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Contamination Assessment Summary
RISE Concept Plan – MP08-0234 application
Bilambil Heights
New South Wales

Prepared for:
Terranora Group Management

April, 2009

Document control

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Title:	**Contamination Assessment Summary** **RISE Concept Plan – MP08-0234 application, Bilambil Heights, New South Wales**	
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Client Reference:		
Synopsis:	This report summarises the previous assessments of the contamination identified onsite associated with historical contaminating activities.	

Revision History

Revision #	Date	Edition By		Approved By	
1	04/09	JJT		LJV	AGG
2					
3					

Distribution

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Darrel Anderson Consulting	1									
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Summary

This summary report describes and summarises the findings of previously completed contamination assessments on lands comprising the MP08-0234 application for the RISE development at Bilambil Heights, New South Wales ('the subject land'). Copies of the previous reports are attached as Appendices.

Between them, the assessments have identified previous uses that have caused contamination, and the areas in which such contamination was identified. Although limited areas of contamination have been identified on the site, the assessments indicate that contaminated areas could be remediated in accordance with an approved Remediation Action Plan (RAP). Subject to validation of the remediation measures, the site would be suitable for the proposed mixed use and residential uses.

Further detailed assessments associated with the former Country Club and outbuildings would be undertaken to facilitate the preparation of a Remediation Action Plan prior to the detailed design phase.

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1) Introduction

Terranora Group Management Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to address the NSW Department of Planning, Director General's Environmental Assessment Requirements (DGR).

The DGR specifically require the '*Environmental Assessment to document the identification, assessment and management of any land contamination to ensure that the land is not allowed to be put to a use that is inappropriate because of the presence of contamination. Under the Contaminated Land Management Act 1997 there is a responsibility to notify the DEC of site that pose a significant risk of harm to human health or the environment.*'

As multiple contamination assessments have been undertaken, a report summarising previous contamination assessments has been herein compiled to address the DGRs as this is considered an appropriate preliminary action for the Concept Plan submission.

The contamination assessments associated with the former Terranora Country Club have identified previous uses that have caused contamination, the areas in which contamination occurred and the concentrations of the associated contaminants.

This summary report is based on a series of contamination assessments previously carried out by WBM Oceanics and Gilbert & Sutherland. Based on these assessments the Tweed Shire Council has issued a Development Consent for the demolition of the Country Club and associated outbuildings to slab level.

The previous assessments include;

- Terranora Country Club – Site Contamination Assessment, 1997 (WBM Oceanics Australia).
- Site Contamination Assessment of the existing 11th, 12th and 18th greens, for the proposed Terranora Resort Project, Bilambil Heights, 2002 (Gilbert & Sutherland).
- Stage1 Preliminary Site Investigation Marana Street, Bilambil Heights, 2005 (Gilbert & Sutherland).
- Stage 2 Site Investigation, Marana Street, Bilambil Heights, 2006 (Gilbert & Sutherland).
- Pre-demolition contamination investigation of the outbuildings on Lot 33 on DP1085109, Marana Street, Bilambil Heights, 2007 (Gilbert & Sutherland).

Tweed Shire Council's Development Consent (DA07/0248) on Lot 33 DP 1085109 is also included as further under slab investigation is required prior to the removal of all sub- structures on site.

2) Site characteristics

2.1 Site description

The RISE site is located in New South Wales just south of the border with Queensland, approximately 10km south-west of Tweed Heads in the township of Bilambil.

The site comprises; Lots 32 & 33 on DP1085109, Lot 31 on DP850230, Lot2 on DP867486 and Lot 4 on DP822786 under the ownership of Terranora Group Management Pty Ltd; Lot 1 on DP1033810, Lot 1 on DP1033811 and Lot 1 on DP595529 owned by Tweed Shire Council; and Crown Road separating Lot 2 on DP867486, Lot 33 on DP1085109 and Lot 2 on DP555026. The location of the site is shown on Drawing No. GJ0495.1.1.

With a total area of approximately 184ha, the site is characterised by undulating land ranging from 3m to 216m Australian Height Datum (AHD).

A number of small dams currently exist on the site and these will be preserved as wetland areas in the development.

2.2 Vegetation

The majority of the proposed development will occur in areas that have been cleared of native vegetation for past agricultural activities and a golf course (which currently occupies the south-eastern portion of the development envelope) as shown on the aerial photograph in Drawing No. GJ0495.1.2.

2.3 Geology

A review of the Geological Survey of Queensland Geology, 1:100,000 series - Murwillumbah indicates that the site is underlain by soils of the Cainozoic period which largely comprise of Lamington Group, basalt flows.

2.4 Soil classification

To characterise the site soils, Gilbert & Sutherland undertook a soil survey including the construction of 10 detailed boreholes to an average depth of 0.6m within the area of the site.

Soil sampling and profile description was undertaken according to the Australian Soil and Land Survey Field Handbook (McDonald et al, 1990) with the soils classified according to the Australian Soil Classification (Revised) (Isbell, 2002).

The soils within the MP08-0234 area were identified predominantly as Ferrosols, with a smaller portion of Kurosols and Dermosols also present.

Ferrosols are described by Isbell (2002) as soils other than Vertosols, Hydrosols and Calcarosols that:

(i) Have B2 horizons in which the major part has a free iron oxide content greater than 5% Fe in the fine earth fraction (<2mm); and

(ii) Do not have clear or abrupt textural B horizons or a B2 horizon in which at least 0.3m has vertic properties.

These soils correspond with the Carool soil landscape described by Morand (1996) and are predominantly associated with dark reddish brown clay loams to light medium clays overlying reddish brown medium clays with moderate structure.

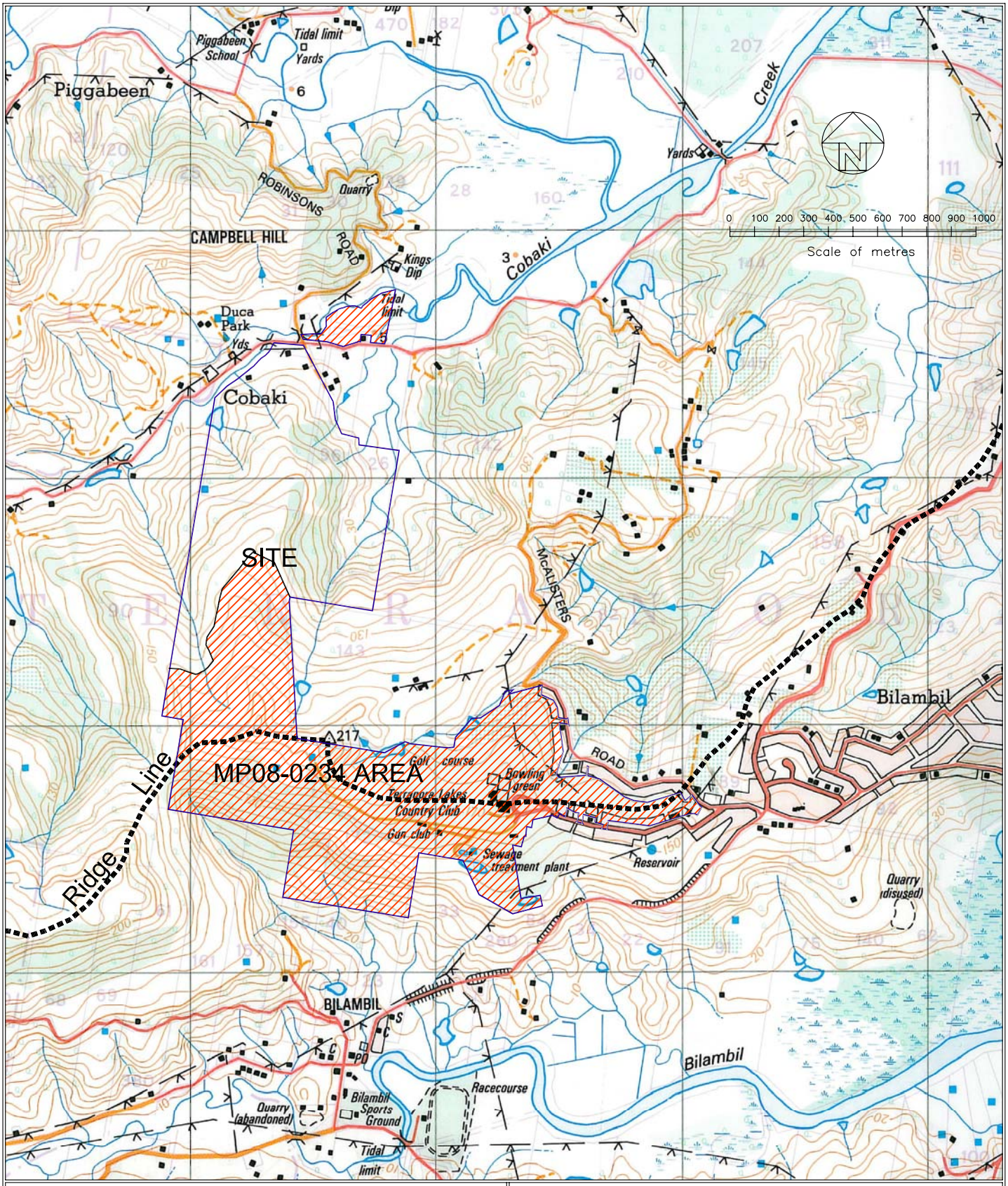
2.5 Acid sulfate soils

A majority of the site is above five (5) metres AHD and it is unlikely acid sulfate soils (ASS) would be encountered above this elevation. However, a small portion of land is below five (5) metres AHD in the northern extent of the site being the proposed Sports Park.

A review of the Bilambil Acid Sulfate Soil Risk Map[1] revealed the subject site is mapped as '*no known occurrence of ASS*'. However, an ASS assessment would be required within the northern extents of the MP08-0234 Area located below five (5) metres AHD (the proposed Sports Park) if disturbance of these soils is to occur.

The Bilambil Acid Sulfate Soil Risk Map with the subject site outlined is attached at the end of this section.

[1] Bilambil Acid Sulfate Soil Risk Map (9541S1) 1997, NSW Dept of Land and Water Conservation, 2nd Edition.



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PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

SITE LOCATION

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No.
		DATE 8/04/09	CHECKED	GJ0495.1.1

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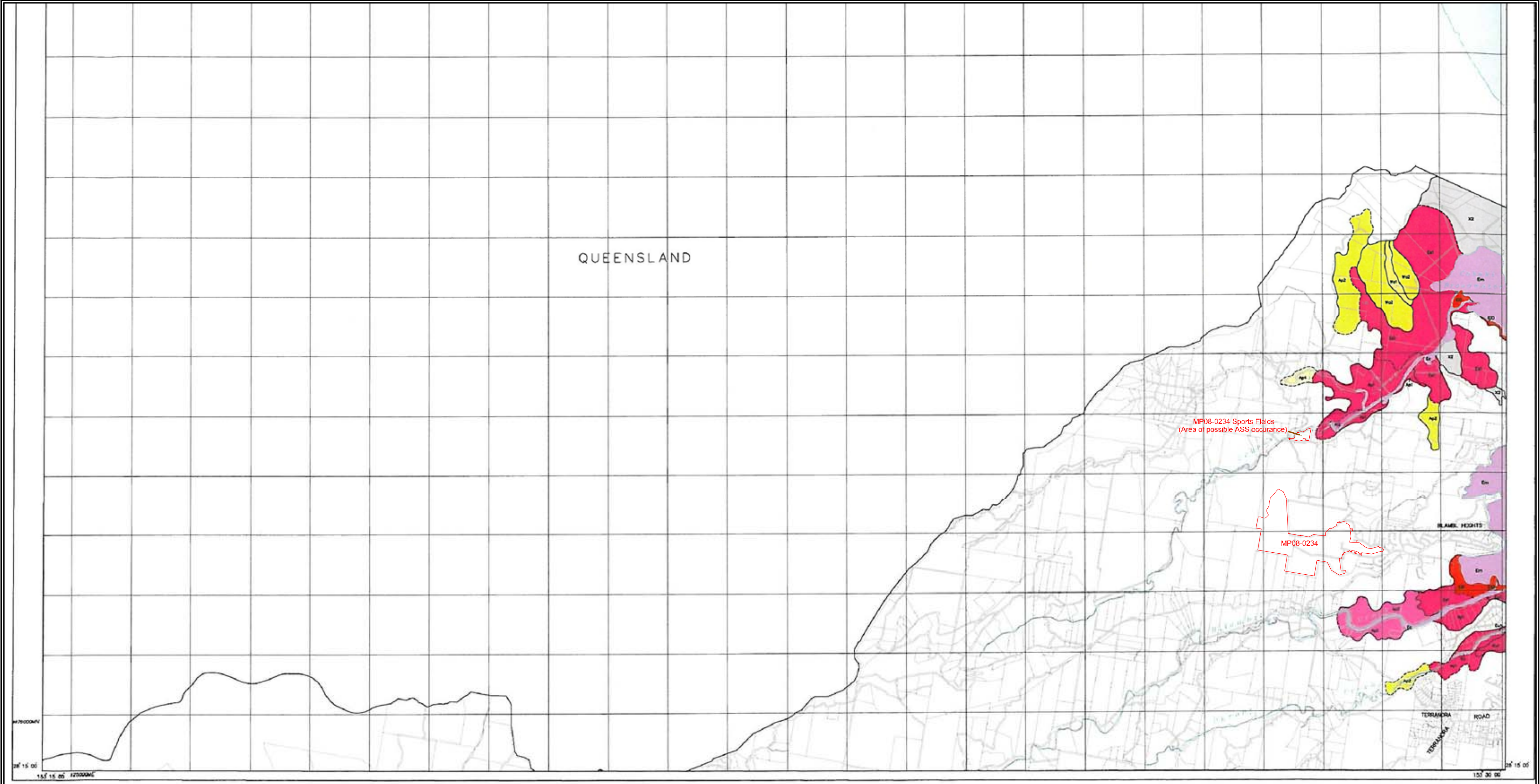
RISE - MP08-0234
BILAMBIL HEIGHTS
EXISTING DEVELOPMENT

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 27/03/09	CHECKED

DRAWING No. GJ0495.1.2



KEY

Map Class Description	Depth to Acid Sulfate Soil Materials		Environmental Risk	Typical Landform Types
HIGH PROBABILITY High probability of occurrence of acid sulfate soil materials within the soil profile. The environment of deposition has been suitable for the formation of acid sulfate soil materials. Acid sulfate soil materials are widespread or sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	Severe environmental risk if bottom sediments are disturbed by activities such as dredging.	Bottom sediments of lakes, lagoons, tidal creeks, rivers and estuaries.
		At or near the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Estuarine swamps, intertidal flats and supratidal flats.
		Within 1 metre of the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Low alluvial plains, estuarine sandplains, estuarine swamps, backswamps and supratidal flats.
		Between 1 and 3 metres below the ground surface.	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavation for pipelines, dams or deep drains.	Alluvial plains, alluvial swamps, alluvial levees and sandplains.
		Greater than 3 metres below the ground surface.*	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavation—e.g. large structure foundations or deep dams.	Elevated levees and sandplains, alluvial plains and alluvial swamps in estuarine reaches of catchments.
LOW PROBABILITY Low probability of occurrence of acid sulfate soil materials within the soil profile. The environment of deposition has generally not been suitable for the formation of acid sulfate soil materials. Soil materials are often Pleistocene in age. Acid sulfate soil materials, if present, are sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	The majority of these landforms are not expected to contain acid sulfate soil materials. Therefore, land management is generally not affected by acid sulfate soils. However, highly localised occurrences may be found, especially near boundaries with environments with a high probability of occurrence. Disturbance of these soil materials will result in an environmental risk that will vary with elevation and depth of disturbance.	Elevated alluvial plains and levees dominated by fluvial sediments. Plains and dunes dominated by aeolian soils. Pleistocene plains. Lacustrine and alluvial bottom sediments.
		At or near the ground surface.		
		Within 1 metre of the ground surface.		
		Between 1 and 3 metres below the ground surface.		
		Greater than 3 metres below the ground surface.*		
NO KNOWN OCCURRENCE Acid sulfate soils are not known or expected to occur in these environments.		No known occurrences of acid sulfate soil materials.	Land management activities not likely to be affected by acid sulfate soil materials.	Bedrock slopes, elevated Pleistocene and Holocene dunes, and elevated alluvial plains.
DISTURBED TERRAIN		Disturbed terrain may include filled areas, which often occur during reclamation of low lying swamps for urban development, or construction of dams or levees. Soil investigations are required to assess these areas for acid sulfate potential. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development.		

*Deep occurrences of acid sulfate soil materials not able to be confirmed by field inspection and sampling.

LAND & WATER CONSERVATION

SCALE 1:25000

TRANSVERSE MERCATOR PROJECTION

LANDFORM CODES

Landform Process Class	Landform Element		Elevation#
[illegible]....Aeolian	b....Backplain	l....Levee Toe	0....0-1 m
A....Alluvial	k....Backswamp	[illegible]....Ox-bow	1....1-2 m
B....Beach	m....Bottom Sediments	p....Plain	2....2-4 m
C....Estuarine	[illegible]....Channel	[illegible]....Sandplain	4....>4 m
L....Lacustrine	d....Dune	[illegible]....Swamp	Additional Descriptive Codes
S....Swamp	r....Interbarrier Swamp	y....Spit	(p)....Pleistocene
	i....Intertidal Flat	[illegible]....Supratidal Flat	(a)....Acidic Scald
	g....Lagoon	[illegible]....Scalds	
X....Disturbed Terrain*	l....Levee	t....Tidal Creek	

*Elevation levels given on the map refer to the elevation of the ground surface at the time of mapping. Depending on the nature of the disturbance, these elevation levels may or may not represent the original ground surface elevation.

#Approximate AHD

LEGEND

LANDFORM BOUNDARY
APPROXIMATE LANDFORM BOUNDARY
SOIL PROFILE DESCRIPTION SITE
RIVER or CREEK
CADASTRE

KEY TO ADJOINING MAPS IN THE SERIES

QUEENSLAND		
	BILAMBIL	TWEED HEADS
	MURWILLUMBAH	CUDGEN

3) Terranora Country Club – Site Contamination Assessment Summary, 1997 (WBM Oceanics Australia)

A site inspection including preliminary soil sampling was conducted by WBM Oceanics Australia on the Terranora Country Club and the adjacent property owned by the Norvill Family.

The complete 1997 Terranora Country Club – Site Contamination Assessment report is attached as Appendix 1. Unfortunately, a diagram showing the locations of sampling was not included or referred to in the WBM Oceanics Australia 1997 report.

The contaminants and areas of the investigation were as follows;

- Heavy metals associated with the holding pond area for biosolids (sludge) from the Terranora Country Club sewerage treatment plant (STP).
- Heavy metals associated with the area of the former gun club.
- Pesticides associated with golf course greens.
- Pesticides associated with the adjacent Norville property.

3.1 STP sampling and results summary

Seven (7) samples were collected from approximately 0.5m from the edge of the pond and analysed by a NATA accredited Laboratory for a range of metals associated with cleaning products used in bathrooms and lavatories including;

- Arsenic,
- Cadmium,
- Chromium,
- Copper,
- Lead,
- Nickel,
- Mercury, and
- Zinc.

Laboratory analysis identified elevated concentrations of copper (89 to 352 mg/kg) and zinc (139 to 470mg/kg) above the typical background concentrations for copper (2-100mg/kg) and zinc levels (10-300mg/kg) found in Australian soils (EILs).[2]

The Health Investigation Levels (HILs)[2] for standard residential garden with accessible soil have been set at concentrations of copper (1,000 mg/kg) and zinc (7,000mg/kg). The concentrations of copper and zinc associated with the STP comply with the HILs standard residential exposure setting.[1]

3.2 The former gun club sampling and results summary

Ten (10) soil samples were collected from various soil types and locations around the gun club site. Three (3) of the ten samples were collected to represent background heavy metal concentrations of the site's soil. All ten samples were analysed by a NATA accredited Laboratory for a range of metals associated with the operation of a gun club including;

- Arsenic,
- Cadmium,
- Chromium,
- Copper,
- Lead,
- Nickel,
- Zinc
- Mercury, and
- Antimony.

Laboratory analysis identified elevated concentrations of copper (7 to 133 mg/kg), mercury (0.1 to 2.8mg/kg) and zinc (51 to 357mg/kg) above the typical background concentrations for copper (2-100mg/kg) mercury (<0.03) and zinc levels (10-300mg/kg) found in Australian soils.[2]

The Health Investigation Levels (HILs) for standard residential garden with accessible soil have been set at concentrations of copper (1,000 mg/kg), mercury (15mg/kg) and zinc (7,000mg/kg). The concentrations of copper, mercury and zinc associated with the former gun club site comply with the HILs standard residential exposure setting.[2]

[2] *Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater.* 1999, National Environment Protection Measure (NEPM).

3.3 Norville property sampling and results summary

Seven (7) composite samples were collected from five (5) agricultural terrace levels and analysed by a NATA accredited Laboratory for organochlorine (OC) pesticides and organophosphorus (OP) pesticides associated with crop spraying. The laboratory analysis indentified pesticide concentrations below both the EILs and HILs.

3.4 Golf course greens sampling and results summary

Surface samples (0-0.15m below NSL) were collected at three (3) random locations on each of the 18 golf course greens. The three (3) samples from each green were combined to form a composite sample representing each green. The 18 composite samples were analysed by a NATA accredited Laboratory for OC and OP pesticides associated with pest control on the greens.

As composite samples were analysed, the HIL is divided by the number of composite samples. In this case, three (3) composite samples were analysed, reducing the HIL by one third.

The laboratory analysis identified elevated levels of Dieldrin above the EILs for composite samples taken from the following golf course greens;

- 11th green (0.49mg/kg)
- 12th green (7.98mg/kg),
- 14th green (10.4mg/kg),
- 15th green (11mg/kg),
- 16th green (2.96mg/kg),
- 17th green (1.36mg/kg), and
- 18th green (1.65mg/kg).

As such further investigation is required to determine the spatial extent of the contamination associated with the OC pesticides applied to the golf course greens.

The HILs presented in the NEPM Guidelines state that the levels of Aldrin and Dieldrin for a composite of three (3) samples should not exceed 3.33mg/kg. As the Dieldrin concentrations exceeded the NEPM HILs guidelines within the greens on the 12th, 14th and 15th holes, remediation of this soil is required. The 16th green OC pesticide concentration (2.96mg/kg) is considered to be marginally elevated due to the composite sampling technique used and would be deemed subject to further investigation.

Figure GJ0495.4.3 shows the indicative locations subject to this contamination investigation

Norville Property

Former gun club location

Sewerage treatment plant

MP08-0234 Area

Numbered golf green

0 20 40 60 80 100 120 140 160 180 200

Scale of metres

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PROJECT

TERRANORA GROUP MANAGEMENT

RISE DEVELOPMENT MP08-0234

INDICATIVE INVESTIGATION LOCATIONS

Source: Google Earth, 2004

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T.	DRAWING No. GJ0495.4.3
		DATE 09/04/09	CHECKED	

4) Summary of Site Contamination Assessment of the existing 11th, 12th and 18th greens, for the proposed Terranora Resort Project, Bilambil Heights, 2002 (Gilbert & Sutherland)

A site inspection including soil sampling was conducted by Gilbert & Sutherland on the Terranora Country Club golf course greens for the 11th, 12th and 18th holes.

This assessment was conducted as a consequence of WBM Oceanics findings of elevated levels of Dieldrin during the previous 1997 investigation Terranora Country Club – Site Contamination Assessment Report.

The complete 2002 Site Contamination Assessment of the existing 11th, 12th and 18th greens, for the proposed Terranora Resort Project, Bilambil Heights report is attached as Appendix 2.

Surface samples were collected at three (3) locations on the 11th, 12th and 18th golf greens. The three (3) samples from each green were combined to form a composite sample representing each green. The three (3) composite samples were analysed by a NATA accredited Laboratory for organochlorine (OC), organophosphorus (OP) pesticide associated with pest control on the greens.

The laboratory results indicated the concentrations of OC and OP pesticide within the composite samples collected from the three (3) golf course greens were below the limit of reporting (LOR), with the exception of Dieldrin concentrations.

As composite samples were analysed, the HIL is divided by the number of composite samples. In this case, three (3) composite samples were analysed, reducing the EILs and HILs by one third.

The HILs presented in the NEPM Guidelines state that the combined levels of Aldrin and Dieldrin should not exceed 3.33mg/kg. the Dieldrin + Aldrin concentrations were below the NEPM HILs guidelines for composite sampling.

Figure GJ0495.4.4 shows the indicative locations subject to this contamination investigation

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PROJECT

TERRANORA GROUP MANAGEMENT

RISE DEVELOPMENT MP08-0234

INDICATIVE INVESTIGATION LOCATIONS

Source: Google Earth, 2004

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T.
		DATE 09/04/09	CHECKED

DRAWING No. GJ0495.4.4

5) Summary of Stage1 Preliminary Site Investigation and Stage 2 Site Investigation, Marana Street, Bilambil Heights, 2005 – 2006 (Gilbert & Sutherland)

A Stage 1 Preliminary Site Investigation was undertaken by Gilbert & Sutherland within Lot 32 on DP 1085109, Marana Street, Bilambil Heights in August 2005, which identified historical use of the site which had the potential to contaminate the site. A copy of this report is attached as Appendix 3.

A site history was obtained through interviews with people who had been living in the area for up to 50 years. The following information was acquired.

The Preliminary Site Investigation for this site reported an interview with Mr Bill Clarke. Mr Clarke's association with the site commenced in 1982 and he was at the time employed as a greenkeeper at the Resort. A summary of this interview is as follows:

- The golf course was developed approximately 45 years ago.
- The site was previously a dairy farm.
- Chemicals possibly used 20 years ago included Dieldrin, chlorpyrifos, and various fungicides.
- Imported sand from Redlands Shire, Kingscliff and Tumbulgum was used for bunker and drainage development.
- A stockpile of rocks, thought to have accumulated during fairway development was present when Mr Clarke commenced employment.

A further interview was held with Mr Albert Garbell as part of the Stage 2 Site Investigation. Mr Garbell had lived in the area for about 50 years. The following is a summary of Mr Garbell's knowledge of the site:

- The site was a dairy farm prior to being developed as a golf resort,
- No dipping or milking areas existed on the site,
- No cropping took place on the site.

As the Site history confirmed potentially contaminating activities on site, additional soil sampling was required to determine the extent of the contamination in reference to the site's intended (residential) use. As such a Stage 2 site investigation was undertaken by Gilbert & Sutherland in September 2005 to further investigate the possible contaminating activities on site. The Stage 2 Site Investigation is attached as Appendix 4.

The sampling regime included three (3) soil samples were retrieved to determine the type, distribution and concentration of potential contaminants in the soil on three (3) golf greens (14th, 15th and 16th holes). An additional six (6) soil samples were retrieved from areas subject to potentially contaminating activities on the site. These areas include;

- Two (2) samples were taken from the north-western portion of the site in the shallow natural gully, where surface waters would be expected to drain.
- Two (2) samples were retrieved from the far eastern portion of the site on the north-eastern facing slope, which is adjacent to significant areas of cropping.
- Two (2) samples were taken from the stockpile of rock (miscellaneous waste) in the northern portion of the site.

All soil samples were analysed for lead, arsenic, organochlorine (OC) and organophosphorus (OP) pesticides by a NATA accredited laboratory.

Laboratory results identified elevated combined Aldrin + Dieldrin concentrations of 8.76mg/kg (15th green). Although none of these samples exceed the HILs (10mg/kg), Dieldrin & Aldrin levels were at elevated concentrations in reference to the EILs.

Figure GJ0495.4.5 shows the indicative locations subject to this contamination investigation

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RISE DEVELOPMENT MP08-0234

INDICATIVE INVESTIGATION LOCATIONS

Source: Google Earth, 2004

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T.	DRAWING No.
		DATE 09/04/09	CHECKED	GJ0495.4.5

6) Summary of Pre-demolition Contamination Investigation of the Outbuildings on Lot 33 on DP1085109, Marana Street, Bilambil Heights, 2007 (Gilbert & Sutherland)

Gilbert & Sutherland (G&S) was engaged to undertake a pre-demolition contamination investigation to assess the contamination status of the outbuildings on Lot 33 on DP1085109, Marana Street, Bilambil Heights. This pre-demolition letter report is attached as Appendix 5.

In an information request (May 3, 2007), from Tweed Council requested that information be provided on the potential for soil contamination associated with the former use of a number of 'outbuildings' including a transformer building, pool shed and a golf buggy shed. Gilbert & Sutherland has requested (January 10, 2007) that the investigation of the transformer house (which is still active) be deferred until the transformer station is decommissioned and partial demolition of the country club superstructure is completed to which the council agreed.

This investigation was therefore limited to the fully detached buildings surrounding the former country club, which included the Golf buggy shed, Pool filter shed & Irrigation shed.

During a site inspection on May 3, 2007, G&S staff identified that the subject outbuildings were 'colourbond' or block structures founded on concrete slabs. It was therefore considered that the Tweed Shire Council's pre-demolition testing guidelines (for OC pesticides) would not be applicable and the investigation was therefore limited to sampling around the perimeter of the slabs for contaminants potentially associated with the former use of each of the outbuildings.

The laboratory results indicated that levels of heavy metals, hydrocarbons, BTEX and OC/OP pesticides around these buildings do not exceed the adopted NEPM investigation levels for Class A 'Standard' residential development[3] with the exception of sample BH7 0.0-0.2 (dieldrin concentration of 30mg/kg) located on the western side of the pool filter shed.

The report recommended that sub-slab investigations for OC/OP pesticides be undertaken on each of the outbuildings prior to the removal of the slabs, simultaneously with the investigation of the country club building proper.

Following the completion of the sub-slab investigations which would delineate the extent of any contamination on the site, a Remediation Action Plan (RAP) will be prepared describing the remediation methodology and validation sampling requirements for any contamination identified, in addition to the already identified contamination adjacent to the pool shed.

Figure GJ0495.4.6 shows the indicative locations subject to this contamination investigation

[3] NEPM Guidelines - A 'Standard' residential area is defined as a residential area with gardens/accessible soil, no poultry, where home-grown produce contributes less than 10% of total household fruit and vegetable intake. This category includes children's day-care centres, preschools and primary schools.

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PROJECT

TERRANORA GROUP MANAGEMENT
RISE DEVELOPMENT MP08-0234
LOCATION OF OUTBUILDINGS

Source: Google Earth, 2007

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T
		DATE 14.02.08	CHECKED

DRAWING No. GJ0495.4.6

7) Summary of Tweed Shire Council Development Consent (DA07/0248) Lot 33 DP 1085109, May 2008

Terranora Group Management Pty Ltd was granted consent by Tweed Council to demolish the country club and outbuildings, including the golf buggy shed, irrigation shed, pool filter shed and transformer building. Prior to the removal of the concrete slabs and sub-structures beneath these buildings, testing beneath each concrete slab shall be carried out on the Country Club and associated outbuildings, in accordance with the provisions of the Council's Pre-demolition Testing Guidelines.

A Remediation Action Plan (RAP) shall be prepared and submitted to the satisfaction of the Council's General Manager if considered necessary by the Council's Environmental Health Officer based upon the results of the pre-demolition testing. The RAP shall be submitted for approval prior to the removal of any of the concrete slabs.

Tweed Shire Council's Development Consent is attached as Appendix 6.

8) Conclusions

8.1 Terranora Country Club – Site Contamination Assessment, 1997

The 1997 WBM Oceanics assessment identified four potentially contaminated locations on the site. These were:

- Golf course greens
- STP biosolids disposal area
- Former gun club
- Former Norville property.

The results of analytical testing identified elevated OC pesticide levels exceeding the HILs on a number of golf course greens. As the Dieldrin + Aldrin concentrations exceeded the NEPM HILs guidelines (3.33mg/kg) within the greens on the 12th (7.98mg/kg) 14th (10.4mg/kg) and 15th (11mg/kg) and 16th (2.96mg/kg) holes during the 1997 investigation, remediation of this soil would be required to allow its use in a standard residential setting.

The biosolids sampling associated with the STP identified copper (89 to 352 mg/kg) and zinc (139 to 470mg/kg) concentrations elevated above the EILs. However, these concentrations comply with the HILs for a standard residential setting.

The gun club area showed no elevated concentrations of lead, but exhibited levels of copper (7 to 133 mg/kg), mercury (0.1 to 2.8mg/kg) and zinc (51 to 357mg/kg) above the typical environmental background concentrations. The Norvill property investigation identified some residue of OCP, however these concentrations were below the HILs and the site would be suitable for the proposed future development.

8.2 Site Contamination Assessment, existing 11th, 12th and 18th greens

This assessment was conducted as a consequence of WBM Oceanics findings of elevated levels of Dieldrin during the 1997 investigation Terranora Country Club – Site Contamination Assessment Report.

The laboratory results indicated concentrations of OC and OP pesticides were below the HILs within the composite samples collected from the three (3) golf course greens.

8.3 Stage1 Preliminary and Stage 2 Site Investigation Marana Street, Bilambil Heights, 2005

The Preliminary Site Investigation confirmed activities with the potential to contaminate were likely to have taken place across the site. The following sampling was conducted for the Stage 2 site investigation:

- Two (2) samples were taken from the north western portion of the site in the shallow natural gully, where surface waters would be expected to drain.
- Two (2) samples were retrieved from the far eastern portion of the site on the north-eastern facing slope, which is adjacent to significant former areas of cropping.
- Two (2) samples were taken from the stockpile of rock (miscellaneous waste) in the northern portion of the site.

All of these samples complied the HIL (10mg/kg); however Dieldrin and Aldrin levels were elevated in reference to the EILs.

8.4 Pre-demolition contamination investigation of the outbuildings

This investigation was limited to the fully detached buildings surrounding the former Country Club. The laboratory results indicate that levels of heavy metals, hydrocarbons, BTEX and OC/OP pesticides adjacent to the investigated buildings do not exceed the adopted NEPM investigation levels with the exception of sample BH7 0.0-0.2 (Dieldrin concentration of 30mg/kg) located on the western side of the pool filter shed. As such, it is considered prudent to undertake sub-slab investigations for OC/OP pesticides on each of the outbuildings prior to the removal of the slabs.

8.5 Tweed Shire Council Development Consent

Terranora Group Management Pty Ltd was granted conditional consent to demolish the super structures of the country club and outbuildings (golf buggy shed, irrigation shed, pool filter shed and transformer building) and prior to the removal of the concrete slabs beneath these buildings, a Remediation Action Plan (RAP) shall be prepared, submitted and approved, if

required, based on the results of the sub slab investigation.

Subject to additional investigations in relation to the 12th, 14th,15th and 16th golf greens and validation of any necessary remediation measures, the site would be suitable for the proposed residential uses in accordance with the provisions of Clause 6 of State Environmental Planning Policy No. 55 – Remediation of Land.

9) Recommendations

9.1 Site Contamination

Elevated OC pesticide levels exceeding 3.33mg/kg on the 12th, 14th, 15th and 16th (marginal concentration of 2.96mg/kg) golf course greens were identified from 0-150mm below the surface in 1997. A further topsoil investigation conducted in 2005 found the concentrations of OC pesticides were below the HILs on the 11th, 12th and 18th golf greens.

Due to the variability of the OC pesticides concentrations in the greens and the sandy material used to construct the greens, we recommend an additional investigation be conducted to determine the spatial extent of OC pesticides within the golf greens as each Development Application is prepared for each Precinct or part Precinct of the Rise project.

The biosolid sampling in 1997 revealed the material associated with the STP complied with the HILs for a suite of metals.

However, it is understood the biosolids pond(s) shall be retained and remediated for stormwater treatment and retention. If biosolids were to be removed and placed elsewhere on site, lab analysis of the material for bacterial antigens, including a written safe work method statement (SWMS) would be prudent to protect persons handling the material. This detail can be resolved during the Works Application process for the relevant Rise Precinct.

An investigation of the outbuildings associated with the Country Club identified Dieldrin concentration of 30mg/kg located on the western side of the pool filter shed. As such, testing for OC pesticides beneath each concrete slab shall be carried out on the Country club and associated outbuildings in accordance with the provisions of the Council's Pre-demolition Testing Guidelines as the demolition works proceed.

Following the reporting of the sub slab investigations, a Remediation Action Plan (RAP) shall be prepared and submitted for approval prior to the commencement of any demolition of the slabs or sub-structures on site.

Subject to the remediation measures being validated as successful in the applicable contamination hot spots, the site would be suitable for the proposed residential uses.

9.2 Acid Sulfate Soils

A majority of the site is above five (5) metres AHD and it is unlikely acid sulfate soils (ASS) would be encountered above this elevation. However, a small portion of land is below five (5) metres AHD in the northern extent of the site (the proposed Sports Park).

A review of the Bilambil Acid Sulfate Soil Risk Map[4] revealed the subject site is mapped as '*no known occurrence of ASS*'. However, an ASS assessment would be required within the northern extents of the MP08-0234 Area located below five (5) metres AHD (the proposed Sports Park) if disturbance of these soils is to occur.

[4] Bilambil Acid Sulfate Soil Risk Map (9541S1) 1997, NSW Dept of Land and Water Conservation, 2nd Edition.

10) Appendix 1 – Terranora Country Club – Site Contamination Assessment, 1997

TERRANORA COUNTRY CLUB - SITE CONTAMINATION ASSESSMENT

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Project Manager:	Tony McAlister

Title:	Terranora Country Club - Site Contamination Assessment
Author:	Jenny Pocock
Client:	William Job Architect
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Synopsis:

A soil contamination sampling exercise was undertaken for the Terranora Country Club, involving sampling of the golf course greens, the biosolids from the sewage treatment plant holding pond, the former gun club in the Terranora Country Club and also soil sampling on an adjacent property, owned by the Norville family.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY		ISSUED BY	
0	24/3/97	A. McAlister		J Pocock	

DISTRIBUTION

DESTINATION	0	1	2	3	4	5	6	7	8	9
William Job Architect	1									
Terranora Country Club	1									
WBM Library	1									

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1 INTRODUCTION

WBM Oceanics Australia were commissioned by William Job Architect to perform some soil sampling on the Terranora Country Club property and on the adjacent property, owned by the Norville family. The Tweed Shire Council raised soil contamination concerns with respect to the proposed future urban development within and around the Terranora Country Club. In particular Council were concerned with possible heavy metal contamination of soils in some sections of the Terranora Country Club property, particularly in the holding pond area for biosolids (sludge) from the sewage treatment plant and in the area of the former gun club. Council also raised the issue of possible pesticide contamination in the soils of golf course greens and on a terraced area of the adjacent Norville property. These two areas were the only areas within the proposed development area to have had known pesticide application.

WBM Oceanics Australia sampled the four areas of concern, basing the sampling strategy on the EPA Sampling Design Guidelines for Contaminated Sites (EPA, 1995). Samples were analysed by a NATA certified laboratory, and results were interpreted using methods outlined in the EPA Guidelines (1995). This report details the sampling performed, the laboratory results and the interpretation of these results.

2 SAMPLING PERFORMED

The site inspection (including soil sampling) of the Terranora Country Club was performed on 19th February, 1997 by a WBM Oceanics Australia Environmental Engineer. Soil samples were collected from the golf course greens and the former gun club site. Biosolids (sludge) samples from the sewage treatment plant were also collected from a holding pond adjacent to the sewage treatment plant. The Norville property was also inspected by a WBM Oceanics Australia Environmental Engineer (including soil sampling) on 26th February, 1997. Each sampling strategy is discussed separately below.

2.1 Golf Course Greens Sampling

A representative from the Terranora Country Club had previously detailed their knowledge of previous pesticide usage within the golf course and the types of pesticides used. This information was passed to WBM Oceanics Australia to assist in the development of a suitable sampling strategy. This information indicated that pesticides were only applied to golf course greens, to the best of the present Terranora Country Club's personnel's knowledge. Therefore the golf course greens were the only areas within the Terranora Country Club which were tested for a range of organochlorine and organophosphorus pesticides.

Most organochlorine pesticides (historically used until the 1980's) are highly toxic to both insects and mammals and do not readily biodegrade. Therefore, residual levels of organochlorine pesticides in soils can be very persistent. The information provided by the Terranora Country Club indicated that the last application of pesticides was in 1996. Therefore, the analysis of organophosphorus pesticides (principally used since the 1980's) was also undertaken.

Surface samples (to a depth of 100 to 150mm) were collected at three random locations on each of the 18 golf course greens. The laboratory was instructed to composite these three sub-samples and test only the composite samples for organochlorine and organophosphorus pesticides. The compositing of the samples still allowed gross soil contamination to be detected, with some cost savings for analysis. The EPA Guidelines (EPA, 1995) describe various conditions to consider when compositing samples, which were adhered to in this sampling exercise.

Results of this sampling exercise are outlined in Table 3.1.

2.2 Biosolids Sampling

The Terranora Country Club has a sewage treatment plant which presently treats effluent from the Club and some minor accommodation areas. Some of the raw effluent from the Club may contain some levels of heavy metals, due to the use of cleaning products etc. and the low loading of common domestic wastewater.

The biosolids from the sewage treatment plant holding pond was sampled by means of a long handled trowel. Seven samples from the settled biosolids were taken from approximately 0.5m from the edge of the pond. The samples were each analysed by a NATA certified laboratory for a range of metals, including arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc.

Results of this sampling exercise are outlined in Table 3.2.

2.3 Gun Club Sampling

An area within the Terranora Country Club was previously used by a gun club for many years. The gun club is no longer active although some of the shooting facilities are still present on the site.

It is understood that the gun club was used for "skeet shooting", where a clay disc is fired and shooters must hit the disc whilst it is in flight in the area delineated by two long poles. If the shot is successful, then the shooter moves back a designated distance (along a concrete firing path), until the shooter cannot hit the clay disc. Skeet shooting involves the use of a shotgun using ammunition consisting of a brass/plastic cartridge filled with fine lead shot. The lead shot typically used is 1-2mm diameter and the lead projectiles are often hardened with antimony or arsenic. Therefore, the potential contaminants from the former gun club are heavy metals, including lead, copper, antimony and arsenic.

There were two general firing areas, each with about six or seven firing paths, with the paths radiating out from a central mound. The facilities still present on the site include the two concrete firing areas, the long poles used to designate the shooting area, a club house, and two bunkers which contained the firing arm for the clay discs.

Tweed Shire Council raised the potential issue of heavy metal contamination of the soil resulting from spent shot arising from the gun club activities. As a result, the area was searched with a metal detector, to locate possible bullet remnants, either live ammunition, used cartridges or lead shot. From conversations with the greenkeeping staff, it is understood that all ammunition was removed from the firing areas by raking the ground around the concrete firing mounds.

Very few used shotgun cartridges could be located by the metal detector (which has an effective search depth of 60cm soil) in the vicinity of the firing mound and paths. Only one spent cartridge was found in both areas, one lying on the surface of the grassed areas between the concrete firing paths, and the other partially buried. Soil samples were taken from both the areas where the spent cartridges were found (Samples 3 and 6).

A third spent cartridge was found approximately 50m from the firing paths, buried about 20cm below the soil surface. A soil sample was also collected from this area (Sample 2).

A metal detector search of the target areas, between the firing paths and the poles was performed. The area adjacent to the poles was steep and had very long grass. This made the searching difficult, as the metal detector needs to be moving to detect metals (by detecting the

difference in the electromagnetic forces. However, the long grass made searching difficult, as the detector could not be "swept" effectively at ground level as the thick grass would "jar" the detector. Raising the detector out of the dense grass at ground level reduced the effective search depth and sensitivity to metal deposits considerably.

The metal detector search did appear to pick up some metallic objects in the target area, however digging to about 30cm did not reveal any sizeable metallic objects. The metallic signal may have been due to combined fragments of buried lead shot. However, the shot size may have been sufficiently small such that the detector was only capable of detecting larger clusters of the shot. Digging clumps of soil and passing the metal detector over the removed soil may have split the clusters of lead shot to a size below the metal detector's capability.

Several soil samples were collected from these areas where positive readings on the detector were observed (Samples 1, 5, 7 and 10).

Three samples were collected from various soil types and locations around the gun club site to illustrate background metal concentrations (Samples 4, 8 and 9).

Results of this sampling exercise are outlined in Table 3.3.

2.4 Norville Property Sampling

The Norville family own the property adjacent to the Terranora Country Club and the family indicated to the Terranora Country Club that pesticides may have been used on a terraced section of the property, where intensive agriculture was once present.

The terraced area of the Norville property consisted of 5 agricultural terrace levels, separated by large stones. The general area consisted of a spur ridge running from the top of a hill (the highest point on the Norville property) with an almost peninsular shape, with steeper drop-offs surrounding the area on three sides.

Not all the terraces were equal in size, with the third terrace from the bottom in particular being narrower.

Seven samples (A-G) were collected from each terrace (1-5), except the third terrace and the hill top area above the terraces. Four and three samples were collected from these areas respectively.

The laboratory was instructed to composite some of the sample, such that gross contamination could still be detected, but allowing some analytical cost savings to be made.

Results of this sampling exercise are outlined in Table 3.4.

3 SAMPLING RESULTS

All sample results are outlined below in Tables 3.1 to 3.4. Each table includes ANZECC Guidelines criteria (ANZECC, 1992) and where appropriate, Dutch criteria for pesticides also. The EPA Guidelines for the Sampling of Contaminated Sites (1995) refers to the ANZECC criteria for definition of contamination. Values which exceed these criteria are shaded for easy identification.

3.1 Golf Course Greens Results

The organochlorine pesticides and pesticide derivatives tested by the laboratory included a-BHC, b- & g-BHC, d-BHC, HCB, Heptachlor, Aldrin, Heptachlor epoxide, Chlordane - trans, Chlordane - cis, Endosulfan 1, Endosulfan 2, Endosulfan sulphate, Dieldrin, Endrin, Endrin aldehyde, Endrin ketone, DDT, DDE, DDD and Methoxychlor. The organophosphorus pesticides and pesticide derivatives tested by the laboratory included Dichlorvos, Demeton-S-methyl, Monocroptophos, Dimthoate, Diazinon, Chlorpyrifos-methyl, Parathion-methyl, Malathion, Fenthion, Chloripyrifos, Parathion, Pirimphos-ethyl, Fenamiphos, Prothiofos, Ethion and Azinphos-methyl.

Only samples which showed detectable pesticide levels are outlined in Table 3.1, as the majority of results are below the detection limit. Dutch criteria have also been included, as these criteria are widely accepted and applied in Australia, as the ANZECC Guidelines (1992) have only limited pesticide criteria.

Table 3.1 Golf Course Greens - Sampling Results (mg/kg)

Green (composite samples)	DDE organochlorine pesticide	Chlorpyrifos organophosphorus pesticide	Dieldrin and Dieldrin derivatives organochlorine pesticide		
			Dieldrin	Endrin	Endrin Ketone
11	<0.05	<0.05	0.49	<0.05	<0.05
12	0.11	<0.05	7.98	0.06	<0.05
14	0.05	<0.05	10.4	<0.05	<0.05
15	0.15	0.14	11.0	0.07	0.05
16	<0.05	<0.05	2.96	<0.05	<0.05
17	<0.05	<0.05	1.36	<0.05	<0.05
18	<0.05	<0.05	1.65	<0.05	<0.05
ANZECC CRITERIA					
HEALTH	< 1.0 mg/kg	-	< 10 mg/kg *		
DUTCH CRITERIA - INDIVIDUAL ORGANOCHLORINE PESTICIDES					
A - Clean Below	< 0.1 mg/kg				
B - Further Investigation	> 0.5 mg/kg				
C - Remove Soil	> 5.0 mg/kg				

* - ANZECC guideline is a total for Dieldrin, Dieldrin derivatives and Aldrin.

3.2 Biosolids Results

Sampling results from the sewage treatment plant's biosolids sampling exercise are outlined in Table 3.2 below. Background metal levels typically found in Australian soils (as outlined in ANZECC, 1992) are also included in Table 3.2.

Table 3.2 Biosolids - Sampling Results (mg/kg)

Site	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
1	2	<1	27	89	4	0.1	36	139
2	3	<2	30	256	18	0.3	25	206
3	<2	<2	36	248	9	0.4	38	421
4	<2	<2	36	220	16	0.3	34	272
5	<2	<2	31	130	5	0.2	34	207
6	<2	<2	34	285	20	0.4	28	470
7	<2	<2	29	352	13	0.4	34	354
ANZECC CRITERIA								
ENV.	20	20	50	60	300	1.0	60	200
HEALTH	100	20	-	-	300	-	-	-
B'Ground	0.2 - 30	0.04 - 2	0.5 - 110	1 - 190	<2 - 200	0.001 - 0.1	2 - 400	2 - 180

3.3 Gun Club Results

Sampling results from the gun club sampling exercise are outlined in Table 3.3 below. Background metal levels typically found in Australian soils (as outlined in ANZECC, 1992) are also included in Table 3.3.

Table 3.3 Gun Club - Sampling Results (mg/kg)

Site	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Antimony
1	7	<1	39	9	13	0.1	20	62	<1
2	3	<1	26	8	1	2.8	12	57	<1
3	3	<1	43	40	15	0.2	18	212	<1
4	1	<1	19	7	4		9	51	<1
5	6	<1	33	15	6	0.1	22	120	<1
6	<1	<1	40	133	14	0.2	24	357	<1
7	11	<1	34	15	6	0.2	21	92	<1
8	<1	<1	38	15	3	0.2	27	92	<1
9	3	<1	37	17	2	0.2	26	89	<1
10	9	<1	36	16	5	0.2	27	98	<1
ANZECC CRITERIA									
ENV.	20	20	50	60	300	1.0	60	200	20
HEALTH	100	20	-	-	300	-	-	-	-
B'Ground	0.2 - 30	0.04 - 2	0.5 - 110	1 - 190	<2 - 200	0.001 - 0.1	2 - 400	2 - 180	4 - 44

3.4 Norville Property Results

Sampling results from the Norville property are outlined in Table 3.4 below.

The organochlorine pesticides and pesticide derivatives tested by the laboratory included a-BHC, b- & g-BHC, d-BHC, HCB, Heptachlor, Aldrin, Heptachlor epoxide, Chlordane - trans, Chlordane - cis, Endosulfan 1, Endosulfan 2, Endosulfan sulphate, Dieldrin, Endrin, Endrin aldehyde, Endrin ketone, DDT, DDE, DDD and Methoxychlor. The organophosphorus pesticides and pesticide derivatives tested by the laboratory included Dichlorvos, Demeton-S-methyl, Monocroptophos, Dimthoate, Diazinon, Chlorpyrifos-methyl, Parathion-methyl, Malathion, Fenthion, Chloripyrifos, Parathion, Pirimphos-ethyl, Fenamiphos, Prothiofos, Ethion and Azinphos-methyl.

Only samples which showed detectable pesticide levels are outlined in Table 3.4, as the majority of results are below the detection limit. Dutch criteria have also been included, as these criteria are widely accepted and applied in Australia, as the ANZECC Guidelines (1992) have only limited pesticide criteria.

Table 3.4 Norville Property - Sampling Results (mg/kg)

Sites (composite samples indicated)	DDE organochlorine pesticide	Dieldrin and Dieldrin derivatives organochlorine pesticide		
		Dieldrin	Endrin	Endrin Ketone
N1A	0.05	<0.05	<0.05	<0.05
N1B, N1C, N1D	0.13	<0.05	<0.05	<0.05
N1E, N1F, N1G	0.28	<0.05	<0.05	<0.05
N2A, N2B, N2C	0.16	<0.05	<0.05	<0.05
N2F, N2G	0.05	<0.05	<0.05	<0.05
N3C, N3D	0.09	<0.05	<0.05	<0.05
N4E, N3F	<0.05	0.13	<0.05	<0.05
ANZECC CRITERIA				
HEALTH	< 1.0 mg/kg	< 10 mg/kg *		
DUTCH CRITERIA - INDIVIDUAL ORGANOCHLORINE PESTICIDES				
A - Clean Below	< 0.1 mg/kg			
B - Further Investigation	> 0.5 mg/kg			
C - Remove Soil	> 5.0 mg/kg			

* - ANZECC guideline is a total for Dieldrin, Dieldrin derivatives and Aldrin.

4 DISCUSSION OF RESULTS

4.1 EPA Guideline Calculations

The EPA Guidelines (EPA, 1995) for contaminated sites outlines statistical analysis methods for interpreting contaminated site soil sampling results. These calculations assist in determining whether or not the acceptable criteria have been met. These calculations include determination of the critical size of "hot spots" on the site and the upper confidence limit (UCL) of the arithmetic average concentration of the contaminants. Each of these methods are discussed separately below.

4.1.1 Critical Size of Hot Spots

If all sampling results are below the acceptable criteria (ANZECC or Dutch criteria in this report), then this "hot spot" determination can be performed. A "hot spot" is a localised area where the level of contamination is noticeably greater than that in surrounding areas.

Therefore, the calculation shows the sampling area is free of "hot spots" larger than this critical size, within a defined confidence limit. For this report we have chosen a 95% confidence level, ie there is a 5% chance that a "hot spot" greater than the critical level determined exists on the site. In each case, the size of a circular hot spot was determined.

The calculation for determining the critical size of potential "hot spots" is only based on the distance between sampling points. This methodology is outlined in Procedure F of the EPA Guidelines (EPA, 1995).

4.1.2 Upper Confidence Limit of the Arithmetic Average Concentration

The upper confidence limit (UCL) of the arithmetic average concentration calculation is a statistical analyses required to determine the upper-bound estimate of the average contaminant concentration in the sampling area. For this calculation a 95% confidence level is required by the standard.

If a site has a 95% UCL average concentration for each contaminant(s) less than the acceptable criteria, then the sampling area can be considered uncontaminated.

This methodology is outlined in Procedure D of the EPA Guidelines (EPA, 1995). The calculation is based on the mean and standard deviation of soil sampling test results.

4.2 Golf Course Greens Results

Table 3.1 shows that only Dieldrin levels exceed the ANZECC or Dutch C criteria (for the removal of soil). The DDE and Chlorpyrifos results do not exceed the Dutch B criteria (for further investigation of the soils).

Dieldrin has not been sold since the mid 1980's, but can remain in soils for extended periods, as do most organochlorines. Dieldrin was predominantly used for termite treatment, and was commonly sprayed onto the soil surrounding wooden fence posts. Greens 12, 14, 15, 16, 17 and 18 all recorded high levels of Dieldrin which exceeded the Dutch B criteria for further investigation of soils, but only the results from Greens 12, 14 and 15 exceeded the Dutch C criteria for removal of soil.

These laboratory results are from composite samples. Therefore, it could be possible that only one sub-sample contained a high Dieldrin level and that the other two sub samples had low levels which "diluted" the total Dieldrin level. This could be the case if the soil surrounding an old dieldrin treated fence post was sampled and the other two samples were not along this fence line and were therefore not treated. This could be confirmed by further testing of each of the remainder of the individual sub-samples.

The Dieldrin concentrations for samples from Greens 14 and 15 were the highest, with these levels also exceeding ANZECC health criteria. These soils would therefore not be suitable as topsoil in residential areas, as children ingesting this soil may suffer from adverse health effects.

4.2.1 Critical Size of Hot Spots

As the Dieldrin levels on some of the greens exceeded the acceptable criteria, the critical size of hot spots on the greens could not be calculated.

4.2.2 Upper Confidence Limit of the Arithmetic Average Concentration

The UCL for the golf course greens was calculated to be 0.05mg/kg for DDE, 0.03mg/kg for Chlorpyrifos and 4.6mg/kg for Dieldrin.

Therefore, the DDE and Chlorpyrifos UCLs were below the ANZECC and Dutch A criteria (clean soil). The UCL for Dieldrin was below the ANZECC health criterion, but above the Dutch B criterion (further investigation).

The UCL was also below the Dutch C criterion for soil removal.

4.2.3 Summary - Golf Course Greens

This area should be suitable for continued use as a golf course, as the grass forms a stabilising layer, which should prevent migration and ingestion of the pesticide through wind erosion of soil particles. The UCL for the golf course greens was acceptable for DDE and Chlorpyrifos, however the Dieldrin UCL was above the Dutch B criterion (further investigation) but was below the Dutch C criterion for soil removal.

Due to the high concentrations of Dieldrin found on some of the greens (particularly 12, 14 and 15), the soil from these areas may not be suitable for use as topsoil on a residential property. If this area is intended for residential development, the soil from the golf green areas should be removed or buried under at least 0.5m of clean fill.

4.3 Biosolids Results

Table 3.2 shows that elevated levels of both copper and zinc can be seen in most of the collected samples. A comparison of the higher concentrations with background levels common to Australian soils (as outlined in the ANZECC Guidelines, 1992) show both the zinc and copper levels in the collected samples are above the background range given. Many samples have copper and zinc concentrations which exceed the ANZECC environmental criteria, although none of the applicable ANZECC health criteria have been exceeded.

The ANZECC environmental criteria are defined as an investigation threshold, where further investigation may be warranted if sensitive environments may be affected as a result of soil contamination. It is considered that the biosolids holding pond does not discharge to any sensitive environments, and therefore the sample levels observed should not pose a threat to the surrounding environment.

The statistical analysis methods for interpreting contaminated site soil sampling results, as per the EPA Guidelines are outlined below.

4.3.1 *Critical Size of Hot Spots*

As the copper and zinc levels in some of the biosolids samples exceeded the ANZECC criteria, the critical size of hot spots for the biosolids holding pond area could not be calculated.

4.3.2 *Upper Confidence Limit of the Arithmetic Average Concentration*

The UCLs in the biosolids samples were calculated to be as follows:

- Arsenic 3.5 mg/kg
- Cadmium < 2 mg/kg
- Chromium 37 mg/kg
- Copper 335 mg/kg
- Lead 22 mg/kg
- Nickel 40 mg/kg
- Mercury 0.5 mg/kg
- Zinc 480 mg/kg

Therefore, it may be seen that only the UCLs for copper and zinc exceed the ANZECC criteria. Implications of this exceedence and disposal methods are further outlined in Section 4.3.3 below.

4.3.3 *Disposal of Biosolids*

Use of the sewage treatment plant biosolids for top dressing on some areas of the golf course, in residential areas or other uses will require licensing by the EPA. There are set criteria for uses of such biosolids, dependant on the level of contaminants contained. The NSW EPA has

developed an "Interim Code of Practice for Use and Disposal of Biosolids Products; Draft - June 1994" which outlines grades for the biosolids dependant on the contaminant concentrations and the appropriate uses for each grade.

The sampling results were reviewed in relation to the proposed biosolids management and handling procedures at the developed Terranora site, to ensure that licensing of the operation was unlikely to present any problems. The following notes relate to these assessments.

Firstly, the nature of the sewage waste stream being treated at the plant is of relevance. In the present operation, wastewaters discharging to the treatment plant are primarily from cleaning and kitchen operations, with only minor volumes of general domestic waste. Therefore, the existing load to the sewage treatment plant may contain more concentrated contaminants from the use of industrial cleaners than is present in general domestic wastewater. If the proposed residential development within and around the Terranora Country Club proceeds, the sewage treatment plant will receive mostly domestic wastewater and these wastewaters will dilute any industrial cleaners used in the Club. No tradewastes will either be generated on site, or be discharged to the site sewage system under the proposed development plan. Consequently, the occurrent of 'exotic' contaminants in plant bio-solids after the proposed development is constructed, is considered highly unlikely.

From perusal of the biosolids sampling results (refer Table 3.2), and comparison of these results with EPA Guidelines (EPA, 1994), it is apparent that present copper and zinc levels fall between EPA Grade A and B criteria for contaminant acceptance concentration thresholds. Following composting of site biosolids, which will involve mixing with substantial quantities of on-site organic material, it is expected that these levels will be within the Grade A criteria. It should be recognised that these sampling results are from the existing plant, which has little or no domestic wastewater load. For the proposed development, greater purely domestic loadings are expected which should result in lower copper and zinc levels in biosolids.

Secondly, the proposed sewage treatment process is expected to continues to produce biosolids of an extremely 'stable' nature. The extended aeration process will produce biosolids requiring no further aerobic or anaerobic digestion to produce a largely 'innocuous' material.

Finally, all biosolids produced by the plant will be composted at a suitably designed site adjacent to the sewage plant. At this site, biosolids will be mixed with lawn clippings from the golf course and other mulched site plant material, and stockpiled for several months to ensure both stabilisation and removal of any pathogens. The composting site will be bunded to ensure no allowable runoff of material in stormwater. Collected runoff from within the bunded area will be stored in a sump within the bund, before pumping back to the sewage treatment plant.

The combination of 'innocuous' nature of influent sewage, advanced waste water treatment, and biosolids composting is expected to produce a final compost which complies with Contaminant Grade 'A' and Stabilisation Grade 'A' of the relevant NSW EPA Guidelines. At worst, Contaminant Grade 'B' may result due to the minor entry of heavy metals and

organochlorine compounds into the sewer system. In either case (that is Grade A/A or B/A biosolids), the produced material should still be suitable for use for land application to public contact sites (eg golf courses) and urban landscaping areas (eg public garden beds).

4.3.4 *Summary - Sewage Treatment Plant Biosolids*

Consequently, the composted biosolids from the proposed development which will be produced on site are expected to be readily able to be disposed of within the site itself, where the demand for such material is for golf course top dressing and garden bed establishment. If Grade A/A material is achieved, as is expected, biosolids would be of a condition suitable for 'unrestricted use', and they could be sold off-site, if desired.

All of the above actions would be subject to detailed operational monitoring and sampling, and EPA licensing, prior to being commencement. The monitoring and sampling requirements of the Interim EPA Guidelines are rigorous, and will ensure no adverse effects result from bio-solids management. A Pollution Control Licence will probably be required from the EPA before on-site biosolids disposal can commence.

4.4 Gun Club Results

Some elevated metal concentrations were observed in the collected samples, particularly mercury in sample 2 and copper and/or zinc in samples 3 and 6. These levels exceeded the ANZECC environmental criteria, however no health criteria are outlined by ANZECC for these metals. The ANZECC environmental criteria are defined as an investigation threshold, where further investigation may be warranted if sensitive environments may be affected as a result of soil contamination. It is considered that the former gun club area is not a sensitive environment, and surrounding areas also do not appear to have sensitive environmental receptors. Therefore, the metal levels observed should not pose a significant threat to the surrounding environment.

No levels of lead were above the environmental or health criteria in any of the collected soil samples.

4.4.1 *Critical Size of Hot Spots*

As some samples from the former gun club area exceeded the ANZECC criteria for mercury, zinc and copper, the critical size of hot spots in the gun club area could not be calculated.

4.4.2 *Upper Confidence Limit of the Arithmetic Average Concentration*

The UCLs for the former gun club area was calculated to be as follows:

- Arsenic 8.9 mg/kg
- Antimony < 1 mg/kg
- Cadmium < 2 mg/kg
- Chromium 42 mg/kg

- Copper 67 mg/kg
- Lead 12 mg/kg
- Nickel 27 mg/kg
- Mercury 1.3 mg/kg
- Zinc 220 mg/kg

Therefore, only the UCLs for copper, mercury and zinc exceed the ANZECC criteria. The elevated levels of these metals are only marginally above the respective environmental criteria, and as no sensitive environment would be affected, it is considered unlikely that any adverse impact would result from this site.

4.4.3 *Summary - Gun Club*

This area is not considered to be severely contaminated through the previous gun club activities. Should this area become residential development or fill removed from this site for residential development, a thorough search may be warranted to check no unexploded ammunition can be found in the area. Only small numbers of spent shotgun cartridges could be found and these should not pose a threat for major soil contamination or any safety concerns.

Any isolated areas of spent lead shot subsequently found could be readily removed by scraping and/or removal of the surface soil layer.

4.5 Norville Property Results

Table 3.4 shows that none of the Dieldrin or DDE levels exceeded either the ANZECC or Dutch B criteria (for further investigation).

These test results are also from composite samples. It is therefore possible that only one high pesticide level was found and that the other sub-samples "diluted" the pesticide level. This could be confirmed by further testing of each of the individual sub-samples. However, only the sub-samples from sites N1E, N1F, N1G would require testing, as this is the only composite soil sample that could approach the guideline criteria where two sub-samples contained no DDE, and the other contained three times the composite level. If this was the case, the highest level (of 0.84mg/kg DDE) would not exceed the relevant ANZECC health guideline and would therefore not be considered to be particularly serious.

4.5.1 *Critical Size of Hot Spots*

Assuming the average distance between samples on the Norville property was approximately 30m, the critical size of a hot spot on the Norville property was determined to be less than 18m. Therefore, there is a 5% chance that an area of approximately 18m across could be present on the site, which shows some higher level of contamination than indicated by the sampling performed.

4.5.2 Upper Confidence Limit of the Arithmetic Average Concentration

The UCLs for the Norville property was calculated to be 0.14mg/kg for DDE and 0.04mg/kg for Dieldrin. Therefore, all organochlorine pesticides levels were below the ANZECC criterion. The Dieldrin UCL was below the Dutch A criteria (clean soil). The UCL for DDE was below the Dutch B criterion (further investigation).

4.5.3 Summary - Norville Property

Although some samples indicated that residues of DDE and Dieldrin were present on the site, none appear to be present at levels in excess of acceptable health criteria. No further investigation or remediation is considered necessary.

5 CONCLUSIONS

The golf course greens showed high levels of some organochlorine pesticides, particularly Dieldrin. These levels would preclude the topsoils being used for residential development topsoil, although the continued use of the area as a golf course should not pose any significant risk to golfers or green keepers, provided appropriate footwear is worn. The EPA methods for interpretation of contaminated land sampling results indicated that the upper confidence limit of the arithmetic mean for the golf course greens was acceptable for DDE and Chlorpyrifos, but the Dieldrin levels exceeded the further investigation criterion. However the UCL for Dieldrin did not exceed the Dutch C criterion for the removal of soil.

The biosolids samples from the sewage treatment plant holding pond showed slightly elevated copper and zinc levels. However, composting of biosolids with organic material (eg lawn clippings) should ensure acceptable criteria are met and a Grade A/A material is achieved. That is, with composting, the biosolids are likely to be of a condition suitable for 'unrestricted use', and may be sold off-site, if desired.

The gun club area showed no elevation of lead levels, but one sample showed elevated levels of copper and zinc and another an elevated level of mercury. The UCL for the site resulted in marginal elevation over the ANZECC environmental criteria for copper, mercury and zinc.

The Norville property showed some residues of organochlorine pesticides, however these levels were not considered potentially hazardous and therefore the site should be suitable for future development, or any other uses.

6 REFERENCES

ANZECC (1992) Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites. Australian and New Zealand Environment and Conservation Council and National Health and Medical Research Council Publication.

EPA (1994) Interim Code of Practice for Use and Disposal of Biosolids Products; Draft - June 1994. NSW Environment Protection Authority Publication.

EPA (1995) Contaminated Sites - Sampling Design Guidelines. NSW Environment Protection Authority Publication.

11) Appendix 2 – Site Contamination Assessment of the existing 11th, 12th and 18th greens, for the proposed Terranora Resort Project, Bilambil Heights, 2002

Gilbert & Sutherland
Specialist Soil and Water Scientists

Site Contamination Assessment of the existing 11th, 12th and 18th greens, for the proposed Terranora Resort Project, Bilambil Heights.

Prepared for
Jim Glazebrook and Associates

January, 2002

Originating office:

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Also at Kawana and Ballina

Table of contents

1. Introduction and purpose of report

Gilbert & Sutherland Pty Ltd, was commissioned by Jim Glazebrook & Associates to prepare a Site Contamination Assessment in relation to the areas associated with stages 1 and 2 of the proposed Terranora Resort Development. The subject site is described as Lot 5 DP 822786, Lot 31 DP 850230 Marana Street and Part Lot 5 DP 789875 Cobaki Road, Bilambil Heights. The site location is shown on Figure 1.

This report has been prepared in accordance with the NSW Environmental Protection Authority (EPA) *Guidelines for Consultants Reporting on Contaminated Sites*[1] (1997) and in compliance with the Tweed Shire Council's *Guidelines for the Submission of Reports on Contaminated Land*[2].

The purpose of this report is to assess the likelihood of soil contamination in the vicinity of the existing 11th, 12th and 18th greens at the Terranora Lakes Country Club. These are the only greens flagged by Council as requiring further investigation which are affected by Stages 1 and 2 of the proposed development.

Any other areas of the site which may be affected by subsequent stages of the development have not been addressed within this report.

If contamination is identified, the preparation of a Remediation Action Plan (RAP) would be necessary detailing the specific requirements for the handing, treatment and removal of contaminated material for any greens affected by contaminants.

[1] NSW Environmental Protection Authority (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. NSW EPA, Sydney.

[2] Tweed Shire Council (1992) *Guidelines for the Submission of Reports on Contaminated Land.*

2. Preliminary investigations

The scope of work associated with this site contamination investigation involves the following aspects:

- identify all past and present potentially contaminating activities,
- identify potential contaminants,
- discuss the site condition,
- provide a preliminary assessment of site contamination and;
- assess the need for further investigations.

2.1 Previous Assessments

WBM Oceanics carried out sampling of the greens in 1997 for the purpose of assessing possible chemical contamination of the soil. Seven composited samples were collected from greens 11, 12, 14, 15, 16, 17 & 18 and forwarded to the laboratory for the analysis of Organochlorine and organophosphorous pesticides.

The results for organochlorine pesticides were above the Health Investigation Levels (HILs) presented in the National Environmental Protection Council's (NEPC) *Guideline on the Investigation Levels for Soil and Groundwater*[3] for the 14th and 15th greens. The more specific Dutch criteria are often adopted and applied in Australia as the ANZECC and NEPC guidelines address a limited range of pesticides. Assessing the results against these criteria showed that soils from greens 12, 14, 15, 16 & 17 had Dieldrin levels above the Dutch B level threshold suggesting further investigation is necessary. Additionally, greens 12, 14 & 15 also exceeded the Dutch C level threshold which indicates that the soils should be removed.

WBM concluded that there were elevated levels of Dieldrin at the abovementioned greens and that such contamination would prevent the use of this material in a residential setting. It was suggested that continued use of the site as a golf course was appropriate because the grass provided stability, preventing the movement of contaminated soil. Should the area be developed for residential purposes it was recommended that the affected soil be removed or buried under clean fill.

[3] National Environmental Protection Council's (1999) *National Environment Protection (Assessment of Site Contamination) Measure 1999*. Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater

3. Sampling Methodology

A site inspection and sampling program was undertaken by Gilbert & Sutherland on 10.01.02 and nine boreholes were constructed by hand auger on the 11th, 12th and 18th greens.

Three samples were collected from each of the three greens and composited to form 1 sample per green. The table below outlines the green and borehole numbers and the corresponding composite sample number.

Green No. & Boreholes	Composite Sample No.
11) Boreholes 1,2 & 3	1
12) Boreholes 4,5 & 6	2
18) Boreholes 7,8 & 9	3

Boreholes were retrieved from depressions and down-slope sections of the green where contaminants were likely to leach to and accumulate.

Following collection, the three composited samples were forwarded to Australian Laboratory Services (ALS) for analysis of organochlorine (OC) and organophosphorous (OP) pesticides (including Aldrin, Dieldrin, DDT and chlorpyrifos).

Figure 2 shows the borehole locations with respect to the golf course greens.

4. Results

The results of the 3 composited soil samples recovered from greens 11, 12 and 18 are presented in the following table. The laboratory certificates are attached as appendix 1.

Table 1 – Laboratory Results

Organochlorine Pesticides	Composite Sample 1 BH1-3 mg/kg	Composite Sample 2 BH4-6 mg/kg	Composite Sample 3 BH7-9 mg/kg	Limit of Reporting mg/kg
alpha-BHC	<0.05	<0.05	<0.05	0.05
HCB	<0.05	<0.05	<0.05	0.05
beta-BHC	<0.1	<0.1	<0.1	0.1
delta-BHC	<0.05	<0.05	<0.05	0.05
Heptachlor	<0.05	<0.05	<0.05	0.05
Aldrin	<0.05	<0.05	<0.05	0.05
Heptachlor	<0.05	<0.05	<0.05	0.05
Chlordane- trans	<0.05	<0.05	<0.05	0.05
Endosulfan	<0.05	<0.05	<0.05	0.05
Chlordane cis	<0.05	<0.05	<0.05	0.05
Dieldrin	0.56	0.15	0.86	0.05
DDE	<0.05	<0.05	<0.05	0.05
Endrin	<0.05	<0.05	<0.05	0.05
Endosulfan	<0.05	<0.05	<0.05	0.05
DDD	<0.05	<0.05	<0.05	0.05
Endrin	<0.05	<0.05	<0.05	0.05
Endosulfan	<0.05	<0.05	<0.05	0.05
DDT	<0.2	<0.2	<0.2	0.2
Endrin	<0.05	<0.05	<0.05	0.05
Methoxychlor	<0.2	<0.2	<0.2	0.2
Organophosphorous Pesticides	**Composite Sample 1 BH1-3 mg/kg**	**Composite Sample 2 BH4-6 mg/kg**	**Composite Sample 3 BH7-9 mg/kg**	**Limit of Reporting mg/kg**
Dichlorvos	<0.05	<0.05	<0.05	0.05
Demeton-S-methyl	<0.05	<0.05	<0.05	0.05
Monocroptophos	<0.2	<0.2	<0.2	0.2
Dimethoate	<0.05	<0.05	<0.05	0.05
Diazinon	<0.05	<0.05	<0.05	0.05
Chlorpyrifos-methyl	<0.05	<0.05	<0.05	0.05
Parathion-methyl	<0.2	<0.2	<0.2	0.2
Malathion	<0.05	<0.05	<0.05	0.05
Fenthion	<0.05	<0.05	<0.05	0.05
Chlorpyrifos	<0.05	<0.05	<0.05	0.05
Parathion	<0.05	<0.05	<0.05	0.05
Pirimphos-ethyl	<0.05	<0.05	<0.05	0.05
Chlorfenvinphos E	<0.05	<0.05	<0.05	0.05
Chlorfenvinphos Z	<0.05	<0.05	<0.05	0.05
Bromophos-ethyl	<0.05	<0.05	<0.05	0.05
Fenamiphos	<0.05	<0.05	<0.05	0.05
Prothiofos	<0.05	<0.05	<0.05	0.05
Ethion	<0.05	<0.05	<0.05	0.05
Carbophenothion	<0.05	<0.05	<0.05	0.05
Azinphos-methyl	<0.05	<0.05	<0.05	0.05

As illustrated in the above table, the laboratory results for all suspected contaminants, with the exception of Dieldrin, were below the laboratory's Limits of Reporting (LOR).

The Health Investigation Levels (HILs) presented in the National Environmental Protection Council's (NEPC) *Guideline on the Investigation Levels for Soil and Groundwater*[4] state that combined levels of Aldrin and Dieldrin should not exceed 10mg/kg.

Dieldrin levels in composite samples 1, 2 & 3 were above the Laboratories LOR at 0.56, 0.15 and 0.86mg/kg, however were well below the recommended maximum for Aldrin + Dieldrin discussed above.

The NSW EPA Contaminated Sites *Sampling Design Guidelines*[5] describe the limitations of the use of composite sampling and suggest methods for minimising error resulting from compositing samples. Even with the application of the most conservative method which involves dividing the threshold level by the number of samples composited, these results are well below the Health Investigation Levels.

[4] National Environmental Protection Council's (1999) *National Environment Protection (Assessment of Site Contamination) Measure 1999*. Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater

[5] NSW EPA (1995) *Sampling Design Guidelines.* EPA, Sydney.

5. Conclusions & recommendations

The historical information provided suggests that the most likely contaminating activity conducted on the site was the use of pesticides and herbicides on the golf course greens.

The laboratory results for all suspected contaminants (organochlorine and organophosphorous pesticides), with the exception of Dieldrin, were below the Laboratory's Limits of Reporting (LOR).

Whilst dieldrin levels were above the LOR, all results recovered were well below the NEPC Health Investigation Levels (HILs). This is despite elevated levels of Dieldrin being demonstrated in a 1997 investigation.

On the basis of this investigation, the results obtained from the current 11th, 12th and 18th greens are all below the accepted NEPC Health Investigation Levels. As such, there appears to be negligible environmental or health risk associated with the movement or redevelopment of these soils. However, Gilbert and Sutherland recommend that the topsoil materials stripped from these greens for the purpose of the development, be stockpiled separately so that they can be reused on the golf course areas. In this way, these materials will be separated from any materials being used on landscaping areas around the resort and accommodation facilities and the risk of exposure can further be minimised.

On this basis, further sampling and laboratory analysis is not considered necessary.

Additionally, in the absence of contaminants, a Remediation Action Plan is not considered necessary for the first and second stage of this development. Subsequent stages affecting those greens noted in Council's consent notice would need to be considered separately and assessed accordingly.

Appendix 1 – Laboratory Certificates

ALS Environmental

CERTIFICATE OF ANALYSIS

CONTACT:	MR N SURIG	**BATCH:**	EB42833
CLIENT:	GILBERT & SUTHERLAND PTY LTD	**SUB BATCH:**	0
ADDRESS:		**LABORATORY:**	BRISBANE
	P O BOX 857	**DATE RECEIVED:**	10/01/2002
	ROBINA QLD 4226	**DATE COMPLETED:**	16/01/2002
		SAMPLE TYPE:	SOIL
ORDER No.:	GJ0139	**No. of SAMPLES:**	3
PROJECT:			

COMMENTS

Results apply to sample(s) as submitted. Samples analysed on an as received basis. Results reported on a dry weight basis.

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

Phone: 61-7-3243 7222
Fax: 61-7-3243 7218
Email: paulv@als.com.au

Signatory

Batch: EB42833
Sub Batch: 0
Date of Issue: 16/01/2002
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

CERTIFICATE OF ANALYSIS

				SAMPLE IDENTIFICATION								
	Laboratory I.D.			1	2	3						
	Date Sampled			10/01/2002	10/01/2002	10/01/2002						
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	BH1,2,3 0-0.15	BH4,5,6 0-0.15	BH7,8,9 0-0.15						
EA-055	Moisture Content (dried @ 103°C)	%	0.1	17.6	8.2	11.2						
EP-068A-SS	**ORGANOCHLORINE PESTICIDES**											
EP-068A-SS	alpha-BHC	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	HCB	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	beta-BHC & gamma-BHC	mg/kg	0.1	<0.1	<0.1	<0.1						
EP-068A-SS	delta-BHC	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Heptachlor	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Aldrin	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Chlordane - trans	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Endosulfan 1	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Chlordane - cis	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Dieldrin	mg/kg	0.05	0.56	0.15	0.86						
EP-068A-SS	DDE	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Endrin	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Endosulfan 2	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	DDD	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Endrin aldehyde	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	DDT	mg/kg	0.2	<0.2	<0.2	<0.2						
EP-068A-SS	Endrin ketone	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068A-SS	Methoxychlor	mg/kg	0.2	<0.2	<0.2	<0.2						
EP-068B-SS	**ORGANOPHOSPHORUS PESTICIDES**											
EP-068B-SS	Dichlorvos	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068B-SS	Demeton-S-methyl	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068B-SS	Monocroptophos	mg/kg	0.2	<0.2	<0.2	<0.2						
EP-068B-SS	Dimethoate	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068B-SS	Diazinon	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068B-SS	Chlorpyrifos-methyl	mg/kg	0.05	<0.05	<0.05	<0.05						
EP-068B-SS	Parathion-methyl	mg/kg	0.2	<0.2	<0.2	<0.2						

Batch: EB42833
Sub Batch: 0
Date of Issue: 16/01/2002
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

CERTIFICATE OF ANALYSIS

				SAMPLE IDENTIFICATION									
		Laboratory I.D.		1	2	3							
		Date Sampled		10/01/2002	10/01/2002	10/01/2002							
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	BH1,2,3 0-0.15	BH4,5,6 0-0.15	BH7,8,9 0-0.15							
EP-068B-SS	Malathion	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Fenthion	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Chlorpyrifos	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Parathion	mg/kg	0.2	<0.2	<0.2	<0.2							
EP-068B-SS	Pirimphos-ethyl	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Chlorfenvinphos E	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Chlorfenvinphos Z	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Bromophos-ethyl	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Fenamiphos	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Prothiofos	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Ethion	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Carbophenothion	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068B-SS	Azinphos-methyl	mg/kg	0.05	<0.05	<0.05	<0.05							
EP-068S-SS	**ORGANOCHLORINE PESTICIDE SURROGATE**												
EP-068S-SS	Dibromo-DDE	%	1	65	69	66							
EP-068T-SS	**ORGANOPHOSPHORUS PESTICIDE SURROGATE**												
EP-068T-SS	DEF	%	1	65	67	61							

Batch: EB42833
Sub Batch: 0
Date of Issue: 16/01/2002
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

QUALITY CONTROL REPORT

				SAMPLE IDENTIFICATION									
		Laboratory I.D.		200	406	407							
		Date Sampled		10/01/2002	10/01/2002	10/01/2002							
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	Method Blank 1	OCOPS1204 SCS % Rec	OCOPS1204 DCS % Rec							
				CHECKS AND SPIKES									
EA-055	Moisture Content (dried @ 103°C)	%	0.1	—	—	—							
EP-068A-SS	**ORGANOCHLORINE PESTICIDES**												
EP-068A-SS	alpha-BHC	mg/kg	0.05	<0.05	80.2%	74.1%							
EP-068A-SS	HCB	mg/kg	0.05	<0.05	80.2%	74.4%							
EP-068A-SS	beta-BHC & gamma-BHC	mg/kg	0.1	<0.1	83.6%	78.0%							
EP-068A-SS	delta-BHC	mg/kg	0.05	<0.05	80.8%	76.0%							
EP-068A-SS	Heptachlor	mg/kg	0.05	<0.05	90.7%	82.0%							
EP-068A-SS	Aldrin	mg/kg	0.05	<0.05	82.5%	75.0%							
EP-068A-SS	Heptachlor epoxide	mg/kg	0.05	<0.05	83.7%	79.2%							
EP-068A-SS	Chlordane - trans	mg/kg	0.05	<0.05	89.0%	80.6%							
EP-068A-SS	Endosulfan 1	mg/kg	0.05	<0.05	87.9%	84.0%							
EP-068A-SS	Chlordane - cis	mg/kg	0.05	<0.05	82.5%	77.6%							
EP-068A-SS	Dieldrin	mg/kg	0.05	<0.05	64.2%	61.8%							
EP-068A-SS	DDE	mg/kg	0.05	<0.05	72.1%	68.1%							
EP-068A-SS	Endrin	mg/kg	0.05	<0.05	80.1%	75.4%							
EP-068A-SS	Endosulfan 2	mg/kg	0.05	<0.05	84.7%	76.7%							
EP-068A-SS	DDD	mg/kg	0.05	<0.05	86.2%	78.5%							
EP-068A-SS	Endrin aldehyde	mg/kg	0.05	<0.05	90.7%	79.4%							
EP-068A-SS	Endosulfan sulfate	mg/kg	0.05	<0.05	82.3%	78.5%							
EP-068A-SS	DDT	mg/kg	0.2	<0.2	107%	105%							
EP-068A-SS	Endrin ketone	mg/kg	0.05	<0.05	87.0%	80.0%							
EP-068A-SS	Methoxychlor	mg/kg	0.2	<0.2	107%	98.8%							
EP-068B-SS	**ORGANOPHOSPHORUS PESTICIDES**												
EP-068B-SS	Dichlorvos	mg/kg	0.05	<0.05	60.9%	58.8%							
EP-068B-SS	Demeton-S-methyl	mg/kg	0.05	<0.05	80.3%	70.5%							
EP-068B-SS	Monocrotophos	mg/kg	0.2	<0.2	80.0%	74.4%							
EP-068B-SS	Dimethoate	mg/kg	0.05	<0.05	86.8%	77.6%							
EP-068B-SS	Diazinon	mg/kg	0.05	<0.05	84.1%	80.8%							

Batch: EB42833
Sub Batch: 0
Date of Issue: 16/01/2002
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

QUALITY CONTROL REPORT

				SAMPLE IDENTIFICATION									
		Laboratory I.D.		200	406	407							
		Date Sampled		10/01/2002	10/01/2002	10/01/2002							
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	Method Blank 1	OCOPS1204 SCS % Rec	OCOPS1204 DCS % Rec							
				CHECKS AND SPIKES									
EP-068B-SS	Chlorpyrifos-methyl	mg/kg	0.05	<0.05	82.6%	75.9%							
EP-068B-SS	Parathion-methyl	mg/kg	0.2	<0.2	91.1%	82.9%							
EP-068B-SS	Malathion	mg/kg	0.05	<0.05	84.9%	77.4%							
EP-068B-SS	Fenthion	mg/kg	0.05	<0.05	82.1%	77.0%							
EP-068B-SS	Chlorpyrifos	mg/kg	0.05	<0.05	82.1%	79.2%							
EP-068B-SS	Parathion	mg/kg	0.2	<0.2	93.5%	87.8%							
EP-068B-SS	Pirimphos-ethyl	mg/kg	0.05	<0.05	82.6%	77.2%							
EP-068B-SS	Chlorfenvinphos E	mg/kg	0.05	<0.05	---	---							
EP-068B-SS	Chlorfenvinphos Z	mg/kg	0.05	<0.05	89.3%	82.1%							
EP-068B-SS	Bromophos-ethyl	mg/kg	0.05	<0.05	85.8%	77.7%							
EP-068B-SS	Fenamiphos	mg/kg	0.05	<0.05	83.2%	75.0%							
EP-068B-SS	Prothiofos	mg/kg	0.05	<0.05	82.4%	78.6%							
EP-068B-SS	Ethion	mg/kg	0.05	<0.05	84.4%	80.1%							
EP-068B-SS	Carbophenothion	mg/kg	0.05	<0.05	84.4%	83.5%							
EP-068B-SS	Azinphos-methyl	mg/kg	0.05	<0.05	80.6%	75.4%							
EP-068S-SS	**ORGANOCHLORINE PESTICIDE SURROGATE**												
EP-068S-SS	Dibromo-DDE	%	1	60	72	71							
EP-068T-SS	**ORGANOPHOSPHORUS PESTICIDE SURROGATE**												
EP-068T-SS	DEF	%	1	59	65	61							

ALS Environmental

ORGANICS QUALITY CONTROL REPORT

BATCH No. : EB42833 **DATE BATCH RECEIVED : 10/01/02**

CLIENT : Gilbert & Sutherland **DATE BATCH COMPLETED : 15/01/02**

Where applicable, internal standards are added to sample extracts prior to instrumental analysis.
Absolute peak areas and retention times fall within the criteria specified in the individual methods.

Method Code	Test	Matrix	Method Reference		QC Lot Number	Date Samples Extracted	Date Samples Analysed
			Extraction	Analysis			
EP-068	Pesticides	Soil	Tumbler	USEPA 8270B	OCOPS1204	14/01/02	14/01/02

BATCH QUALITY CONTROL

ALS EP-068 : PESTICIDES

QC LOT No. : OCOPS1204 ANALYST: G Entwistle
MATRIX: Soil

COMPOUND	Blank Conc	Spike Level	SPIKE QC RESULTS				Control Limits		
			SCS Conc	DCS Conc	Average Rec.	RPD	Rec.		RPD
	mg/kg	mg/kg	mg/kg	mg/kg	%	%	Low	High	%
EP-068A : ORGANOCHLORINE PESTICIDES									
a-BHC	<LOR	0.25	0.20	0.19	77	8	48	114	20
HCB	<LOR	0.25	0.20	0.19	77	8	43	123	20
b- & g-BHC	<LOR	0.50	0.42	0.39	81	7	47	122	20
d-BHC	<LOR	0.25	0.20	0.19	78	6	47	113	20
Heptachlor	<LOR	0.25	0.23	0.21	86	10	40	109	20
Aldrin	<LOR	0.25	0.21	0.19	79	10	56	119	20
Heptachlor epoxide	<LOR	0.25	0.21	0.20	81	6	50	120	20
trans-Chlordane	<LOR	0.25	0.22	0.20	85	10	51	127	20
Endosulfan 1	<LOR	0.25	0.22	0.21	86	5	49	134	20
cis-Chlordane	<LOR	0.25	0.21	0.19	80	6	46	129	20
Dieldrin	<LOR	0.25	0.16	0.15	63	4	41	121	20
DDE	<LOR	0.25	0.18	0.17	70	6	38	124	20
Endrin	<LOR	0.25	0.20	0.19	78	6	37	114	20
Endosulfan 2	<LOR	0.25	0.21	0.19	81	10	51	118	20
DDD	<LOR	0.25	0.22	0.20	82	9	55	136	20
Endrin aldehyde	<LOR	0.25	0.23	0.20	85	13	48	118	20
Endosulfan sulfate	<LOR	0.25	0.21	0.20	80	5	35	111	20
DDT	<LOR	0.25	0.27	0.26	106 *	2	28	93	20
Endrin ketone	<LOR	0.25	0.22	0.20	84	8	38	118	20
Methoxychlor	<LOR	0.25	0.27	0.25	103	8	43	108	20
EP-068B : ORGANOPHOSPHORUS PESTICIDES									
Dichlorvos	<LOR	0.25	0.15	0.15	60	4	15	127	20
Demeton-s-methyl	<LOR	0.25	0.20	0.18	75	13	41	103	20
Monocroptophos	<LOR	0.25	0.20	0.19	77	7	14	115	20
Dimethoate	<LOR	0.25	0.22	0.19	82	11	53	108	20
Diazinon	<LOR	0.25	0.21	0.20	82	4	60	107	20
Chlorpyrifos methyl	<LOR	0.25	0.21	0.19	79	8	59	110	20
Parathion methyl	<LOR	0.25	0.23	0.21	87	9	62	106	20
Malathion	<LOR	0.25	0.21	0.19	81	9	56	106	20
Fenthion	<LOR	0.25	0.21	0.19	80	6	59	111	20
Chlorpyrifos	<LOR	0.25	0.21	0.20	81	4	61	110	20
Parathion	<LOR	0.25	0.23	0.22	91	6	27	136	20
Pirimiphos ethyl	<LOR	0.25	0.21	0.19	80	7	32	139	20
Chlorfenvinphos E	<LOR	0.25	N/A	N/A	N/A		--	--	
Chlorfenvinphos Z	<LOR	0.25	0.22	0.21	86	8	45	116	20
Bromophos ethyl	<LOR	0.25	0.21	0.19	82	10	61	113	20
Fenamiphos	<LOR	0.25	0.21	0.19	79	10	38	116	20
Prothiofos	<LOR	0.25	0.21	0.20	81	5	48	111	20
Ethion	<LOR	0.25	0.21	0.20	82	5	49	109	20
Carbofenthion	<LOR	0.25	0.21	0.21	84	1	44	116	20
Azinphos methyl	<LOR	0.25	0.20	0.19	78	7	12	111	20
EP-068C : TRIAZINE PESTICIDES									
Atrazine	<LOR	0.25	0.21	0.20	82	8	1	160	20
Simazine	<LOR	0.25	0.21	0.19	80	7	46	124	20
EP-068D : SYNTHETIC PYRETHROIDS									
Cypermethrins	<LOR	0.25	0.20	0.19	77	7	37	108	20

COMMENTS:

1) The control limits are based on ALS laboratory statistical data. (Method QWI-ORG/07)

2) * : Recovery or RPD falls outside of the recommended control limits.

6342833 S (A) 10/1 16/1 (orc)

Attn: Janine / Kelly,
C-O-C for 3 jars you should receive early this afternoon.

CHAIN OF CUSTODY DOCUMENTATION

Client	Gilbert and Sutherland	**For:**	Australian Laboratory Services
Postal Address:	PO Box 857, Robina QLD 4226	**Address:**	32 Shand Street, Stafford, Q4053
Send Report to:	Nathan Surig	**Tel:**	073 243 7222
Data Needed By:	16.01.02	**Fax:**	073 243 7218
G&S Project ID:	GJ0139		
Send Invoice to:	D. Endres (Robina)		
Report Needed By:			
Quote Number:			
Comments:			

Sample ID	Matrix	Date	Time	Type and Pres	OC Pesticides	OP Pesticides	Notes:
BH 1, 2, 3: 0 - 0.15 1	S	10.01.02	9am		x	x	
BH 4,5,6: 0 - 0.15 2	S	10.01.02	9am		x	x	
BH 7,8,9: 0 - 0.15 3	S	10.01.02	9am		x	x	

Relinquished by:
Name: Nathan Surig [signature]
of: G&S
Date: 10.01.02
Time: 9am

Received by:
Name: S. Davidson
of: ALS
Date: 10.1.2
Time: pm

Appendix 2 – Soil bore logs

12) Appendix 3 – Stage1 Preliminary Site Investigation Marana Street, Bilambil Heights, 2005

Gilbert & Sutherland
Specialist Soil and Water Scientists

Stage 1 - Preliminary Site Investigation

Marana Street, Bilambil Heights, New South Wales

Prepared for
Terranora Group Management

August, 2005

Originating office:

Suite 12, Riverwalk One
140 Robina Town Centre Drive,
Robina Q4230
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gsrobina@bigpond.com

Also at Kawana and Ballina

Table of Contents

1. Introduction

Gilbert & Sutherland Pty Ltd was commissioned by Terranora Group Management to undertake a Stage 1 - Preliminary Site Investigation of Bilambil Heights Estate, Stage 1. The site comprises a portion of Lot 32 in DP 1085109, Marana Street, Bilambil Heights, New South Wales. The total area of the Stage 1 investigation site is approximately 6.96 hectares. It is proposed that the site would be developed for residential allotments. The site locality is displayed in Drawing GJ0425.2.1 within Appendix A.

1.1 Objective and scope of work

The objective of this project was to undertake an environmental investigation to review the contamination status in relation to past and present land uses carried out on the site. The Stage 1 – Preliminary Site Investigation works were undertaken in accordance with the New South Wales Environmental Protection Authority (NSW EPA) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.*

In achieving this objective, the following tasks were undertaken as the scope of work:

- Development of a site history through review of historical aerial photographs and an interview with people conversant with site history and historical operations.
- A desktop study and site inspection to assess any potentially contaminating activities, contaminant migration paths and susceptible receptors through the study of soil types, topography, drainage, vegetation status and hydrology.
- Preparation of a Stage 1 – Preliminary Site investigation report detailing the conclusions and recommendations of the investigation.

2. Site description

2.1 Current and historical land use

Historical land use information was gained from an anecdotal account and a review of historical aerial photography. This information review indicated that prior to the construction of the resort and golf course the site was most likely utilised as a dairy farm operation.

2.2 Property description

A summary of the relevant property details is provided in Table 2 with current and historical titles presented in Appendix B. The titles information for Lot 32 in DP 1085109 was not available at the time of this report as the processing of the registration at the titles office had not been finalised. The titles information for Lot 5 on DP 822786, of which Lot 32 in DP 1085109 forms part, has been provided instead.

Table 1 Summary of relevant property details.

Description	Information
Land title	Lot 32 in DP 1085109 County of Rous, Parish of Terranora and Local Authority of Tweed.
Location	Marana Street, Bilambil Heights, New South Wales.
Area	6.96 hectares
Registered owner	Terranora Group Management Pty Limited
Local Government	Tweed Shire Council
Current land zoning	'Residential'

2.3 Topography and drainage

The site is characterised as an elevated portion of a ridge with elevation ranging between 145m to 160m Australian Height Datum (AHD). The investigation area largely slopes towards the north east with limited artificial undulations constructed as features incorporated into the golf course design (bunkers, tees and greens). The slope across the site is generally gently sloped (approximately 3%), however the site also features moderately inclined to steep (approximately 20% to 40%)[1] regions located along the northern boundary of the investigation area.

Overland surface water flow traverses the site from the elevated central south western portion of the site towards the north and to the east towards McAlisters Road at the eastern portion of the site.

[1] R.C.Mcdonald, R.F.Isbell, J.G.Speight, J.Walker and M.S.Hopkins (1990) Australian Soil and land Survey, Field Hand book. Second Edition. Inkata Press. Melbourne & Sydney.

2.4 Geology and soils

A review of the Geological Survey of Queensland Geology, 1:100,000 series - Murwillumbah indicates that the site is underlain by soils of the Cainozoic period which largely comprise of Lamington Group basalt flows.

Field observations were recorded by Gilbert & Sutherland representatives undertaking fieldwork for the stormwater management investigation. Borehole soil samples showed that the shallow geology of the site was characterised by a surface layer consisting of a shallow loamy soil layer (0.05m – 0.1m) underlain by silty clay, with some gravels appearing after 0.4m below near surface level. The borehole investigation was limited to a depth of 0.6m.

2.5 Vegetation

The aerial photograph review shows that large scale clearing of the site had occurred prior to 1962, presumably for the purpose of the historical land use. The site is currently utilised as a section of the golf course which comprises maintained grass fairways, greens and tees as well as a variety of mature *Eucalyptus, Grevillea* and *Ficus species*. The vegetation observed at the time of the site inspection appeared to be in good health and showed no signs of stress which may indicate contaminated soil or water exposure.

2.6 Surrounding environment

The surrounding land use bordering the investigation area is summarised as follows;

Table 2 Exhibits a description of surrounding land use.

Direction from site	Land use description
North:	Residential dwellings and McAlisters Road borders the site to the north. Further to the north, land is primarily utilised for agricultural cropping.
South:	The area south of the site is utilised for residential dwellings, Marana Street and a resort facility.
East:	McAlisters Road borders the site to the east followed by residential dwellings.
West:	Immediately west of the site lies the golf club house and utility area.

2.7 Sensitive environments

The site inspection did not indicate the presence of any downstream sensitive aquatic environments likely to suffer adversely from any potentially contaminating activities on site. Such environments may

include rivers, lakes, creeks or wetlands. However, sensitive receptors in the form of residential dwellings bound the site to the north, south and east.

3. Site history

A brief site history was developed through a review of historical photographs and an interview with people conversant with site history.

3.1 Review of historical aerial photographs

Two (2) aerial photographs of the site were available for review and were used to gain insight into historical land uses carried out at the site. The photographs were taken in the years of 1962 and 2001 (photographs are attached as Drawing No. GJ0425.2.2 and Drawing No. GJ0425.2.3 in Appendix A). The aerial photographs were obtained from Tweed Shire Council, Murwillumbah. Details observed in the photographs are summarised below:

3.1.1 Photograph dated 1962.

The photograph indicates that the site and majority of the surrounding region had been cleared of native vegetation. The site appeared to contain fields, possibly some fencing and a number of structures thought to be either residential dwellings or farm sheds. The exact purpose of the paddocks and field area could not confidently be determined in the 1962 photograph although it did appear grazing of some descript was likely.

The immediate surrounding area was utilised in a similar manner, with cleared paddocks and several additional structures also thought to be residential dwellings or farm sheds. Further to the north of the site, north of McAlisters Rd, cropping is clearly evident.

A review of the greater region indicates land was largely used for agricultural operations, as fields appear recently ploughed or in crop. The remaining area has no distinguishable features which could provide further identification of land use for the site.

3.1.2 Photograph dated 2001.

At the time the 2001 photograph was taken, the site was utilised as a section of a golf course. Distinguishable features of the site identified in the photograph include two fairways, rows of mature trees, golf greens and sand bunkers.

The immediate area surrounding the site had undergone significant development including the addition of residential dwellings, golf clubhouse and resort.

3.2 Site history interview

A brief site history was developed through an interview with a long term employee of the golf course, Mr Bill Clarke. Mr Clarke's association with the site commenced in 1982 and he is currently employed as a greenkeeper at the Terranora Golf Resort. To the best of Mr Clarke's knowledge:

- The golf course was developed approximately 40 years ago.
- The site was utilised as a dairy farm prior to the development of the golf course. Mr Clarke was not aware of how long the site operated as a dairy farm nor was he aware of any agricultural cropping associated with the dairy farm operation.
- Chemicals utilised 18 to 20 years ago included Dieldrin, chlorpyrifos and various fungicides. The chemical applications were limited to the golf greens only and at low application rates of between 20 – 60 grams per 100m^2. No storage, spills, leaks or accidents involving chemicals were known to have occurred within the site boundary.
- Current chemical applications are limited to the use of fungicides on golf greens only.
- Imported fill in the form of washed and sieved sand was used in bunker and drainage development. Originally, imported sands were sourced from the Redlands Shire region; however, more recently sands were sourced from Kingscliff and Tumbulgum. The estimated quantity of sand imported was between 20m^3 to 40m^3 per year over the entire golf course area.
- An area of stockpiled boulders with limited waste items was present at the time Mr Clarke commenced employment. The stockpile was thought to have been generated during fairway development. Mr Clarke was unsure of further waste materials.
- Mr Clarke was not aware of any material having been burnt or buried on site.

Plate 2. This view is from the centre of the site facing east and shows a sand bunker, golf green and northern fairway.

Plate 3. This photograph was taken from the eastern portion of the site bordering McAlisters Road. The view displays the easterly facing slope which appears to have been used as a former site access.

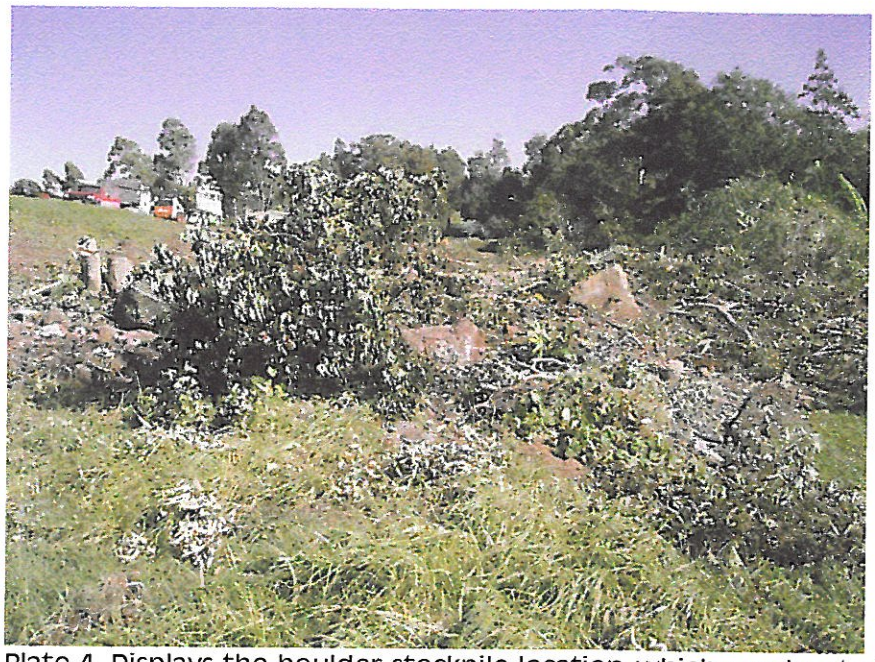


Plate 4. Displays the boulder stockpile location which was located on the northern site boundary. Tree maintenance works in the immediate area of the stockpile limited further inspection of this area.

Plate 5. Displays a portion of the contents of the boulder stockpile materials. This photograph identifies boulders, concrete fragments, and a steel rod (star picket).

Plate 6. Displays the eastern boundary of the site, McAlister's Road and the neighbouring land use, banana cropping.

4.2 Past contamination investigations

Two prior investigations have been undertaken which have included Lot 5 on DP 822786, of which Lot 32 in DP1085109 forms part. Lot 32 in DP1085109 includes golf greens (14-17).

The first investigation was carried out by WBM Oceanics in 1997 and included sampling golf greens (11, 12, 14, 15, 16, 17 & 18) for organochlorine and organophosphorus pesticide (OC's and OP's).

The results of the sampling investigation established that sample results from the 14th and 15th golf greens exceeded the *National Environmental Protection Council* (NEPC) threshold guidelines. Further exceedances of guideline thresholds were reported when sample results were compared to the Dutch Intervention B level (golf greens 12, 14, 15, 16 & 17) and Dutch Intervention C level (golf greens 12, 14 & 15).

The conclusion of the WBM Oceanics report determined that the elevated concentrations of Dieldrin at the abovementioned greens exceeded the threshold guidelines for residential purposes. The recommendation was made that the site should continue to operate as a golf course which would limit contaminant mobility. Additionally, if the site was to be utilised for residential purposes it was recommended that the contaminated areas be removed or capped.

A secondary investigation into the contamination status was undertaken in January 2002 by Gilbert & Sutherland. The scope of the project included the investigation of the 11th, 12th and 18th golf course greens for evidence of OC's and OP's contamination. The investigation included the

construction of three boreholes on each of the three greens investigated. The three samples from each green were then composited, and the three composited samples were then analysed for OC's and OP's contamination.

The results of the sampling established that the composited samples from 11th, 12 and 18th golf greens reported concentrations of OC's and OP's below the limit of laboratory reporting, with the exception of Dieldrin. The range of Dieldrin concentrations were reported between 0.15mg/Kg to 0.86mg/Kg. This level though is below the *National Environmental Protection Council* (NEPC) threshold guidelines of 10mg/kg.

5.0 Conclusion

Based upon the site inspection observations, historical aerial photography review and an interview with an employee conversant with site history, Gilbert & Sutherland provides the following conclusions:

5.1 Conclusions

- Historical review of the 1962 aerial photograph identified paddocks, some fencing and a number of structures on the site. The purpose of the land use appeared to be for grazing of some descript. Surrounding land uses appeared to be dominated by similar agricultural practices and some cropping. The 2001 aerial photograph indicated significant development of the site and surrounding area. The site in the 2001 photograph was utilised as a section of a golf course. The immediate surrounding area was used for residential dwellings and the golf course club house and resort.

- Details documented in the site history interview ascertained that the site was formerly a dairy farm, which was subsequently developed into a golf course approximately 40 years ago. Highlighted activities which had the potential to cause contamination included the use of pesticides, including Dieldrin and Chlorpyrifos on golf course greens. The golf course required between $20m^3$ to $40m^3$ of sand fill per year. The sand was imported onto the site from Redland Shire, Kingscliff and Tumbulgum.

- An inspection of the site on the 24.06.05 identified a stockpile of boulders and other miscellaneous waste. An employee of the golf course informed Gilbert & Sutherland staff that the stockpile was present at the time his employment had commenced.

- Past investigations have identified concentrations of Dieldrin in composite samples. The concentrations which exceeded the *National Environmental Protection Council* (NEPC) threshold guidelines were reported at the 14^{th} and 15^{th} golf greens in the 1997 investigation. During the January, 2002 investigation of the 11^{th}, 12^{th} and 18^{th} greens, dieldrin concentrations were reported above the limit of laboratory reporting; however the results were below NEPC threshold guidelines for residential purpose.

5.2 Recommendations

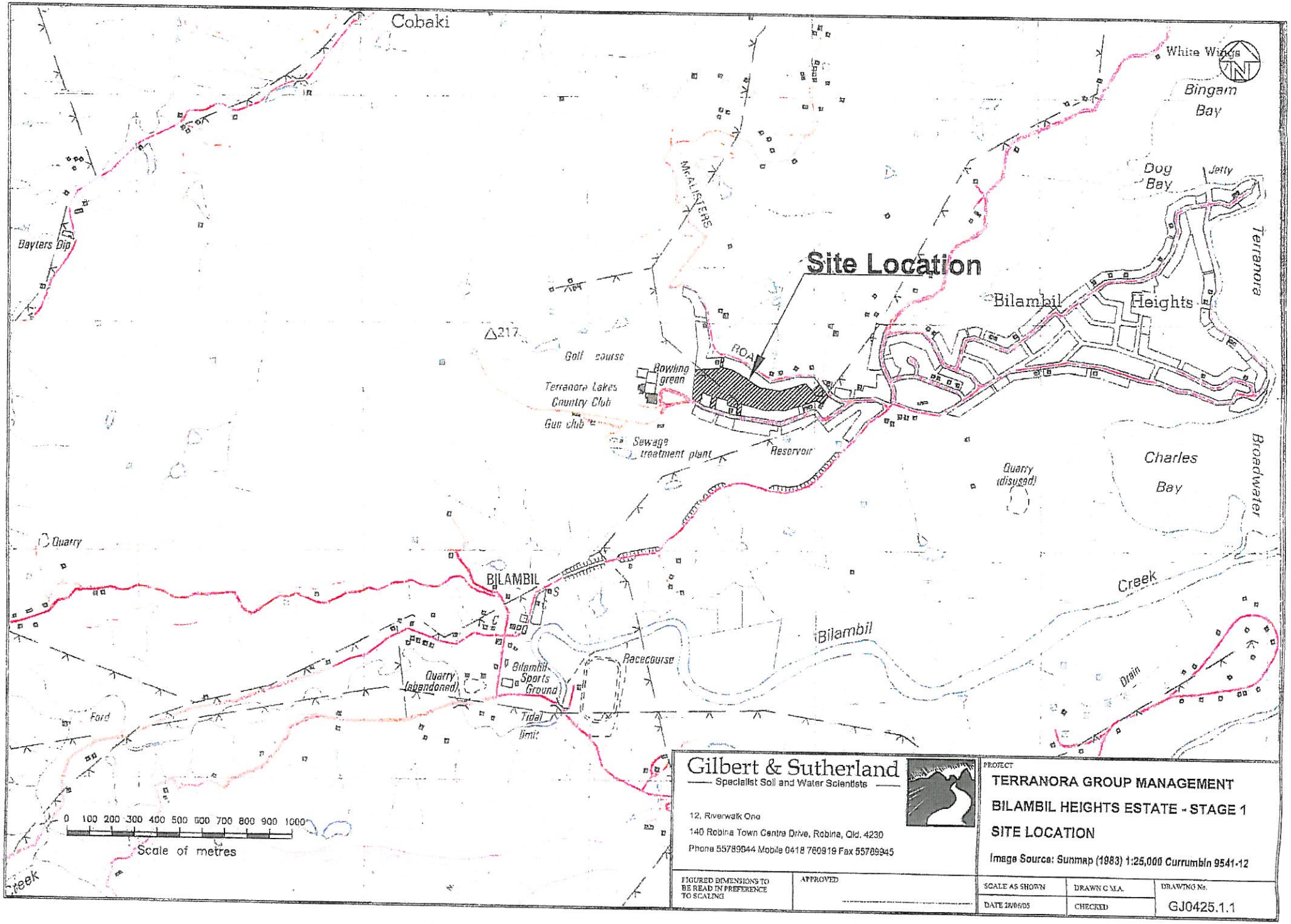
Based on the observations of the site inspection, historical aerial photography review and an interview with an employee conversant with site history, Gilbert & Sutherland provides the following recommendations:

- The 1962 aerial photograph and anecdotal evidence indicated the site was most likely part of a dairy operation at this time. There is a possibility there could have been some cropping on the site at some stage, previous to the development of the golf course, which historical investigations have not been able to identify. It is therefore recommended that a stage 2, detailed site investigation should include a transect from McAlisters Road to the eastern edge of the golf course with samples recovered at 15m intervals. Samples should then be analysed for OC and OP concentrations. If laboratory results indicate the presence of OC or OP concentrations then further investigation of the site would be recommended to delineate the extent of contamination.

- As OC's and OP's were used on golf greens, it is recommended that as part of a stage 2, detailed site investigation, all golf course greens within the site undergo systematic sampling and analysis for OC's and OP's. Sampling should be undertaken in accordance with *Australian Standard 4482.1 – 1997 Guideline to the sampling and investigation of potentially contaminated soil, Part 1: Non – Volatile and semi volatile compounds*. This has now been commissioned.

- A stockpile of rocks and a small amount of miscellaneous waste material was identified at the northern portion of the site. It is likely that this material originated from clearing of the land during the construction of the golf course and could include some remnants from previous structures on, or in the vicinity of, the site. It is therefore recommended that the contents be further investigated, catalogued and sampled for asbestos, arsenic, OC and OP compounds to establish the contaminant potential. This would be done as part of a stage 2, detailed site investigation. Based on these results, further inspection may be required during the excavation of the stockpiled area and representative samples collected and analysed for contaminants by suitable qualified scientists. These actions would confirm whether or not the stockpile material was free of likely contaminants.

Appendix A Drawings


Cobaki
White Wings
Bingam Bay
Dog Bay
Jetty
Bayters Dip
McALISTERS
Site Location
Bilambil Heights
Terranora
△217
Golf course
Bowling green
Terranora Lakes Country Club
Gun club
Sewage treatment plant
Reservoir
Quarry (disused)
Charles Bay
Broadwater
Quarry
BILAMBIL
Creek
Bilambil
Racecourse
Quarry (abandoned)
Bilambil Sports Ground
Tidal limit
Ford
Drain
0 100 200 300 400 500 600 700 800 900 1000
Scale of metres
Gilbert & Sutherland
Specialist Soil and Water Scientists
12, Riverwalk One
140 Robina Town Centre Drive, Robina, Qld. 4230
Phone 55789944 Mobile 0418 760919 Fax 55789945
PROJECT
TERRANORA GROUP MANAGEMENT
BILAMBIL HEIGHTS ESTATE - STAGE 1
SITE LOCATION
Image Source: Sunmap (1983) 1:25,000 Currumbin 9541-12
FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING
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SCALE AS SHOWN
DRAWN C.M.A.
DRAWING No.
DATE 28/06/05
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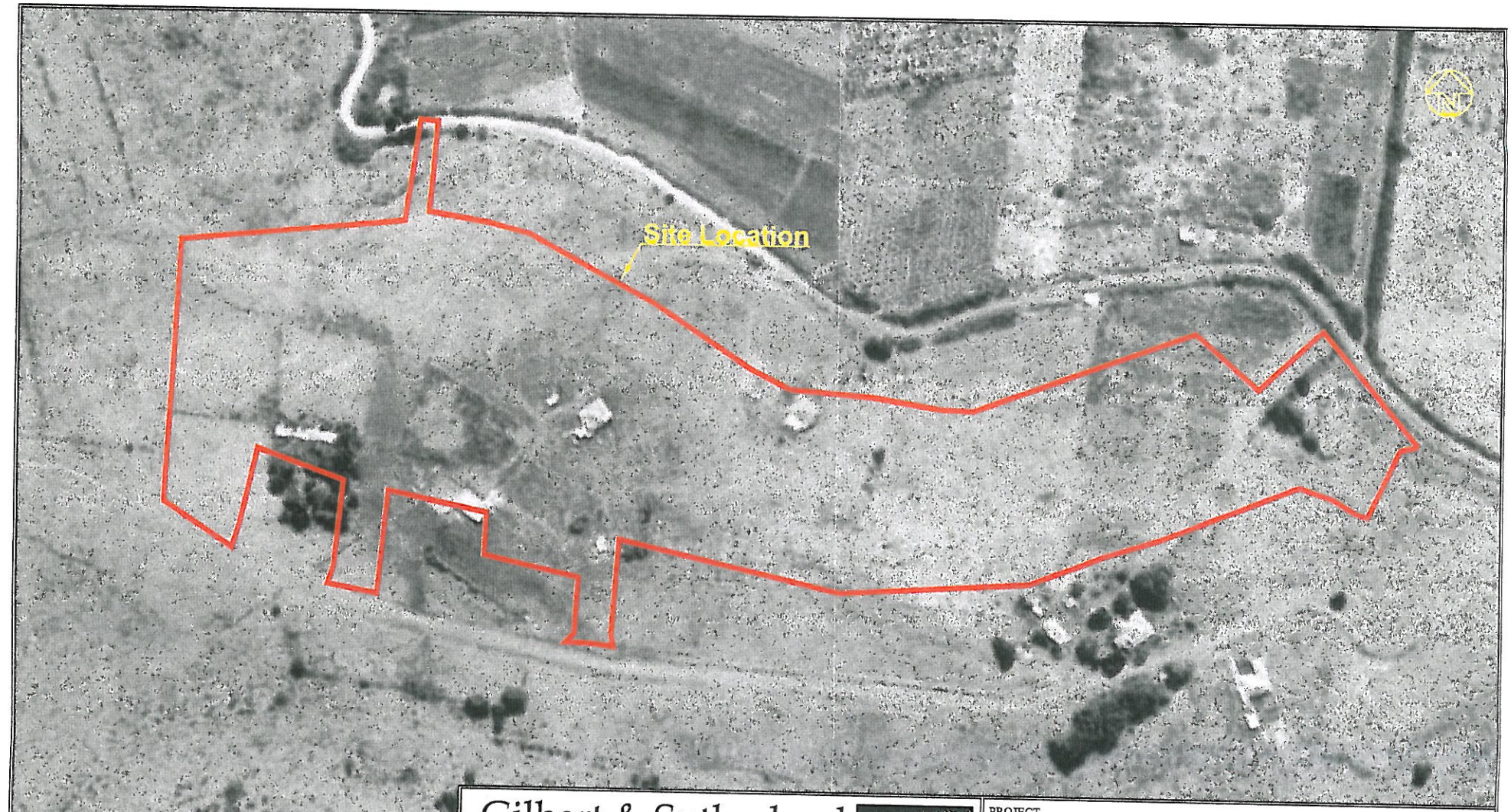
GJ0425.1.1



Gilbert & Sutherland
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PROJECT

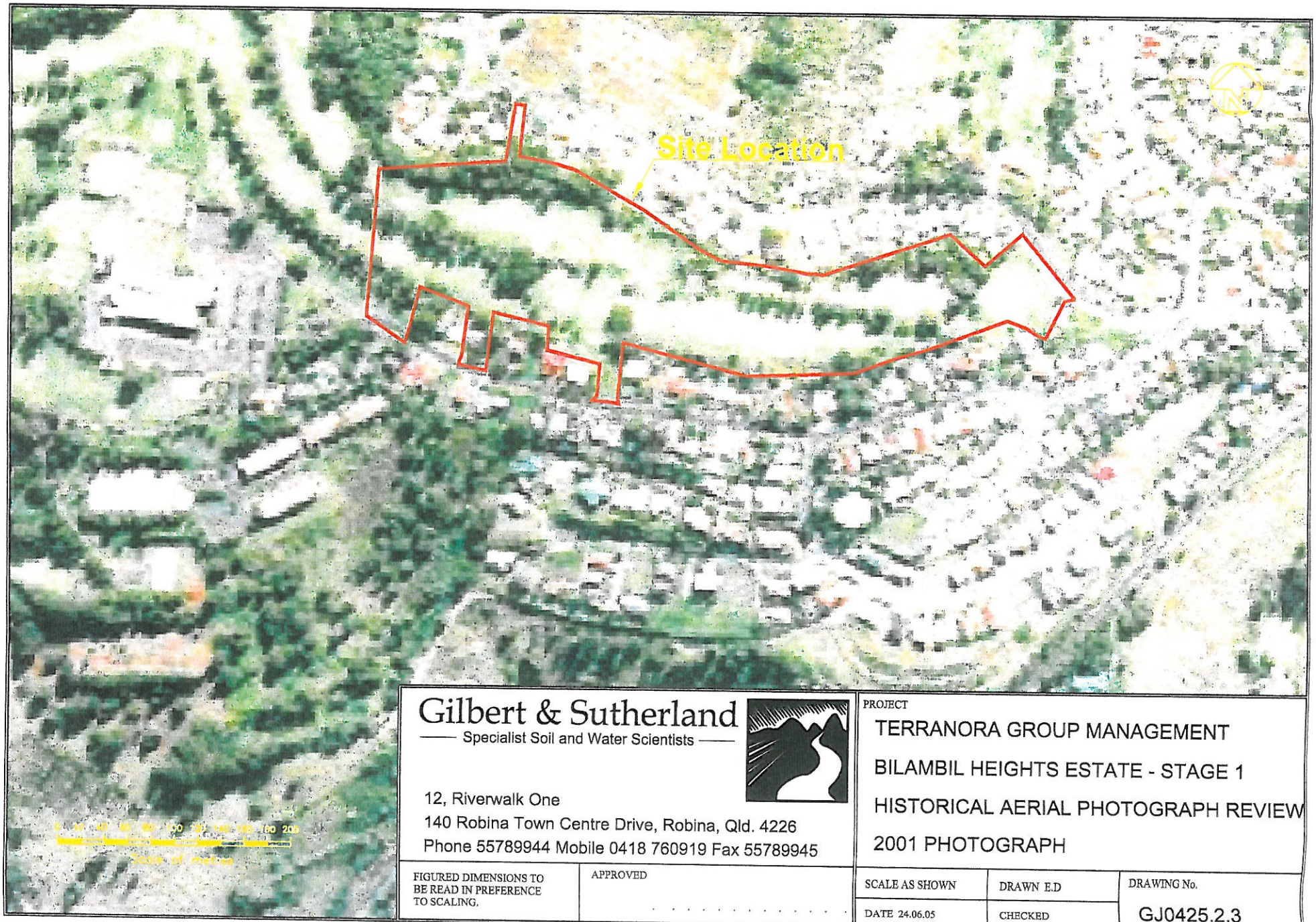
TERRANORA GROUP MANAGEMENT

BILAMBIL HEIGHTS ESTATE STAGE -1

HISTORICAL AERIAL PHOTOGRAPHY

1962 PHOTOGRAPH

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	
SCALE AS SHOWN	DRAWN E.D	DRAWING No.
DATE 24.06.05	CHECKED	GJ0425.2.2



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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT

TERRANORA GROUP MANAGEMENT

BILAMBIL HEIGHTS ESTATE - STAGE 1

HISTORICAL AERIAL PHOTOGRAPH REVIEW

2001 PHOTOGRAPH

SCALE AS SHOWN	DRAWN E.D	DRAWING No.
DATE 24.06.05	CHECKED	GJ0425.2.3

Appendix B Current & historical titles

*** END OF SEARCH ***

GJ0425.2 PRINTED ON 29/6/2005

LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

29/6/2005 10:56AM

FOLIO: 5/822786

First Title(s): VOL 733 FOL 137 VOL 1841 FOL 204
VOL 1850 FOL 186 VOL 1956 FOL 146
VOL 2018 FOL 172 VOL 2011 FOL 232
VOL 2149 FOL 185 VOL 2197 FOL 144
VOL 2209 FOL 118 VOL 4728 FOL 175
VOL 11608 FOL 153
Prior Title(s): 4/712605

Recorded	Number	Type of Instrument	C.T. Issue
15/9/1993	DP822786	DEPOSITED PLAN	LOT RECORDED FOLIO NOT CREATED
25/11/1993	DP822786	DEPOSITED PLAN	FOLIO CREATED CT NOT ISSUED
27/9/1996	2493347	DISCHARGE OF MORTGAGE	
27/9/1996	2493349	TRANSFER	
27/9/1996	2493350	MORTGAGE	EDITION 1
23/10/1996	DP862986	DEPOSITED PLAN	
30/9/1997	3455178	CAVEAT	
8/1/1998	3614123	REQUEST	
8/1/1998	3703456	WITHDRAWAL OF CAVEAT	

*** END OF SEARCH ***

GJ0425.2 PRINTED ON 29/6/2005

LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 5/822786

SEARCH DATE	TIME	EDITION NO	DATE
29/6/2005	10:59 AM	1	27/9/1996

LAND

LOT 5 IN DEPOSITED PLAN 822786
AT BILAMBIL
LOCAL GOVERNMENT AREA: TWEED
PARISH OF TERRANORA COUNTY OF ROUS
TITLE DIAGRAM: DP822786

FIRST SCHEDULE

TERRANORA GROUP MANAGEMENT PTY LIMITED (T 2493349)

SECOND SCHEDULE (8 NOTIFICATIONS)

1. LAND EXCLUDES MINERALS AND IS SUBJECT TO RESERVATIONS AND CONDITIONS IN FAVOUR OF THE CROWN - SEE CROWN GRANT(S)
2. DP252868 EASEMENT TO PUMP WATER APPURTENANT TO THE PART OF THE LAND ABOVE DESCRIBED SHOWN SO BENEFITED IN DP712605
3. DP252868 RIGHT OF CARRIAGEWAY APPURTENANT TO THE PART OF THE LAND ABOVE DESCRIBED SHOWN SO BENEFITED IN DP712605
4. DP594397 RIGHT OF CARRIAGEWAY AFFECTING THE PART OF THE LAND ABOVE DESCRIBED SHOWN SO BURDENED IN DP594397 (SEE R486212)
5. T241908 EASEMENT FOR WATER SUPPLY AND ACCESS AFFECTING THE PART OF THE LAND ABOVE DESCRIBED SHOWN SO BURDENED IN DP712605
6. DP641769 EASEMENT FOR UNDERGROUND POWER RETICULATION APPURTENANT TO THE LAND ABOVE DESCRIBED
7. 2493350 MORTGAGE TO COMMONWEALTH BANK OF AUSTRALIA
* 8. DP862986 EASEMENT TO DRAIN WATER 4 WIDE APPURTENANT TO THE LAND ABOVE DESCRIBED

NOTATIONS

UNREGISTERED DEALINGS: PE DP1085109.

*** END OF SEARCH ***

GJ0425.2

PRINTED ON 29/6/2005

CITEC hereby certifies that the information contained in this document has been provided electronically by the Registrar-General in accordance with section 96-B (2) of the Real Property Act, 1900.

13) Appendix 4 – Stage 2 Site Investigation, Marana Street, Bilambil Heights, 2006

GILBERT+SUTHERLAND
agricultural and environmental scientists

Stage 2 – Site Investigation

Marana Street,
Bilambil Heights
New South Wales

Prepared for

Terranora Group Management

January 2006

Document control

Document:	**GJ0425.CA2.RAA2D.doc**	Gilbert & Sutherland P/L ABN 56 077 310 840
Title:	**Stage 2 – Site Investigation, Marana St Bilambil Heights**	Originating Office: Robina
Project Manager:	Neil Sutherland	Riverwalk One 12/140 Robina Town Centre Drive, Q4230 PO Box 4115, Robina Q4230 Telephone 07 5578 9944 Facsimile 07 5578 9945 gsrobina@bigpond.com
Author:	Adam Anderson	
Client:	Terranora Group Management	
Client Contact:	Godfrey Mantle	
Client Reference:	Pacific Heights	Also at Kawana and Brisbane
Synopsis:	A Stage 2 – Detailed Site Investigation to establish the contamination status of potentially contamination areas identified in the Stage 1 – Preliminary Site Investigation.	

Revision History

Revision #	Date	Edition By		Approved By	
1	16.01.06	Adam Anderson		Nathan Surig	

Distribution

	Revision Number									
Distribution	1	2	3	4	5	6	7	8	9	10

Table of contents

Summary

Gilbert & Sutherland Pty Ltd was commissioned by Terranora Group Management to undertake a Stage 2 Site Investigation at the site of the proposed Bilambil Heights Estate, Stage 1 residential development on Marana Street, Bilambil, New South Wales. This investigation, which follows an August, 2005 "Stage 1 Preliminary Site Investigation" also by Gilbert & Sutherland, was undertaken to determine the contamination status of the site.

The preliminary site investigation had identified the possibility of past cropping activities on the site. Through this Stage 2 investigation, further site history was gathered and a sampling program was undertaken to determine whether the site would be suitable for the proposed residential development.

The results of the additional site history investigations found the site had operated as a dairy farm prior to development as a golf resort. Dairy farm operations did not include cattle dipping or milking onsite and no cropping took place on the site.

The sampling program focused on the golf course greens, a downgradient discharge area and an area of stockpiled material. The analytical results found that no contaminant concentrations exceeded either the environmental or health based industry guidelines. However, low concentrations of dieldrin were identified on golf course greens. This confirmed anecdotal accounts that chemicals were applied to the golf course.

Based on sample results and analysis, the Stage 2 Site Investigation indicated no sample concentrations exceeded either the health-based or environmental investigation levels. It is therefore considered that contamination of the site is negligible and the site is suitable for the proposed residential development.

1) Introduction

Gilbert & Sutherland Pty Ltd was commissioned by Terranora Group Management to undertake a Stage 2 Site Investigation of the proposed Bilambil Heights Estate, Stage 1. The site is located on Marana Street, Bilambil, New South Wales, which is shown in Drawing GJ0425.1.1.

This report follows the Stage 1 Preliminary Site Investigation undertaken by Gilbert & Sutherland in August 2005, which identified the possibility of a history of contaminating activities at the site. It is proposed that the site would be developed for residential allotments.

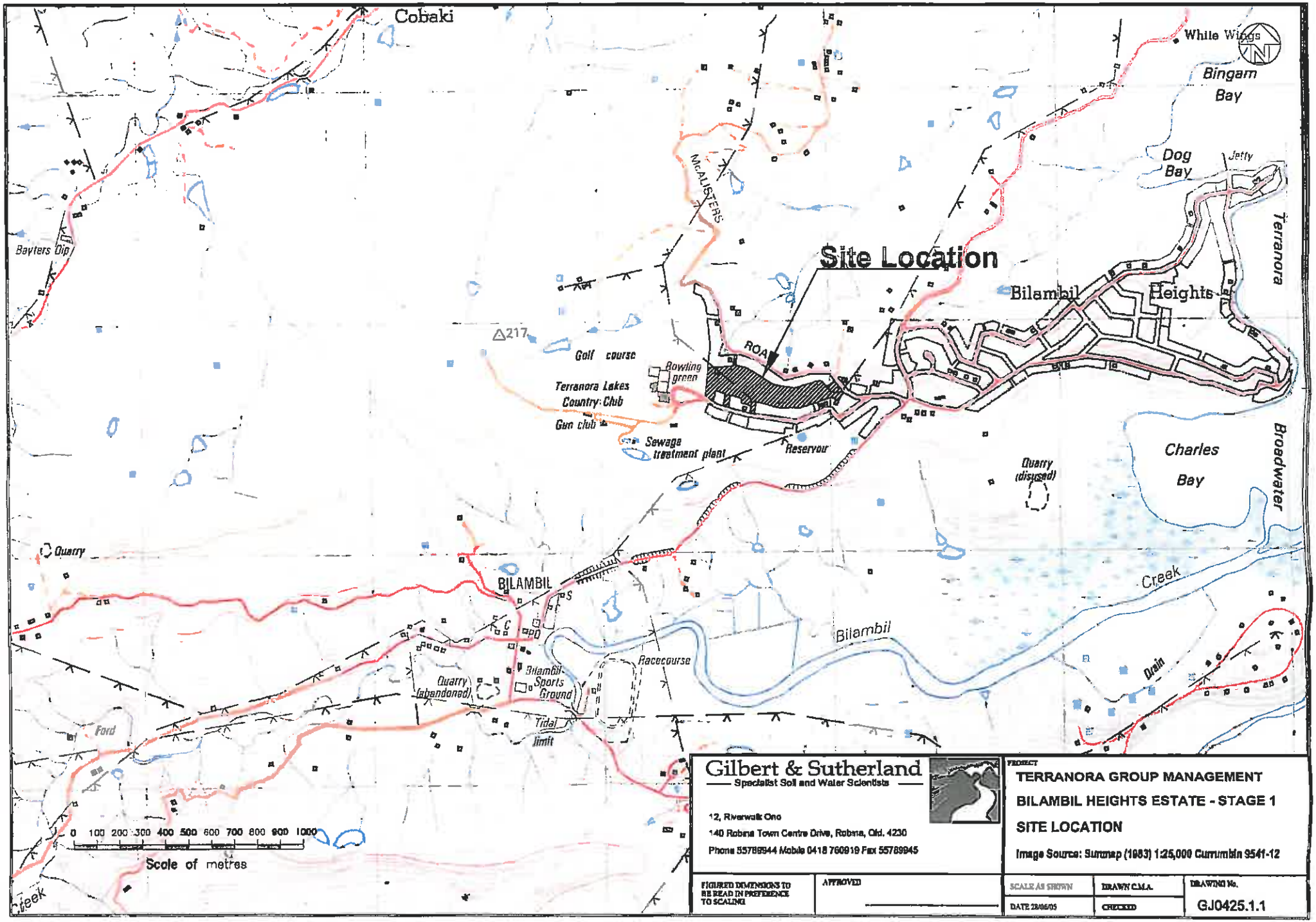
1.1 Objective and scope of work

The objective of this project was to undertake a detailed investigation to establish the contamination status of potentially contaminated areas identified in the Stage 1 Preliminary Site Investigation. These areas included a stockpile of rocks and miscellaneous waste, golf greens and other areas identified as possibly supporting small crops at some time in their history. The works undertaken during the Stage 2 Site Investigation were based upon the following guidelines:

- NSW EPA (1995), Contaminated Sites, Sampling Design Guidelines.
- NSW EPA (1997), Contaminated Sites, Guidelines for Consultants Reporting on contaminated Sites.
- Australian Standard 4482.1-1997 Guide to the sampling and investigation of potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds.

The Preliminary Site Investigation (Stage 1) identified the possibility of some past cropping activities having taken place on the site. This stage 2 investigation involved soil sampling and the gathering of further anecdotal information to address the following objectives:

- to assess the nature, severity and extent of potential contaminants associated with the subject site,
- to determine if the subject site is suitable for the proposed use,
- to assess the need for any further investigations; and
- if required, to provide options for the remediation of any contaminated areas of the site.



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PROJECT
TERRANORA GROUP MANAGEMENT
BILAMBIL HEIGHTS ESTATE - STAGE 1
SITE LOCATION
Image Source: Sunmap (1983) 1:25,000 Currumbin 9541-12

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING | APPROVED

SCALE AS SHOWN	DRAWN C.M.A.	DRAWING No.
DATE 28/06/05	CHECKED	GJ0425.1.1

2) Method

2.1 Property description

The site is accessible via both Marana Street and the Terranora Golf Resort, and forms the eastern end of the Resort's golf course. The site is bounded to the north, east and south by existing development and to the west by the Terranora Golf Resort. A significant area of banana plantation is present beyond the strip of development to the north of the site. A summary of the relevant property details is provided in Table 2.1.

Table 2.1 – Summary of property details

Description	Information
Land title	Lot 32 on DP 1085109 County of Rous, Parish of Terranora and Local Authority of Tweed
Location	Marana Street, Bilambil Heights, New South Wales
Area	6.96 hectares
Registered owner	Terranora Group Management Pty Limited
Local Government	Tweed Shire Council
Current land zoning	Residential

2.2 Environmental and health based investigation threshold levels

As the proposed development for the site includes the construction of residential allotments, the following guidelines were utilised as a basis for comparison of analytical soil results attained from the field investigations:

- National Environment Protection Council (1999), National Environment Protection (Assessment of Site Contamination) Schedule B (7a) Guidelines on Health-Based Investigation Levels.
- National Environment Protection Council (1999), National Environment Protection (Assessment of Site Contamination) Schedule B (1) Guidelines on the Investigation Levels for Soil and Groundwater.
- NSW EPA (1997), Contaminated Sites, Guidelines for Consultants Reporting on Contaminated Sites.

The health-based investigation levels (HIL's) and phytotoxicity-based or environmental investigation levels (EIL's) for frequently occurring substances are shown in the table below. To comply with the relevant guidelines, consideration must be given to the future use of areas within the site where the concentration/(s) of substances are found to exceed one or more of the HIL's/EIL's described in Table 2.2.

2.3 Fieldwork investigation program

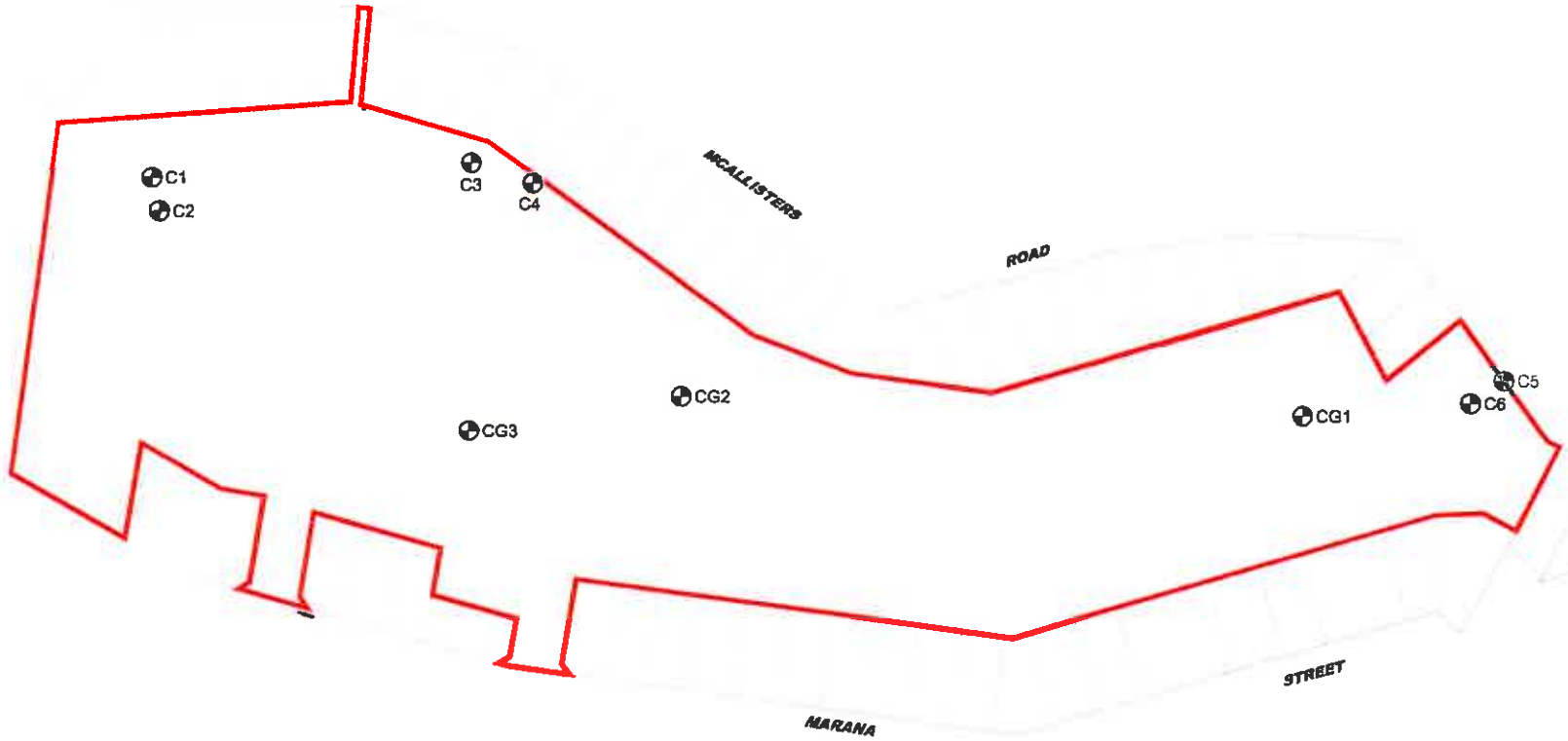
Fieldwork investigations were undertaken by Gilbert & Sutherland on September 13, 2005. Surface soil samples (0.05m-0.15m) were retrieved to determine the type, distribution and concentration of potential contaminants in the soil. Samples were obtained using a turf corer. The corer was decontaminated and rinsed using standard environmental decontamination procedures for the purpose of limiting cross contamination potential.

Sample location areas were identified in the Preliminary Site Investigation based on the likelihood of previous cropping activity. Samples were taken from the three greens (CG1, CG2 and CG3) as they were identified as potential areas of contamination. The location of these sampling points have been included in Drawing GJ0425.2.5, at the end of this section.

Table 2.2 Analyte thresholds (mg/kg).

Analyte	Background ranges	EIL's	HIL's[A]	HIL's[B]
Metals/Metalloids				
Arsenic	1 – 50	20	100	200
Lead	2 - 200	300	300	600
Organics				
Aldrin + Dieldrin (A+D)	-	-	10	20
Chlordane	-	-	50	100
DDT + DDD + DDE	-	-	200	400
Heptachlor	-	-	10	20

Notes
EIL's - Environmental Investigation Levels
HIL's[A] - Health Based Investigation Thresholds of Residential Sites
HIL's[B] - Health Based Investigation Thresholds of Parks and Recreational Open Spaces



Site boundary

Sample locations

0 10 20 30 40 50 60 70 80 90 100

Scale of metres

GILBERT+SUTHERLAND
agricultural and environmental scientists

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Phone 55789944 Mobile 0418 760918 Fax 55789945

PROJECT

TERRANORA GROUP MANAGEMENT
BILAMBIL HEIGHTS ESTATE - STAGE 2
SITE INVESTIGATION
SOIL SAMPLING LOCATIONS

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING	APPROVED	SCALE AS SHOWN	DRAWN A.L.A.
		DATE 10.05.05	CHECKED

DRAWING No. GJ0425.2.5

For the remainder of the site, six additional samples were taken. A stratified sampling pattern was adopted for these samples. Two samples (C1 and C2) were taken from the north western portion of the site in the shallow natural gully, where surface waters would be expected to drain. Additional samples (C5 and C6) were retrieved from the far eastern portion of the site on the north-eastern facing slope, which is adjacent to significant areas of cropping. Samples (C3 and C4) were taken from the stockpile of rock in the northern portion of the site. The location of these sampling points, have been identified in Drawing GJ0425.2.5, at the end of this section.

All samples were collected in pretreated laboratory supplied containers and bottles and immediately placed into a chilled esky prior to delivery to the laboratory. Sample analysis was performed by Australian Laboratory Services (ALS) which is NATA accredited for the analysis undertaken in this investigation.

2.4 Laboratory analytical program

All soil samples were analysed for lead, arsenic, organochlorine (OC's) and organophosphorus (OP's) pesticides. Summaries of the laboratory results for the subject site are shown in the following sections and the laboratory certificates are attached in Appendix A.

3) Results

3.1 Geology and soils

A review of the Geological Survey of Queensland 1:100,000 Geology series - Murwillumbah indicates that the site is underlain by soils of the Cainozoic period, which are largely comprised of Lamington Group basalt flows.

Field observations, in addition to those carried out as part of this assessment, were recorded by Gilbert & Sutherland staff undertaking fieldwork for a separate stormwater management investigation. Borehole soil samples from the stormwater management investigation showed that the shallow geology of the site was characterised by a shallow surface layer of loamy soil (0.05m ~ 0.1m) underlain by silty clay, with some gravels appearing after 0.4m below near surface level. The subsurface investigation was limited to a depth of 0.6m.

3.2 Hydrogeology

No groundwater was intercepted during the fieldwork for this assessment or during the construction of the boreholes constructed as part of investigations for the stormwater management plan.

3.3 Topography and drainage

The site is characterised as an elevated portion of a ridge with elevation ranging between 145m and 160m Australian Height Datum (AHD). The investigation area largely slopes towards the north east with limited artificial undulations constructed as features incorporated into the golf course (bunkers, tees and greens). The site is generally gently sloped (approximately 3%), however the site also features moderately inclined to steep (approximately 20% to 40%)[1] regions located along the northern boundary of the investigation area.

Overland surface water flow traverses the site from the elevated south western portion of the site towards the north and to the east towards McAlisters Road.

3.4 Site history

A site history was obtained through interviews with people who had been living in the area for up to 50 years. The following information was aquired.

The Preliminary Site Investigation for this site reported an interview with Mr Bill Clarke. Mr Clarke's association with the site commenced in 1982 and he is currently employed as a greenkeeper at the Resort. A summary of this interview is as follows:

- The golf course was developed approximately 45 years ago,
- The site was previously a dairy farm,
- Chemicals possibly used 20 years ago included Dieldrin, chlorpyrifos, and various fungicides,
- Imported sand from Redlands Shire, Kingscliff and Tumbulgum was used for bunker and drainage development,
- A stockpile of rocks, thought to have accumulated during fairway development was present when Mr Clarke commenced employment.

A further interview was held with Mr Albert Garbell as part of the Stage 2 Site Investigation. Mr Garbell has lived in the area for about 50 years. The following is a summary of Mr Garbell's knowledge of the site:

- The site was a dairy farm prior to being developed as a golf resort,
- No dipping or milking areas existed on the site,
- No cropping took place on the site.

3.5 Laboratory results

Summaries of the laboratory results are presented within the table below and the laboratory documentation is attached in Appendix A. Results exceeding EIL's are shown in bold type and HIL' s are shown in bold type with shading.

[1] R.c.Mcdonald, R.F.Isbell, J.G.Speight, J.Walker and M.S.Hopkins (1990) Australian Soil and land Survey, Fleld Hand book. Second Edition. Inkata Press. Melbourne & Sydney.

Table 3.5 - Summary of laboratory results (mg/kg).

Sample	As	Pb	∑ OP's	Aldrin + Dieldrin	Chlordane (total)	DDT + DDD + DDE	Heptachlor (total)
C1	**<LOR**	**10**	**<LOR**	**<LOR**	<LOR	**<LOR**	<LOR
C2	<LOR	**14**	<LOR	**<LOR**	<LOR	**<LOR**	<LOR
C3	<LOR	**14**	<LOR	**<LOR**	**<LOR**	**<LOR**	<LOR
C4	**<LOR**	**11**	**<LOR**	**<LOR**	<LOR	<LOR	<LOR
C5	<LOR	**20**	**<LOR**	<LOR	**<LOR**	**<LOR**	<LOR
C6	**<LOR**	27	**<LOR**	**<LOR**	**<LOR**	<LOR	<LOR
CG1	**9**	**<LOR**	<LOR	**8.76**	**0.15**	**0.22**	<LOR
CG2	**<LOR**	**<LOR**	<LOR	**3.83**	**<LOR**	**<LOR**	<LOR
CG3	**<LOR**	<LOR	**<LOR**	**4.54**	<LOR	<LOR	<LOR

Notes:
Bold indicates an exeedence of the Environmental Investigation Level
Bold and shaded indicates an exeedence of the Health Based Investigation for Residential areas
LOR: limit of reporting

The analytical results are summarised below.

- Arsenic – concentrations ranged from below the ALS limit of reporting (1mg/kg) to 9mg/kg. None of these samples exceeded the health-based investigation levels (20mg/kg).
- Lead – concentrations ranged from below the ALS limit of reporting (1mg/kg) to 27mg/kg. None of these samples exceeded the health-based investigation levels (300mg/kg).
- Organophosphorus pesticides – none of these samples exceeded the limit of reporting (0.05mg/kg).
- Aldrin & dieldrin – concentrations ranged from below the ALS limit of reporting (0.05mg/kg for both) to 8.76mg/kg. Although none of these samples exceed the health-based investigation levels, dieldrin levels were slightly elevated. It is expected the dieldrin would be a result of previous applications of pesticides to the greens exclusively (as confirmed by anecdotal evidence).
- Chlordane (total)– concentrations ranged from below the ALS limit of reporting (0.05mg/kg) to 0.15mg/kg. None of these samples exceeded the health-based investigation levels (50mg/kg).
- DDT + DDD + DDE – concentrations ranged from below the ALS limit of reporting (0.05mg/kg) to 0.22mg/kg. None of these samples exceeded the health-based investigation levels (200mg/kg).
- Heptachlor (total) – none of these samples exceeded the limit of reporting (0.05mg/kg).

4) Conclusions

Based on the analytical results of samples recovered and analysed during the Stage 2 Site Investigation, none of the samples exceeded either the health-based or environmental investigation levels for any of the analytes tested. Dieldrin levels were slightly elevated on some of the greens, but as previously noted, levels were below the health based industry guidelines. It is expected the dieldrin recorded would have resulted from previous applications which were exclusively to the putting greens (as confirmed by anecdotal evidence).

As there was very little contamination found in the soils samples it is considered unlikely that any groundwater that may be present would be contaminated.

5) Recommendations

No site remediation is required for the proposed residential development.

6) Limitations of reporting

Gilbert & Sutherland Pty Ltd has attempted to be accurate in providing the information contained in this report. The interpretation of scientific data, however, often involves professional judgement. As such, interpretation is open to error.

In recognising the potential for errors in scientific interpretation, Gilbert & Sutherland Pty Ltd does not guarantee that the information is totally accurate or complete and clients are advised not to rely solely on this information when making commercial decisions. Any representation, statement, opinion or advice, expressed or implied is made in good faith and on the basis that the authors, Gilbert & Sutherland Pty Ltd, their agents or employees are not liable (whether by reason or lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Furthermore, this information should not be relied upon by any other persons than the client for whom this information was compiled. This information reflects the specific brief and the budget of the client concerned, who enjoys an individual tolerance of risk.

7) Statutory declaration

(INVESTIGATOR AND VALIDATION REPORT PREPARER)

Address of Site Investigated:	Marana Street, Bilambil Heights New South Wales.
Real Property Description:	Lot 32 on DP 1085109 County of Rous, Parish of Terranora and Local Authority of Tweed
Title of Report:	Stage 2 - Detailed Site Investigation

I, Neil Sutherland, of Gilbert and Sutherland Pty Ltd, PO Box 4115 Robina Queensland 4230, do solemnly and sincerely declare that;

- I was the investigator of the report described above;
- I am a member of the Environment Institute of Australia and my qualifications and experience as outlined in my Curriculum Vitae (attached as Appendix F) are relevant to this investigation;
- I have not knowingly included any false, misleading or incomplete information in the report;
- I have not knowingly failed to reveal any relevant information or document to any administering authority; and

I certify that:

- The report addresses the relevant matters for the investigation and is factually correct; and
- The opinions expressed in it are honestly and reasonably held.

And I make this solemn declaration conscientiously believing the same to be true and by the virtue of the provisions of the Oaths Act 1867.

Signature

Name:

Declared at the

day of 20

Before me

Witness (Justice of the Peace/Commissioner for Declarations)

8) Appendix 1 – Analytical results and laboratory documentation

CHAIN OF CUSTODY DOCUMENTATION

Client	Gilbert and Sutherland	**For:**	Australian Laboratory Services
Postal Address:	PO Box 4115, Robina QLD 4230	**Address:**	32 Shand Street, Stafford, Q4053
Send Report to:	Adrian Stackman	**Send Invoice to:**	D. Endres (Robina)
Tel:	073 243 7222		
Data Needed By:		**Report Needed By:**	
Fax:	073 243 7218		
G&S Project ID:	GJ0425	**Quote Number:**	

Comments:

Sample ID	Matrix	Date	Time	Type and Pres	Arsenic	lead	OC's	OP's	Notes:
1 C1	Soil	13.09.05		J	/	/	/	/	
2 C2	Soil	13.09.05		J	/	/	/	/	
3 C3	Soil	13.09.05		J	/	/	/	/	
4 C4	Soil	13.09.05		J	/	/	/	/	
5 C5	Soil	13.09.05		J	/	/	/	/	
6 C6	Soil	13.09.05		J	/	/	/	/	
7 CG1	Soil	13.09.05		J	/	/	/	/	
8 CG2	Soil	13.09.05		J	/	/	/	/	
9 CG3	Soil	13.09.05		J	/	/	/	/	

ALS Environmental
Brisbane
Work Order
EB0508293

Telephone : 61-7-32437222

Relinquished by:
Name: Adrian Stackman
of: Gilbert & sutherland
Date: 21.07.05
Time:

Received by:
Name:
of: ALS
Date: 14/9
Time: 16-20

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	:	**GILBERT & SUTHERLAND PTY LTD**	**Laboratory**	:	ALS Environmental Brisbane	**Page**	: **1 of 6**
Contact	:	MR ADRIAN STACKMAN	**Contact**	:	Michael Heery		
Address	:	P O BOX 4115 ROBINA QLD AUSTRALIA 4230	**Address**	:	32 Shand Street Stafford QLD Australia 4053	**Work order**	: **EB0508293**
Project	:	GJ0425	**Quote number**	:	Bkt Disc.	**Date received**	: 14 Sep 2005
Order number	:	- Not provided -				**Date issued**	: 22 Sep 2005
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	gsrobina@bigpond.com	**E-mail**	:	Michael.Heery@alsenviro.com	**No. of samples**	
Telephone	:	07 5578 9944	**Telephone**	:	61-7-32437222	**Received**	: 9
Facsimile	:	07 5578 9945	**Facsimile**	:	61-7-32437259	**Analysed**	: 9

This final report for the ALSE work order reference EB0508293 supersedes any previous reports with this reference.
Results apply to the samples as submitted. All pages of this report have been checked and approved for release.
This report contains the following information:

- Analytical results for samples submitted
- Surrogate control limits

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory - 825

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

Accredited for compliance with ISO/IEC 17025.

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Amanda Conkle	Organics - NATA 818 (Brisbane)
Kim McCabe	Inorganics - NATA 818 (Brisbane)

ALS Environmental

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits).
Abbreviations: ***CAS number*** = *Chemical Abstract Services number,* ***LOR*** = *Limit of Reporting.* ***# Indicates a raised LOR, * Indicates failed Surrogate Recoveries.***
When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Analytical Results

				Client Sample ID :	C1	C2	C3	C4	C5
				Sample Matrix Type / Description :	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL
				Sample Date / Time :	13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00
				Laboratory Sample ID :	EB0508293-001	EB0508293-002	EB0508293-003	EB0508293-004	EB0508293-005
Analyte	*CAS number*	*LOR*	*Units*						
EA055: Moisture Content									
Moisture Content (dried @ 103°C)		1.0	%		31.2	20.1	33.9	15.5	<1.0
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		10	14	14	11	20
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
4,4'-DDE	72-55-9	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Endrin	72-20-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
4,4'-DDD	72-54-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
4,4'-DDT	50-29-3	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Endrin ketone	53494-70-5	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	72-43-5	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	60-51-5	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Diazinon	333-41-5	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: C1 Sample Matrix Type / Description: SOIL / SOIL Sample Date / Time: 13 Sep 2005 15:00 Laboratory Sample ID: EB0508293-001	C2 SOIL / SOIL 13 Sep 2005 15:00 EB0508293-002	C3 SOIL / SOIL 13 Sep 2005 15:00 EB0508293-003	C4 SOIL / SOIL 13 Sep 2005 15:00 EB0508293-004	C5 SOIL / SOIL 13 Sep 2005 15:00 EB0508293-005
EP068B: Organophosphorus Pesticides (OP)								
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Methyl Azinphos	86-50-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE		0.1	%	88.6	87.3	93.0	96.2	95.6
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	92.5	93.8	82.8	84.1	84.8

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: C6	CG1	CG2	CG3	
Sample Matrix Type / Description:				SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	
Sample Date / Time:				13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00	
Laboratory Sample ID:				EB0508293-006	EB0508293-007	EB0508293-008	EB0508293-009	
EA055: Moisture Content								
Moisture Content (dried @ 103°C)		1.0	%	13.3	10.8	11.2	14.4	
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	9	<5	<5	
Lead	7439-92-1	5	mg/kg	27	<5	<5	<5	
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	<0.05	0.06	
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	0.07	<0.05	<0.05	
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	0.08	<0.05	<0.05	
Dieldrin	60-57-1	0.05	mg/kg	<0.05	8.76	3.83	4.54	
4,4'-DDE	72-55-9	0.05	mg/kg	<0.05	0.17	<0.05	<0.05	
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
4,4'-DDD	72-54-8	0.05	mg/kg	<0.05	0.05	<0.05	<0.05	
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
4,4'-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	
Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	
Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	

ALS Environmental

Analytical Results

				Client Sample ID :	C6	CG1	CG2	CG3	
				Sample Matrix Type / Description :	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	
				Sample Date / Time :	13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00	13 Sep 2005 15:00	
				Laboratory Sample ID :	EB0508293-006	EB0508293-007	EB0508293-008	EB0508293-009	
Analyte	*CAS number*	*LOR*	*Units*						
EP068B: Organophosphorus Pesticides (OP)									
Chlorpyrifos	2921-88-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Parathion	56-38-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	
Pirimphos-ethyl	23505-41-1	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Chlorfenvinphos	470-90-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Bromophos-ethyl	4824-78-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Fenamiphos	22224-92-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Prothiofos	34643-46-4	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Ethion	563-12-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Carbophenothion	786-19-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
Methyl Azinphos	86-50-0	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE		0.1	%		84.1	79.9	87.5	81.5	
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		95.8	81.4	94.5	93.6	

Surrogate Control Limits

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL

		Surrogate Control Limits	
Method name	*Analyte name*	*Lower Limit*	*Upper Limit*
EP068: Pesticides by GCMS			
EP068S: Organochlorine Pesticide Surrogate	Dibromo-DDE	10	136
EP068T: Organophosphorus Pesticide Surrogate	DEF	10	110

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**GILBERT & SUTHERLAND PTY LTD**	**Laboratory**	: ALS Environmental Brisbane	**Page**	:	1 of 10
Contact	:	MR ADRIAN STACKMAN	**Contact**	: Michael Heery			
Address	:	P O BOX 4115 ROBINA QLD AUSTRALIA 4230	**Address**	: 32 Shand Street Stafford QLD Australia 4053	**Work order**	:	**EB0508293**
					Amendment No.	:	
Project	:	GJ0425	**Quote number**	: Bkt Disc.	**Date received**	:	14 Sep 2005
Order number	:	- Not provided -			**Date issued**	:	22 Sep 2005
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	gsrobina@bigpond.com	**E-mail**	: Michael.Heery@alsenviro.com	**No. of samples**		
Telephone	:	07 5578 9944	**Telephone**	: 61-7-32437222	**Received**	:	9
Facsimile	:	07 5578 9945	**Facsimile**	: 61-7-32437259	**Analysed**	:	9

This final report for the ALSE work order reference EB0508293 supersedes any previous reports with this reference.
Results apply to the samples as submitted. All pages of this report have been checked and approved for release.
This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

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Accredited for compliance with ISO/IED 17025

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Amanda Conkie	Organics - NATA 818 (Brisbane)
Kim McCabe	Inorganics - NATA 818 (Brisbane)

ALS Environmental

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations: LOR = Limit of Reporting, RPD = Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA055: Moisture Content						
EA055: Moisture Content - (QC Lot: 115401)				%	%	%
EB0508291-028	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	7.9	10.2	25.4
EB0508338-004	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	8.3	8.5	2.6
EA055: Moisture Content - (QC Lot: 115704)				%	%	%
EB0508269-007	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	20.9	20.9	0.0
EB0508293-005	C5	Moisture Content (dried @ 103°C)	1.0 %	<1.0	7.7	154
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 116134)				mg/kg	mg/kg	%
EB0508268-034	Anonymous	Arsenic	5 mg/kg	11	10	13.5
		Lead	5 mg/kg	72	60	17.4
EB0508293-003	C3	Arsenic	5 mg/kg	<5	<5	0.0
		Lead	5 mg/kg	14	16	12.0
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 116595)				mg/kg	mg/kg	%
EB0508258-001	Anonymous	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 116595) - continued				mg/kg	mg/kg	%
EB0508258-001	Anonymous	4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EB0508293-009	CG3	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	0.06	0.06	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	4.54	4.47	1.4
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595)				mg/kg	mg/kg	%
EB0508258-001	Anonymous	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595) - continued				mg/kg	mg/kg	%
EB0508258-001	Anonymous	Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0
EB0508293-009	CG3	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595) - continued				mg/kg	mg/kg	%
EB0508293-009	CG3	Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term **Method / Laboratory Blank** refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term **Laboratory Control Sample (LCS)** refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 116134)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	---	13.8	108	70	130
	5 mg/kg	<5	---	---	---	---
Lead	5 mg/kg	<5	---	---	---	---
	5 mg/kg	---	55.5	104	70	130
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 116595)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.025 mg/kg	---	0.25	88.0	62	118
	0.05 mg/kg	<0.05	---	---	---	---
4,4'-DDE	0.025 mg/kg	---	0.25	96.4	71	111
	0.05 mg/kg	<0.05	---	---	---	---
4,4'-DDT	0.025 mg/kg	---	0.25	90.9	60	118
	0.2 mg/kg	<0.2	---	---	---	---
Aldrin	0.025 mg/kg	---	0.25	80.4	69	114
	0.05 mg/kg	<0.05	---	---	---	---
alpha-BHC	0.025 mg/kg	---	0.25	99.0	69	113
	0.05 mg/kg	<0.05		---		
alpha-Endosulfan	0.025 mg/kg	---	0.25	84.4	72	110
	0.05 mg/kg	<0.05	---	---	---	---
beta-BHC	0.025 mg/kg	---	0.25	96.2	73	110
	0.05 mg/kg	<0.05	---	---	---	---
beta-Endosulfan	0.025 mg/kg	---	0.25	98.1	69	114
	0.05 mg/kg	<0.05	---	---	---	---
cis-Chlordane	0.025 mg/kg	---	0.25	91.0	70	115
	0.05 mg/kg	<0.05	---	---	---	---
delta-BHC	0.025 mg/kg	---	0.25	85.6	71	111
	0.05 mg/kg	<0.05	---	---	---	---

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 116595) - continued		mg/kg	mg/kg	%	%	%
Dieldrin	0.05 mg/kg	<0.05	---	---	---	---
	0.025 mg/kg	---	0.25	99.3	68	116
Endosulfan sulfate	0.025 mg/kg	---	0.25	85.6	70	117
	0.05 mg/kg	<0.05	---	---	---	---
Endrin	0.025 mg/kg	---	0.25	88.3	74	109
	0.05 mg/kg	<0.05	---	---	---	---
Endrin aldehyde	0.025 mg/kg	---	0.25	86.3	58	128
	0.05 mg/kg	<0.05	---	---	---	---
Endrin ketone	0.025 mg/kg	---	0.25	93.2	65	112
	0.05 mg/kg	<0.05	---	---	---	---
gamma-BHC	0.025 mg/kg	---	0.25	97.1	75	110
	0.05 mg/kg	<0.05	---	---	---	---
Heptachlor	0.025 mg/kg	---	0.25	83.7	73	109
	0.05 mg/kg	<0.05	---	---	---	---
Heptachlor epoxide	0.025 mg/kg	---	0.25	85.3	63	116
	0.05 mg/kg	<0.05	---	---	---	---
Hexachlorobenzene (HCB)	0.025 mg/kg	---	0.25	87.9	64	115
	0.05 mg/kg	<0.05	---	---	---	---
Methoxychlor	0.025 mg/kg	---	0.25	82.1	65	112
	0.2 mg/kg	<0.2	---	---	---	---
trans-Chlordane	0.025 mg/kg	---	0.25	86.8	71	114
	0.05 mg/kg	<0.05	---	---	---	---
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.025 mg/kg	---	0.25	99.9	65	120
	0.05 mg/kg	<0.05	---	---	---	---
Bromophos-ethyl	0.025 mg/kg	---	0.25	92.1	56	137
	0.05 mg/kg	<0.05	---	---	---	---
Carbophenothion	0.025 mg/kg	---	0.25	84.9	68	122
	0.05 mg/kg	<0.05	---	---	---	---

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595) - continued		mg/kg	mg/kg	%	%	%
Chlorfenvinphos	0.025 mg/kg	---	0.25	104	57	134
	0.05 mg/kg	<0.05	---	---	---	---
Chlorpyrifos	0.025 mg/kg	---	0.25	103	71	110
	0.05 mg/kg	<0.05	---	---	---	---
Chlorpyrifos-methyl	0.025 mg/kg	---	0.25	86.4	68	115
	0.05 mg/kg	<0.05	---	---	---	---
Demeton-S-methyl	0.025 mg/kg	---	0.25	80.8	64	116
	0.05 mg/kg	<0.05	---	---	---	---
Diazinon	0.025 mg/kg	---	0.25	99.9	69	108
	0.05 mg/kg	<0.05	---	---	---	---
Dichlorvos	0.025 mg/kg	---	0.3	75.3	68	105
	0.05 mg/kg	<0.05	---	---	---	---
Dimethoate	0.025 mg/kg	---	0.25	92.1	69	112
	0.05 mg/kg	<0.05	---	---	---	---
Ethion	0.025 mg/kg	---	0.25	65.7	73	109
	0.05 mg/kg	<0.05	---	---	---	---
Fenamiphos	0.025 mg/kg	---	0.25	100	64	124
	0.05 mg/kg	<0.05	---	---	---	---
Fenthion	0.025 mg/kg	---	0.25	93.2	65	115
	0.05 mg/kg	<0.05	---	---	---	---
Malathion	0.025 mg/kg	---	0.25	94.2	68	113
	0.05 mg/kg	<0.05	---	---	---	---
Monocrotophos	0.025 mg/kg	---	0.25	63.6	53	124
	0.2 mg/kg	<0.2	---	---	---	---
Parathion	0.025 mg/kg	---	0.25	81.9	71	110
	0.2 mg/kg	<0.2	---	---	---	---
Parathion-methyl	0.025 mg/kg	---	0.25	94.1	69	110
	0.2 mg/kg	<0.2	---	---	---	---
Pirimphos-ethyl	0.025 mg/kg	---	0.25	94.6	73	110
	0.05 mg/kg	<0.05	---	---	---	---

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
				LCS	Low	High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595) - continued		mg/kg	mg/kg	%	%	%
Prothiofos	0.025 mg/kg	—	0.25	73.0	67	109
	0.05 mg/kg	<0.05	—	—	—	—

ALS Environmental

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations: LOR = Limit of Reporting, RPD = Relative Percent Difference.*

* Indicates failed QC

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EG005T: Total Metals by ICP-AES								
EG005T: Total Metals by ICP-AES - (QC Lot: 116134)				mg/kg	mg/kg	%	%	%
Arsenic	EB0508268-035	Anonymous	5 mg/kg	50.0	8	96.5	70	130
Lead			5 mg/kg	50.0	58	97.2	70	130
EP068A: Organochlorine Pesticides (OC)								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 116595)				mg/kg	mg/kg	%	%	%
gamma-BHC	EB0508258-002	Anonymous	.025 mg/kg	0.25	<0.05	88.0	70	130
Heptachlor			.025 mg/kg	0.25	<0.05	81.9	70	130
Aldrin			.025 mg/kg	0.25	<0.05	103	70	130
Dieldrin			.025 mg/kg	0.25	<0.05	81.3	70	130
Endrin			.025 mg/kg	0.25	<0.05	87.1	70	130
4,4'-DDT			.025 mg/kg	0.25	<0.2	81.8	70	130
EP068B: Organophosphorus Pesticides (OP)								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 116595)				mg/kg	mg/kg	%	%	%
Diazinon	EB0508258-002	Anonymous	.025 mg/kg	0.25	<0.05	90.5	70	130
Chlorpyrifos-methyl			.025 mg/kg	0.25	<0.05	81.6	70	130
Pirimphos-ethyl			.025 mg/kg	0.25	<0.05	81.2	70	130
Bromophos-ethyl			.025 mg/kg	0.25	<0.05	79.2	70	130
Prothiofos			.025 mg/kg	0.25	<0.05	82.5	70	130

9) Appendix 2 – Curriculum Vitae of N.M. Sutherland

Gilbert & Sutherland
Specialist Soil and Water Scientists

Neil Sutherland
Agriculture
Soils
Water quality
Environmental management

Curriculum Vitae

Name: Neil Matthew Sutherland
Contact Details: Office: 07 5578 9944, Fax 07 5578 9945, Mobile: 0418 760 919
Email: gsrobina@bigpond.com

Experience:

02/1997 – Present	**Director** and **Principal Environmental Scientist** of **Gilbert and Sutherland Pty. Ltd.**, a soil and water resource consultancy with offices in Robina, Ballina and Kawana. The firm specialises in soil and water assessments and environmental management services to miners, planners, engineers, developers, surveyors, financial institutions, farmers, statutory authorities and community groups.
10/1995 – 02/1997	**Principal Environmental Scientist**/Branch Office Manager for **Woodward-Clyde International** in Robina, Queensland, Australia. Woodward-Clyde is a firm of Environmental Scientists, Engineers and Geochemists with offices in each of the Capital Cities and overseas.
11/1990 – 10/1995	Principal of **Soil and Water Control**, a consulting firm which had offices on Mount Tamborine and in Murwillumbah offering agricultural, land and water management assessments. The firm had conducted various soil and water assessments, site contamination reports, environmental management plans, environmental impact assessments and effluent disposal designs. Soil and Water Control was purchased by Woodward-Clyde.
7/1998 – 7/1990	**Environmental adviser/Soil and Water Engineer** on The Sultan of Oman's Desert Agricultural Project, a 250 acre commercial research project in the interior desert of south Oman. Seconded to **Royal Dutch Shell Subsidiary Petroleum Development Oman**. Direct responsibilities included: soil management, salinity protection, soil assessment, monitoring and reclamation. Water supply management and water quality monitoring. Irrigation systems, irrigation agronomy and irrigation efficiency and monitoring. Responsibilities as senior staff included: workforce management, marketing, leave relief work in crop agronomy, livestock husbandry, machinery maintenance, administration.
5/1987 – 9/1987	Team member operating a pumped water supply in New South Wales, Australia.
6/1983 – 9/1983	Team member of an agricultural cultivations/harvesting operation in southern England.
7/1985 – 11/1985 6/1986 – 10/1986 2/1984 – 11/1984	Cultivations/harvester operator in northern England.
7/1981 – 9/1982	Pre-college employment on a mixed farm in southern England.
Easter 1983, 1985 and 1998	Lambing season employment on a mixed farm in central Wales.

Education And Qualifications:

Griffith University, Brisbane, Australia. **Master of Science in Environmental Management.** Areas of study included: land resources management, water resources management, social and environmental impact assessment, ecological concepts and applications, environmental planning and laws, environmental pollution and health at the University of Queensland, geographical information systems, natural resource information systems.

National College of Agricultural Engineering – Cranfield Institute of Technology, Silsoe, England. **Post-graduate Diploma in Land and Water Management.** Areas of study included: soil assessment, management and reclamation, drainage, hydrology, hydraulics, irrigation engineering, management and agronomy. Feasibility studies and project planning.

Seale-Hayne Agricultural College – Polytechnic South-West Devon, England. **BTEC Higher Diploma in Agriculture.** Areas of study included: soil science, crop production, animal production, farm management.

Colyton Grammar School, Devon, England.

Practical Skills
Acid reaction trend soil assessment
Arable Cultivations, Husbandry and Harvesting
Computing Experience
Environmental Impact Assessment
Environmental Planning
Grasslands Management
Irrigation System Assessment
Land Resource Assessment
Livestock Husbandry
Machinery Operation, Maintenance and Repair
Soil Assessment, Management and Amelioration
Spoken Arabic
Water Quality Assessment

Management Skills
Attracting business
Communicating with and working for a client
Communicating with officers of statutory authorities

Professional Contributions/University Lecturing:

Former Chairman of the Queensland Acid Sulfate Soils Committee and the QDNR&M liaison Committee.
Part-time lecturing to graduate and post graduate students at Griffith University, Brisbane in sustainable land management, acid sulfate soils and land disposal of effluent.
Contribution to Queensland Acid Sulfate Soil Investigation Team Guidelines for Acid Sulfate Soil Assessment and Management in Queensland.
Contribution to the Acid Sulfate Soil Management Advisory Committee (ASSMAC) Guidelines for Acid Sulfate Soil Assessment and Management in New South Wales.
Contribution to revised Australian Standard on Domestic Effluent Disposal (AS1547).

Membership Of Professional Bodies:

Certified Practicing Agriculturalist
Member of the Australian Institute of Agricultural Scientists
Member of the Environment Institute of Australia

Recent Work Experience (1994-Current)

Water quality monitoring

Water quality monitoring assessment including detail on nutrient stripping areas for a large-scale urban development at Coombabah, Queensland.
Water quality monitoring, soil assessment and effluent disposal design for an urban development at Jacobs Well, Queensland.
Water quality management, irrigation design and soil management recommendations for a large industrial corporation at Gympie, Queensland.
Baseline water quality monitoring for the proposed Cypress Waters development, Isle of Capri, Queensland.
Ongoing environmental management advice and water quality monitoring at Banora Waters development site, Banora Point, New South Wales.
Water quality advice for Noosa Springs development, Noosa, Queensland.
Baseline water quality monitoring of a lake system, Currumbin, Queensland.
Water quality monitoring as a component of the Urban Stormwater Strategy for the Ballina Shire, Ballina, New South Wales.
Water quality monitoring of groundwater bores associated with Gold Coast City Council controlled landfills, Gold Coast City, Queensland.
Water quality monitoring of groundwater bores associated with Beaudesert Shire Council controlled landfills. Training program for Council officers, Beaudesert Shire, Queensland.
Water quality monitoring of an algal bloom in the Coomera River, Coomera, Queensland.
Water quality monitoring of surface water and groundwater for Coomera Waters proposed development, Coomera, Queensland.
Event based pre-construction and construction phase surface and groundwater monitoring at Brygon Creek Estate, Gold Coast, Queensland.
Water quality advice for Kimbrickle Landfill, Sydney.
Water quality advice for Kemps Creek Landfill, Sydney.
Water quality advice for proposed residential subdivision, South Tweed Heads, New South Wales.
Drainage advice associated with a proposed sporting field development at Lennox Head, New South Wales.
Construction phase, event based water quality monitoring at O'Briens Golf Course/Residential development, Coombabah, Queensland.
Construction phase, event based water quality monitoring at Pacific Pines residential development, Helensvale, Queensland.
Provision of groundwater quality advice for sand extraction operation, North Stradbroke Island, Queensland.
Event based water quality monitoring at Banyula Drive industrial subdivision, Nerang, Queensland.
Water quality monitoring at the Pacific Beach development, Tugun, Queensland.
Water quality monitoring of a construction site at Township Drive, West Burleigh Heads, Queensland.
Construction phase water quality monitoring of Nelsens Road residential subdivision, Carrara, Queensland.
Construction phase, event water quality monitoring at the Southern Vales development, Robina, Queensland.
Event based water quality monitoring along a proposed sewer line at the Pacific Pines development, Helensvale.
Water quality monitoring of groundwater bores associated with the Varsity Lakes residential subdivision site, Robina, Queensland.
Water quality advice for Kingscliff Sand Pit, Kingscliff, New South Wales.
Construction phase water quality monitoring at Woodlands Residential development, Ashmore, Queensland.
Construction phase water quality monitoring, Nerang Broadbeach Road upgrade in accordance with Main Roads standard specifications, Gold Coast, Queensland.
Water quality advice for All Saints Anglican School regarding the school sporting ovals, Gold Coast, Queensland.
Construction and operational phase water quality monitoring at the proposed residential development at Batchworth Road, Molendinar, Queensland.
Water quality monitoring, environmental management advice and the preparation of a stormwater management plan for Southern Vales residential development. Robina, Queensland.
Water quality advice for the proposed residential subdivision, Casuarina Beach Development, Kingscliff, New South Wales.
Construction phase, event water quality monitoring for the Spencer Road Industrial Subdivision, Spencer Road, Nerang, Queensland.
Water quality monitoring to assess possible contamination from banana plantations, Kianga Court, Currumbin Valley, Queensland.
Water quality monitoring for a sedimentation basin at Gowan Road, Stretton, Queensland.
Baseline water quality assessment for Cable Ski World, Pine Ridge Road, Coombabah, Queensland.

Acid sulfate soil assessments

Acid sulfate soil assessment and management plan preparation for proposed maintenance dredging of navigation channel, Newport Waterways. Dredging License review and advice, Redcliffe, Queensland.
Acid sulfate soil assessment and management plan preparation for Newport Waterways development. Site contamination advice. Site management and monitoring, Redcliffe, Queensland.
Acid sulfate soil advice, environmental management plan preparation, site management and monitoring for Cudgen Sandpit, New South Wales.
Acid sulfate soil assessment, preparation of a soil and Water management plan, site auditing and monitoring of the Flame Tree Park development, Tweed Heads, New South Wales.
Acid sulfate soil assessment and management plan preparation, site management and monitoring of the Burleigh Cove development, West Burleigh Heads, Queensland.
Acid sulfate soil assessment and management plan preparation, site management and monitoring of surface water and groundwater for the Monterey Keys development, Helensvale, Queensland.
Acid sulfate soil assessment and management plan preparation for proposed excavation activities at Cabarita Gardens, Cabarita, New South Wales.
Acid sulfate soil assessment and management plan preparation for the proposed Cobaki Lakes development, Cobaki, New South Wales.

Acid sulfate soil advice for sand extraction activities at Jacobs Well, Jacobs Well, Queensland.
Acid sulfate soil assessment and management plan preparation for a proposed rural residential development at Broadwater, Broadwater, New South Wales.
Acid sulfate soil advice and ongoing environmental management for the proposed Broadlakes development, Mudgeeraba, Queensland.
Acid sulfate soil assessment and advice for a proposed residential area at Lennox Head, Lennox Head, New South Wales.
Acid sulfate soil assessment and management plan preparation and stormwater management advice for the Fern Street development, Lennox Head, New South Wales.
Acid sulfate soil assessment, site contamination assessment and environmental management plan contributions for an environmental impact assessment for Wellington Harbour, Wellington Point, Queensland.
Acid sulfate soil investigation and agricultural (sugar cane) suitability assessment of a proposed clay target shooting site, Jacobs Well, Queensland.
Acid sulfate soil advice, surface water and groundwater monitoring for the Beenleigh Marketplace, Beenleigh, Queensland.
Preliminary Acid sulfate soil assessment for the proposed Barretts residential subdivision, Lennox Head, New South Wales.
Acid sulfate soil assessment for a proposed road corridor adjacent to an existing residential development, Lennox Head, New South Wales.
Preliminary Acid sulfate soil assessment for proposed extensions to Chickiba Lake, East Ballina, New South Wales.
Acid sulfate soil investigation and advice for Bienvenue Lake, Currumbin, Queensland.
Soil survey and acid sulfate soil investigation of a proposed residential development, Bribie Island, Queensland.
Acid sulfate soil assessment and management plan preparation for Broadwater Avenue, Hope Island, Queensland.
Acid sulfate soil management plan preparation, site management and monitoring for a residential development on Greenlands Drive, West Burleigh Heads, Queensland.
Acid sulfate soil assessment of the proposed Italo Club, Mermaid Waters, Queensland.
Acid sulfate soil assessment of a proposed drainage line adjacent to the Black Rocks residential development, Pottsville, New South Wales.
Acid sulfate soil and Seismic investigation of the Parreara navigation channel, Kawana, Queensland.
Acid sulfate soil investigation of a proposed drainline associated with the Currumundi North residential development, Kawana, Queensland.
Acid sulfate soil investigation of a proposed dredge spoil disposal area, Newport Waterways, Redcliffe, Queensland.
Preliminary acid sulfate soil investigation of fill material to be used for a proposed residential development on Anzac Ave, Redcliffe, Queensland.
Preliminary acid sulfate soil assessment of a proposed development at Waterway Drive, Coomera, Queensland.
Acid sulfate soil assessment associated with drain maintenance works in the Wilsons Drain for Gold Coast City Council, Queensland.
Acid sulfate soil investigations for various stages of construction for the Varsity Lakes Development, Robina.
Provision of acid sulfate soil advice for Currumbin Park Estate, Currumbin, Queensland.
Acid sulfate soil assessment, data review and soil survey of a proposed Ecotourism and Retirement Complex, Robina Floodplain, Robina, Queensland.
Preliminary acid sulfate soil investigation of the Lakewood Sewer Main, Guiness Road, Elanora, Queensland.
Acid sulfate soil investigation and management plan preparation for the proposed Calypso Bay development, Jacobs Well, Queensland.
Acid sulfate soil assessment and environmental management plan preparation for the Birtinya Channel Excavation, Kawana Waters, Queensland.
Acid sulfate soil assessment for the proposed Western Waterway excavation, Kawana Waters, Queensland.
Acid sulfate soil assessment and the provision of neutralization recommendations for Coolangatta Airport Sandpit, Coolangatta, Queensland.
Preliminary acid sulfate assessment of pool sand materials, Versace Hotel, Main Beach, Queensland.
Acid sulfate soil investigation and the provision of water quality advice for the proposed extension of Christine Avenue, Burleigh Waters, Queensland.
Acid sulfate soil assessment, geotechnical investigation and stormwater management plan preparation for the proposed Bundilla Development, Kawana, Queensland.
Acid sulfate soil assessment, groundwater quality assessment and stormwater management plan preparation (to be submitted as part of the Local Environmental Study) for the proposed residential development of Seaside City, Kingscliff, New South Wales.
Acid sulfate soil assessment, soil and water management plan preparation (including soil survey) for the Terranora Village development, Terranora, New South Wales.
Acid sulfate soil management plan preparation for proposed showroom development on Enid Street, Tweed Heads, New South Wales.
Acid sulfate soil investigation for Banyanda Lake maintenance activities, Ballina, New South Wales.
Acid sulfate assessment and stormwater management plan preparation, former Brisbane Airport, Eagle Farm, Brisbane, Queensland.
Acid sulfate soil assessment for the proposed Varsity Parade, Varsity Lakes, Robina, Queensland.
Acid sulfate soil assessment and stormwater management plan preparation for Lot 4, 197 Beattie Road, Coomera Marine Precinct, Queensland.

Environmental auditing and/or ongoing management

Environmental auditing and the provision of environmental management advice on the Newport Waterways development, Redcliffe, Queensland.
Environmental auditing and the provision of environmental management advice for the East Lake development site, Robina, Queensland.
An Environmental audit of the Mt Gravatt tunnel project, Mt Gravatt, Queensland.
environmental auditing of Package 5 of the Main Roads Pacific Motorway project, Nerang, Queensland.
Environmental auditing of Package 6 of the Main Roads Pacific Motorway project, Nerang, Queensland.
Site management, monitoring and the provision of landfill advice for the Namoona Drive Landfill, Casino, New South Wales.

Site management, monitoring and the provision of landfill advice for the Ballina Waste Management Centre, Ballina, New South Wales.
Environmental auditing of the Flame Tree Park residential development, Tweed Heads, New South Wales.
Environmental auditing and site monitoring of the O'Briens Golf Course development, Coombabah, Queensland.
Environmental auditing of the Mermaid Cove construction site, Mermaid Waters, Queensland.
Environmental auditing of the Parrearra Development, Sunshine Coast, Queensland.
Environmental auditing of the Birtinya Development, Sunshine Coast, Queensland.
Environmental auditing and monitoring for the Bellvista Development, Caloundra, Queensland.
Environmental auditing and monitoring for the Creekside Development, Caloundra, Queensland.
An environmental audit of the Paradise Springs Golf Course operations, Robina, Queensland.
An environmental audit of the Robina Woods Golf Course operations, Robina, Queensland.
Erosion and Sediment Control Plan preparation for the proposed residential subdivision at Pacific Place, Gaven.
Environmental auditing and monitoring of the Duranbah Quarry operations, Duranbah, New South Wales.

Environmental Management Plans

Environmental impact assessment and environmental management plan preparation incorporating a soil survey for a proposed tourist development, Mt Tamborine, Queensland.
Environmental management advice and environmental management plan preparation for piggery operations at Tabulum, New South Wales.
Environmental management plan preparation for proposed development at Mt Cotton, Queensland.
Review of existing documentation, response preparation and environmental management plan preparation for hard rock quarry operations at Bromelton, near Beaudesert, Queensland.
Provision of advice for sand extraction activities including site management and monitoring for the Ballina Airport Sandpit, Ballina, New South Wales.
The provision of environmental management advice in addition to an EIS submission for Riveria Marina, Coomera, Queensland.
The provision of environmental management advice in addition to an EIS submission for the Waterway Drive development, Coomera, Queensland.
Environmental management plan preparation for a proposed sand extraction and residential filling operation on Cudgen Road, Cudgen, New South Wales.
Environmental management plan preparation for a proposed waterfront development at Mermaid Waters, Gold Coast, Queensland.
Provision of environmental management advice for proposed dredging activities at Fingal, New South Wales.
Preparation of Landfill environmental management plan's (LEMP) for the Evans Head & Broadwater landfills, Richmond Valley, New South Wales.

Site Contamination Assessments & Soil Surveys

Agricultural operation feasibility study at Wongawallen, Queensland and Woodenbong, New South Wales.
Site contamination assessments prepared for Department of Environment and Heritage submission in Queensland at Ashmore, Mudgeeraba and Underwood and in New South Wales at Mooball, Murwillumbah and Terranora.
Site suitability assessment, soil analysis and effluent disposal reports at Mount Tambourine in Queensland and Cobaki, Cudgen, Kell Vale, Murwillumbah, Nimbin, Palm Vale, Terranora and Uki in New South Wales.
Soil survey and Acid sulfate soil assessment for a proposed residential township development at Cudgen, New South Wales.
Site contamination assessment for a site at Labrador, Queensland.
Site contamination assessment for a site on Geoff Walter Drive, Queensland.
Site contamination assessment of land previously used for agricultural purposes at Terranora, New South Wales.
Preliminary site contamination assessment for proposed residential subdivision at Bilambil, New South Wales.
Preliminary Site Contamination assessment for the proposed Murwillumbah Rural Bushfire Brigade Headquarters, Murwillumbah, New South Wales.
Soil survey and effluent disposal assessment for the Tanglewood development, Cabarita, New South Wales.
Site contamination assessment and acid sulfate soil investigation of proposed construction works associated with the Opal Shed, Helensvale, Queensland.
Soil survey, effluent disposal assessment and site suitability assessment for proposed residential development, Wongawallan, Queensland.
Preliminary site contamination assessment on a disused banana lot, Bilambil, New South Wales.
Soil survey and stormwater management plan preparation for a proposed residential development on Brygon Creek Road, Gold Coast, Queensland.
Soil survey and stormwater management plan preparation for a proposed residential development on Kopps Road, Maudsland, Queensland.
Soil survey and stormwater management plan preparation for the proposed Pacific Pines residential development, Helensvale, Queensland.
Soil survey and stormwater management plan preparation for a proposed residential development on Mason Street, Southport, Queensland.
Preliminary site contamination assessment of an existing service station facility, River Street, Ballina, New South Wales.
Water quality monitoring, environmental management advice and the preparation of a stormwater Management plan for 'The Dales' residential development, Robina, Queensland.
Preliminary site contamination assessment for the Wollumbin Wildlife Refuge, Mt Warning Road, Murwillumbah, New South Wales.
Preliminary site contamination assessment of an existing service station facility on Golden Four Drive, Tugun, Queensland.
Preliminary site contamination assessment for the Penny Bros Winery, Carool Road, Carool, New South Wales.
Site contamination assessment of the Hanna and Edmed Site, Murwillumbah, New South Wales.
Site contamination assessment for a private dwelling, Charles Street, Tweed Heads, New South Wales.

Site contamination assessment and stormwater management plan preparation for a proposed residential subdivision at Mudgeeraba, Queensland.
Site contamination assessment for the proposed adventure tourism facility 'Terragon Terror', Uki, New South Wales.
Site contamination assessment for a previously used service station facility, Chinderah.
Preliminary site contamination assessment on the Murwillumbah Tyre Service property, Murwillumbah, New South Wales.
Site contamination assessment and effluent disposal report for Blissetts Road, Carool, New South Wales.
Preliminary site contamination and soil slope stability assessment for Lot 11 on Loders Road, Duranbah, New South Wales.
Site contamination assessment and acid sulfate soil investigation for a caravan park facility, Siganto Drive, Oxenford Queensland.
Site contamination assessment of a proposed boundary alteration, Machinery Drive, Tweed Heads South, New South Wales.
Preliminary site contamination assessment of 193 Scenic Drive, Bilambil Heights, New South Wales.
Soil survey for a proposed residential development on Lot 2, Pallaranda and Windmill Streets, Tarragindi, Queensland.

Effluent Disposal Assessments

Effluent disposal assessment for a proposed development at Springbrook, Springbrook, Queensland.
Effluent disposal assessment for a proposed residential development on Boundary Road Narangbar, Narangbar, Queensland.
Effluent disposal assessment for a proposed residential development on Rowley Road, Burpengary, Queensland.
Effluent disposal assessment for a proposed development on Tallebudgera Connection Road, Tallebudgera, Queensland.
Effluent disposal assessment for a proposed cabin development, Mt Tamborine, Queensland.
Nutrient impact assessment for a proposed residential development, Upper Coomera, Queensland.
Effluent disposal assessment for a proposed house relocation as a result of Pacific Highway widening, Broadwater, New South Wales.
Effluent disposal assessment for a proposed residential development on Haughton Road, Burpengary, Queensland.
Effluent disposal assessment for a proposed equestrian center, Murwillumbah, New South Wales.
Effluent disposal assessment for a proposed residential development on Porter Road, Caboolture, Queensland.
Effluent disposal assessment for a proposed tourist development at Eagle Heights, Eagle Heights, Queensland.
Effluent disposal assessment for a proposed residential development on Long Road. Caboolture, Queensland.
Effluent disposal assessment for a proposed residential development on Forest Home Road, Rathdowney, Queensland.
Effluent disposal assessment for a proposed residential development on Trees Road, Tallebudgera, Queensland.
Effluent disposal assessment for a proposed development on San Fernando Drive, Worongary, Queensland.
Effluent disposal assessment for a proposed guesthouse development on Curtis Road, Mt Tamborine, Queensland.
Effluent disposal assessment for a proposed Main Street Café development on Mt Tamborine, Queensland.
Effluent disposal assessment for a proposed development on Tallebudgera Connection Road, Tallebudgera, Queensland.
Effluent disposal assessment for a proposed Panorama Park development, Tallai, Queensland.
Effluent disposal assessment for a proposed development on Long Road, Mt Tamborine, Queensland.
Effluent disposal assessment for a proposed development on Daryl Radnell Drive, Tallai, Queensland.
Effluent disposal assessment for a rural residential subdivision on Clothiers Creek Road, Cudgen, New South Wales.
Effluent disposal assessment for Roselyns Lodge on Mt Tamborine, Queensland.
Effluent disposal assessment for proposed boundary relocation works on Dulguigan Road, North Tumbulgum, New South Wales.
Effluent impact assessment for a development on Clagiraba Rd, Clagiraba, Queensland.
Effluent disposal and Nutrient impact assessment of Stage 1 of a subdivision on Billabirra Cres, Nerang, Queensland.
Effluent disposal assessment for 91 Tallai Road, Tallai, Queensland.
Effluent disposal assessment for the proposed residential subdivision at Woodlands Way, Ashmore, Queensland.
Effluent disposal assessment and stormwater management plan preparation for a proposed subdivision at San Fernando Drive, Worongary, Queensland.
Effluent disposal assessment and stormwater management plan preparation for stage 8C of the proposed Panorama Park Development, Queensland.
Effluent disposal assessment and stormwater management plan preparation for a proposed rural subdivision at Bonogin Road, Bonogin, Queensland.
Effluent disposal assessment for a Proposed Bed & Breakfast facility at Gilston, Queensland.
Effluent disposal assessment for a single dwelling, Tomewin Road, Currumbin, Queensland.
Effluent disposal assessment for the Canungra Gun Club, Queensland.
Effluent disposal advice for the proposed Rivermill Tourist Facility Development, Mt Nathan, Queensland.
Effluent disposal assessment for Lots 3 & 4 Worongary Road, Worongary, Queensland.
Effluent disposal assessment and report preparation for the Gilston Jewish School, Gilston, Queensland.
Effluent disposal advice for the Terranora Country Club, Terranora, New South Wales.
Effluent disposal assessment for the Ugarte Property, Otmoor Road, Coomera, Queensland.
Effluent disposal assessment for Lot 2, Hardy's Road, Mudgeeraba, Queensland.
Effluent disposal assessment for a proposed Rainforest Centre, Chisholm Road, Carrara, Queensland.

Court Cases

Water quality advice for a proposed trout hatchery in the Blue Mountains, Cooma, New South Wales.
Acid sulfate soil and water quality advice for a development at Cobaki, New South Wales.
Site specific water quality issues relating to a nursery operation, Alstonville, New South Wales.
Acid sulfate soils advice on farm drainage works, Maclean, New South Wales.
Soil condition and effluent disposal advice for proposed subdivision of land, Dunoon, New South Wales.
Soil and water advice relating to landfill activities, Runaway Bay, Queensland.
Agricultural, soil and water quality advice with regard to a proposed school facility, Cudgen, New South Wales.
Soil condition, water quality and sediment and erosion control advice for Doonella Lake, Noosa, Queensland.
Sediment and erosion control advice for a proposed development, Armstrong Way, Nerang, Queensland.
Effluent disposal advice for land development, Tumbulgum, New South Wales.

Erosion and sediment control, water quality and soil condition advice for the proposed Noosa Hill Development, Noosa, Queensland.
Water quality advice for the proposed Armstrong Beach Aquaculture facility, Queensland.
Composting and water quality advice for an existing composting facility/landfill, Burpengary, Queensland.
Acid sulfate soil and water quality advice for the Twin Lakes development, Sunshine Coast, Queensland.
Stormwater and soil condition advice for the proposed Survey Street development, Lennox Head, New South Wales.
Water quality advice associated with an existing Hydroponics Lettuce farm operation, Coffs Harbour, New South Wales.
Acid sulfate soil advice for an existing cane farm operation, Yelgun, New South Wales.
Effluent disposal advice for Lismore City Council on a proposed residential development.
Acid sulfate soil advice for the proposed Four Mile Beach development, Port Douglas, Queensland.
Erosion and sediment control, water quality and sedimentation advice associated with roadworks, Ballina, New South Wales.
Water quality and erosion and sediment control advice for the proposed Peregian Springs development, Peregian, Queensland.
Acid sulfate soil advice for the proposed Cobaki Lakes Estate, Cobaki, New South Wales.

Soil and Water Assessments (including stormwater management plans)

Environmental impact assessment work on two sand extraction operations at Beachmere, Queensland, four quarries in New South Wales, a turf farm in northern New South Wales, an agricultural operation in New South Wales and a residential subdivision on the Gold Coast, Queensland.
Soil and Water assessment (including soil survey and water quality monitoring) and environmental management plan preparation for a sand quarry near Beaudesert, Queensland.
Soil and Water assessment (including soil survey and water quality monitoring) and environmental management plan preparation for proposed residential development and golf course at Morayfield, Queensland.
Soil and water assessment contribution for an environmental impact assessment for a proposed rock extraction for the purpose of a marina development, Airlie Beach, Queensland.
Soil and water assessment incorporating an effluent disposal assessment for a proposed country club and golf course development at Terranora, New South Wales.
Soil and water assessment (including soil survey and water quality monitoring) and environmental management plan preparation for proposed residential development off Fraser Drive, Tweed Heads, New South Wales.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for a proposed residential development. Pottsville, New South Wales.
Soil and water Assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for a proposed residential development at Cumbalum, Ballina, New South Wales.
Soil and water assessment (including soil survey) and stormwater management plan preparation for the proposed 'Ballina Heights' residential development at Cumbalum, Ballina, New South Wales.
Soil and water assessment (including soil survey) and stormwater management plan preparation for proposed Nerang River Place residential development, Nerang, Queensland.
Soil and water assessment (including soil survey), stormwater management plan, Preliminary Site Contamination assessment and Effluent disposal assessment preparation for a proposed development at Wongawallan, Queensland.
Soil and water assessment (including soil survey) and stormwater management plan preparation for the proposed Lakewoods residential development, Elanora, Queensland.
Soil and water assessment (including soil survey) and stormwater management plan preparation for a proposed development on Foxwell Road, Coomera, Queensland.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for proposed O'Briens Golf Course/Residential development, Coombabah, Queensland.
Preparation of a stormwater management plan (including soil survey) for proposed Stages 3 and 4 of the Pacific Place development, Helensvale, Queensland.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for the Rochdale Turf Farm, Rochdale, Queensland.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for the proposed Watabe Project, Merrimac, Queensland.
Soil and water assessment (including soil survey) and stormwater management plan preparation for proposed Ormeau Hills residential development, Ormeau, Queensland.
Soil and water assessment (including soil survey) and stormwater management plan preparation for a proposed development on Scenic Drive, Bilambil, New South Wales.
Soil and water assessment (including soil survey) and stormwater management plan preparation for the proposed Helensvale Retirement Village, Helensvale, Queensland.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for the proposed Nelsens Road development, Carrara, Queensland.
Soil and water assessment (including soil survey) and stormwater management plan preparation for the Riverlink development - Stage 1, Oxenford, Queensland.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for the proposed Rivermeadows Stage 11 development, Coomera, Queensland.
Preparation of a stormwater management plan for the proposed extensions to the Wet n Wild Water Park, Helensvale, Queensland.
Soil and water assessment (including soil survey and water quality monitoring) and stormwater management plan preparation for various stages of the Varsity Lakes development, Robina, Queensland.
Peer review of a stormwater management plan for the Coomera Lakes development, Coomera, Queensland.
Peer review of stormwater management plan for the proposed Survey Street development, Lennox Head, New South Wales.
Soil and water assessment (including soil survey) and stormwater management plan preparation for the proposed Sunshine Beach development, Wooyung, New South Wales.
Soil and water assessment (including soil survey) and stormwater management plan preparation for the proposed Spencer Road Industrial Area development, Nerang, Queensland.

Soil and water assessment (including soil survey and water quality monitoring), Effluent disposal, Preliminary Site Contamination assessment and stormwater management plan preparation for the proposed Bronta Residential development, Tallebudgera, Queensland.
Soil and water assessment and stormwater management plan for proposed subdivision at Days Road, Coomera.
Soil and water assessment and stormwater management plan preparation for proposed extensions to the Crescent Street sand extraction, Cudgen, New South Wales.
Soil and water assessment and stormwater management plan preparation for the Carrara Industrial Subdivision, Eastlake Street, Carrara.
Stormwater management plan preparation for the proposed Road Runner Roller Coaster, Movie World, Gold Coast, Queensland.
Stormwater management plan preparation for the Port Macquarie, Wauchope and Dunbogan Landfills, New South Wales.
Soil and water assessment and effluent disposal assessment for the proposed residential subdivision of the Davenport Site, Bonogin, Queensland.
Soil and water assessment and stormwater management plan preparation for the proposed residential subdivision at Crestview, Palm Meadows, Queensland.
Stormwater management plan preparation for the Coomera Retail Showrooms, Coomera, Queensland.
Stormwater management plan preparation and effluent disposal assessment for the proposed subdivision of Lakeview Downs Estate, Maudsland Road, Maudsland, Queensland.
Soil and water assessment (incorporating surface and ground water) for the proposed Ningi residential subdivision, Ningi, Queensland.
Stormwater management plan preparation for a proposed new display at Movieworld theme park, Oxenford, Queensland.
Stormwater management plan preparation, preliminary site contamination, acid sulfate soil and water quality assessment for a proposed residential subdivision on Franklin Drive, Mudgeeraba, Queensland.
The provision of advice on stormwater management measures for the Kenmore Baptist Church carpark, Pullenvale, Queensland.
Stormwater management plan preparation (including soil survey) for a subdivision application on Kopps Road, Coomera, Queensland.

14) Appendix 5 – Pre-demolition Contamination Investigation of the Outbuildings on Lot 33 on DP1085109, Marana Street, Bilambil Heights, 2007

15) Appendix 6 – Tweed Shire Council Development Consent (DA07/0248) Lot 33 DP 1085109, May 2008

February 14, 2007

Tweed Shire Council
PO Box 816
Murwillumbah
NSW 2484

Attn: Mr Brad Pearce

Dear Sir,

RE: PRE-DEMOLITION CONTAMINATION INVESTIGATION AROUND OUTBUILDINGS AT PACIFIC HEIGHTS, BILAMBIL HEIGHTS, NEW SOUTH WALES

Background

Gilbert & Sutherland (G&S) was engaged to undertake a pre-demolition contamination investigation at Pacific Heights to assess the contamination status of the outbuildings on Lot 33 on DP1085109, Marana Street, Bilambil Heights.

The pre-demolition investigation of the former Terranora Country Club will be conducted on a staged basis whereby the existing buildings will be demolished to ground floor slab level prior to a sub-slab investigation for pesticide contamination. This strategy was discussed and agreed to by Tweed Shire Council (TSC) as documented in email correspondence dated February 16, 2007 (from G&S) and February 19, 2007 (from Council).

In an information request (May 3, 2007) Council requested that information be provided on the potential for soil contamination associated with the former use of a number of 'outbuildings' including a transformer building, pool shed and a golf buggy shed. Gilbert & Sutherland has requested (January 10, 2007) that the investigation of the transformer house (which is still active) be deferred until the transformer station is decommissioned and partial demolition of the country club superstructure is completed. We see this as logical as this building is partially attached to the country club proper.

This investigation was therefore limited to the fully detached buildings illustrated on drawing GJ0495.2.2, which includes the Golf buggy shed, Pool filter shed & Irrigation shed.

Rationale

During a site inspection on May 3, 2007, G&S staff identified that the subject outbuildings are colour bond or block structures founded on concrete slabs. We therefore consider that the Tweed Shire Council's pre-demolition testing guidelines (for OC's) would not be applicable and have limited our investigation to sampling around the perimeter of the slabs for contaminants potentially associated with the former use of each of the outbuildings. Drawing GJ0495.2.2 indicates the outbuildings that are the subject of this investigation.

Methods

A preliminary site contamination investigation was undertaken with reference to ANZECC/NHMRC (1992) '*Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*', NSW EPA *Guidelines for the NSW Site Auditors Scheme* and NSW EPA *Guidelines for Assessing Service Stations*. All sampling was

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undertaken by appropriately qualified and trained environmental scientists in accordance with AS4482.1-2005.

The preliminary sampling program and site inspection was undertaken on January 16, 2008 during which soil was collected from 16 boreholes around the three (3) subject outbuildings (as shown in Drawing no. GJ0495.2.3). The relevant boreholes and contaminants of concern for each of the outbuildings are detailed in Table 1 below.

Table 1. Target soil contamination for each outbuilding

Outbuilding	Borehole No.	Target soil contaminants
Golf buggy shed	BH1-BH6	TPH, BTEX, PAH, OC/OP Pesticides and heavy metals
Pool filter shed	BH7-BH10	OC/OP Pesticides and heavy metals
Irrigation shed	BH11-BH14	OC/OP Pesticides and heavy metals

A photo-ionization detector (PID) was used to field screen all soil samples for the presence of volatile organic compounds (VOC) in soil stratification at depths of 0.0-0.2m, 0.3-0.4m and 0.5-0.6m. The surface samples (0.0-0.2m) were analysed for TPH BTEX and PAH regardless of the PID results.

Sampling strategy

Samples were obtained from depths of approximately 0.0–0.2m, 0.3-0.4m and 0.5-0.6m below near surface level (NSL) around the perimeter of the subject outbuildings. The samples were then forwarded to AMDEL for the relevant laboratory analysis

The investigation criteria for hydrocarbons were adopted from 'Table 3 Threshold concentrations for sensitive land use – soils', (NSW EPA) *Guidelines for Assessing Service Station Sites*, 1994. The investigation criteria for metalloids and pesticides were adopted from 'Table 5-A Soil Investigation Levels - Health Investigation Level exposure setting A' (HIL_A - Standard Residential) from the National Environment Protection Measure (NEPM) *Schedule B (1) Guidelines on the Investigation Levels for Soil and Groundwater*, 1999. The Health Investigation Level (HIL_A) was adopted as the proposed redevelopment of the site may include standard residential dwellings.

Additional samples were also collected during the investigation for quality control purposes. This included the collection of two duplicate soil samples.

Results

The results indicate that levels of heavy metals, hydrocarbons, BTEX and OC/OP pesticides on site do not exceed the adopted investigation levels for Class A 'Standard' residential development[1] with the exception of sample BH7 0.0-0.2 (dieldrin concentration of 30mg/kg) located on the western side of the pool filter shed. The results including the limit of reporting (LOR) and the adopted investigation criteria for each analyte are provided in Table 1.1 (over page). Laboratory certificates are attached for your reference.

The PID results were used as an indicative method to detect the presence of VOCs. The results indicated a minimal presence of VOCs within all of the soil samples collected with the highest reading of 2.7 parts per million (ppm). The PID results are attached as Table 1.2 for your reference.

[1] A 'Standard' residential area is defined as a residential area with gardens/accessible soil, no poultry, where home-grown produce contributes less than 10% of total household fruit and vegetable intake. This category includes children's day-care centres, preschools and primary schools.

Table 1.1 Analytical results for pre-demolition investigation of outbuildings

Sample ID	C6-C9 Fraction (mg/kg)	C10-C14 Fraction (mg/kg)	C15-C28 Fraction (mg/kg)	C29-C36 Fraction (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Total Xylenes (mg/kg)	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)	Total Mercury (mg/kg)	Total PAH (mg/kg)	Total OC/OP Pesticides (mg/kg)
LOR	<5	<10	<20	<20	<0.2	<1	<1	<3	<3	<1	<2	<1	<5	<2	<2	<0.05	<1	<0.5
Investigation Criteria[2]	65	1000	1000	1000	1	1.4	3.1	14	100	20	100	1000	300	600	7000	15	20	10
BH1 0.0-0.2	<5	<10	<20	<20	<0.2	<1	<1	<3	<3	<1	10	2.3	<5	3.6	24	0.06	<1	<0.5
BH2 0.0-0.2	<5	<10	<20	<20	<0.2	<1	<1	<3	<3	<1	8.4	8.8	<5	15	41	0.1	<1	<0.5
BH3 0.0-0.2	<5	<10	37	30	<0.2	<1	<1	<3	<3	<1	38	13	9.8	19	80	0.14	<1	<0.5
BH4 0.0-0.2	<5	<10	20	<20	<0.2	<1	<1	<3	5.3	<1	24	15	6.8	18	64	0.14	<1	<0.5
BH5 0.0-0.2	<5	<10	22	22	<0.2	<1	<1	<3	3.8	<1	30	15	11	11	66	0.12	<1	<0.5
BH6 0.0-0.2	<5	<10	67	58	<0.2	<1	<1	<3	<3	<1	35	16	12	16	77	0.18	<1	<0.5
BH7 0.0-0.2	-	-	-	-					4.8	<1	14	58	15	7.9	110	2.6	<1	30*
BH8 0.0-0.2	-	-	-	-					4.4	<1	29	950	26	15	150	1.2	<1	0.9
BH90.0-0.2	-	-	-	-					<3	<1	24	20	11	13	77	1.2	<1	<0.5
BH15 (BH9 Duplicate) 0.0-0.2	-	-	-	-					<3	<1	20	22	10	12	73	1.1	<1	<0.5
BH10 0.0-0.2	-	-	-	-					<3	<1	10	11	<5	6.3	38	5.9	<1	<0.5
BH11 0.0-0.2	-	-	-	-					<3	<1	19	12	6.9	10	68	1.3	<1	<0.5
BH12 0.0-0.2	-	-	-	-					5	<1	25	17	7.9	16	68	1.9	<1	<0.5
BH13 0.0-0.2	-	-	-	-					<3	<1	28	16	7.6	17	64	1.1	<1	<0.5
BH16 (BH13 Duplicate) 0.3-0.4	-	-	-	-					3.2	<1	31	18	9	20	74	1.3	<1	<0.5
BH14 0.0-0.2	-	-	-	-					3.5	<1	40	20	20	23	92	0.63	<1	<0.5
Exceeds investigation criteria																		

[2] Based on the threshold concentrations of hydrocarbons, Table 3 Threshold concentrations for sensitive land use – soils, (NSW EPA) *Guidelines for Assessing Service Stations,* 1994, and Health Investigation Level exposure setting A (HIL_A) for metalloids and pesticides Table 5-A Soil Investigation levels (NEPM) Schedule B(1) *Guidelines on the investigation levels for Soil and Groundwater*, 1999.

Quality assurance
Two blind replicate samples were collected and analysed for the purpose of quality assurance. The results of the analysis were compared using relative percentage difference (RPD) The results of the original and duplicate samples compared using this method are attached as Table 1.3.

Generally the RPD is expected to be in the range of 30% – 50%, however greater variation may occur and can be attributed to numerous factors, including: very low concentrations; organic analysis (which generally contains greater variation than inorganic analysis); and sample heterogeneity. The split sample returned RPD results within the recommended 30 – 50% for all analytes, indicating good correlation (0% to 16%) between analyses.

The analytes measured returned levels from below the respective laboratory's limits of report to 16% located in BH13 0.0-0.2. Where concentrations of the specified analytes were detected, there were a further twelve (12) samples below the recommended 30 – 50% RPD range. A review of Amdel quality control reports verified internal laboratory quality controls to be within industry standards.

Discussion
The cause of the elevated dieldrin concentration at BH7 could not be determined during the preliminary site investigation. The pool filter shed is a concrete block structure which was unlikely (due to its small size) to have been used to store pesticides such as dieldrin. Although the pool shed's block construction would not logically require sub slab termite treatment, this is the most likely explanation for its occurrence in close proximity to the pool shed. As such, it is considered prudent to undertake sub-slab investigations for OC/OP pesticides on each of the outbuildings prior to the removal of the slabs. It is considered appropriate that this be undertaken following the demolition of each of the shed superstructures, simultaneous with the investigation of the country club proper.

This investigation has determined that no other contaminants of concern are present in the soils immediately surrounding each of the outbuildings.

Following the completion of the sub-slab investigations which will delineate the extent of any contamination on the site, a Remediation Action Plan (RAP) will be prepared describing the remediation methodology and validation sampling requirements for any contamination identified, in addition to the already identified contamination identified adjacent to the pool shed.

We trust that this is acceptable. Should you require any further details or elaboration, please do not hesitate to contact this office.

Yours faithfully,

Gilbert & Sutherland Pty Ltd

Nathan Zurig
Manager/Senior Environmental Scientist

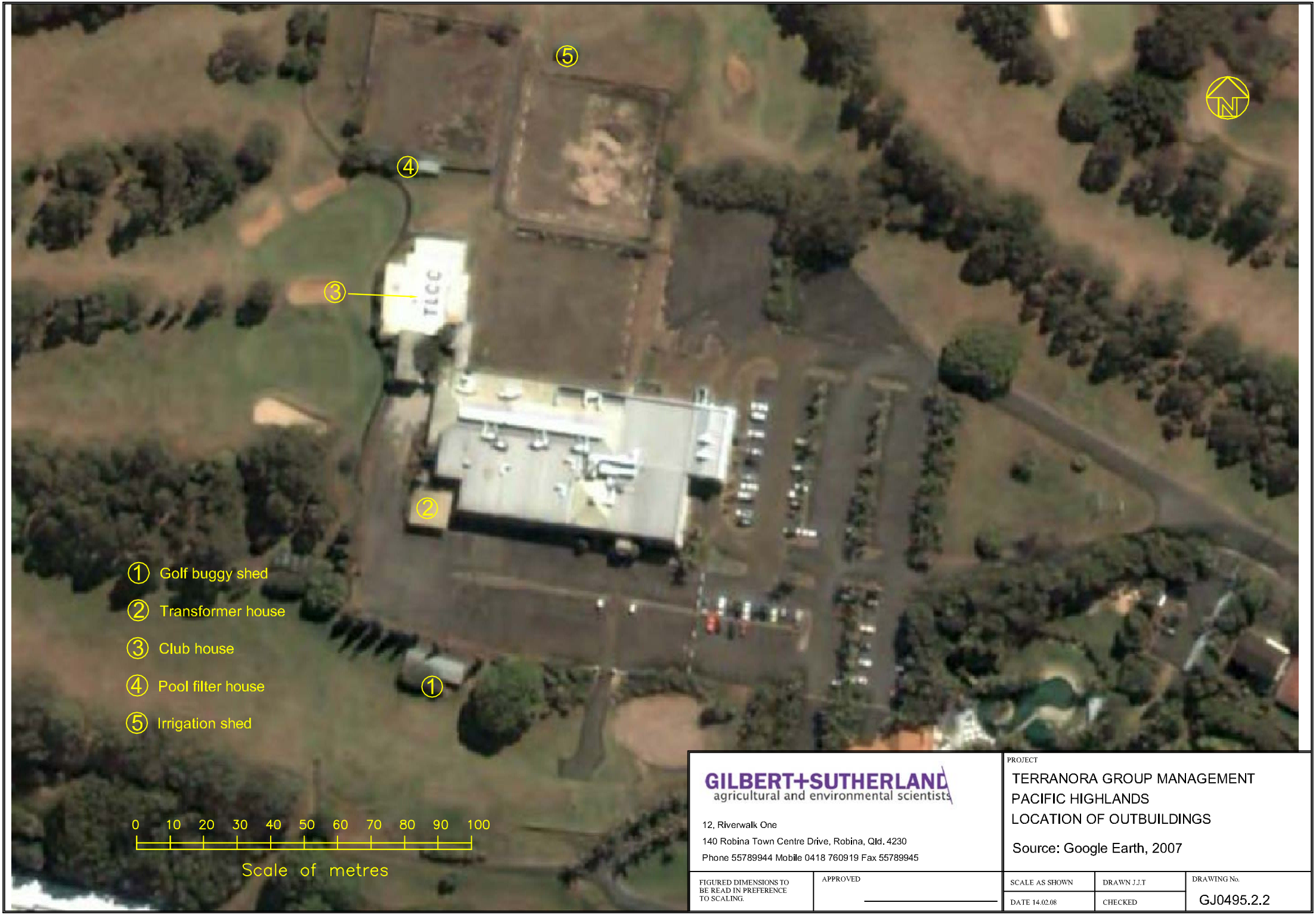
Jacob Tobin
Environmental Scientist

Table 1.2 Photo-ionisation detector (PID) results

Sample ID	VOC (ppm)
BH1 0.0-0.2	0.4
BH1 0.3-0.4	0.3
BH1 0.5-0.6	1.3
BH2 0.0-0.2	0.5
BH2 0.3-0.4	2.7
BH2 0.5-0.6	1.3
BH3 0.0-0.2	0.5
BH3 0.3-0.4	0.3
BH3 0.5-0.6	0.2
BH4 0.0-0.2	0.1
BH4 0.3-0.4	0.1
BH4 0.5-0.6	0.1
BH5 0.0-0.2	0.1
BH5 0.3-0.4	0.1
BH5 0.5-0.6	0.1
BH6 0.0-0.2	0.1
BH6 0.3-0.4	0
BH6 0.5-0.6	0
BH7 0.0-0.2	1.4
BH7 0.3-0.4	0.3
BH7 0.5-0.6	0.2
BH8 0.0-0.2	0.1
BH8 0.3-0.4	0.1
BH8 0.5-0.6	0.1
BH9-0.0-0.2	0.1
BH9 0.3-0.4	0
BH9 0.5-0.6	0
BH10 0.0-0.2	0.1
BH10 0.3-0.4	0
BH10 0.5-0.6	0
BH11 0.0-0.2	0.1
BH11 0.3-0.4	0
BH11 0.5-0.6	0
BH12 0.0-0.2	0
BH12 0.3-0.4	0
BH12 0.5-0.6	0
BH13 0.0-0.2	0
BH13 0.3-0.4	0
BH13 0.5-0.6	0
BH14 0.0-0.2	0
BH14 0.3-0.4	0
BH14 0.5-0.6	0

Table 1.3 Intra-lab quality control - Relative Percentage Difference (RPD%)

Sample ID	Arsenic (mg/kg)	RPD%	Cadmium (mg/kg)	RPD%	Chromium (mg/kg)	RPD%	Copper (mg/kg)	RPD%	Lead (mg/kg)	RPD%	Nickel (mg/kg)	RPD%	Zinc (mg/kg)	RPD%	Total Mercury (mg/kg)	RPD%	Total PAH (mg/kg)	RPD%	Total OC/OP Pesticides (mg/kg)	RPD%
BH9 0.0-0.2	<3	0	<1	0	24	9	20	10	11	7	13	8	77	5	1.2	7	<1	0	<0.5	0
BH15 0.0-0.2	<3		<1		20		22		10		12		73		1.1		<1		<0.5	
BH13 0.0-0.2	<3	0	<1	0	28	10	16	11	7.6	16	17	16	64	14	1.1	16	<1	0	<0.5	0
BH16 0.3-0.4	3.2		<1		31		18		9		20		74		1.3		<1		<0.5	



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PROJECT

TERRANORA GROUP MANAGEMENT
PACIFIC HIGHLANDS
LOCATION OF OUTBUILDINGS

Source: Google Earth, 2007

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T
		DATE 14.02.08	CHECKED

DRAWING No. GJ0495.2.2

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PROJECT
TERRANORA GROUP MANAGEMENT
PACIFIC HIGHLANDS
LOCATION OF BOREHOLES

Source: Google Earth, 2007

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T	DRAWING No.
		DATE 14/02/08	CHECKED	GJ0495.2.3

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Certificate of Analysis

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Attention: Jacob Tobin

Project	**08ENBR0001238**
Client Reference	GJ0495-2
Order Number	GJ0495-2
Received Date	17/01/2008 09:18:00 AM

Customer Sample ID			**BH1 0.0-0.2**	**BH2 0.0-0.2**	**BH3 0.0-0.2**
Amdel Sample Number			**804132**	**804135**	**804138**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
VOC					
Test/Reference	PQL	Unit			
1100 BTEX &(C6-C9) in Soil by P&T					
Benzene	0.2	mg/kg	<0.2	<0.2	<0.2
Ethylbenzene	1	mg/kg	<1	<1	<1
Meta- & Para- Xylene	2	mg/kg	<2	<2	<2
Ortho-Xylene	1	mg/kg	<1	<1	<1
Toluene	1	mg/kg	<1	<1	<1
Total Xylenes	3	mg/kg	<3	<3	<3
C6-C9 Fraction	5	mg/kg	<5	<5	<5
4-Bromofluorobenzene - Surrogate	-	%	97	100	96
SVOC					
Test/Reference	PQL	Unit			
2300 OC Pesticides in Soil by GC-MS					
a-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
a-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
a-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
Aldrin	0.5	mg/kg	<0.5	<0.5	<0.5
b-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
b-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
d-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
DDD	0.5	mg/kg	<0.5	<0.5	<0.5
DDE	0.5	mg/kg	<0.5	<0.5	<0.5
DDT	0.5	mg/kg	<0.5	<0.5	<0.5
Dieldrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endosulfan sulfate	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin Aldehyde	0.5	mg/kg	<0.5	<0.5	<0.5
g-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
g-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor epoxide	0.5	mg/kg	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	0.5	mg/kg	<0.5	<0.5	<0.5
Methoxychlor	0.5	mg/kg	<0.5	<0.5	<0.5
Oxychlordane	0.5	mg/kg	<0.5	<0.5	<0.5
2,4,5,6-tetrachloro-m-xylene - Surrogate	-	%	95	100	101
2400 OP Pesticides in Soil by GCMS					
Chlorpyrifos	0.5	mg/kg	<0.5	<0.5	<0.5

Customer Sample ID			BH1 0.0-0.2	BH2 0.0-0.2	BH3 0.0-0.2
Amdel Sample Number			**804132**	**804135**	**804138**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
SVOC					
Test/Reference	PQL	Unit			
Chlorpyrifos Methyl	0.5	mg/kg	<0.5	<0.5	<0.5
Diazinon	0.5	mg/kg	<0.5	<0.5	<0.5
Ethion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenitrothion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenthion	0.5	mg/kg	<0.5	<0.5	<0.5
Malathion	0.5	mg/kg	<0.5	<0.5	<0.5
Methyl Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Ronnel	0.5	mg/kg	<0.5	<0.5	<0.5
Triphenyl Phosphate - Surrogate	1	%	124	122	Q09 137
2100 PAH in Soil by GC					
Acenaphthene	0.5	mg/kg	<0.5	<0.5	<0.5
Acenaphthylene	0.5	mg/kg	<0.5	<0.5	<0.5
Anthracene	0.5	mg/kg	<0.5	<0.5	<0.5
Benz(a)anthracene	0.5	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene	0.5	mg/kg	<0.5	<0.5	<0.5
Benzo(b)&(k)fluoranthene	1	mg/kg	<1	<1	<1
Benzo(g.h.i)perylene	0.5	mg/kg	<0.5	<0.5	<0.5
Chrysene	0.5	mg/kg	<0.5	<0.5	<0.5
Dibenz(ah)anthracene	0.5	mg/kg	<0.5	<0.5	<0.5
Fluoranthene	0.5	mg/kg	<0.5	<0.5	<0.5
Fluorene	0.5	mg/kg	<0.5	<0.5	<0.5
Indeno(123-cd)pyrene	0.5	mg/kg	<0.5	<0.5	<0.5
Naphthalene	0.5	mg/kg	<0.5	<0.5	<0.5
Phenanthrene	0.5	mg/kg	<0.5	<0.5	<0.5
Pyrene	0.5	mg/kg	<0.5	<0.5	<0.5
2-Fluorobiphenyl - Surrogate	-	%	110	111	106
p-Terphenyl-D14 - Surrogate	-	%	117	118	125
Anthracene-d10 - Surrogate	-	%	102	102	98
2600 PCBs in Soil by GC					
Aroclor 1016DB	0.5	mg/kg	<0.5	<0.5	<0.5
Aroclor 1221DB	0.5	mg/kg	<0.5	<0.5	<0.5
Aroclor 1232 and 1242 as totalDB	1	mg/kg	<1	<1	<1
Aroclor 1248 and 1254 as totalDB	1	mg/kg	<1	<1	<1
Aroclor 1260DB	0.5	mg/kg	<0.5	<0.5	<0.5
Total Polychlorinated biphenylsDB	1	mg/kg	<1	<1	<1
Decachlorobiphenyl - PCB surrogate	1	%	128	120	120
2000 TPH (C10 - C36) in Soil by GC					
C10-C14 Fraction	10	mg/kg	<10	<10	<10
C15-C28 Fraction	20	mg/kg	<20	<20	37
C29-C36 Fraction	20	mg/kg	<20	<20	30
Metals					
Test/Reference	PQL	Unit			
3200 Tot Recov. Metals in Soil by ICPAES					
Arsenic	3	mg/kg	<3	<3	<3
Cadmium	1	mg/kg	<1	<1	<1
Chromium	2	mg/kg	10	8.4	38
Copper	1	mg/kg	2.3	8.8	13
Lead	5	mg/kg	<5	<5	9.8

Customer Sample ID			BH1 0.0-0.2	BH2 0.0-0.2	BH3 0.0-0.2
Amdel Sample Number			**804132**	**804135**	**804138**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
Metals					
Test/Reference	PQL	Unit			
Nickel	2	mg/kg	3.6	15	19
Zinc	2	mg/kg	24	41	80
3400 Total Mercury in Soil by ICP-AES					
Total Mercury	0.05	mg/kg	0.06	0.1	0.14
Miscellaneous					
Test/Reference	PQL	Unit			
5000 Moisture Content					
% Moisture	1	%	1	4	19

Customer Sample ID			BH4 0.0-0.2	BH5 0.0-0.2	BH6 0.0-0.2
Amdel Sample Number			**804141**	**804144**	**804147**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
VOC					
Test/Reference	PQL	Unit			
1100 BTEX &(C6-C9) in Soil by P&T					
Benzene	0.2	mg/kg	<0.2	<0.2	<0.2
Ethylbenzene	1	mg/kg	<1	<1	<1
Meta- & Para- Xylene	2	mg/kg	<2	<2	<2
Ortho-Xylene	1	mg/kg	<1	<1	<1
Toluene	1	mg/kg	<1	<1	<1
Total Xylenes	3	mg/kg	<3	<3	<3
C6-C9 Fraction	5	mg/kg	<5	<5	<5
4-Bromofluorobenzene - Surrogate	-	%	100	104	96
SVOC					
Test/Reference	PQL	Unit			
2300 OC Pesticides in Soil by GC-MS					
a-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
a-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
a-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
Aldrin	0.5	mg/kg	<0.5	<0.5	<0.5
b-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
b-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
d-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
DDD	0.5	mg/kg	<0.5	<0.5	<0.5
DDE	0.5	mg/kg	<0.5	<0.5	<0.5
DDT	0.5	mg/kg	<0.5	<0.5	<0.5
Dieldrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endosulfan sulfate	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin Aldehyde	0.5	mg/kg	<0.5	<0.5	<0.5
g-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
g-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor epoxide	0.5	mg/kg	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	0.5	mg/kg	<0.5	<0.5	<0.5
Methoxychlor	0.5	mg/kg	<0.5	<0.5	<0.5

Customer Sample ID			BH4 0.0-0.2	BH5 0.0-0.2	BH6 0.0-0.2
Amdel Sample Number			804141	804144	804147
Date Sampled			16/01/2008	16/01/2008	16/01/2008
SVOC					
Test/Reference	PQL	Unit			
Oxychlordane	0.5	mg/kg	<0.5	<0.5	<0.5
2,4,5,6-tetrachloro-m-xylene - Surrogate	-	%	98	105	102
2400 OP Pesticides in Soil by GCMS					
Chlorpyrifos	0.5	mg/kg	<0.5	<0.5	<0.5
Chlorpyrifos Methyl	0.5	mg/kg	<0.5	<0.5	<0.5
Diazinon	0.5	mg/kg	<0.5	<0.5	<0.5
Ethion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenitrothion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenthion	0.5	mg/kg	<0.5	<0.5	<0.5
Malathion	0.5	mg/kg	<0.5	<0.5	<0.5
Methyl Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Ronnel	0.5	mg/kg	<0.5	<0.5	<0.5
Triphenyl Phosphate - Surrogate	1	%	125	Q09 145	Q09 170
2100 PAH in Soil by GC					
Acenaphthene	0.5	mg/kg	<0.5	<0.5	<0.5
Acenaphthylene	0.5	mg/kg	<0.5	<0.5	<0.5
Anthracene	0.5	mg/kg	<0.5	<0.5	<0.5
Benz(a)anthracene	0.5	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene	0.5	mg/kg	<0.5	<0.5	<0.5
Benzo(b)&(k)fluoranthene	1	mg/kg	<1	<1	<1
Benzo(g.h.i)perylene	0.5	mg/kg	<0.5	<0.5	<0.5
Chrysene	0.5	mg/kg	<0.5	<0.5	<0.5
Dibenz(ah)anthracene	0.5	mg/kg	<0.5	<0.5	<0.5
Fluoranthene	0.5	mg/kg	<0.5	<0.5	<0.5
Fluorene	0.5	mg/kg	<0.5	<0.5	<0.5
Indeno(123-cd)pyrene	0.5	mg/kg	<0.5	<0.5	<0.5
Naphthalene	0.5	mg/kg	<0.5	<0.5	<0.5
Phenanthrene	0.5	mg/kg	<0.5	<0.5	<0.5
Pyrene	0.5	mg/kg	<0.5	<0.5	<0.5
2-Fluorobiphenyl - Surrogate	-	%	101	103	115
p-Terphenyl-D14 - Surrogate	-	%	123	126	129
Anthracene-d10 - Surrogate	-	%	98	103	102
2600 PCBs in Soil by GC					
Aroclor 1016DB	0.5	mg/kg	<0.5	<0.5	<0.5
Aroclor 1221DB	0.5	mg/kg	<0.5	<0.5	<0.5
Aroclor 1232 and 1242 as totalDB	1	mg/kg	<1	<1	<1
Aroclor 1248 and 1254 as totalDB	1	mg/kg	<1	<1	<1
Aroclor 1260DB	0.5	mg/kg	<0.5	<0.5	<0.5
Total Polychlorinated biphenylsDB	1	mg/kg	<1	<1	<1
Decachlorobiphenyl - PCB surrogate	1	%	118	114	120
2000 TPH (C10 - C36) in Soil by GC					
C10-C14 Fraction	10	mg/kg	<10	<10	<10
C15-C28 Fraction	20	mg/kg	20	22	67
C29-C36 Fraction	20	mg/kg	<20	22	58
Metals					
Test/Reference	PQL	Unit			
3200 Tot Recov. Metals in Soil by ICPAES					
Arsenic	3	mg/kg	5.3	3.8	<3

Customer Sample ID			BH4 0.0-0.2	BH5 0.0-0.2	BH6 0.0-0.2
Amdel Sample Number			**804141**	**804144**	**804147**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
Metals					
Test/Reference	PQL	Unit			
Cadmium	1	mg/kg	<1	<1	<1
Chromium	2	mg/kg	24	30	35
Copper	1	mg/kg	15	15	16
Lead	5	mg/kg	6.8	11	12
Nickel	2	mg/kg	18	11	16
Zinc	2	mg/kg	64	66	77
3400 Total Mercury in Soil by ICP-AES					
Total Mercury	0.05	mg/kg	0.14	0.12	0.18
Miscellaneous					
Test/Reference	PQL	Unit			
5000 Moisture Content					
% Moisture	1	%	15	26	21

Customer Sample ID			BH7 0.0-0.2	BH8 0.0-0.2	BH9-0.0-0.2
Amdel Sample Number			**804150**	**804153**	**804157**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
SVOC					
Test/Reference	PQL	Unit			
2300 OC Pesticides in Soil by GC-MS					
a-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
a-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
a-Endosulfan	0.5	mg/kg	5.5	<0.5	<0.5
Aldrin	0.5	mg/kg	<0.5	<0.5	<0.5
b-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
b-Endosulfan	0.5	mg/kg	2.4	<0.5	<0.5
d-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
DDD	0.5	mg/kg	<0.5	<0.5	<0.5
DDE	0.5	mg/kg	<0.5	<0.5	<0.5
DDT	0.5	mg/kg	<0.5	<0.5	<0.5
Dieldrin	0.5	mg/kg	30	0.9	<0.5
Endosulfan sulfate	0.5	mg/kg	3.0	<0.5	<0.5
Endrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin Aldehyde	0.5	mg/kg	<0.5	<0.5	<0.5
g-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
g-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor epoxide	0.5	mg/kg	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	0.5	mg/kg	<0.5	<0.5	<0.5
Methoxychlor	0.5	mg/kg	<0.5	<0.5	<0.5
Oxychlordane	0.5	mg/kg	<0.5	<0.5	<0.5
2,4,5,6-tetrachloro-m-xylene - Surrogate	-	%	100	104	109
2400 OP Pesticides in Soil by GCMS					
Chlorpyrifos	0.5	mg/kg	<0.5	<0.5	<0.5
Chlorpyrifos Methyl	0.5	mg/kg	<0.5	<0.5	<0.5
Diazinon	0.5	mg/kg	<0.5	<0.5	<0.5
Ethion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenitrothion	0.5	mg/kg	<0.5	<0.5	<0.5

Customer Sample ID			BH7 0.0-0.2	BH8 0.0-0.2	BH9-0.0-0.2
Amdel Sample Number			**804150**	**804153**	**804157**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
SVOC					
Test/Reference	PQL	Unit			
Fenthion	0.5	mg/kg	<0.5	<0.5	<0.5
Malathion	0.5	mg/kg	<0.5	<0.5	<0.5
Methyl Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Ronnel	0.5	mg/kg	<0.5	<0.5	<0.5
Triphenyl Phosphate - Surrogate	1	%	Q09 155	Q09 143	Q09 157
Metals					
Test/Reference	PQL	Unit			
3200 Tot Recov. Metals in Soil by ICPAES					
Arsenic	3	mg/kg	4.8	4.4	<3
Cadmium	1	mg/kg	<1	<1	<1
Chromium	2	mg/kg	14	29	24
Copper	1	mg/kg	58	950	20
Lead	5	mg/kg	15	26	11
Nickel	2	mg/kg	7.9	15	13
Zinc	2	mg/kg	110	150	77
3400 Total Mercury in Soil by ICP-AES					
Total Mercury	0.05	mg/kg	2.6	1.2	1.2
Miscellaneous					
Test/Reference	PQL	Unit			
5000 Moisture Content					
% Moisture	1	%	7	26	24

Customer Sample ID			BH10 0.0-0.2	BH11 0.0-0.2	BH12 0.0-0.2
Amdel Sample Number			**804160**	**804162**	**804165**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
SVOC					
Test/Reference	PQL	Unit			
2300 OC Pesticides in Soil by GC-MS					
a-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
a-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
a-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
Aldrin	0.5	mg/kg	<0.5	<0.5	<0.5
b-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
b-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
d-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
DDD	0.5	mg/kg	<0.5	<0.5	<0.5
DDE	0.5	mg/kg	<0.5	<0.5	<0.5
DDT	0.5	mg/kg	<0.5	<0.5	<0.5
Dieldrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endosulfan sulfate	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin Aldehyde	0.5	mg/kg	<0.5	<0.5	<0.5
g-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
g-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor	0.5	mg/kg	<0.5	<0.5	<0.5

Customer Sample ID			BH10 0.0-0.2	BH11 0.0-0.2	BH12 0.0-0.2
Amdel Sample Number			804160	804162	804165
Date Sampled			16/01/2008	16/01/2008	16/01/2008
SVOC					
Test/Reference	PQL	Unit			
Heptachlor epoxide	0.5	mg/kg	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	0.5	mg/kg	<0.5	<0.5	<0.5
Methoxychlor	0.5	mg/kg	<0.5	<0.5	<0.5
Oxychlordane	0.5	mg/kg	<0.5	<0.5	<0.5
2,4,5,6-tetrachloro-m-xylene - Surrogate	-	%	101	98	107
2400 OP Pesticides in Soil by GCMS					
Chlorpyrifos	0.5	mg/kg	<0.5	<0.5	<0.5
Chlorpyrifos Methyl	0.5	mg/kg	<0.5	<0.5	<0.5
Diazinon	0.5	mg/kg	<0.5	<0.5	<0.5
Ethion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenitrothion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenthion	0.5	mg/kg	<0.5	<0.5	<0.5
Malathion	0.5	mg/kg	<0.5	<0.5	<0.5
Methyl Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Ronnel	0.5	mg/kg	<0.5	<0.5	<0.5
Triphenyl Phosphate - Surrogate	1	%	128	126	Q09 153
Metals					
Test/Reference	PQL	Unit			
3200 Tot Recov. Metals in Soil by ICPAES					
Arsenic	3	mg/kg	<3	<3	5.0
Cadmium	1	mg/kg	<1	<1	<1
Chromium	2	mg/kg	10	19	25
Copper	1	mg/kg	11	12	17
Lead	5	mg/kg	<5	6.9	7.9
Nickel	2	mg/kg	6.3	10	16
Zinc	2	mg/kg	38	68	68
3400 Total Mercury in Soil by ICP-AES					
Total Mercury	0.05	mg/kg	5.9	1.3	1.9
Miscellaneous					
Test/Reference	PQL	Unit			
5000 Moisture Content					
% Moisture	1	%	8	18	18

Customer Sample ID			BH13 0.0-0.2	BH14 0.0-0.2	BH15 0.0-0.2
Amdel Sample Number			804168	804171	804174
Date Sampled			16/01/2008	16/01/2008	16/01/2008
SVOC					
Test/Reference	PQL	Unit			
2300 OC Pesticides in Soil by GC-MS					
a-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
a-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
a-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
Aldrin	0.5	mg/kg	<0.5	<0.5	<0.5
b-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
b-Endosulfan	0.5	mg/kg	<0.5	<0.5	<0.5
d-BHC	0.5	mg/kg	<0.5	<0.5	<0.5

Customer Sample ID			BH13 0.0-0.2	BH14 0.0-0.2	BH15 0.0-0.2
Amdel Sample Number			**804168**	**804171**	**804174**
Date Sampled			**16/01/2008**	**16/01/2008**	**16/01/2008**
SVOC					
Test/Reference	PQL	Unit			
DDD	0.5	mg/kg	<0.5	<0.5	<0.5
DDE	0.5	mg/kg	<0.5	<0.5	<0.5
DDT	0.5	mg/kg	<0.5	<0.5	<0.5
Dieldrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endosulfan sulfate	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin	0.5	mg/kg	<0.5	<0.5	<0.5
Endrin Aldehyde	0.5	mg/kg	<0.5	<0.5	<0.5
g-BHC	0.5	mg/kg	<0.5	<0.5	<0.5
g-Chlordane	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor	0.5	mg/kg	<0.5	<0.5	<0.5
Heptachlor epoxide	0.5	mg/kg	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	0.5	mg/kg	<0.5	<0.5	<0.5
Methoxychlor	0.5	mg/kg	<0.5	<0.5	<0.5
Oxychlordane	0.5	mg/kg	<0.5	<0.5	<0.5
2,4,5,6-tetrachloro-m-xylene - Surrogate	-	%	107	101	99
2400 OP Pesticides in Soil by GCMS					
Chlorpyrifos	0.5	mg/kg	<0.5	<0.5	<0.5
Chlorpyrifos Methyl	0.5	mg/kg	<0.5	<0.5	<0.5
Diazinon	0.5	mg/kg	<0.5	<0.5	<0.5
Ethion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenitrothion	0.5	mg/kg	<0.5	<0.5	<0.5
Fenthion	0.5	mg/kg	<0.5	<0.5	<0.5
Malathion	0.5	mg/kg	<0.5	<0.5	<0.5
Methyl Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Parathion	0.5	mg/kg	<0.5	<0.5	<0.5
Ronnel	0.5	mg/kg	<0.5	<0.5	<0.5
Triphenyl Phosphate - Surrogate	1	%	105	112	106
Metals					
Test/Reference	PQL	Unit			
3200 Tot Recov. Metals in Soil by ICPAES					
Arsenic	3	mg/kg	<3	3.5	<3
Cadmium	1	mg/kg	<1	<1	<1
Chromium	2	mg/kg	28	40	20
Copper	1	mg/kg	16	20	22
Lead	5	mg/kg	7.6	20	10
Nickel	2	mg/kg	17	23	12
Zinc	2	mg/kg	64	92	73
3400 Total Mercury in Soil by ICP-AES					
Total Mercury	0.05	mg/kg	1.1	0.63	1.1
Miscellaneous					
Test/Reference	PQL	Unit			
5000 Moisture Content					
% Moisture	1	%	23	28	22

Customer Sample ID	BH16 0.3-0.4
Amdel Sample Number	**804175**
Date Sampled	**16/01/2008**

Customer Sample ID			**BH16 0.3-0.4**
Amdel Sample Number			**804175**
Date Sampled			**16/01/2008**
SVOC			
Test/Reference	PQL	Unit	
2300 OC Pesticides in Soil by GC-MS			
a-BHC	0.5	mg/kg	<0.5
a-Chlordane	0.5	mg/kg	<0.5
a-Endosulfan	0.5	mg/kg	<0.5
Aldrin	0.5	mg/kg	<0.5
b-BHC	0.5	mg/kg	<0.5
b-Endosulfan	0.5	mg/kg	<0.5
d-BHC	0.5	mg/kg	<0.5
DDD	0.5	mg/kg	<0.5
DDE	0.5	mg/kg	<0.5
DDT	0.5	mg/kg	<0.5
Dieldrin	0.5	mg/kg	<0.5
Endosulfan sulfate	0.5	mg/kg	<0.5
Endrin	0.5	mg/kg	<0.5
Endrin Aldehyde	0.5	mg/kg	<0.5
g-BHC	0.5	mg/kg	<0.5
g-Chlordane	0.5	mg/kg	<0.5
Heptachlor	0.5	mg/kg	<0.5
Heptachlor epoxide	0.5	mg/kg	<0.5
Hexachlorobenzene (HCB)	0.5	mg/kg	<0.5
Methoxychlor	0.5	mg/kg	<0.5
Oxychlordane	0.5	mg/kg	<0.5
2,4,5,6-tetrachloro-m-xylene - Surrogate	-	%	102
2400 OP Pesticides in Soil by GCMS			
Chlorpyrifos	0.5	mg/kg	<0.5
Chlorpyrifos Methyl	0.5	mg/kg	<0.5
Diazinon	0.5	mg/kg	<0.5
Ethion	0.5	mg/kg	<0.5
Fenitrothion	0.5	mg/kg	<0.5
Fenthion	0.5	mg/kg	<0.5
Malathion	0.5	mg/kg	<0.5
Methyl Parathion	0.5	mg/kg	<0.5
Parathion	0.5	mg/kg	<0.5
Ronnel	0.5	mg/kg	<0.5
Triphenyl Phosphate - Surrogate	1	%	113
Metals			
Test/Reference	PQL	Unit	
3200 Tot Recov. Metals in Soil by ICPAES			
Arsenic	3	mg/kg	3.2
Cadmium	1	mg/kg	<1
Chromium	2	mg/kg	31
Copper	1	mg/kg	18
Lead	5	mg/kg	9.0
Nickel	2	mg/kg	20
Zinc	2	mg/kg	74
3400 Total Mercury in Soil by ICP-AES			
Total Mercury	0.05	mg/kg	1.3
Miscellaneous			
Test/Reference	PQL	Unit	

Customer Sample ID	**BH16 0.3-0.4**
Amdel Sample Number	**804175**
Date Sampled	**16/01/2008**

Miscellaneous

Test/Reference	PQL	Unit	
5000 Moisture Content			
% Moisture	1	%	18

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.

Description	Extracted	Analysed
1100 BTEX &(C6-C9) in Soil by P&T	18/01/2008	21/01/2008
2000 TPH (C10 - C36) in Soil by GC	18/01/2008	21/01/2008
2100 PAH in Soil by GC	18/01/2008	24/01/2008
2300 OC Pesticides in Soil by GC-MS	18/01/2008	24/01/2008
2400 OP Pesticides in Soil by GCMS	18/01/2008	24/01/2008
2600 PCBs in Soil by GC	21/01/2008	22/01/2008
3200 Tot Recov. Metals in Soil by ICPAES	18/01/2008	22/01/2008
3400 Total Mercury in Soil by ICP-AES	18/01/2008	23/01/2008
5000 Moisture Content		21/01/2008

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Amdel Internal Quality Control Review

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. Proficiency Trial results are available on request.
3. Actual PQLs are matrix dependant. Quoted PQLs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spike or surrogate recoveries.
5. Test samples duplicated or spiked, are for this job only and are identified in the following QC report.
6. SVOC analyses on waters are performed on homogenized, unfiltered sample, unless noted otherwise.
7. When individual results are qualified in the body of a report, refer to the qualifier descriptions that follow.
8. The 'Sum of PAHs' result in the body of the report is the sum of any positive results.
9. Sampled Dates quoted in this report are those listed on the COC or sample jars; if no sample dates are noted, the date the samples are received at the laboratory have been used
10. Matrix Spike recoveries are calculated on an 'As Received' basis; the parent sample result is moisture corrected after the %recovery is determined

Holding Times

Please refer to 'Sampling and Preservation Chart for Soils & Waters' for holding times. (Amdel form AS-FOR-ADM-020)

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Acknowledgement.
If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitability qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

** **Note**: pH duplicates below are expressed as a range not as an RPD.

Quality Control Results

Laboratory: **EN_METALS**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
805306 [Method Blank]							
3200 Tot Recov. Metals in Soil by ICPAES							
Arsenic	mg/kg	<3			< 3	T	
Cadmium	mg/kg	<1			< 1	T	
Chromium	mg/kg	<2			< 2	T	
Copper	mg/kg	<1			< 1	T	
Lead	mg/kg	<5			< 5	T	
Nickel	mg/kg	<2			< 2	T	
Zinc	mg/kg	<2			< 2	T	
805339 [Method Blank]							
3400 Total Mercury in Soil by ICP-AES							
Total Mercury	mg/kg	<0.05			< 0.05	T	
805307 [Laboratory Control Sample]							
3200 Tot Recov. Metals in Soil by ICPAES			Expected Value	Percent Recovery			
Arsenic	mg/kg	49	50.0	98	70-130 %	T	
Cadmium	mg/kg	50	50.0	100	70-130 %	T	
Chromium	mg/kg	50	50.0	99	70-130 %	T	
Copper	mg/kg	51	50.0	102	70-130 %	T	
Lead	mg/kg	51	50.0	101	70-130 %	T	
Nickel	mg/kg	51	50.0	102	70-130 %	T	
Zinc	mg/kg	52	50.0	105	70-130 %	T	
805340 [Laboratory Control Sample]							
3400 Total Mercury in Soil by ICP-AES			Expected Value	Percent Recovery			
Total Mercury	mg/kg	0.48	0.5	95	75-125 %	T	

Laboratory: **EN_METALS**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
804532 [Duplicate of 804138]							
3200 Tot Recov. Metals in Soil by ICPAES			Result 2	RPD			
Arsenic	mg/kg	<3	<3	<1	0-30 %	T	
Cadmium	mg/kg	<1	<1	<1	0-30 %	T	
Chromium	mg/kg	39	38	1	0-30 %	T	
Copper	mg/kg	13	13	2	0-30 %	T	
Lead	mg/kg	9.3	9.8	5	0-30 %	T	
Nickel	mg/kg	19	19	<1	0-30 %	T	
Zinc	mg/kg	78	80	2	0-30 %	T	
804533 [Duplicate of 804171]							
3200 Tot Recov. Metals in Soil by ICPAES			Result 2	RPD			
Arsenic	mg/kg	3.7	3.5	5	0-30 %	T	
Cadmium	mg/kg	<1	<1	<1	0-30 %	T	
Chromium	mg/kg	44	40	9	0-30 %	T	
Copper	mg/kg	20	20	<1	0-30 %	T	
Lead	mg/kg	20	20	3	0-30 %	T	
Nickel	mg/kg	23	23	1	0-30 %	T	
Zinc	mg/kg	93	92	1	0-30 %	T	
804534 [Duplicate of 804138]							
3400 Total Mercury in Soil by ICP-AES			Result 2	RPD			
Total Mercury	mg/kg	0.13	0.14	13	0-30 %	T	
804535 [Duplicate of 804171]							
3400 Total Mercury in Soil by ICP-AES			Result 2	RPD			
Total Mercury	mg/kg	0.61	0.63	3	0-30 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
805290 [Method Blank]							
2000 TPH (C10 - C36) in Soil by GC							
C10-C14 Fraction	mg/kg	<10			< 10	T	
C15-C28 Fraction	mg/kg	<20			< 20	T	
C29-C36 Fraction	mg/kg	<20			< 20	T	
2100 PAH in Soil by GC							
Acenaphthene	mg/kg	<0.5			< 0.5	T	
Acenaphthylene	mg/kg	<0.5			< 0.5	T	
Anthracene	mg/kg	<0.5			< 0.5	T	
Benz(a)anthracene	mg/kg	<0.5			< 0.5	T	
Benzo(a)pyrene	mg/kg	<0.5			< 0.5	T	
Benzo(b)&(k)fluoranthene	mg/kg	<1			< 1	T	
Benzo(g.h.i)perylene	mg/kg	<0.5			< 0.5	T	
Chrysene	mg/kg	<0.5			< 0.5	T	
Dibenz(ah)anthracene	mg/kg	<0.5			< 0.5	T	
Fluoranthene	mg/kg	<0.5			< 0.5	T	
Fluorene	mg/kg	<0.5			< 0.5	T	
Indeno(123-cd)pyrene	mg/kg	<0.5			< 0.5	T	
Naphthalene	mg/kg	<0.5			< 0.5	T	
Phenanthrene	mg/kg	<0.5			< 0.5	T	
Pyrene	mg/kg	<0.5			< 0.5	T	
Sum of PAHs	mg/kg	<0.5			< 0.5	T	
2-Fluorobiphenyl - Surrogate	%	106			70-130 %	T	
Anthracene-d10 - Surrogate	%	100			70-130 %	T	
p-Terphenyl-D14 - Surrogate	%	106			70-130 %	T	
2300 OC Pesticides in Soil by GC-MS							
a-BHC	mg/kg	<0.5			< 0.5	T	
a-Chlordane	mg/kg	<0.5			< 0.5	T	
a-Endosulfan	mg/kg	<0.5			< 0.5	T	
Aldrin	mg/kg	<0.5			< 0.5	T	
b-BHC	mg/kg	<0.5			< 0.5	T	
b-Endosulfan	mg/kg	<0.5			< 0.5	T	
d-BHC	mg/kg	<0.5			< 0.5	T	
DDD	mg/kg	<0.5			< 0.5	T	
DDE	mg/kg	<0.5			< 0.5	T	
DDT	mg/kg	<0.5			< 0.5	T	
Dieldrin	mg/kg	<0.5			< 0.5	T	
Endosulfan sulfate	mg/kg	<0.5			< 0.5	T	
Endrin	mg/kg	<0.5			< 0.5	T	
Endrin Aldehyde	mg/kg	<0.5			< 0.5	T	
g-BHC	mg/kg	<0.5			< 0.5	T	
g-Chlordane	mg/kg	<0.5			< 0.5	T	
Heptachlor	mg/kg	<0.5			< 0.5	T	
Heptachlor epoxide	mg/kg	<0.5			< 0.5	T	
Hexachlorobenzene (HCB)	mg/kg	<0.5			< 0.5	T	
Methoxychlor	mg/kg	<0.5			< 0.5	T	
Oxychlordane	mg/kg	<0.5			< 0.5	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	101			70-130 %	T	
2400 OP Pesticides in Soil by GCMS							
Chlorpyrifos	mg/kg	<0.5			< 0.5	T	
Chlorpyrifos Methyl	mg/kg	<0.5			< 0.5	T	
Diazinon	mg/kg	<0.5			< 0.5	T	
Ethion	mg/kg	<0.5			< 0.5	T	
Fenitrothion	mg/kg	<0.5			< 0.5	T	
Fenthion	mg/kg	<0.5			< 0.5	T	
Malathion	mg/kg	<0.5			< 0.5	T	
Methyl Parathion	mg/kg	<0.5			< 0.5	T	
Parathion	mg/kg	<0.5			< 0.5	T	
Ronnel	mg/kg	<0.5			< 0.5	T	
Triphenyl Phosphate - Surrogate	%	99			70-130 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
805383 [Method Blank]							
2300 OC Pesticides in Soil by GC-MS							
a-BHC	mg/kg	<0.5			< 0.5	T	
a-Chlordane	mg/kg	<0.5			< 0.5	T	
a-Endosulfan	mg/kg	<0.5			< 0.5	T	
Aldrin	mg/kg	<0.5			< 0.5	T	
b-BHC	mg/kg	<0.5			< 0.5	T	
b-Endosulfan	mg/kg	<0.5			< 0.5	T	
d-BHC	mg/kg	<0.5			< 0.5	T	
DDD	mg/kg	<0.5			< 0.5	T	
DDE	mg/kg	<0.5			< 0.5	T	
DDT	mg/kg	<0.5			< 0.5	T	
Dieldrin	mg/kg	<0.5			< 0.5	T	
Endosulfan sulfate	mg/kg	<0.5			< 0.5	T	
Endrin	mg/kg	<0.5			< 0.5	T	
Endrin Aldehyde	mg/kg	<0.5			< 0.5	T	
g-BHC	mg/kg	<0.5			< 0.5	T	
g-Chlordane	mg/kg	<0.5			< 0.5	T	
Heptachlor	mg/kg	<0.5			< 0.5	T	
Heptachlor epoxide	mg/kg	<0.5			< 0.5	T	
Hexachlorobenzene (HCB)	mg/kg	<0.5			< 0.5	T	
Methoxychlor	mg/kg	<0.5			< 0.5	T	
Oxychlordane	mg/kg	<0.5			< 0.5	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	117			70-130 %	T	
2400 OP Pesticides in Soil by GCMS							
Chlorpyrifos	mg/kg	<0.5			< 0.5	T	
Chlorpyrifos Methyl	mg/kg	<0.5			< 0.5	T	
Diazinon	mg/kg	<0.5			< 0.5	T	
Ethion	mg/kg	<0.5			< 0.5	T	
Fenitrothion	mg/kg	<0.5			< 0.5	T	
Fenthion	mg/kg	<0.5			< 0.5	T	
Malathion	mg/kg	<0.5			< 0.5	T	
Methyl Parathion	mg/kg	<0.5			< 0.5	T	
Parathion	mg/kg	<0.5			< 0.5	T	
Ronnel	mg/kg	<0.5			< 0.5	T	
Triphenyl Phosphate - Surrogate	%	114			70-130 %	T	
807754 [Method Blank]							
2600 PCBs in Soil by GC							
Aroclor 1016	mg/kg	<0.5			< 0.5	T	
Aroclor 1221	mg/kg	<0.5			< 0.5	T	
Aroclor 1232 and 1242 as total	mg/kg	<1			< 1	T	
Aroclor 1248 and 1254 as total	mg/kg	<1			< 1	T	
Aroclor 1260	mg/kg	<0.5			< 0.5	T	
Total Polychlorinated biphenyls	mg/kg	<1			< 1	T	
Decachlorobiphenyl - PCB surrogate	%	124			70-130 %	T	
805292 [Laboratory Control Sample]							
2000 TPH (C10 - C36) in Soil by GC			Expected Value	Percent Recovery			
C10-C14 Fraction	mg/kg	110	125.0	90	70-130 %	T	
C15-C28 Fraction	mg/kg	120	125.0	94	70-130 %	T	
C29-C36 Fraction	mg/kg	110	125.0	84	70-130 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
805293 [Laboratory Control Sample]							
2100 PAH in Soil by GC			Expected Value	Percent Recovery			
Acenaphthene	mg/kg	1.9	2.0	94	70-130 %	T	
Acenaphthylene	mg/kg	2.1	2.0	104	70-130 %	T	
Anthracene	mg/kg	2.0	2.0	100	70-130 %	T	
Benz(a)anthracene	mg/kg	2.3	2.0	113	70-130 %	T	
Benzo(a)pyrene	mg/kg	2.3	2.0	117	70-130 %	T	
Benzo(b)&(k)fluoranthene	mg/kg	4.9	4.0	124	70-130 %	T	
Benzo(g.h.i)perylene	mg/kg	1.9	2.0	94	70-130 %	T	
Chrysene	mg/kg	1.9	2.0	93	70-130 %	T	
Dibenz(ah)anthracene	mg/kg	1.7	2.0	85	70-130 %	T	
Fluoranthene	mg/kg	2.1	2.0	105	70-130 %	T	
Fluorene	mg/kg	1.9	2.0	94	70-130 %	T	
Indeno(123-cd)pyrene	mg/kg	2.2	2.0	108	70-130 %	T	
Naphthalene	mg/kg	1.9	2.0	95	70-130 %	T	
Phenanthrene	mg/kg	1.9	2.0	94	70-130 %	T	
Pyrene	mg/kg	2.1	2.0	103	70-130 %	T	
2-Fluorobiphenyl - Surrogate	%	105			70-130 %	T	
Anthracene-d10 - Surrogate	%	96			70-130 %	T	
p-Terphenyl-D14 - Surrogate	%	106			70-130 %	T	
2300 OC Pesticides in Soil by GC-MS			Expected Value	Percent Recovery			
a-BHC	mg/kg	2.3	2.0	114	70-130 %	T	
a-Chlordane	mg/kg	2.0	2.0	102	70-130 %	T	
a-Endosulfan	mg/kg	2.1	2.0	103	70-130 %	T	
Aldrin	mg/kg	1.9	2.0	95	70-130 %	T	
b-BHC	mg/kg	2.0	2.0	98	70-130 %	T	
b-Endosulfan	mg/kg	2.3	2.0	113	70-130 %	T	
d-BHC	mg/kg	2.0	2.0	99	70-130 %	T	
DDD	mg/kg	2.3	2.0	113	70-130 %	T	
DDE	mg/kg	2.2	2.0	109	70-130 %	T	
DDT	mg/kg	2.1	2.0	106	70-130 %	T	
Dieldrin	mg/kg	2.1	2.0	104	70-130 %	T	
Endosulfan sulfate	mg/kg	2.3	2.0	117	70-130 %	T	
Endrin	mg/kg	2.6	2.0	130	70-130 %	T	
Endrin Aldehyde	mg/kg	1.9	2.0	95	70-130 %	T	
g-BHC	mg/kg	2.0	2.0	99	70-130 %	T	
g-Chlordane	mg/kg	2.1	2.0	106	70-130 %	T	
Heptachlor	mg/kg	1.8	2.0	91	70-130 %	T	
Heptachlor epoxide	mg/kg	1.8	2.0	90	70-130 %	T	
Hexachlorobenzene (HCB)	mg/kg	<0.5	2.0	0	70-130 %	F	
Methoxychlor	mg/kg	2.3	2.0	115	70-130 %	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	93			70-130 %	T	
2400 OP Pesticides in Soil by GCMS			Expected Value	Percent Recovery			
Chlorpyrifos	mg/kg	2.2	2.0	112	70-130 %	T	
Chlorpyrifos Methyl	mg/kg	1.9	2.0	94	70-130 %	T	
Diazinon	mg/kg	2.1	2.0	104	70-130 %	T	
Ethion	mg/kg	2.2	2.0	111	70-130 %	T	
Fenitrothion	mg/kg	1.8	2.0	90	70-130 %	T	
Fenthion	mg/kg	2.0	2.0	101	70-130 %	T	
Malathion	mg/kg	1.9	2.0	94	70-130 %	T	
Methyl Parathion	mg/kg	1.7	2.0	85	70-130 %	T	
Parathion	mg/kg	1.8	2.0	90	70-130 %	T	
Ronnel	mg/kg	1.9	2.0	97	70-130 %	T	
Triphenyl Phosphate - Surrogate	%	116			70-130 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
805385 [Laboratory Control Sample]							
2300 OC Pesticides in Soil by GC-MS			Expected Value	Percent Recovery			
a-BHC	mg/kg	2.4	2.0	121	70-130 %	T	
a-Chlordane	mg/kg	1.8	2.0	88	70-130 %	T	
a-Endosulfan	mg/kg	1.9	2.0	94	70-130 %	T	
Aldrin	mg/kg	2.1	2.0	107	70-130 %	T	
b-BHC	mg/kg	1.8	2.0	92	70-130 %	T	
b-Endosulfan	mg/kg	2.4	2.0	119	70-130 %	T	
d-BHC	mg/kg	2.2	2.0	109	70-130 %	T	
DDD	mg/kg	1.8	2.0	88	70-130 %	T	
DDE	mg/kg	1.9	2.0	95	70-130 %	T	
DDT	mg/kg	2.2	2.0	111	70-130 %	T	
Dieldrin	mg/kg	1.9	2.0	96	70-130 %	T	
Endosulfan sulfate	mg/kg	1.7	2.0	85	70-130 %	T	
Endrin	mg/kg	2.7	2.0	135	70-130 %	F	Q13
Endrin Aldehyde	mg/kg	1.4	2.0	72	70-130 %	T	
g-BHC	mg/kg	1.9	2.0	95	70-130 %	T	
g-Chlordane	mg/kg	1.8	2.0	90	70-130 %	T	
Heptachlor	mg/kg	2.0	2.0	98	70-130 %	T	
Heptachlor epoxide	mg/kg	1.8	2.0	92	70-130 %	T	
Methoxychlor	mg/kg	1.8	2.0	92	70-130 %	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	101			70-130 %	T	
2400 OP Pesticides in Soil by GCMS			Expected Value	Percent Recovery			
Chlorpyrifos	mg/kg	2.1	2.0	104	70-130 %	T	
Chlorpyrifos Methyl	mg/kg	1.8	2.0	90	70-130 %	T	
Diazinon	mg/kg	1.8	2.0	91	70-130 %	T	
Ethion	mg/kg	1.8	2.0	91	70-130 %	T	
Fenitrothion	mg/kg	1.8	2.0	89	70-130 %	T	
Fenthion	mg/kg	1.9	2.0	96	70-130 %	T	
Malathion	mg/kg	2.3	2.0	117	70-130 %	T	
Methyl Parathion	mg/kg	1.8	2.0	92	70-130 %	T	
Parathion	mg/kg	2.1	2.0	104	70-130 %	T	
Ronnel	mg/kg	1.8	2.0	90	70-130 %	T	
Triphenyl Phosphate - Surrogate	%	108			70-130 %	T	
804536 [Duplicate of 804138]							
2300 OC Pesticides in Soil by GC-MS			Result 2	RPD			
a-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
a-Chlordane	mg/kg	<0.5	<0.5	<1	0-30 %	T	
a-Endosulfan	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Aldrin	mg/kg	<0.5	<0.5	<1	0-30 %	T	
b-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
b-Endosulfan	mg/kg	<0.5	<0.5	<1	0-30 %	T	
d-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
DDD	mg/kg	<0.5	<0.5	<1	0-30 %	T	
DDE	mg/kg	<0.5	<0.5	<1	0-30 %	T	
DDT	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Dieldrin	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Endosulfan sulfate	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Endrin	mg/kg	<0.5	<0.5	<1	0-30 %	T	Q02
Endrin Aldehyde	mg/kg	<0.5	<0.5	<1	0-30 %	T	
g-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
g-Chlordane	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Heptachlor	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Heptachlor epoxide	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Hexachlorobenzene (HCB)	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Methoxychlor	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Oxychlordane	mg/kg	<0.5	<0.5	<1	0-30 %	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	103			70-130 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
804537 [Duplicate of 804171]							
2300 OC Pesticides in Soil by GC-MS			Result 2	RPD			
a-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
a-Chlordane	mg/kg	<0.5	<0.5	<1	0-30 %	T	
a-Endosulfan	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Aldrin	mg/kg	<0.5	<0.5	<1	0-30 %	T	
b-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
b-Endosulfan	mg/kg	<0.5	<0.5	<1	0-30 %	T	
d-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
DDD	mg/kg	<0.5	<0.5	<1	0-30 %	T	
DDE	mg/kg	<0.5	<0.5	<1	0-30 %	T	
DDT	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Dieldrin	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Endosulfan sulfate	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Endrin	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Endrin Aldehyde	mg/kg	<0.5	<0.5	<1	0-30 %	T	
g-BHC	mg/kg	<0.5	<0.5	<1	0-30 %	T	
g-Chlordane	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Heptachlor	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Heptachlor epoxide	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Hexachlorobenzene (HCB)	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Methoxychlor	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Oxychlordane	mg/kg	<0.5	<0.5	<1	0-30 %	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	102			70-130 %	T	
804538 [Duplicate of 804138]							
2400 OP Pesticides in Soil by GCMS			Result 2	RPD			
Chlorpyrifos	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Chlorpyrifos Methyl	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Diazinon	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Ethion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Fenitrothion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Fenthion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Malathion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Methyl Parathion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Parathion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Ronnel	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Triphenyl Phosphate - Surrogate	%	158			70-130 %	F	Q09
804539 [Duplicate of 804171]							
2400 OP Pesticides in Soil by GCMS			Result 2	RPD			
Chlorpyrifos	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Chlorpyrifos Methyl	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Diazinon	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Ethion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Fenitrothion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Fenthion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Malathion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Methyl Parathion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Parathion	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Ronnel	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Triphenyl Phosphate - Surrogate	%	111			70-130 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
804540 [Duplicate of 804138]							
2100 PAH in Soil by GC			Result 2	RPD			
Acenaphthene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Acenaphthylene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Anthracene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Benz(a)anthracene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Benzo(a)pyrene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Benzo(b)&(k)fluoranthene	mg/kg	<1	<1	<1	0-30 %	T	
Benzo(g.h.i)perylene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Chrysene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Dibenz(ah)anthracene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Fluoranthene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Fluorene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Indeno(123-cd)pyrene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Naphthalene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Phenanthrene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Pyrene	mg/kg	<0.5	<0.5	<1	0-30 %	T	
2-Fluorobiphenyl - Surrogate	%	80			70-130 %	T	
Anthracene-d10 - Surrogate	%	95			70-130 %	T	
p-Terphenyl-D14 - Surrogate	%	128			70-130 %	T	
804541 [Duplicate of 804221]							
2600 PCBs in Soil by GC			Result 2	RPD			
Aroclor 1016DB	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Aroclor 1221DB	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Aroclor 1232 and 1242 as totalDB	mg/kg	<1	<1	<1	0-30 %	T	
Aroclor 1248 and 1254 as totalDB	mg/kg	<1	<1	<1	0-30 %	T	
Aroclor 1260DB	mg/kg	<0.5	<0.5	<1	0-30 %	T	
Decachlorobiphenyl - PCB surrogate	%	114			70-130 %	T	
804542 [Duplicate of 804138]							
2000 TPH (C10 - C36) in Soil by GC			Result 2	RPD			
C10-C14 Fraction	mg/kg	<10	<10	<1	0-30 %	T	
C15-C28 Fraction	mg/kg	41	37	11	0-30 %	T	
C29-C36 Fraction	mg/kg	49	30	50	0-30 %	F	Q15
804546 [Spike of 804138]							
2300 OC Pesticides in Soil by GC-MS			Spike Value	Percent Recovery			
a-BHC	mg/kg	2.2	2.0	110	70-130 %	T	
a-Chlordane	mg/kg	2.3	2.0	113	70-130 %	T	
a-Endosulfan	mg/kg	2.1	2.0	106	70-130 %	T	
Aldrin	mg/kg	2.0	2.0	98	70-130 %	T	
b-BHC	mg/kg	1.9	2.0	95	70-130 %	T	
b-Endosulfan	mg/kg	2.5	2.0	123	70-130 %	T	
d-BHC	mg/kg	2.0	2.0	100	70-130 %	T	
DDD	mg/kg	2.5	2.0	125	70-130 %	T	
DDE	mg/kg	2.4	2.0	120	70-130 %	T	
DDT	mg/kg	2.0	2.0	100	70-130 %	T	
Dieldrin	mg/kg	2.3	2.0	113	70-130 %	T	
Endosulfan sulfate	mg/kg	2.7	2.0	134	70-130 %	F	Q08
Endrin	mg/kg	4.7	2.0	235	70-130 %	F	Q08
Endrin Aldehyde	mg/kg	1.7	2.0	84	70-130 %	T	
g-BHC	mg/kg	2.0	2.0	98	70-130 %	T	
g-Chlordane	mg/kg	2.2	2.0	109	70-130 %	T	
Heptachlor	mg/kg	1.9	2.0	95	70-130 %	T	
Heptachlor epoxide	mg/kg	2.0	2.0	98	70-130 %	T	
Methoxychlor	mg/kg	2.1	2.0	95	70-130 %	T	
2,4,5,6-tetrachloro-m-xylene - Surrogate	%	96			70-130 %	T	

Laboratory: **EN_SVOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
804547 [Spike of 804138]							
2400 OP Pesticides in Soil by GCMS			Spike Value	Percent Recovery			
Chlorpyrifos	mg/kg	2.6	2.0	129	70-130 %	T	
Chlorpyrifos Methyl	mg/kg	2.1	2.0	106	70-130 %	T	
Diazinon	mg/kg	2.2	2.0	109	70-130 %	T	
Ethion	mg/kg	2.5	2.0	126	70-130 %	T	
Fenitrothion	mg/kg	2.2	2.0	108	70-130 %	T	
Fenthion	mg/kg	2.3	2.0	114	70-130 %	T	
Malathion	mg/kg	2.2	2.0	110	70-130 %	T	
Methyl Parathion	mg/kg	2.3	2.0	116	70-130 %	T	
Parathion	mg/kg	2.3	2.0	115	70-130 %	T	
Ronnel	mg/kg	2.1	2.0	104	70-130 %	T	
Triphenyl Phosphate - Surrogate	%	126			70-130 %	T	
804548 [Spike of 804138]							
2100 PAH in Soil by GC			Spike Value	Percent Recovery			
Acenaphthene	mg/kg	1.9	2.0	95	70-130 %	T	
Acenaphthylene	mg/kg	2.1	2.0	103	70-130 %	T	
Anthracene	mg/kg	2.0	2.0	102	70-130 %	T	
Benz(a)anthracene	mg/kg	2.4	2.0	122	70-130 %	T	
Benzo(a)pyrene	mg/kg	1.6	2.0	81	70-130 %	T	
Benzo(b)&(k)fluoranthene	mg/kg	4.9	4.0	123	70-130 %	T	
Benzo(g.h.i)perylene	mg/kg	1.7	2.0	87	70-130 %	T	
Chrysene	mg/kg	1.9	2.0	96	70-130 %	T	
Dibenz(ah)anthracene	mg/kg	2.0	2.0	101	70-130 %	T	
Fluoranthene	mg/kg	2.1	2.0	107	70-130 %	T	
Fluorene	mg/kg	1.9	2.0	93	70-130 %	T	
Indeno(123-cd)pyrene	mg/kg	2.4	2.0	118	70-130 %	T	
Naphthalene	mg/kg	1.9	2.0	97	70-130 %	T	
Phenanthrene	mg/kg	1.9	2.0	97	70-130 %	T	
Pyrene	mg/kg	2.2	2.0	108	70-130 %	T	
2-Fluorobiphenyl - Surrogate	%	104			70-130 %	T	
Anthracene-d10 - Surrogate	%	100			70-130 %	T	
p-Terphenyl-D14 - Surrogate	%	115			70-130 %	T	
804550 [Spike of 804216]							
2600 PCBs in Soil by GC			Spike Value	Percent Recovery			
Aroclor 1016	mg/kg	2.1	2.0	106	70-130 %	T	
Aroclor 1248 and 1254 as total	mg/kg	2.4	2.0	119	70-130 %	T	
Aroclor 1260	mg/kg	2.4	2.0	118	70-130 %	T	
Decachlorobiphenyl - PCB surrogate	%	120			70-130 %	T	

Laboratory: **EN_VOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
805265 [Method Blank]							
1100 BTEX &(C6-C9) in Soil by P&T							
Benzene	mg/kg	<0.2			< 0.2	T	
C6-C9 Fraction	mg/kg	<5			< 5	T	
Ethylbenzene	mg/kg	<1			< 1	T	
Meta- & Para- Xylene	mg/kg	<2			< 2	T	
Ortho-Xylene	mg/kg	<1			< 1	T	
Toluene	mg/kg	<1			< 1	T	
4-Bromofluorobenzene - Surrogate	%	102			70-130 %	T	
805266 [Laboratory Control Sample]							
1100 BTEX &(C6-C9) in Soil by P&T			Expected Value	Percent Recovery			
Benzene	mg/kg	5.1	5.0	102	70-130 %	T	
C6-C9 Fraction	mg/kg	52	50.0	100	70-130 %	T	
Ethylbenzene	mg/kg	4.7	5.0	95	70-130 %	T	
Meta- & Para- Xylene	mg/kg	9.7	10.0	97	70-130 %	T	
Ortho-Xylene	mg/kg	5.1	5.0	102	70-130 %	T	
Toluene	mg/kg	5.0	5.0	101	70-130 %	T	
4-Bromofluorobenzene - Surrogate	%	103			70-130 %	T	

Laboratory: **EN_VOC**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
804531 [Duplicate of 804138]							
1100 BTEX &(C6-C9) in Soil by P&T			Result 2	RPD			
Benzene	mg/kg	<0.2	<0.2	<1	0-30 %	T	
C6-C9 Fraction	mg/kg	<5	<5	<1	0-30 %	T	
Ethylbenzene	mg/kg	<1	<1	<1	0-30 %	T	
Meta- & Para- Xylene	mg/kg	<2	<2	<1	0-30 %	T	
Ortho-Xylene	mg/kg	<1	<1	<1	0-30 %	T	
Toluene	mg/kg	<1	<1	<1	0-30 %	T	
4-Bromofluorobenzene - Surrogate	%	96			70-130 %	T	
804543 [Spike of 804138]							
1100 BTEX &(C6-C9) in Soil by P&T			Spike Value	Percent Recovery			
Benzene	mg/kg	3.9	5.0	77	70-130 %	T	
C6-C9 Fraction	mg/kg	40	50.0	80	70-130 %	T	
Ethylbenzene	mg/kg	3.7	5.0	72	70-130 %	T	
Meta- & Para- Xylene	mg/kg	7.4	10.0	74	70-130 %	T	
Ortho-Xylene	mg/kg	3.7	5.0	74	70-130 %	T	
Toluene	mg/kg	3.8	5.0	77	70-130 %	T	
4-Bromofluorobenzene - Surrogate	%	93			70-130 %	T	

Project Comments

Comments	The expected due date only applies to analysis performed in Murarrie

Sample Integrity

Custody Seals Intact (if used)	Yes
Attempt to Chill was evident	Yes
Samples correctly preserved	Yes
Organic samples had Teflon liners	Yes
Samples received with Zero Headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Qualifier Codes/Comments

Code	Description
Q02	The duplicate %RPD is outside the recommended acceptance criteria. Further analysis indicates sample heterogeneity as the cause.
Q08	The Matrix Spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference.
Q09	The Surrogate recovery is outside of the recommended acceptance criteria due to matrix interference. Acceptance Criteria were met for all other QC
Q13	Some individual compounds for this analysis have failed. However the QC sample is considered acceptable if 80% of the compounds meet Acceptance Criteria.
Q15	The RPD reported passes Amdel's Acceptance Criteria as stipulated in AS-POL-002. The Criteria displayed in this report are for results >10 x PQL; the results of this sample are < 10 x PQL

Authorised By

Alex Petridis	Senior Analyst - SVOC	
Elizabeth Button	Senior Analyst - Environmental	Accreditation Number: 14356
Helen Lei	Senior Analyst - Waters	Accreditation Number: 1645
Olga Alieva	Analyst - SVOC	Accreditation Number: 1645

Laboratory Manager

Michael Mowle	Team Leader - Environmental	

Final Report

- Indicates Not Requested * Indicates NATA accreditation does not cover the performance of this service

The samples were not collected by Amdel staff.

15) Appendix 6 – Tweed Shire Council Development Consent (DA07/0248) Lot 33 DP 1085109, May 2008

TWEED
SHIRE
COUNCIL

Please Quote
Council Ref: DA07/0248

For Enquiries
Please Contact: Robert Noakes

Telephone Direct (02) 6670 2440

71625

RN/mg

[DAConsent]

1 May 2008

Terranora Group Management Pty Ltd
GPO Box 2866
BRISBANE QLD 4001

Dear Sir/Madam,

Development Application DA07/0248 - demolition of country club & outbuildings - Terranora Lakes Country Club at Lot 33 DP 1085109; Marana Street BILAMBIL HEIGHTS

I refer to your Development Application regarding the above, and enclose herewith Development Consent No. DA07/0248.

Yours faithfully

R Cameron
Manager Building & Environmental Health

Enc

NOTICE NO. DA07/0248

TWEED SHIRE COUNCIL

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979

NOTICE OF DETERMINATION OF A DEVELOPMENT APPLICATION

To: Terranora Group Management Pty Ltd
GPO Box 2866
BRISBANE QLD 4001

Pursuant to Section 81(1)(a) of the Act, notice is hereby given of the determination by the Tweed Shire Council of Development Application No. **DA07/0248** relating to land described as:-

Lot 33 DP 1085109; Marana Street BILAMBIL HEIGHTS

to be developed in accordance with plans and details submitted for the purpose of –

DEMOLITION OF COUNTRY CLUB & OUTBUILDINGS - TERRANORA LAKES COUNTRY CLUB

The Development Application has been determined by the granting of consent subject to the conditions described below:-

GENERAL

1. The demolition shall be completed in accordance with the Statement of Environmental Effects prepared by Darryl Anderson Consulting Pty Ltd and dated March 2007, except where varied by the conditions of this consent.

[GEN0005]

2. A Demolition Works Noise Management Plan shall be prepared in respect to the demolition of the Country Club building and associated out buildings including the Golf buggy shed, Pool filter shed, Irrigation shed and Transformer building. Such Plan shall include but not be limited to the following: Noise Levels that would be experienced at the nearest affected neighbouring residential premises for the types of equipment proposed to be used Eg backhoe mounted jack hammers. Proposed work start and finish times, monitoring regime including recording of monitoring results, responsible persons under the Plan, appropriate noise exposure levels applicable to the location and any noise attenuation measures that would need to be employed. Such Plan shall be prepared by a suitably qualified acoustic consultant and be submitted to the satisfaction of Council's General Manager or Delegate prior to demolition works commencing.

[GENNS01]

3. Under slab testing shall be carried out in accordance with the provisions of Council's Pre-demolition Testing Guidelines on the Country Club building and associated out buildings including the Golf buggy shed, Irrigation shed, Pool filter shed and Transformer building prior to the removal of the concrete slabs beneath these buildings. The results of the Pre-demolition Testing shall be submitted to Council's Environmental Health Officer for

consideration. A Remediation Action Plan shall be prepared and submitted to the satisfaction of Council's General Manager or Delegate if considered necessary by Council's Environmental Health Officer based upon the results of the Pre-demolition Testing. The Remediation Action Plan shall be approved by Council's General Manager or Delegate prior to the removal of any of the concrete slabs.

[GENNS02]

4. A Waste Management Plan shall be prepared and submitted to the satisfaction of Council's General Manager or Delegate which details how all waste material generated from the demolition of the Country Club and associated out buildings will be managed on site. Such Plan shall detail how waste materials will be stored and contained prior to disposal off site and where such materials are proposed to be disposed of. Such Plan shall be submitted for approval prior to the commencement of any demolition works on site.

[GENNS03]

PRIOR TO COMMENCEMENT OF WORK

5. The proponent shall accurately locate and identify any existing sewer main, stormwater line or other underground infrastructure within or adjacent to the site and Council's General manager or Delegate be advised of its location and depth prior to commencing works and ensure there shall be no conflict between the demolition and existing infrastructure prior to start of any works.

[PCW0005]

6. Prior to work commencing, a "Notice of Commencement of Building or Subdivision Work and Appointment of Principal Certifying Authority" shall be submitted to Council at least 2 days prior to work commencing.

[PCW0225]

7. A temporary builder's toilet is to be provided prior to commencement of work at the rate of one (1) closet for every fifteen (15) persons or part of fifteen (15) persons employed at the site. Each toilet provided must be:-

   (a) a standard flushing toilet connected to a public sewer, or

   (b) if that is not practicable, an accredited sewage management facility approved by the council

[PCW0245]

8. **Where prescribed by the provisions of the Environmental Planning and Assessment Amendment (Quality of Construction) Act 2003**, a sign must be erected in a prominent position on any site on which building work, subdivision work or demolition work is being carried out:

   (a) showing the name, address and telephone number of the principal certifying authority for the work, and

   (b) showing the name of the principal contractor (if any) for any building work and a telephone number on which that person may be contacted outside working hours, and

   (c) stating that unauthorised entry to the site is prohibited.

Any such sign is to be maintained while the building work, subdivision work or demolition work is being carried out, but must be removed when the work has been completed.

[PCW0255]

9. Prior to the commencement of works, detail of the point of disposal, haul route and transport management plan shall be submitted to Tweed Shire Council for the approval of the General manager or his delegate.

[PCWNS01]

10. A Waste management Plan shall be prepared and submitted to the satisfaction of Council's General Manager or Delegate which details how all waste material generated from the demolition of the Country Club and associated outbuildings will be managed on site. Such Plan shall be submitted for approval prior to the commencement of any demolition works on site.

[PCWNS02]

11. Where any existing sewer junctions are to be disused on the site, the connection point shall be capped off by Council staff. Applications shall be made to Tweed Shire Council and include the payment of fees in accordance with Councils adopted fees and charges.

[PCWNS03]

DURING CONSTRUCTION

12. Demolition site work including the entering and leaving of vehicles is limited to the following hours, unless otherwise permitted by Council: -

    Monday to Saturday from 7.00am to 7.00pm

    No work to be carried out on Sundays or Public Holidays

    The proponent is responsible to instruct and control subcontractors regarding hours of work.

[DUR0205]

13. All reasonable steps shall be taken to muffle and acoustically baffle all plant and equipment. In the event of complaints from the neighbours, which Council deem to be reasonable, the noise from the demolition site is not to exceed the following:

    A. Short Term Period - 4 weeks.

    L10 noise level measured over a period of not less than 15 minutes when the construction site is in operation, must not exceed the background level by more than 20dB(A) at the boundary of the nearest likely affected residence.

    B. Long term period - the duration.

    L10 noise level measured over a period of not less than 15 minutes when the construction site is in operation, must not exceed the background level by more than 15dB(A) at the boundary of the nearest affected residence.

[DUR0215]

14. Provision shall be made for the collection of builder's solid waste in accordance with the following requirements:

    (a) A temporary builder's waste chute is to be erected to vertically convey builder's debris to a bulk container.

(b) The chute shall be located in a position approved by Council's General manager or Delegate.

(c) A canopy shall be provided to the chute outlet and container to reduce the spillage of materials and nuisance caused by dust.

[DUR0385]

15. It is the responsibility of the applicant to restrict public access to the demolition works site, demolition works or materials or equipment on the site when demolition work is not in progress or the site is otherwise unoccupied in accordance with WorkCover NSW requirements and Occupational Health and Safety Regulation 2001.

[DUR0415]

16. Excavation

(a) All excavations and backfilling associated with the erection or demolition of a building must be executed safely and in accordance with WorkCover 2000 Regulations.

(b) All excavations associated with the erection or demolition of a building must be properly guarded and protected to prevent them from being dangerous to life or property.

[DUR0425]

17. If the work involved in the erection or demolition or a building:

(a) is likely to cause pedestrian or vehicular traffic in a public place to be obstructed or rendered inconvenient; or

(b) building involves the enclosure of a public place,

a hoarding or fence must be erected between the work site and the public place in accordance with the WorkCover Authority of NSW Code of Practice and relevant Australian Standards.

Where necessary the provision for lighting in accordance with AS 1158 - Road lighting and provision for vehicular and pedestrian traffic in accordance with AS 1742 shall be provided.

Any such hoarding, fence or awning is to be removed prior to the issue of an occupation certificate/subdivision certificate.

Application shall be made to Tweed Shire Council including associated fees for approval prior to any structure being erected within Councils road reserve.

[DUR0435]

18. All demolition work is to be carried out in accordance with the provisions of Australian Standard AS 2601 "The Demolition of Structures" and to the relevant requirements of the WorkCover NSW, Occupational Health and Safety Regulation 2001.

[DUR0645]

19. All work associated with this approval is to be carried out so as not to impact on neighbourhood, adjacent premises or the environment. All necessary precautions, covering and protection shall be taken to minimise impact from: -

- Noise, water or air pollution

- Minimise impact from dust during filling operations and also from construction vehicles
- No material is removed from the site by wind

[DUR1005]

20. The contractor is to maintain a copy of the development consent including plans, and specifications on the site at all times.

[DUR2015]

21. The builder must provide an adequate trade waste service to ensure that all waste material is contained, and removed from the site for the period of demolition.

[DUR2185]

22. Appropriate measures are to be put in place during the construction and/or demolition period to prevent the transport of sediment from the site. Should any material be transported onto the road or any spills occur it is to be cleaned up prior to cessation of same days work and/or commencement of any rain event.

[DUR2405]

USE

23. Activities occurring at the premises must be carried out in a manner that will minimise emissions of dust from the premises.

[USE0145]

24. All externally mounted artificial lighting, including security lighting, is to be shielded to the satisfaction of the General Manager or his delegate where necessary or required so as to prevent the spill of light or glare creating a nuisance to neighbouring or adjacent premises.

[USE0225]

The reasons for the imposition of conditions are to minimise any adverse impact the development may cause and to give effect to the objectives of the Environmental Planning and Assessment Act, 1979.

The application was determined on: **1 May 2008**
The consent to operate from: **1 May 2008**
The consent to lapse on 1 May 2013 unless commenced prior to that date.

RIGHT OF APPEAL

If you are dissatisfied with this decision Section 97 of the Environmental Planning and Assessment Act, 1979 gives you to right to appeal to the Land and Environment Court within 12 months after the date on which you receive this notice.

Signed on behalf of the Tweed Shire Council

Robert Noakes, Senior Building Surveyor
1 May 2008