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Conceptual Groundwater Assessment
Cobaki Lakes Concept Plan

Prepared for

Leda Manorstead Pty Ltd

April 2008

Document control

Document:	**Conceptual Groundwater Assessment**	Gilbert & Sutherland P/L ABN 56 077 310 840 Originating Office: Robina Eastside 5/232 Robina Town Centre Drive, Q4230 PO Box 4115, Robina Q4230 Telephone 07 5578 9944 Facsimile 07 5578 9945 gsrobina@bigpond.com Also at Kawana and Brisbane
Title:	**Conceptual Groundwater Assessment Cobaki Lakes Concept Plan**	
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Synopsis:	This report provides a conceptual assessment of groundwater at the Cobaki Lakes site and considers the likely groundwater impacts of development in accordance with the Cobaki Lakes Concept Plan. Indicative measures proposed to manage the likely impacts of development are provided in the attached Groundwater Management Plan (GMP).	

Revision History

Revision #	Date	Edition By		Approved By	
1	11/04/08	CMA		LJV	NMS

Distribution

	Revision Number									
Distribution	1	2	3	4	5	6	7	8	9	10
Leda	1									
Gilbert & Sutherland library	2									

Summary

Gilbert & Sutherland Pty Ltd (G&S) was commissioned by LEDA Manorstead Pty Ltd (LEDA) to undertake specialist studies and assessments in support of a concept plan of development for the Cobaki Lakes site at Cobaki, New South Wales.

Lodgement of a concept plan for the proposed Cobaki Lakes Development was authorised by the New South Wales Minister for Planning on January 24, 2007. The Director General of the Department of Planning issued Environmental Assessment Requirements (DGRs) for the concept plan on March 5, 2007.

This report provides:

- a summary of the site stratigraphy and site characteristics relevant to groundwater considerations
- a summary of field work to establish groundwater characteristics
- a summary and discussion of groundwater results to date
- a preliminary assessment of likely groundwater flow paths and seepage characteristics
- discussion of acid sulfate soils influences on groundwater
- discussion of the Concept Plan impacts on the site's groundwater flow regimes.

Eleven (11) groundwater bores were installed across the low-lying parts of the site to facilitate the groundwater modelling and assessment. To date, seven rounds of monthly groundwater quality data has been recovered from the bore network. While further data is required and will be available in time, some preliminary trends are emerging. The data collected thus far indicates the following:

- Groundwater quality at the site appears to be heavily influenced by site stratigraphy.
- Groundwater height appears reasonably consistent over time.
- Mounding of groundwater is evident within the sand ridge in the central to eastern part of the site.
- The central drainage line draws down groundwater from the sand ridge.
- Soil permeability in the vicinity of the groundwater bores ranges from 1.9 x 10^{-5}m/s to 8.7 x 10^{-6}m/s.
- The overall groundwater flow appears to be in a south easterly direction towards the Cobaki broadwater.

Given the nature of the site soils and groundwater characteristics observed to date, the most likely potential impacts on groundwater as a result of development would be:

- Impacts on the pre-development groundwater flow regimes as a result of excavation, road building and hardening of the site.
- Impacts on groundwater quality as a result of the construction phase and subsequent urban stormwater runoff.
- Acid sulfate soils impacts as a result of disturbance of such materials.

These identified potential impacts are readily anticipated and manageable. At the detailed design phase for each stage of development, the surface water quality treatment devices would be designed to integrate with the groundwater requirements of the site, providing adequate opportunity for groundwater management.

The investigations conducted to date suggest that potential impacts on groundwater quality and flow regimes do not represent an impediment to development of the site in accordance with the Cobaki Lakes Concept Plan.

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Figures

1) Introduction

Gilbert & Sutherland Pty Ltd (G&S) was commissioned by LEDA Manorstead Pty Ltd to undertake specialist studies and assessments in support of a concept plan of development for the Cobaki Lakes site at Cobaki, New South Wales. The site location is shown on Drawing No. GJ0640.1.1.

Gilbert & Sutherland Pty Ltd (G&S) was engaged by Leda Manorstead Pty Ltd to undertake a groundwater assessment that:

- considers groundwater conditions generally at the Cobaki Lakes Development site
- considers specific issues as described by the DGRs
- provides management strategies, responsibilities and procedures for the management of groundwater during the construction and operational phases of the development.

1.1 Development concept

Appropriate zoning and other development controls for the entire site are outlined in *Tweed Shire Development Control Plan: Section B7 – Cobaki Lakes* (DCP B7).

The Cobaki Lakes Concept Plan proposes the creation of a master planned residential community integrating residential development and supporting commercial, retail, recreational and educational facilities. Large areas of open space will be provided for environmental enhancement and for recreational purposes.

The development concept is shown on Drawing No. GJ0640.1.2.

1.2 Scope of works

To achieve the objectives stated above, the following scope of works was undertaken for this report.

- Desktop assessment.
- Additional field investigations.
- Conceptual groundwater modelling and drawdown calculations.
- Report preparation.

This report is divided into sections describing the method, the physical characteristics of the site, and assessment of the reported groundwater conditions at the site and modelled groundwater impacts during the construction and operational phases of the development.

Management measures are proposed (in the form of a management plan included as Attachment 1) to limit any deleterious effects that may result from the proposed excavation and dewatering regime.

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PROJECT

LEDA MANORSTEAD PTY LTD

COBAKI LAKES

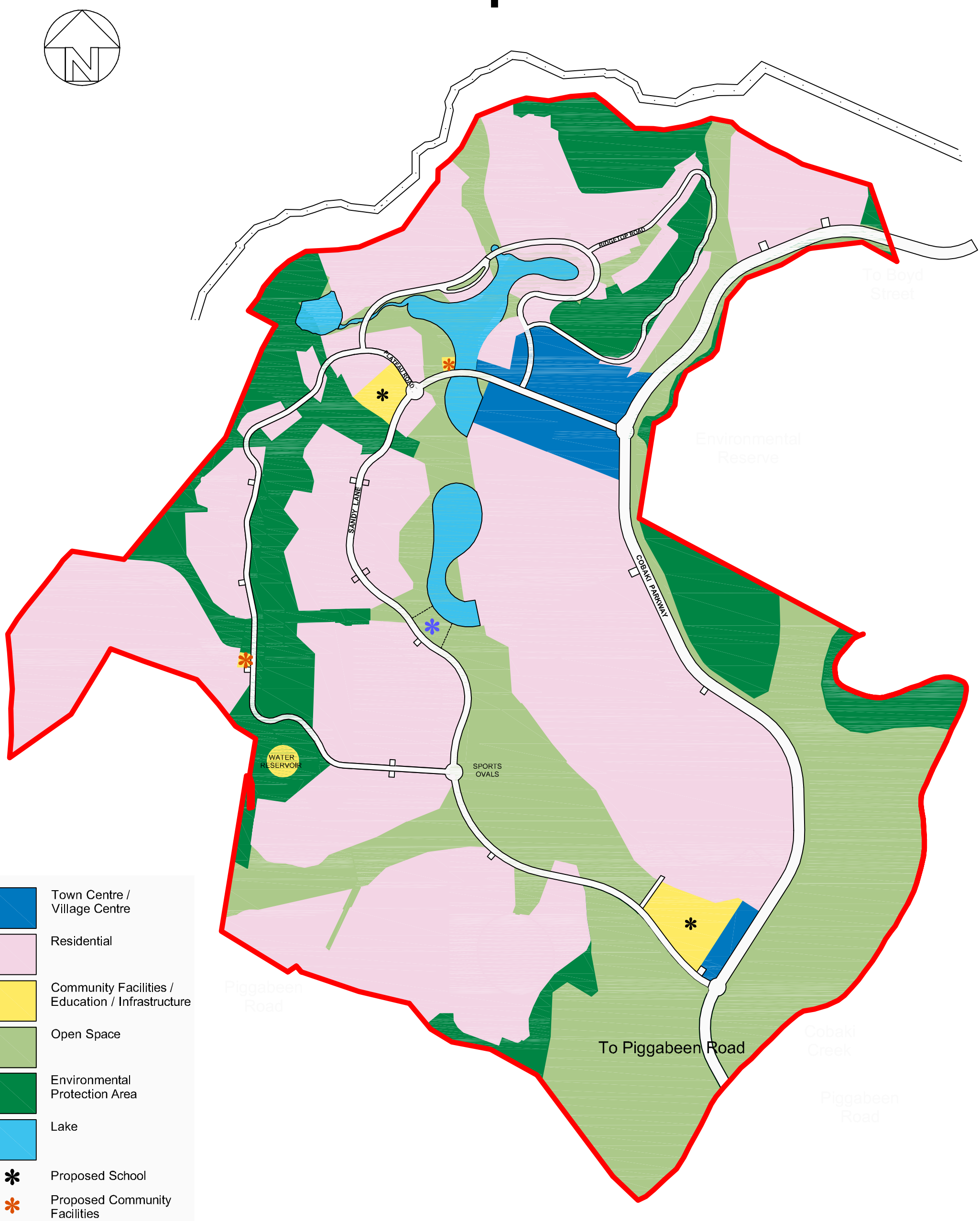
CONCEPTUAL GROUNDWATER ASSESSMENT

SITE LOCATION

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN C.T.H.
		DATE 16/04/08	CHECKED

DRAWING No. GJ0640.1.1

Concept Plan



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COBAKI LAKES
CONCEPT PLAN

Source: DFA Architects

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.J.T	DRAWING No.
		DATE 22/08/08	CHECKED	GJ0640.1.2

2) Method

This report is a conceptual groundwater assessment in support of the Cobaki Lakes Concept Plan.

The New South Wales State Groundwater Protection Policy 1998[1] seeks to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The policy focus is in three broad areas:

- Groundwater quality protection.
- Groundwater quantity management.
- Groundwater Dependent Ecosystems (GDEs).

This report considers likely impacts on groundwater quality and quantity. A separate report by James Warren & Associates (JWA) confirms there are no GDEs present on or near the site.

2.1 Desktop assessment

The following previous reports were considered as part of this report:

- *Geotechnical Investigation Cobaki Lakes – Marine Clay Investigation Tweed Heads, NSW, June 1997*, prepared by Golder Associates Pty Ltd.
- *Cobaki Development Water Quality Study December 1991* prepared by WBM Oceanics.

This assessment also considered the following reports prepared by Gilbert & Sutherland, April, 2008:

- *Stormwater Concept Plan, Cobaki Lakes, NSW (April 2008)*
- *Soil Survey, Geotechnical Review, Acid Sulfate Soil Assessment and Management Plan, Cobaki Lakes Concept Plan (April 2008).*

2.2 Additional field investigations

Gilbert & Sutherland installed eleven (11) bores in August 2007. These bores were sited to replicate (as closely as possible) the original WBM monitoring locations (now destroyed). These new bores were installed to facilitate:

- increased reliability of groundwater calculations and modelling
- assess influence of soil strata, and acid sulfate soils on groundwater quality
- allow for the calculation of soil permeabilities
- enable the collection of a sufficiently robust data set upon which to base an initial groundwater model. As further data become available and detailed designs are produced, this groundwater model will be refined and improved to help identify groundwater impacts as a result of development in accordance with the Concept Plan and to manage those impacts.

The location of the groundwater bores is shown on Drawing No. GJ0640.1.3. The groundwater bores were installed to depths of 2m (GW1, GW3, GW4, GW11), 2.5m (GW2, GW10), 3.0m (GW9) and 3.5m(GW5, GW6, GW7, GW8).

The borelogs have been attached as Appendix 1.

2.2.1 Groundwater flow paths

The groundwater flow path was assessed using a three dimensional digital model created to show the spatial distribution of boreholes and groundwater levels in each. The software used was Quicksurf, which is a three dimensional surface modelling package that is incorporated into Autocad. Groundwater levels from the ten (10) bores (GW2 was destroyed in October 2007) were used in the modelling. The results of the modelling are show in Section 3.4.1.

2.2.2 Permeability

Permeability testing was undertaken on the soils surrounding each of the groundwater bores using the Rising Head Test method. The rising head tests were conducted in accordance with the methods outlined in Cedergren (1997). The results of these tests are included in Section 3.4.2.

2.2.3 Construction phase seepage

In order to estimate the potential inflow rate associated with the dry excavations (constructed wetlands) during the construction phase, the Darcian flow rate was calculated using the following equation:

$$Q = KiA$$

[1] NSW Department of Land and Water Conservation, 1998, *'The NSW Groundwater Quality Protection Policy – A Component Policy of the NSW State Groundwater Policy'*, NSW Government, Sydney.

Where: Q = volumetric flow rate (m^3/day)
K = hydraulic conductivity; (m/day)
i = hydraulic gradient; (m/m)
A = cross sectional area of the dewatered pit (m^2)

The results of the calculations are included in Section 3.4.3.

2.2.4 Construction phase drawdown calculations

Groundwater drawdown associated with dry excavations (lake construction), was estimated using Hooghoudt's Equation.

Hooghoudt's Equation is a steady state drainage formula used to estimate head losses due to horizontal and radial flow. While primarily used to estimate drain spacing, it also provides a useful indicator of likely groundwater drawdown given theoretical inputs such as:

- inflow rates:
- hydraulic conductivities
- depth of drain below surface
- allowable rise in water surface.

Hooghoudt's Steady State Formula is shown below:

$$L^2 = \frac{8K_2dh}{q} + \frac{4K_1h^2}{q}$$

where

q	Inflow rate (mm/day)
K1	Hydraulic conductivity - pipe to surface (m/day)
K2	Hydraulic conductivity- below pipe (m/day)
d	Depth of drain below surface (m)
h	Allowable rise in water surface between drains (m)
L	Estimated spacing between drains (m)

2.3 Groundwater quality

The eleven monitoring bores were accurately located using GPS and MGA co-ordinates. The natural surface level (NSL) at the monitoring locations relative to the Australian Height Datum (AHD) was surveyed during March, 2008. The monitoring bore details surveyed are displayed in Table 2.3.

Table 2.3 Surveyed monitoring bore details

Borehole	Easting	Northing	RL (m)
GW 1	546945.281	6881908.624	1.332
GW 2	Destroyed		
GW 3	546850.495	6883541.240	3.560
GW 4	546629.010	6884079.370	1.259
GW 5	547262.449	6882795.805	4.284
GW 6	547409.616	6882558.603	1.276
GW 7	547471.355	6883307.535	3.602
GW 8	547933.134	6884803.892	3.920
GW 9	546737.848	6884509.639	2.378
GW 10	547225.931	6883073.817	4.688
GW 11	547105.698	6883397.725	4.153

The method of extracting a representative groundwater sample consisted of developing the bore until the sample collected was representative of surrounding groundwater conditions. Bore development involved the removal of twice the volume of groundwater contained in the bore (or until the bore was dry) prior to extracting a representative groundwater sample. This was achieved by using a hand held bailer.

Once the representative groundwater was extracted, samples were collected in laboratory supplied containers and immediately placed into a chilled esky prior to delivery to the laboratory. Sample analysis was performed by a NATA accredited laboratory. The groundwater bores are monitored on a monthly basis for Alkalinity, Iron, Aluminium, Total Nitrogen, Total Phosphorus, Orthophosphorus, Sulfate, Chloride, Nitrate, Nitrite, Total Kjeldahl Nitrogen.

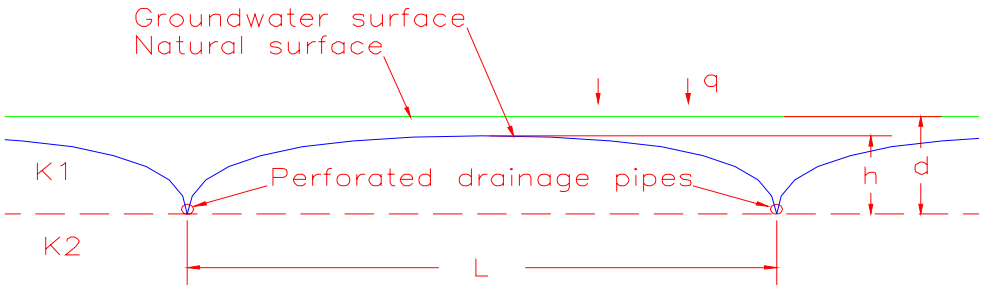

Plate 2.2.1 – Graphical representation of Hooghoudt's Steady State Formula

3) Results

3.1 Site location

The site location is shown on Drawing No GJ0640.1.1. The Concept Plan for the proposed development is shown in Drawing No. GJ0640.1.2 included in Section 1. The site covers approximately 596 hectares, immediately south of the Queensland/NSW border and approximately 2km west of the coastal township of Kirra.

3.2 Stratigraphy and soils

A soil survey of the site was conducted by Gilbert & Sutherland in May 1998. A summary of the finding of that survey is presented below.

In general the soil types across the site can be separated into those soils occurring on the low lying areas (floodplain and beach ridge) and the soils of the alluvial plain and higher slopes of the low hills.

The majority of the soils occurring on the low lying floodplain areas were classed in as Hydrosols, indicating soils which are inundated periodically (such as on springtides) and contain sulfidic material in the upper 1.5m of the soil profile (Isbell, 1996). These soils are essentially Holocene sediments deposited in a backswamp environment over the last 10,000 years.

Consequently these sediments have very limited soil formation and were characterised by a shallow organic layer at the surface and unconsolidated marine silty clays to greater than 6m depth in parts.

Podosols were identified mainly on the beach ridge area composed of wave and aeolian deposited fine to medium sand. These soils were characterised in general by a shallow organic A1 horizon, bleached light grey to white A2 horizon and with a sapric organic indurated B2 horizon at depth.

A small area of Organosols occurs to the east of the beach ridge area and is associated with low heathland. These soils consisted of an organic hemic peat to sapric/hemic peat layer of greater than 1m depth, with sand and silty clay horizons.
Kurosols and Rudosols, derived from weathered metasediments of the Neranleigh-Fernvale group, were identified on the low hills and alluvial plain areas on the northern and western portions of the site.

The Kurosols were associated with the soils of the ridges, lower slopes and the alluvial plain and were characterised in general by dark brown silty loam to clay loam horizons with strong structure and subangular blocky peds overlying yellowish brown light to heavy clay with weak to moderate structure.

The Rudosols were associated mainly with the ridge areas and consisted of very shallow silty loam overlying bedrock.

Drawing No. GJ0640_1_3 indicates the soil distribution.

3.3 Geology and landform

The site is generally low lying and of very low to extremely low relief with a large proportion of the site comprised of floodplain and alluvial plain.

The centre of the site is dominated by an elevated relict beach ridge of very low relief (approx 4m AHD) whilst the site is bounded to the north and west in part by a series of low hills reaching to approximately 90m in height in some areas.

The low lying areas of the floodplain are predominantly of Holocene origin formed in a backswamp estuarine environment by the accretion of sediments supplied by stream, creek and tidal flow.

The relict beach ridge located within the low lying area is essentially that of wave and aeolian deposited sand (beach and dune sand).

It is apparent that in this process the beach ridge acted as a barrier behind which sediments could accumulate in a low energy environment. These sediments are essentially unconsolidated marine silty clays of a sulfidic nature.

The low hills on the western and northern boundaries of the site are formed from Silurian aged Neranleigh-Fernvale shales, siltstones and sandstones. The eroded sediments from these hills also form the alluvial plain areas of the site.

The western and northern boundaries of the floodplain (where it abuts the alluvial plain), are also comprised of Neranleigh-Fernvale derived material at the basement depth (below any Holocene sediments). This basement would typically have been the pre-transgressive surface, being a gently sloping continuation of the low hills. As the floodplain reaches west and north, the depth of Holocene material diminishes until it is no longer present.

Groundwater bores have been installed within the various geology. Monitoring bores GW8 and GW9 are located within the Neranleigh-Fernvale metasediments to the north of the site. GW2 and GW4 are located centrally along the drainage channel to the south and north respectively, which is underlain by marine clays. GW1 is located in the southern portion of the site which is underlain by floodplain material on the footslopes of the Neranleigh-Fernvale metasediments. The remaining groundwater bores (GW3, 5, 6, 7, 10 &11) are located around a low sand ridge in the east of the site which is underlain by fine to medium sand.

Runoff from this development flows in a south-easterly direction via a number of unnamed ephemeral gullies towards Cobaki Creek, which runs along the south-eastern site boundary, and directly into Cobaki Broadwater. Cobaki Broadwater adjoins the Tweed River which discharges into the Pacific Ocean at Tweed Heads.

3.4 Groundwater assessment

3.4.1 Groundwater flow paths

The modelled groundwater contours for the period of recent monitoring from August 2007 to March 2008 are shown on Drawing No's. GJ0640.1.4a to GJ0640.1.4g.

The contours show that the groundwater level is reasonably consistent over time with groundwater mounding within the sand ridge and is drawn down to the west by the central drainage line. The overall groundwater flow generally follows the topography in a south-easterly direction towards the Cobaki Broadwater.

3.4.2 Permeability testing

The results of the rising head tests conducted within 10 groundwater bores are summarised in Table 3.4.2.

Table 3.4.2 Rising head test results

Borehole	Permeability (m/s)
GW1	8.7×10^{-6}
GW2	1.9×10^{-5}
GW3	7.4×10^{-5}
GW4	5.0×10^{-6}
GW5	6.4×10^{-6}
GW6	2.2×10^{-5}
GW7	8.5×10^{-6}
GW8	1.1×10^{-5}
GW10	2.9×10^{-5}
GW11	3.2×10^{-5}

3.4.3 Construction phase seepage

To determine the likely seepage rate into the excavation following the initial excavation and storage release the Darcian flow rate was calculated. The flow rate was calculated using the following assumptions:

Scenario 1 – lake within metasediments (upper northern lake)	
Permeability	0.3m/day
Hydraulic gradient (assumed)	0.7 m/m
Base of excavation	-0.5m AHD
Average groundwater level	1.75 m AHD
Cross sectional area (at maximum excavation area and depth)	5000m^2

$Q = 0.3 \times 0.7 \times 5{,}000m^2$
$Q = 1050\ m^3/day$

Scenario 2 – lake within alluvial material (southern lake)	
Permeability	0.3 m/d
Hydraulic gradient (assumed)	0.7m/m
Base of excavation	-1.5 mAHD
Average groundwater level	0.53 mAHD
Cross sectional area (at maximum excavation area and depth)	1300m^2

$Q = 0.3 \times 0.7 \times 1300m^2$
$Q = 275\ m^3/day$

The above calculations indicate that following the initial excavation and storage release the expected seepage rates range from 275m^3/day to 1050m^3/day depending on the size of the excavation. It is noted that the construction of the wetlands will most likely be staged to minimise the volume of seepage that is required to be managed at one time. The Groundwater management plan attached as Attachment 1 outlines the management requirements when dealing with the seepage water during the construction phase.

3.4.4 Construction phase

The wetlands and constructed wetlands have been elevated to minimise the disturbance of acid sulfate soils during the construction phase.

To estimate the groundwater drawdown associated with the construction of the wetlands, Hooghoudt's Equation was used. This approach is conservative given the assumed hydraulic conductivity (0.05m/day) and inflow rate (1.8mm/day). Accordingly, the result provides a 'worst case scenario' estimate of 35m without any mitigation measure in place.

During the detailed design phase, modelling of the proposed development situation would be undertaken to determine the expected drawdown associated with the construction of the wetlands. Specific measures available to mitigate drawdown impacts are described in Attachment 1.

3.4.5 Operational phase

The wetlands and constructed wetalnds have been elevated to minimise the effect (if any) of operational phase groundwater drawdown on acid sulfate soils.

During the detailed design phase modelling of the proposed development will be undertaken to appropriately size and locate infiltration devices such as bioretention basins, bioretention trenches and subsurface infiltration devices. This will be undertaken to minimise any adverse impact on the groundwater flow regime as a result of reducing infiltration through the 'hardening' of the site.

Groundwater monitoring is also proposed to confirm the effectiveness of the proposed management measures (see Attachment 1).

3.5 Groundwater quality

The analytical results for each parameter are discussed in this section. Complete results tables for each parameter are included as Appendix 2. Copies of the laboratory certificates and in situ sheets are attached as Appendix 2. The location of each groundwater bore is shown on Drawing No. GJ0640.1.3.

The water quality results for each groundwater bore have been discussed with reference to the underlying geology. Monitoring location GW8 and GW9 are located within the Neranleigh-Fernvale metasediments to the north of the site. GW2 and GW4 are located centrally along the drainage channel to the south and north respectively, which is underlain by marine clays. GW1 is located in the southern portion of the site which is underlain by floodplain material on the footslopes of the Neranleigh-Fernvale metasediments. The remaining groundwater bores (GW3, 5, 6, 7, 10 &11) are located around a low sand ridge in the east of the site which is underlain by fine to medium sand.

3.5.1 Groundwater level (mAHD)

The results for groundwater levels recorded during the six month sampling period ranged from a minimum of -0.14m (GW4) within the marine clays on March 18, 2008 in the north of the site to a maximum of 3.53m (GW10) on January 17, 2008.

The average groundwater levels ranged from 0.10m (GW4) to an average of 3.22m (GW10). Groundwater contour plans are attached as Drawing No's GJ0640.1.4a to GJ0640.1.4g

During the monitoring period groundwater levels varied concurrently with rainfall across the site, indicating that groundwater in the area generally responds to seasonal weather patterns.

3.5.2 pH

The average results for groundwater pH obtained from the monitoring bores in the Neranleigh-Fernvale metasediments ranged from 5.56 (GW8) to 5.93 (GW9). The underlying metasediments generally consist

of light to heavy clay soils which are inherently acidic in nature. This inherent acidity may have contributed to the pH results recorded.

The pH results within monitoring bores located within the sand ridge were generally more acidic than those located within marine clays. The average pH within the sand ridge ranged from 3.51 (GW5) – 5.84 (GW6). The average pH within the groundwater bores located around the marine clays ranged from 5.18 (GW4) to 5.22 (GW2). The greater pH within the marine clays may possibly be due to electrical conductivity buffering.

3.5.3 Electrical conductivity

The groundwater in the vicinity of the sand ridge may be described as fresh with electrical conductivity values ranging from 111µS/cm (GW11) – 678µS/cm (GW11).

The groundwater to the north of the site (Neranleigh-Fernvale metasediments) may be described as fresh to brackish with electrical conductivity ranging from 707µS/cm (GW8) to 7920µS/cm (GW9).

Groundwater within the marine clays (GW2 and GW4) and the footslopes of the metasediments in the south of the site (GW1) may be described as brackish with the average electrical conductivity ranging from 6642µS/cm (GW1) to 8530µS/cm (GW4).

3.5.4 Total nitrogen (mg/L)

The average total nitrogen results across the site ranged from 0.45mg/L (GW2) to 7.3 mg/L (GW8). Results were seen to be more consistent through the sand ridge with average results ranging from 2.0mg/L (GW6) to 5.0mg/L (GW7).

3.5.5 Total phosphorus (mg/L)

The results for total phosphorus were variable within the Neranleigh-Fernvale metasediments and marine clays, ranging from 0.05mg/L (GW2) to 1.77mg/L (GW8). The results from the monitoring bores around the sand ridge to the east of the site were more consistent with average total phosphorus, ranging from 0.34mg/L (GW6) to 0.57mg/L (GW5).

The percentage of orthophosphorus in total phosphorus results varied across the site, ranging from 1.2% (GW1) to 24% (GW2). The groundwater in the region represents a significant source of total phosphorus which may have implications for the management of wetlands that are groundwater fed, however the percentage of orthophosphorus in total phosphorus suggests the majority is unavailable and bound within the soil structure.

3.5.6 Sulfate (mg/L)

The results for sulfate were lowest through the sand ridge in the east of the site with average sulfate concentrations ranging from 3.2mg/L (GW11) to 22.7mg/L (GW7). The average concentration of sulfate was seen to increase in the metasediments (ranging from 83.3mg/L at GW8 to 145.3mg/L at GW9), with the greatest concentration recorded in the marine clays (GW4 3300mg/L).

3.5.7 Alkalinity (mg/L)

The results recorded for alkalinity were <20mg/L around the sand ridge and marine clays with the exception of GW6 (average 92mg/L). These low alkalinity levels correspond with the low pH values recorded in these areas.

The results within the Neranleigh-Fernvale metasediments ranged from an average of 39mg/L (GW8) to 65mg/L (GW9). The greatest alkalinity concentration was recorded in the south of the site at GW1 (250mg/L), reflecting the relationship between pH and alkalinity.

3.5.8 Chloride (mg/L)

The concentration of chloride was lowest around the sand ridges with average results ranging from 21mg/L (GW11) to 70mg/L (GW7). The results within the Neranleigh-Fernvale metasediments, marine clays and the footslopes of the metasediments were more variable with averages ranging from 145mg/L (GW8) to 1950mg/L (GW4).

3.5.9 Iron (mg/L)

The concentration of iron ranged from 3mg/L (GW11) to 13mg/L (GW7) around the sand ridge. Iron was seen to increase within the metasediments with average results ranging from 42mg/L (GW9) to 88mg/L (GW8). The greatest concentration of iron was recorded in the footslopes of the metasediments in the south of the site (163mg/L) and the marine clays (333mg/L).

3.5.10 Aluminium (mg/L)

The concentration of aluminium was greatest around the Neranleigh-Fernvale metasediments with average concentrations ranging from 191mg/L (GW9) to 545mg/L (GW8). Aluminium ranged from 20mg/L (GW2) to 84mg/L (GW4) around the marine clays and the footslopes of the metasediments. The aluminium concentration was lowest around the sand ridge, ranging from 12mg/L (GW6) to 20mg/L (GW3).

3.6 Groundwater users and groundwater dependant ecosystems (GDE's)

A search of the NSW Natural Resources Atlas for groundwater does not show any down-gradient groundwater users (before the Cobaki Broadwater).

Separate reporting by James Warren & Associates (JWA) confirms no GDE's are present in or near the Cobaki Lakes site.

GW8

GW9

GW4

GW3

GW11

GW7

GW10

GW2

GW5

GW6

GW1

0 100 200 300 400 500 600 700 800 900 1000

Scale of metres

Legend

- Groundwater Bore
- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT

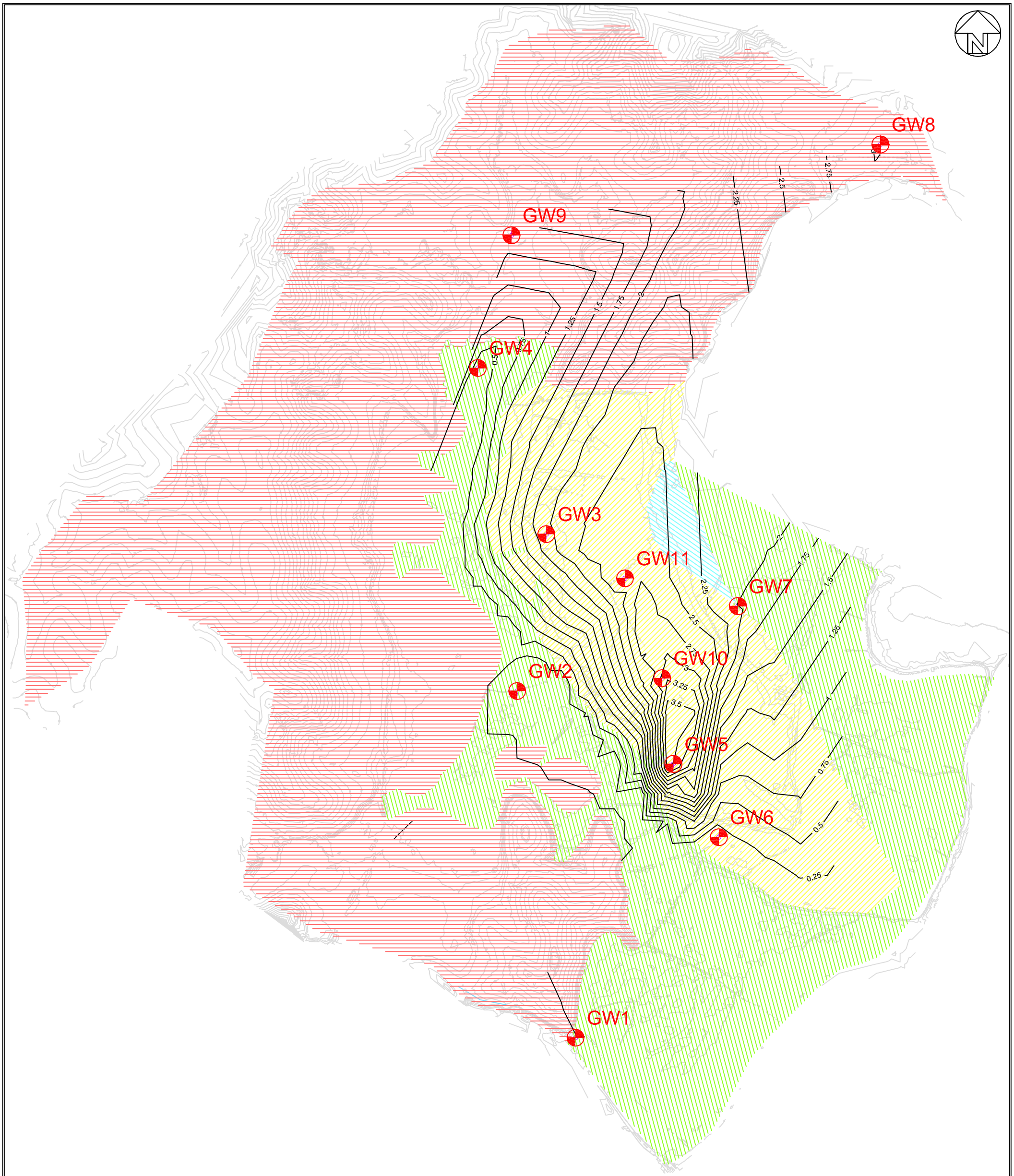
LEDA MANORSTEAD

COBAKI LAKES, NSW

CONCEPTUAL GROUNDWATER ASSESSMENT

GROUNDWATER BORE LOCATIONS

SCALE AS SHOWN	DRAWN C.T.H.	DRAWING No.
DATE 29/04/08	CHECKED	GJ0640.1.3



Legend

- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

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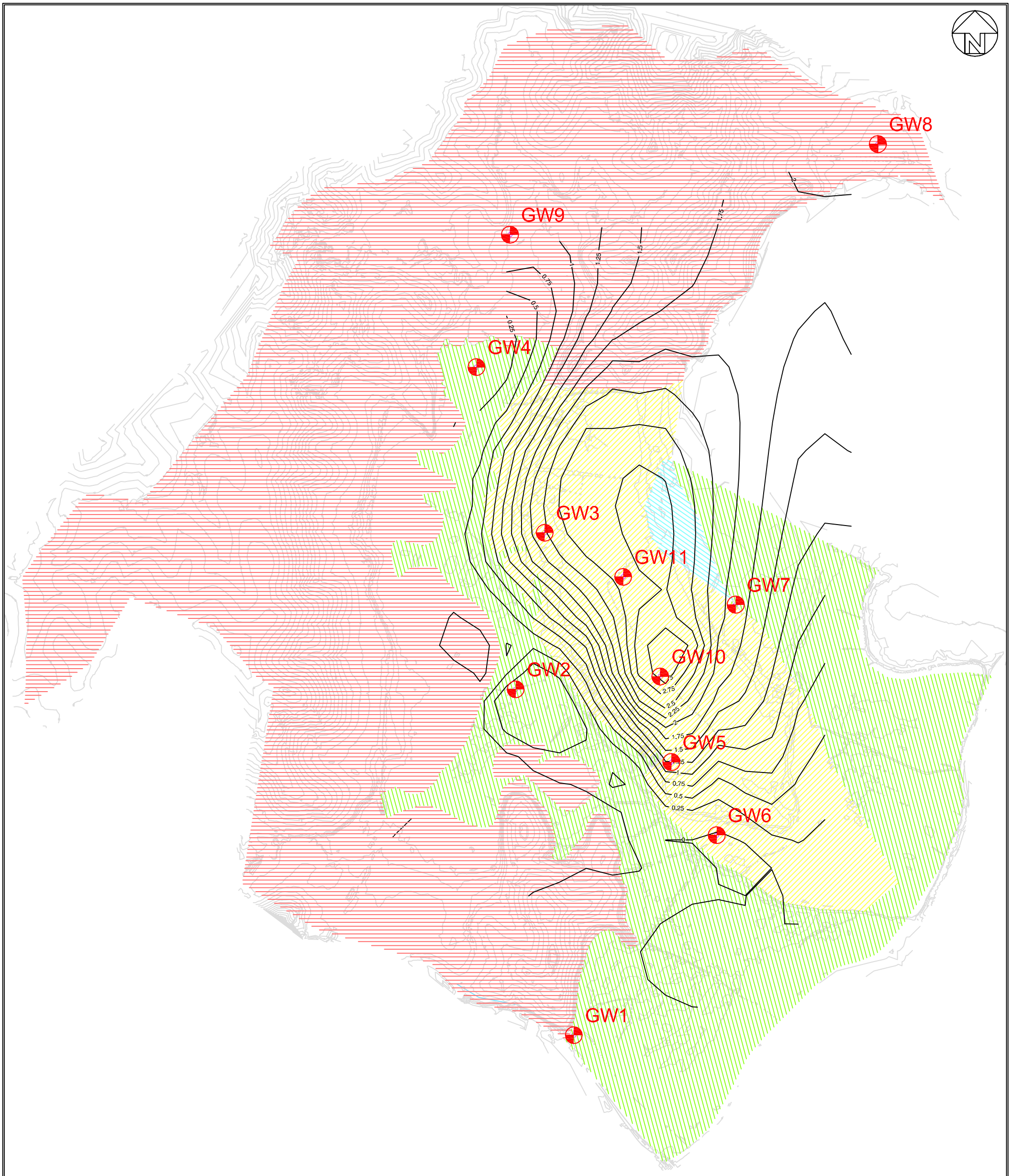
COBAKI LAKES, NSW

INTERPOLATED GROUNDWATER LEVELS

RECORDED 3 SEPTEMBER 2007

SCALE AS SHOWN	DRAWN C.T.H.	DRAWING No.
DATE 29/04/08	CHECKED	GJ0640.1.4a



Legend

- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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agriculture · water · environment

Eastside
5/232 Robina Town Centre Drive, Robina, Qld. 4226
Phone 55789944 Mobile 0418 760919 Fax 55789945

PROJECT

LEDA MANORSTEAD

COBAKI LAKES, NSW

INTERPOLATED GROUNDWATER LEVELS

RECORDED 22 OCTOBER 2007

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED .	SCALE AS SHOWN	DRAWN C.T.H.
		DATE 29/04/08	CHECKED

DRAWING No. GJ0640.1.4b

GW8

GW9

GW4

GW3

GW11

GW7

GW10

GW2

GW5

GW6

GW1

3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0

0 100 200 300 400 500 600 700 800 900 1000

Scale of metres

Legend

- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT

LEDA MANORSTEAD

COBAKI LAKES, NSW

INTERPOLATED GROUNDWATER LEVELS

RECORDED 20 NOVEMBER 2007

SCALE AS SHOWN	DRAWN C.T.H.	DRAWING No.
DATE 29/04/08	CHECKED	GJ0640.1.4c

GW8
GW9
GW4
GW3
GW11
GW7
GW10
GW2
GW5
GW6
GW1
3.75
3.5
3.25
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0

0 100 200 300 400 500 600 700 800 900 1000

Scale of metres

Legend

- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

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COBAKI LAKES, NSW

INTERPOLATED GROUNDWATER LEVELS

RECORDED 17 JANUARY 2008

SCALE AS SHOWN	DRAWN C.T.H.	DRAWING No.
DATE 29/04/08	CHECKED	GJ0640.1.4d

GW8
GW9
GW4
GW3
GW11
GW7
GW10
GW2
GW5
GW6
GW1
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0

0 100 200 300 400 500 600 700 800 900 1000

Scale of metres

Legend

- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT

LEDA MANORSTEAD

COBAKI LAKES, NSW

INTERPOLATED GROUNDWATER LEVELS

RECORDED 31 JANUARY 2008

SCALE AS SHOWN	DRAWN C.T.H.	DRAWING No.
DATE 29/04/08	CHECKED	GJ0640.1.4e

GW8
GW9
GW4
GW3
GW11
GW7
GW10
GW2
GW5
GW6
GW1
3.25
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25

0 100 200 300 400 500 600 700 800 900 1000

Scale of metres

Legend

- Podosols
- Meta–Sediments
- Hydrosols
- Organosols

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FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT

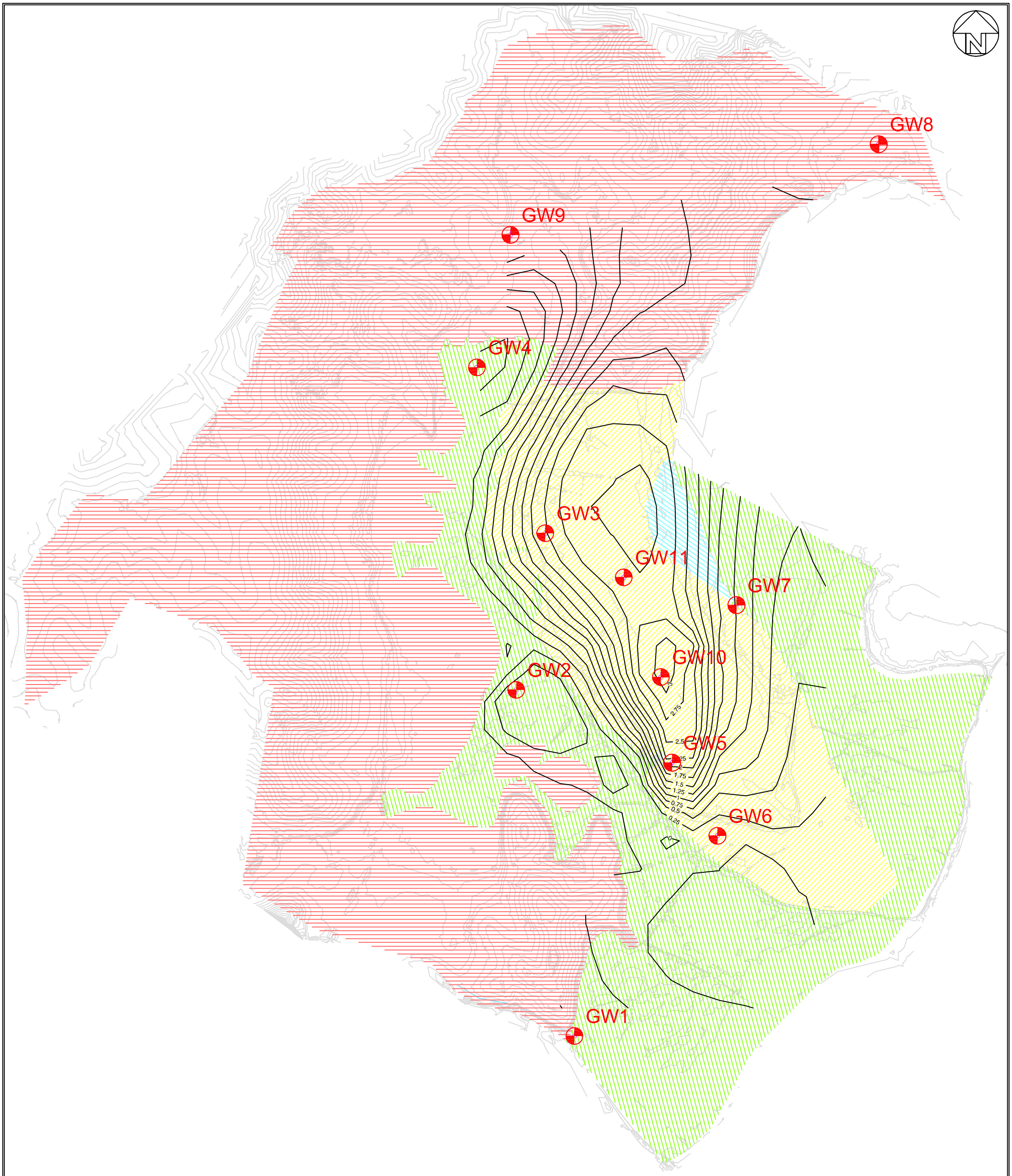
LEDA MANORSTEAD

COBAKI LAKES, NSW

INTERPOLATED GROUNDWATER LEVELS

RECORDED 25 FEBRUARY 2008

SCALE AS SHOWN	DRAWN C.T.H.	DRAWING No.
DATE 29/04/08	CHECKED	GJ0640.1.4f



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PROJECT
LEDA MANORSTEAD
COBAKI LAKES, NSW
INTERPOLATED GROUNDWATER LEVELS
RECORDED 03 MARCH 2008

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED .	SCALE AS SHOWN	DRAWN C.T.H.
		DATE 29/04/08	CHECKED

DRAWING No. GJ0640.1.4g

4) Discussion

Eleven (11) groundwater bores were installed across the low-lying parts of the site to facilitate the groundwater modelling and assessment.

To date, seven rounds of monthly groundwater quality data has been recovered from the bore network. While further data is required and will be available in time, some preliminary trends are emerging. The data collected thus far indicates the following:

- Groundwater quality at the site appears to be heavily influenced by site stratigraphy.
- Groundwater height appears reasonably consistent over time.
- Mounding of groundwater is evident within the sand ridge in the central to eastern part of the site.
- The central drainage line draws down groundwater from the sand ridge.
- Soil permeability in the vicinity of the groundwater bores ranges from 1.9 x 10^{-5}m/s to 8.7 x 10^{-6}m/s.
- The overall groundwater flow appears to be in a south easterly direction towards the Cobaki broadwater.

To estimate the potential groundwater drawdown associated with the construction of the wetlands, Hooghoudt's Equation was used. The result provided a 'worst case scenario' estimate of 36m without any mitigation measures.

As stated above the water quality results demonstrate the relationship between geology and groundwater characteristics.

In general, the groundwater within the low sand ridge (classified as Podosols and consisting of fine to medium sand), is characterised by acidic, fresh waters with low sulfate, alkalinity and chloride concentrations.

The marine clays lying to the west of the low sand ridge are of a sulfidic origin and generally consist of dark, grey, silty clays with occasional organics, shell and jarosite mottling. The groundwater in this region is generally characterised by acidic, fresh to brackish waters, with high aluminium, iron, chloride and sulfate concentrations and low alkalinity concentrations.

The elevated regions to the north and west of the site are Silurian aged Neranleigh-Fernvale derived shales, siltstones and sandstones. The groundwater in this region can generally be described as acidic, fresh waters with high concentrations of chloride, sulfate, alkalinity and variable concentrations of iron and aluminium.

The soils within the southern portion of the site have been classified as floodplain material of Holocene silty clays, sulfidic supratidal hydrosols. The groundwater bore in this area is located on the footslopes of the Neranleigh-Fernvale metasediments on floodplain material. The groundwater in this region is generally characterised by slightly acidic, brackish waters, with high concentrations of iron, aluminium, chloride, sulfate and alkalinity.

The concentration of total nitrogen and total phosphorus is elevated and variable across the site. This may have management implications for a groundwater fed lake in terms of water quality. However the percentage concentration of orthophosphorus in the total phosphorus results indicates the majority of phosphorus is unavailable and bound to sediments.

During the six month monitoring period groundwater levels varied concurrently with rainfall across the site, indicating that groundwater in the area generally responds to seasonal weather patterns.

5) Conclusions

5.1 Likely groundwater impacts

Given the nature of the site soils and groundwater characteristics observed to date, the most likely potential impacts on groundwater as a result of development would be:

- Impacts on the pre-development groundwater flow regimes as a result of excavation, road building and hardening of the site.
- Impacts on groundwater quality as a result of the construction phase and subsequent urban stormwater runoff.
- Acid sulfate soils impacts as a result of disturbance of such materials.

5.2 Groundwater impact management

The identified potential impacts are readily anticipated and manageable. At the detailed design phase for each stage of development, the surface water quality treatment devices would be designed to integrate with the groundwater requirements of the site, providing adequate opportunity for groundwater management.

Management measures proposed during during the construction and operational phases of the development are included as a Groundwater Management Plan (see Attachment 1).

5.3 GDE's

Separate reporting by James Warren & Associates (JWA) confirms no GDE's are present in or near the Cobaki Lakes site.

5.4 Cobaki Lakes Concept Plan

The investigations conducted to date suggest that potential impacts on groundwater quality and flow regimes do not represent an impediment to development of the site in accordance with the Cobaki Lakes Concept Plan.

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 both professional and subjective judgements. 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 of 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 or the relevant statutory authority determining the client's application, 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) Appendix 1 – Borehole logs

Borehole: GW1

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.00

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 08.08.07

Completion date: 08.08.07

Drilling			Soil Description					Assays			
Depth NSL(m)	Depth (RL) m	Method	Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Sample ID	Emerson class	pH(Field) 3 5 8 10	Depth NSL(m)
				LIGHT CLAY Dark grey with light grey & orange mottling, wet, abrupt change to								
.5				LIGHT CLAY Yellow brown, wet								.5
1.0												1.0
				LIGHT CLAY Yellow brown, wet				Screen 1.5m				
1.5												1.5
2.0												2.0
2.5												2.5
3.0												3.0

Borehole: GW2

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.50

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 08.08.07

Completion date: 08.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
.5				CLAY (Fill) Red, fine gravel (10%), moist								.5
1.0				GRAVEL Coarse gravel								1.0
1.5				SANDY CLAY Grey, wet								1.5
2.0				SANDY CLAY Grey, wet				Screen 1.5m				2.0
2.5				HEAVY CLAY Dark red								2.5
3.0												3.0

Borehole: GW3

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.00

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 07.08.07

Completion date: 07.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description: Soil Description (as per McDonald et.al1990)	Soil Description: Secondary Soil type	Soil Description: Revised Standard Colour	Soil Description: Accessories	Soil Description: Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
.5				FINE TO MEDUM SAND Grey, moist				Screen 0.5-2.0m				.5
				FINE TO MEDUM SAND Grey, wet								
1.0				FINE TO MEDUM SAND Grey, wet								1.0
1.5				FINE TO MEDUM SAND Grey-brown (indurated)								1.5
2.0												2.0
2.5												2.5
3.0												3.0

Borehole: GW4

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.00

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 07.08.07

Completion date: 07.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Soil Description: Secondary Soil type	Soil Description: Revised Standard Colour	Soil Description: Accessories	Soil Description: Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
				LIGHT MEDIUM CLAY Dark grey, moist								
.5				LIGHT MEDIUM CLAY Grey with orange mottling, moist				Screen from 1.5m (0.5-2.0m)				.5
1.0				LIGHT CLAY Grey with orange mottles (15%), wet	Trace sand							1.0
				LIGHT CLAY Grey with orange mottles (15%), wet								
1.5				LIGHT CLAY Grey with orange mottles (5%)								1.5
2.0												2.0
2.5												2.5
3.0												3.0

Borehole: GW5

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 3.50

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 06.08.07

Completion date: 06.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
.5				FINE SAND Light grey, medium density, moist								.5
				FINE SAND Light grey, gradual change to grey-brown, medium density, moist								
1.0				FINE SAND Grey-brown, gradual change to grey, wet								1.0
				FINE SAND Grey, wet								
1.5												1.5
2.0				FINE SAND Dark brown (indurated)				Screen from 2.0-3.5m				2.0
2.5												2.5
3.0				FINE SAND Dark brown (indurated)								3.0

Borehole: GW6

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 3.50

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 06.08.07

Completion date: 06.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
				FINE TO MEDUM SAND Dark brown, loose, low-med plasticity silt & clay fines, moist	ZC							
.5												.5
1.0												1.0
				FINE TO MEDUM SAND Dark brown (indurated), dense, low plascticity silt fines, moist	Z			Screen from 2.0-3.5m				
1.5												1.5
2.0												2.0
2.5												2.5
				FINE TO MEDUM SAND Brown/dark brown (indurated), frace of F-M gravel, wet	Z							
3.0												3.0

Borehole: GW7

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 3.50

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 06.08.07

Completion date: 06.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
				FINE SAND Grey with dark brown mottling, loose, low plasticity silty fines, moist	Z							
.5				FINE SAND Grey, medium-dense, moist								.5
1.0				FINE TO MEDUM SAND Grey, medium-dense, moist								1.0
				FINE TO MEDUM SAND Dark grey/brown, medium density, trace of low plasticity silt fines, moist								
1.5												1.5
2.0				FINE TO MEDUM SAND Dark brown (indurated), medium-high density, moist	Z							2.0
2.5												2.5
3.0				FINE TO MEDUM SAND Dark brown (indurated), medium-high density, wet	Z							3.0

Borehole: GW8

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 3.50

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 06.08.07

Completion date: 06.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
.5				SANDY CLAY (Fill) Yellow with fine gravel (10%), dry to moist, abrupt change to								.5
				LIGHT CLAY Dark grey, firm, moist								
1.0				LIGHT CLAY Dark grey with orange mottling, firm, moist								1.0
				MEDIUM CLAY Yellow-brown with orange mottling (20%), moist								
1.5				SANDY MEDIUM CLAY Yellow-brown with orange mottling (20%), moist								1.5
2.0												2.0
2.5				SAND Grey, wet	C			Screen from 2.0-3.5m				2.5
3.0				SAND Grey/brown, wet	C							3.0
				SILTY SAND Light brown (indurated)								

Borehole: GW9

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 3.00

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 07.08.07

Completion date: 07.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
				LIGHT CLAY Grey-brown, wet								
.5				LIGHT CLAY Grey-brown, moist								.5
1.0				HEAVY CLAY Light grey with yellow/orange mottling, very stiff, moist-wet								1.0
1.5				HEAVY CLAY Light grey, yellow/orange mottling (10%), moist-wet				Screen from 1.5-3.0m				1.5
2.0				HEAVY CLAY Light grey, red-yellow mottling (10%)	Trace sand							2.0
2.5				SANDY CLAY Light grey								2.5
3.0				SANDY CLAY Light grey with yellow mottling, weathered rock fragments								3.0

Borehole: GW10

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.50

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 07.08.07

Completion date: 07.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
				FINE SAND Grey, moist								
.5				FINE SAND Light grey, moist				Screen from 0.5-2.0m				.5
				FINE SAND Grey, moist-wet								
1.0												1.0
1.5				SILTY SAND Dark grey (indurated), wet								1.5
2.0												2.0
2.5				SILTY SAND Brown (indurated), wet								2.5
3.0												3.0

Borehole: GW11

Project GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m)

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.00

Logged by: DC

Drilled by: Sutherland Exploration

Start date: 07.08.07

Completion date: 07.08.07

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Assays: Sample ID	Assays: Emerson class	Assays: pH(Field)	Depth NSL(m)
											3 5 8 10	
				FINE SAND Grey, loose, moist				Screen from 0.5-2.0m				
.5				FINE TO MEDUM SAND Light grey, medium density, moist				Screen from 0.5-2.0m				.5
				FINE TO MEDUM SAND Light grey, medium density, wet								
1.0												1.0
1.5				SILTY SAND Dark grey (indurated), saturated								1.5
2.0												2.0
2.5												2.5
3.0												3.0

8) Appendix 2 – Water quality monitoring results

Parameter: Groundwater level from NSL
Units: mAHD
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
03.09.07	0.26	-1.47	2.35	0.30	4.28	0.16	1.97	3.04	1.40	3.24	2.853
22.10.07	0.16	-1.44	2.23	-0.01	1.31	-0.02	1.87	2.04	1.21	3.11	2.603
20.11.07	0.03	-	2.17	-0.08	1.02	0.00	1.80	1.97	1.21	3.10	2.563
17.01.08	0.47	-	2.59	0.53	2.76	0.48	-	2.33	1.75	3.53	2.983
31.01.08	0.33	-	2.27	-0.04	2.44	0.28	2.13	2.18	1.48	3.24	2.763
25.02.08	0.42	-	2.41	0.16	2.55	0.38	2.48	2.27	1.57	-	2.823
average	0.28	-1.46	2.34	0.14	2.40	0.21	2.05	2.31	1.43	3.24	2.76
minimum	0.03	-1.47	2.17	-0.08	1.02	-0.02	1.80	1.97	1.21	3.10	2.56
maximum	0.47	-1.44	2.59	0.53	4.28	0.48	2.48	3.04	1.75	3.53	2.98

Parameter: Sulfate
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1		GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	150.0	230.0	10.0	3300.0	13.0	4.8	-	87.0	220.0	5.8	3.4
20.11.07	170.0	-	7.7	3100.0	9.5	5.2	11.0	85.0	190.0	5.2	3.1
17.01.08	170.0	-	1.5	2900.0	2.7	9.8	40.0	83.0	100.0	5.1	2.7
25.02.08	110.0	-	2.9	2800.0	1.5	8.6	17.0	78.0	71.0	5.0	3.6
average	150.00	230.00	5.53	3025.00	6.68	7.10	22.67	83.25	145.25	5.28	3.20
median	160.00	230.00	5.30	3000.00	6.10	6.90	17.00	84.00	145.00	5.15	3.25
minimum	110.00	230.00	1.50	2800.00	1.50	4.80	11.00	78.00	71.00	5.00	2.70
maximum	170.00	230.00	10.00	3300.00	13.00	9.80	40.00	87.00	220.00	5.80	3.60

Parameter: Aluminium
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	18	20.00	8	9	15	15	-	81	2	21	20
20.11.07	170	-	34	240	17	14	42	1800	720	17	26
17.01.08	30	-	11	75	3	9	2	140	9	18	8
25.02.08	68	-	26	11	18	11	15	160	31	24	21
average	71.50	20.00	19.65	83.75	13.15	12.18	19.60	545.25	190.60	20.00	18.70
median	49.00	20.00	18.50	43.00	16.00	12.50	15.00	150.00	20.15	19.50	20.50
minimum	18.00	20.00	7.60	9.00	2.60	8.70	1.80	81.00	2.10	17.00	7.80
maximum	170.00	20.00	34.00	240.00	18.00	15.00	42.00	1800.00	720.00	24.00	26.00

Parameter: Iron
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	120.00	14.0	1.70	290.00	2.80	3.40	-	1.80	11.00	6.40	1.30
20.11.07	230.00	-	5.50	410.00	5.20	8.90	25.00	270.00	130.00	3.80	2.50
17.01.08	120.00	-	2.70	310.00	0.99	2.40	1.20	55.00	6.90	7.00	2.00
25.02.08	180.00	-	9.30	320.00	7.20	6.50	13.00	25.00	19.00	12.00	6.10
average	162.50	14.00	4.80	332.50	4.05	5.30	13.07	87.95	41.73	7.30	2.98
median	150.00	14.00	4.10	315.00	4.00	4.95	13.00	40.00	15.00	6.70	2.25
minimum	120.00	14.00	1.70	290.00	0.99	2.40	1.20	1.80	6.90	3.80	1.30
maximum	230.00	14.00	9.30	410.00	7.20	8.90	25.00	270.00	130.00	12.00	6.10

Parameter: Alkalinity
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1		GW2		GW3		GW4		GW5	GW6		GW7	GW8	GW9		GW10		GW11
22.10.07	200	<	20	<	20	<	20	<	20	91		-	36	84	<	20	<	20
20.11.07	190		-	<	20	<	20	<	20	99	<	20	35	80	<	20	<	20
17.01.08	250		-	<	2	<	2	<	2	94	<	2	45	50	<	2	<	2
25.02.08	250		-	<	5	<	5	<	5	85	<	5	39	47	<	5	<	5
average	222.50	<	20.00	<	11.75	<	11.75	<	11.75	92.25	<	9.00	38.75	65.25	<	11.75	<	11.75
median	225.00	<	20.00	<	12.50	<	12.50	<	12.50	92.50	<	5.00	37.50	65.00	<	12.50	<	12.50
minimum	190.00	<	20.00	<	2.00	<	2.00	<	2.00	85.00	<	2.00	35.00	47.00	<	2.00	<	2.00
maximum	250.00	<	20.00	<	20.00	<	20.00	<	20.00	99.00	<	20.00	45.00	84.00	<	20.00	<	20.00

Parameter: Chloride
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1		GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	1600		670	30	2300	40	69	-	150	2100	25	23
20.11.07	1800		-	28	2000	46	62	62	150	1800	24	22
17.01.08	1800		-	26	1800	36	57	62	130	970	28	19
25.02.08	1400		-	32	1700	28	62	86	150	600	24	19
average	1650.00		670.00	29.00	1950.00	37.50	62.50	70.00	145.00	1367.50	25.25	20.75
median	1700.00		670.00	29.00	1900.00	38.00	62.00	62.00	150.00	1385.00	24.50	20.50
minimum	1400.00		670.00	26.00	1700.00	28.00	57.00	62.00	130.00	600.00	24.00	19.00
maximum	1800.00		670.00	32.00	2300.00	46.00	69.00	86.00	150.00	2100.00	28.00	23.00

Parameter: Total nitrogen
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	1.20	0.45	2.00	2.00	3.00	1.70	-	1.10	0.25	2.20	1.80
20.11.07	8.10	-	5.20	5.10	6.40	2.40	9.60	16.00	1.70	3.10	3.60
17.01.08	6.40	-	5.30	7.70	8.00	2.20	5.20	11.00	1.10	4.70	3.30
25.02.08	3.00	-	4.90	4.80	0.17	1.90	0.38	1.30	1.50	5.00	4.80
average	4.68	0.45	4.35	4.90	4.39	2.05	5.06	7.35	1.14	3.75	3.38
median	4.70	0.45	5.05	4.95	4.70	2.05	5.20	6.15	1.30	3.90	3.45
minimum	1.20	0.45	2.00	2.00	0.17	1.70	0.38	1.10	0.25	2.20	1.80
maximum	8.10	0.45	5.30	7.70	8.00	2.40	9.60	16.00	1.70	5.00	4.80

Parameter: Total phosphorus
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	0.05	0.05	0.03	0.07	0.09	<0.02	-	0.09	0.01	0.23	0.05
20.11.07	2.40	-	1.10	0.87	0.95	0.67	0.71	4.60	1.20	0.57	0.35
17.01.08	1.30	-	0.71	0.95	0.93	0.15	0.28	2.10	0.26	0.73	1.00
25.02.08	0.12	-	0.25	0.10	0.32	0.19	0.45	0.31	0.21	0.31	0.21
average	0.97	0.05	0.52	0.50	0.57	0.34	0.48	1.78	0.42	0.46	0.40
median	0.71	0.05	0.48	0.49	0.63	0.19	0.45	1.21	0.24	0.44	0.28
minimum	0.05	0.05	0.03	0.07	0.09	0.15	0.28	0.09	0.01	0.23	0.05
maximum	2.40	0.05	1.10	0.95	0.95	0.67	0.71	4.60	1.20	0.73	1.00

Parameter: Turbidity
Units: NTU
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	-	-	-	-	-	-	-	-	-	-	-
20.11.07	> 400	-	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400
17.01.08	> 400	-	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400	> 400
25.02.08	150	-	> 400	> 400	> 400	150	> 400	> 400	> 400	> 400	> 400
average	> 316.67		> 400.00	> 400.00	> 400.00	> 316.67	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00
median	> 400.00		> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00
minimum	> 150.00		> 400.00	> 400.00	> 400.00	> 150.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00
maximum	> 400.00		> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00	> 400.00

Parameter: Orthophosphorus
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	0.009	0	0.030	0.029	0.056	0.014		0.018	0.022	0.100	0.038
20.11.07	< 0.006	-	0.018	0.012	< 0.006	< 0.006	0.110	< 0.006	< 0.006	0.038	< 0.006
17.01.08	0.017	-	0.069	0.030	0.054	0.020	0.071	0.025	0.025	0.120	0.046
25.02.08	0.010	-	0.079	0.024	0.059	0.016	0.150	0.020	0.010	0.072	0.029
average	< 0.01	< 0.01	< 0.05	< 0.02	< 0.04	< 0.01	< 0.11	< 0.02	< 0.02	< 0.08	< 0.03
median	< 0.01	< 0.01	< 0.05	< 0.03	< 0.06	< 0.02	< 0.11	< 0.02	< 0.02	< 0.09	< 0.03
minimum	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.07	< 0.01	< 0.01	< 0.04	< 0.01
maximum	< 0.02	< 0.01	< 0.08	< 0.03	< 0.06	< 0.02	< 0.15	< 0.03	< 0.03	< 0.12	< 0.05

Parameter: pH
Units:
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	5.78	5.22	4.40	3.70	3.87	5.85	-	5.20	4.88	4.04	3.34
20.11.07	6.50	-	4.20	5.10	3.20	5.90	3.00	5.20	5.80	3.50	3.60
17.01.08	6.46	-	4.33	5.24	3.58	5.91	3.42	5.52	6.15	3.90	4.01
25.02.08	7.65	-	5.02	6.25	3.10	5.31	4.45	5.93	6.82	4.91	3.37
average	6.60	5.22	4.49	5.07	3.44	5.74	3.62	5.46	5.91	4.09	3.58
median	6.48	5.22	4.37	5.17	3.39	5.88	3.42	5.36	5.98	3.97	3.49
minimum	5.78	5.22	4.20	3.70	3.10	5.31	3.00	5.20	4.88	3.50	3.34
maximum	7.65	5.22	5.02	6.25	3.87	5.91	4.45	5.93	6.82	4.91	4.01

Parameter: Electrical conductivity
Units: uS/cm
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	6820	2790.0	262	122	294	476		957	7920	126	122
20.11.07	7400	-	180	11000	350	460	450	850	7100	180	160
17.01.08	5460	-	128	8460	221	362	512	707	3800	151	111
25.02.08	6810	-	167	11840	190	390	527	888	3190	372	131
average	6622.50	2790.00	184.25	7855.50	263.75	422.00	496.33	850.50	5502.50	207.25	131.00
median	6815.00	2790.00	173.50	9730.00	257.50	425.00	512.00	869.00	5450.00	165.50	126.50
minimum	5460.00	2790.00	128.00	122.00	190.00	362.00	450.00	707.00	3190.00	126.00	111.00
maximum	7400.00	2790.00	262.00	11840.00	350.00	476.00	527.00	957.00	7920.00	372.00	160.00

Parameter: Dissolved oxygen
Units: mg/L
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	5.78	5.22	4.40	3.70	3.87	5.85	-	5.20	4.88	4.04	3.34
20.11.07	6.50	-	4.20	5.10	3.20	5.90	3.00	5.20	5.80	3.50	3.60
17.01.08	6.46	-	4.33	5.24	3.58	5.91	3.42	5.52	6.15	3.90	4.01
25.02.08	7.65	-	5.02	6.25	3.10	5.31	4.45	5.93	6.82	4.91	3.37
average	6.60	5.22	4.49	5.07	3.44	5.74	3.62	5.46	5.91	4.09	3.58
median	6.48	5.22	4.37	5.17	3.39	5.88	3.42	5.36	5.98	3.97	3.49
minimum	5.78	5.22	4.20	3.70	3.10	5.31	3.00	5.20	4.88	3.50	3.34
maximum	7.65	5.22	5.02	6.25	3.87	5.91	4.45	5.93	6.82	4.91	4.01

Parameter: Temperature
Units: ºC
Data Collected by: Gilbert & Sutherland

Sampling Date	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11
22.10.07	22.5	21.1	21.0	19.6	20.7	20.9	-	21.1	19.1	20.8	21.7
20.11.07	24.1	-	24.9	24.9	25.0	23.0	23.0	23.2	21.7	24.5	25.0
17.01.08	29.1	-	30.8	28.9	30.0	28.7	29.1	29.1	27.2	29.9	30.2
25.02.08	27.0	-	26.3	24.7	26.3	25.6	25.9	25.8	24.5	26.3	26.3
average	25.68	21.10	25.75	24.53	25.50	24.55	26.00	24.80	23.13	25.38	25.80
median	25.55	21.10	25.60	24.80	25.65	24.30	25.90	24.50	23.10	25.40	25.65
minimum	22.50	21.10	21.00	19.60	20.70	20.90	23.00	21.10	19.10	20.80	21.70
maximum	29.10	21.10	30.80	28.90	30.00	28.70	29.10	29.10	27.20	29.90	30.20

GILBERT+SUTHERLAND
agricultural and environmental scientists

In Situ & In House
Water Quality Analysis

Job: Cobaki **Job No:** GJ0640	**Date:** 22/10/07	**Time sampled:** 9am – 4pm	**Weather Conditions:** Fine
Extra details: **Tides:** 0541 – 1.17 1124 – 0.14 1750 – 1.43		**Sampled by:** MH DC	**Recent rainfall info:** 18.10.07 – 1.6mm 19.10.07 – 0.2mm 20.10.07 – 0mm 21.10.07 – 0mm 22.10.07 – 0mm

Site	Depth from top of monument	Notes	EC uS/cm	Turb. NTU	pH	Temp °C	DO ppm
GW1	1.17		6820		5.78	22.5	5.75
GW2	1.44		2790		5.22	21.1	3.16
GW3	1.33		262		4.40	21.0	2.16
GW4	1.27		122		3.70	19.6	4.16
GW5	2.97		294		3.87	20.7	3.18
GW6	1.30		476		5.85	20.9	1.96
GW7	1.73	Borehole blocked					
GW8	1.88		957		5.20	21.1	2.87
GW9	1.17		7920		4.88	19.1	1.65
GW10	1.58		126		4.04	20.8	3.80
GW11	1.55		122		3.34	21.7	4.52
SW1			181		4.22	24.0	7.10
SW2		Ponded drainage channel	359		3.65	27.8	6.44
SW6			2990		6.60	23.7	6.40
SW8			4230		6.50	24.1	4.80

Simmonds & Bristow
Established 1965 ACN 010 252 418 Pty Ltd

P/O Box 3160 Yeronga 4104
40 Reginald St
Rocklea, Qld 4106

Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
PO BOX 498

HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0710-316-01 -GW1	J-0710-316-02 -GW2	J-0710-316-03 -GW3	J-0710-316-04 -GW4	J-0710-316-05 -GW5	J-0710-316-06 -GW6	J-0710-316-07 -GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 08
	Date Collected	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007
	Date Received	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
	Date Testing Completed	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007
WC###.4 41&SC###.4	Aluminium as Al - Total	18000 µg/L	20000 µg/L	7600 µg/L	9000 µg/L	15000 µg/L	15000 µg/L	81000 µg/L
	Iron as Fe - Total	120000 µg/L	14000 µg/L	1700 µg/L	290000 µg/L	2800 µg/L	3400 µg/L	18000 µg/L
WC205.	Alkalinity - Total as CaCO3	200 mg/L	< 20 mg/L	< 20 mg/L	< 20 mg/L	< 20 mg/L	91 mg/L	36 mg/L
WC220.4	Chloride as Cl	1600 mg/L	670 mg/L	30 mg/L	2300 mg/L	40 mg/L	69 mg/L	150 mg/L
WC250.65_WC	Total Nitrogen as N	1.2 mg/L	0.45 mg/L	2.0 mg/L	2.0 mg/L	3.0 mg/L	1.7 mg/L	1.1 mg/L

Authorised for release:

Date: 2/11/2007

Simmonds & Bristow
Established 1965 ACN 010 252 418 Pty Ltd

P/O Box 3160 Yeronga 4104
40 Reginald St
Rocklea, Qld 4106

Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
PO BOX 498

HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0710-316-01 -GW1	J-0710-316-02 -GW2	J-0710-316-03 -GW3	J-0710-316-04 -GW4	J-0710-316-05 -GW5	J-0710-316-06 -GW6	J-0710-316-07 -GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 08
	Date Collected	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007
	Date Received	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
	Date Testing Completed	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007
WC250.65_WC	Total Phosphorus as P	0.05 mg/L	0.05 mg/L	0.03 mg/L	0.07 mg/L	0.09 mg/L	< 0.02 mg/L	0.09 mg/L
WC270.113	Orthophosphate as P	0.009 mg/L	0.012 mg/L	0.030 mg/L	0.029 mg/L	0.056 mg/L	0.014 mg/L	0.018 mg/L
WC280.4	Sulphate as SO4	150 mg/L	230 mg/L	10 mg/L	3300 mg/L	13 mg/L	4.8 mg/L	87 mg/L
WP100.X	Suspended Solids	2200 mg/L	4200 mg/L	1000 mg/L	5200 mg/L	2100 mg/L	480 mg/L	11000 mg/L

Authorised for release: _____

Date: 2/11/2007

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P/O Box 3160 Yeronga 4104
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Rocklea, Qld 4106

Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
PO BOX 498

HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0710-316-08 -GW9	J-0710-316-09 -GW10	J-0710-316-10 -GW11	J-0710-316-11 -SW1	J-0710-316-12 -SW2	J-0710-316-13 -SW6	J-0710-316-14 -SW8
	Sample Point	Water Sample 09	Water Sample10	Water Sample11	Water Sample 12	Water Sample 13	Water Sample 14	Water Sample 15
	Date Collected	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007
	Date Received	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
	Date Testing Completed	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007
WC###.4 41&SC###.4	Aluminium as Al - Total	2100 µg/L	21000 µg/L	20000 µg/L	680 µg/L	1300 µg/L	1400 µg/L	340 µg/L
	Iron as Fe - Total	11000 µg/L	6400 µg/L	1300 µg/L	350 µg/L	640 µg/L	2900 µg/L	1600 µg/L
WC205.	Alkalinity - Total as CaCO3	84 mg/L	< 20 mg/L	< 20 mg/L	< 20 mg/L	< 20 mg/L	110 mg/L	93 mg/L
WC220.4	Chloride as Cl	2100 mg/L	25 mg/L	23 mg/L	27 mg/L	64 mg/L	14000 mg/L	14000 mg/L
WC250.65_WC	Total Nitrogen as N	0.25 mg/L	2.2 mg/L	1.8 mg/L	1.5 mg/L	2.4 mg/L	0.30 mg/L	0.34 mg/L

Authorised for release:

Date: 2/11/2007

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Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0710-316-08 -GW9	J-0710-316-09 -GW10	J-0710-316-10 -GW11	J-0710-316-11 -SW1	J-0710-316-12 -SW2	J-0710-316-13 -SW6	J-0710-316-14 -SW8
	Sample Point	Water Sample 09	Water Sample10	Water Sample11	Water Sample 12	Water Sample 13	Water Sample 14	Water Sample 15
	Date Collected	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007
	Date Received	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
	Date Testing Completed	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007	2/11/2007
WC250.65_WC	Total Phosphorus as P	0.08 mg/L	0.23 mg/L	0.05 mg/L	< 0.02 mg/L	< 0.02 mg/L	0.08 mg/L	0.08 mg/L
WC270.113	Orthophosphate as P	0.022 mg/L	0.10 mg/L	0.038 mg/L	0.008 mg/L	0.019 mg/L	0.012 mg/L	0.014 mg/L
WC280.4	Sulphate as SO4	220 mg/L	5.8 mg/L	3.4 mg/L	3.4 mg/L	11 mg/L	2000 mg/L	2000 mg/L
WP100.X	Suspended Solids	11000 mg/L	2500 mg/L	3700 mg/L	< 1.0 mg/L	5.0 mg/L	46 mg/L	16 mg/L

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Date: 2/11/2007

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P/O Box 3160 Yeronga 4104
40 Reginald St
Rocklea, Qld 4106

Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
PO BOX 498

HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

Notes:

Samples are disposed of 14 days after completion of testing.
Results reported on an 'as received' basis

Bacteriological Samples were received in containers which did not meet the 1995 QLD DEH requirements. The results of our analyses may not be truly representative of the water quality at the time of sampling.

Authorised for release: _____

Date: 2/11/2007

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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Microbiological Analytical Results

	Sample Reference	J-0710-316-01 -GW1	J-0710-316-02 -GW2	J-0710-316-03 -GW3	J-0710-316-04 -GW4	J-0710-316-05 -GW5	J-0710-316-06 -GW6	J-0710-316-07 -GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 08
	Date Collected	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007
	Date Received	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
	Date Testing Completed	1/11/2007	1/11/2007	1/11/2007	1/11/2007	1/11/2007	1/11/2007	1/11/2007
WB302.11	Faecal Coliforms 2-1600	< 2 orgs/100mL	21 orgs/100mL	< 2 orgs/100mL	< 2 orgs/100mL	< 2 orgs/100mL	< 2 orgs/100mL	< 2 orgs/100mL

Note: All tests covered by NATA accreditation except where marked

Authorised for release:

Date: 1/11/2007

NATA Accredited Laboratory Number: 1713
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Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Microbiological Analytical Results

	Sample Reference	J-0710-316-08 -GW9	J-0710-316-09 -GW10	J-0710-316-10 -GW11	J-0710-316-11 -SW1	J-0710-316-12 -SW2	J-0710-316-13 -SW6	J-0710-316-14 -SW8
	Sample Point	Water Sample 09	Water Sample10	Water Sample11	Water Sample 12	Water Sample 13	Water Sample 14	Water Sample 15
	Date Collected	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007	22/10/2007
	Date Received	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
	Date Testing Completed	1/11/2007	1/11/2007	1/11/2007	1/11/2007	1/11/2007	1/11/2007	1/11/2007
WB302.11	Faecal Coliforms 2-1600	< 2 orgs/100mL	< 2 orgs/100mL	< 2 orgs/100mL				
WB302.23	Faecal Coliforms - WW				40 CFU/100mL	< 10 CFU/100mL	10 CFU/100mL	10 CFU/100mL

Note: All tests covered by NATA accreditation except where marked

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Client: Gilbert & Sutherland - Robina
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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0710-316

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Microbiological Analytical Results

Notes:

Samples are disposed of 14 days after completion of testing.
Results reported on an 'as received' basis

Bacteriological Samples were received in containers which did not meet the 1995 QLD DEH requirements. The results of our analyses may not be truly representative of the water quality at the time of sampling.

Note: All tests covered by NATA accreditation except where marked

Authorised for release:

Date: 1/11/2007

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In Situ & In House
Water Quality Analysis

Job: Cobaki Lakes **Job No:** GJ0640	**Date:** 20/11/07	**Time sampled:** 10am – 5pm	**Weather Conditions:** Fine, windy
Extra details: **Tides:** 0400 – 1.18 1002 – 0.62 1612 – 2.08		**Sampled by:** MH DC	**Recent rainfall info:** 16.11.07 – 0mm 17.11.07 – 0mm 18.11.07 – 0mm 19.11.07 – 0mm 20.11.07 – 0mm

Site	Depth from top of monument	Monument height	EC uS/cm	Turb. NTU	pH	Temp °C	DO ppm
GW1	1.30	0.78	6360	>400	6.5	24.1	3.55
GW2	Destroyed						
GW3	1.39	0.77	211	>400	4.2	24.9	3.05
GW4	1.34	0.79	9730	>400	5.1	24.9	7.47
GW5	3.26	0.69	250	>400	3.2	25.0	3.20
GW6	1.28	0.71	360	>400	5.9	23.0	3.20
GW7	1.80	0.78	348	>400	3.0	23.0	3.80
GW8	1.95	0.74	790	>400	5.2	23.2	2.70
GW9	1.17	0.79	6370	>400	5.8	21.7	3.03
GW10	1.59	0.82	151	>400	3.5	24.5	4.60
GW11	1.59	0.78	128	>400	3.6	25.0	4.70
SW1			168	40	3.8	26.0	6.00
SW6				<10	7.9	28.5	5.50
SW8				<10	7.7	28.0	5.80

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Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0711-329

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

		Sample Reference	J-0711-329-01 -GW1	J-0711-329-02 -GW3	J-0711-329-03 -GW4	J-0711-329-04 -GW5	J-0711-329-05 -GW6	J-0711-329-06 -GW7	J-0711-329-07 -GW8
		Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
		Date Collected	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007
		Date Received	23/11/2007	23/11/2007	23/11/2007	23/11/2007	23/11/2007	23/11/2007	23/11/2007
		Date Testing Completed	29/11/2007	29/11/2007	29/11/2007	29/11/2007	29/11/2007	29/11/2007	29/11/2007
WCX.4 41&SCX.4	Aluminium as Al - Total		170000 µg/L	34000 µg/L	240000 µg/L	17000 µg/L	14000 µg/L	42000 µg/L	1800000 µg/L
	Iron as Fe - Total		230000 µg/L	5500 µg/L	410000 µg/L	5200 µg/L	8900 µg/L	25000 µg/L	270000 µg/L

Note: All tests covered by NATA accreditation except where marked

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Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
PO BOX 498

HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0711-329

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0711-329-08 -GW9	J-0711-329-09 -GW10	J-0711-329-10 -GW11	J-0711-329-11 -SW1	J-0711-329-12 -SW6	J-0711-329-13 -SW8
	Sample Point	Water Sample 08	Water Sample 09	Water Sample10	Water Sample11	Water Sample 12	Water Sample 13
	Date Collected	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007
	Date Received	23/11/2007	23/11/2007	23/11/2007	23/11/2007	23/11/2007	23/11/2007
	Date Testing Completed	29/11/2007	29/11/2007	29/11/2007	29/11/2007	29/11/2007	29/11/2007
WCX.4 41&SCX.4	Aluminium as Al - Total	720000 µg/L	17000 µg/L	26000 µg/L	1400 µg/L	1900 µg/L	760 µg/L
	Iron as Fe - Total	130000 µg/L	3800 µg/L	2500 µg/L	570 µg/L	2800 µg/L	2200 µg/L

Note: All tests covered by NATA accreditation except where marked

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Client: Gilbert & Sutherland - Robina
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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0711-329

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

Notes:

Samples are disposed of 14 days after completion of testing.
Results reported on an 'as received' basis

Note: All tests covered by NATA accreditation except where marked

Authorised for release: _____

Date: 30/11/2007

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Client: Gilbert & Sutherland - Robina
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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0711-307

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0711-307-01 -GW1	J-0711-307-02 -GW3	J-0711-307-03 -GW4	J-0711-307-04 -GW5	J-0711-307-05 -GW6	J-0711-307-06 -GW7	J-0711-307-07 -GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
	Date Collected	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007
	Date Received	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007
	Date Testing Completed	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007
WC205.	Alkalinity - Total as CaCO3	190 mg/L	< 20 mg/L	< 20 mg/L	< 20 mg/L	99 mg/L	< 20 mg/L	35 mg/L
WC220.4	Chloride as Cl	1800 mg/L	28 mg/L	2000 mg/L	46 mg/L	62 mg/L	62 mg/L	150 mg/L
WC250.232	Nitrite + Nitrate as N	0.04 mg/L	0.08 mg/L	0.06 mg/L	0.08 mg/L	0.04 mg/L	0.17 mg/L	0.05 mg/L
WC250.54	Total Kjel. Nitrogen as N	8.1 mg/L	5.1 mg/L	5.0 mg/L	6.3 mg/L	2.4 mg/L	9.4 mg/L	16 mg/L
WC250.65_WC	Total Nitrogen as N	8.1 mg/L	5.2 mg/L	5.1 mg/L	6.4 mg/L	2.4 mg/L	9.6 mg/L	16 mg/L

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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0711-307

Job Description: GJ0640

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Chemical Analytical Results

	Sample Reference	J-0711-307-01 -GW1	J-0711-307-02 -GW3	J-0711-307-03 -GW4	J-0711-307-04 -GW5	J-0711-307-05 -GW6	J-0711-307-06 -GW7	J-0711-307-07 -GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
	Date Collected	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007
	Date Received	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007
	Date Testing Completed	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007
WC250.65_WC	Total Phosphorus as P	2.4 mg/L	1.1 mg/L	0.87 mg/L	0.95 mg/L	0.67 mg/L	0.71 mg/L	4.6 mg/L
WC270.113	Orthophosphate as P	< 0.006 mg/L	0.018 mg/L	0.012 mg/L	< 0.006 mg/L	< 0.006 mg/L	0.11 mg/L	< 0.006 mg/L
WC280.4	Sulphate as SO4	170 mg/L	7.7 mg/L	3100 mg/L	9.5 mg/L	5.2 mg/L	11 mg/L	85 mg/L
WP040.	Conductivity @ 25øC	7400 µS/cm	180 µS/cm	11000 µS/cm	350 µS/cm	460 µS/cm	450 µS/cm	850 µS/cm

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Client Order No.:

Batch Reference No.: J-0711-307

Job Description: GJ0640

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Chemical Analytical Results

	Sample Reference	J-0711-307-08 -GW9	J-0711-307-09 -GW10	J-0711-307-10 -GW11	J-0711-307-11 -SW1	J-0711-307-12 -SW6	J-0711-307-13 -SW8
	Sample Point	Water Sample 08	Water Sample 09	Water Sample10	Water Sample11	Water Sample 12	Water Sample 13
	Date Collected	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007
	Date Received	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007
	Date Testing Completed	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007
WC205.	Alkalinity - Total as CaCO3	80 mg/L	< 20 mg/L	< 20 mg/L	< 20 mg/L	100 mg/L	100 mg/L
WC220.4	Chloride as Cl	1800 mg/L	24 mg/L	22 mg/L	45 mg/L	14000 mg/L	11000 mg/L
WC250.232	Nitrite + Nitrate as N	0.03 mg/L	0.05 mg/L	0.05 mg/L	0.06 mg/L	0.02 mg/L	0.01 mg/L
WC250.54	Total Kjel. Nitrogen as N	1.7 mg/L	3.0 mg/L	3.6 mg/L	1.7 mg/L	1.5 mg/L	0.39 mg/L
WC250.65_WC	Total Nitrogen as N	1.7 mg/L	3.1 mg/L	3.6 mg/L	1.8 mg/L	1.5 mg/L	0.40 mg/L

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Client Order No.:

Batch Reference No.: J-0711-307

Job Description: GJ0640

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Chemical Analytical Results

	Sample Reference	J-0711-307-08 -GW9	J-0711-307-09 -GW10	J-0711-307-10 -GW11	J-0711-307-11 -SW1	J-0711-307-12 -SW6	J-0711-307-13 -SW8
	Sample Point	Water Sample 08	Water Sample 09	Water Sample10	Water Sample11	Water Sample 12	Water Sample 13
	Date Collected	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007	20/11/2007
	Date Received	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007	22/11/2007
	Date Testing Completed	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007	27/11/2007
WC250.65_WC	Total Phosphorus as P	1.2 mg/L	0.57 mg/L	0.35 mg/L	0.08 mg/L	0.04 mg/L	0.05 mg/L
WC270.113	Orthophosphate as P	< 0.006 mg/L	0.038 mg/L	< 0.006 mg/L	< 0.006 mg/L	< 0.006 mg/L	< 0.006 mg/L
WC280.4	Sulphate as SO4	190 mg/L	5.2 mg/L	3.1 mg/L	4.9 mg/L	2000 mg/L	1500 mg/L
WP040.	Conductivity @ 25øC	7100 µS/cm	180 µS/cm	160 µS/cm	180 µS/cm	41000 µS/cm	34000 µS/cm

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Client Order No.:

Batch Reference No.: J-0711-307

Job Description: GJ0640

Ph: 07 5578 9944

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Chemical Analytical Results

Notes:

Samples are disposed of 14 days after completion of testing.
Results reported on an 'as received' basis

Authorised for release: _____

Date: 27/11/2007

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In Situ & In House
Water Quality Analysis

Job: Cobaki Lakes **Job No:** GJ0640	**Date:** 17/01/08	**Time sampled:** AM	**Weather Conditions:** Overcast
Extra details: **Tides:** 0316 – 1.3 0922 – 0.47 1503 – 1.02 2117 – 0.19		**Sampled by:** MH DC	**Recent rainfall info:** 13.01.08 – 6.6mm 14.01.08 – 0mm 15.01.08 – 17mm 16.01.08 – 2.8mm 17.01.08 – 7mm

Site	Depth	Monument height	EC uS/cm	Turb. NTU	pH	Temp °C	DO ppm
GW1	0.86		5460	>400	6.46	29.1	2.05
GW2							
GW3	0.97		128	>400	4.33	30.8	1.66
GW4	0.73		8460	>400	5.24	28.9	4.40
GW5	1.52		221	>400	3.58	30.0	2.27
GW6	0.80		362	>400	5.91	28.7	1.73
GW7			512	>400	3.42	29.1	1.33
GW8	1.59		707	>400	5.52	29.1	2.76
GW9	0.63		3800	>400	6.15	27.2	1.94
GW10	1.16		151	>400	3.90	29.9	2.04
GW11	1.17		111	>400	4.01	30.2	2.78
SW1							
SW5			3340	40	6.76	32.8	5.27
SW6			3320	40	6.61	32.3	5.48
SW8			1210	20	8.04	32.5	5.63

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Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0801-278

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	J-0801-278-01 -GW1	J-0801-278-02 -GW3	J-0801-278-03 -GW4	J-0801-278-04 -GW5	J-0801-278-05 -GW6	J-0801-278-06 -GW7	J-0801-278-07 -GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
	Date Collected	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008
	Date Received	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008
	Date Testing Completed	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008
WC205.	Alkalinity - Total as CaCO3	250 mg/L	< 2.0 mg/L	< 2.0 mg/L	< 2.0 mg/L	94 mg/L	< 2.0 mg/L	45 mg/L
WC220.4	Chloride as Cl	1800 mg/L	26 mg/L	1800 mg/L	36 mg/L	57 mg/L	62 mg/L	130 mg/L
WC250.65_WC 270.312	Total Nitrogen as N	6.4 mg/L	5.3 mg/L	7.7 mg/L	8.0 mg/L	2.2 mg/L	5.2 mg/L	11 mg/L
	Total Phosphorus as P	1.3 mg/L	0.71 mg/L	0.95 mg/L	0.93 mg/L	0.15 mg/L	0.28 mg/L	2.1 mg/L
WC270.113	Orthophosphate as P	0.017 mg/L	0.069 mg/L	0.030 mg/L	0.054 mg/L	0.020 mg/L	0.071 mg/L	0.025 mg/L

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Rocklea, Qld 4106

Attention: Megan Hancock

Client: Gilbert & Sutherland - Robina
PO BOX 498

HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0801-278

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

		Sample Reference	J-0801-278-01 -GW1	J-0801-278-02 -GW3	J-0801-278-03 -GW4	J-0801-278-04 -GW5	J-0801-278-05 -GW6	J-0801-278-06 -GW7	J-0801-278-07 -GW8
		Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
		Date Collected	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008
		Date Received	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008
		Date Testing Completed	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008
WC280.4	Sulphate as SO4		170 mg/L	1.5 mg/L	2900 mg/L	2.7 mg/L	9.8 mg/L	40 mg/L	83 mg/L
WCX.4 41&SCX.4	Aluminium as Al - Total		30000 µg/L	11000 µg/L	75000 µg/L	2600 µg/L	8700 µg/L	1800 µg/L	140000 µg/L
	Iron as Fe - Total		120000 µg/L	2700 µg/L	310000 µg/L	990 µg/L	2400 µg/L	1200 µg/L	55000 µg/L

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	Sample Reference	J-0801-278-08 -GW9	J-0801-278-09 -GW10	J-0801-278-10 -GW11	J-0801-278-11 -SW5	J-0801-278-12 -SW6	J-0801-278-13 Water Sample 11
	Sample Point	Water Sample 08	Water Sample 09	Water Sample 12	Water Sample 13	Water Sample 10	Water Sample 11
	Date Collected	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008
	Date Received	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008
	Date Testing Completed	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008
WC205.	Alkalinity - Total as CaCO3	50 mg/L	< 2.0 mg/L	< 2.0 mg/L	46 mg/L	45 mg/L	35 mg/L
WC220.4	Chloride as Cl	970 mg/L	28 mg/L	19 mg/L	1100 mg/L	1000 mg/L	250 mg/L
WC250.232	Nitrite + Nitrate as N				0.02 mg/L	< 0.01 mg/L	
WC250.54	Total Kjel. Nitrogen as N				0.66 mg/L	0.74 mg/L	
WC250.65_WC	Total Nitrogen as N	1.1 mg/L	4.7 mg/L	3.3 mg/L	0.68 mg/L	0.75 mg/L	

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	Sample Reference	J-0801-278-08 -GW9	J-0801-278-09 -GW10	J-0801-278-10 -GW11	J-0801-278-11 -SW5	J-0801-278-12 -SW6	J-0801-278-13 Water Sample 11
	Sample Point	Water Sample 08	Water Sample 09	Water Sample 12	Water Sample 13	Water Sample 10	Water Sample 11
	Date Collected	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008	17/01/2008
	Date Received	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008	18/01/2008
	Date Testing Completed	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008	29/01/2008
WC250.65_WC	Total Phosphorus as P	0.26 mg/L	0.73 mg/L	1.0 mg/L	0.19 mg/L	0.20 mg/L	
WC270.113	Orthophosphate as P	0.025 mg/L	0.12 mg/L	0.046 mg/L	0.034 mg/L	0.035 mg/L	
WC280.4	Sulphate as SO4	100 mg/L	5.1 mg/L	2.7 mg/L	140 mg/L	140 mg/L	35 mg/L
WCX.4 41&SCX.4	Aluminium as Al - Total	9300 µg/L	18000 µg/L	7800 µg/L	590 µg/L	1300 µg/L	
	Iron as Fe - Total	6900 µg/L	7000 µg/L	2000 µg/L	2300 µg/L	2400 µg/L	

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...Helping you make good clean water.

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Client Order No.:

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Chemical Analytical Results

Notes:

Samples are disposed of 14 days after completion of testing.
Results reported on an 'as received' basis

Authorised for release: _____

Date: 29/01/2008

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agricultural and environmental scientists

In Situ & In House
Water Quality Analysis

Job: Cobaki Lakes **Job No:** GJ0640	**Date:** 31/01/08	**Time sampled:** PM	**Weather Conditions:** Overcast, periods of rain
Extra details: **Tides:** 0300 – 1.16 0915 – 0.61 1419 – 0.89 2029 – 0.37 (Source: BOM GC Seaway Tides)		**Sampled by:** MH DC	**Recent rainfall info:** 27.01.08 – 0.2mm 28.01.08 – 0.0mm 29.01.08 – 0.0mm 30.01.08 – 0.8mm 31.01.08 – 1.2mm (Source: BOM Coolangatta alert)

Site	Depth (m)	Monument height	EC uS/cm	Turb. NTU	pH	Temp °C	DO ppm
GW1	1.0						
GW2	Destroyed						
GW3	1.29						
GW4	1.30						
GW5	1.84						
GW6	1.00						
GW7	1.47						
GW8	1.74						
GW9	0.9						
GW10	1.45						
GW11	1.39						

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agricultural and environmental scientists

In Situ & In House
Water Quality Analysis

Job: Cobaki Lakes **Job No:** GJ0640	**Date:** 25.02.08	**Time sampled:** AM - PM	**Weather Conditions:** Overcast
Extra details: **Tides:** (Gold coast seaway) 0430 – 0.28 1040 – 1.30 1646 – 0.20 2315 – 1.29 (Source: BOM)		**Sampled by:** MH DC	**Recent rainfall info:** (Coolangatta alert) 25.02.08 – 0mm 24.02.08 – 0mm 23.02.08 – 0mm 22.02.08 – 0mm 21.02.08 – 1mm (Source: BOM)

Site	Depth	Monument height	EC uS/cm	Turb. NTU	pH	Temp °C	DO ppm
GW1	0.91		6810	150	7.65	27.0	1.96
GW2							
GW3	1.15		167	>400	5.02	26.3	4.01
GW4	1.10		11840	>400	6.25	24.7	4.88
GW5	1.73		190	>400	3.10	26.3	4.14
GW6	0.90		390	150	5.31	25.6	2.49
GW7	1.12		527	>400	4.45	25.9	3.96
GW8	1.65		888	>400	5.93	25.8	2.56
GW9	0.81		3190	>400	6.82	24.5	4.47
GW10			372	>400	4.91	26.3	3.91
GW11	1.33		131	>400	3.37	26.3	4.71
SW5			23910	40	8.30	27.2	6.67
SW6			17570	40	7.02	27.8	5.73
SW8			7440	30	8.14	27.4	6.16

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HAMILTON, QLD 4007

Client Order No.:

Batch Reference No.: J-0802-326

Job Description: GJ0640

Ph: 07 5578 9944

Fax: 07 5578 9945

Chemical Analytical Results

	Sample Reference	LJ-0802-326-01 -GJ0640 GW1	LJ-0802-326-02 -GJ0640 GW3	LJ-0802-326-03 -GJ0640 GW4	LJ-0802-326-04 -GJ0640 GW5	LJ-0802-326-05 -GJ0640 GW6	LJ-0802-326-06 -GJ0640 GW7	LJ-0802-326-07 -GJ0640 GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
	Date Collected	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008
	Date Received	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008
	Date Testing Completed	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008
WC205.	Alkalinity - Total as CaCO3	250 mg/L	< 5.0 mg/L	< 5.0 mg/L	< 5.0 mg/L	85 mg/L	< 5.0 mg/L	39 mg/L
WC220.4	Chloride as Cl	1400 mg/L	32 mg/L	1700 mg/L	28 mg/L	62 mg/L	86 mg/L	150 mg/L
WC250.65_WC 270.312	Total Nitrogen as N	3.0 mg/L	4.9 mg/L	4.8 mg/L	0.17 mg/L	1.9 mg/L	0.38 mg/L	1.3 mg/L
	Total Phosphorus as P	0.12 mg/L	0.25 mg/L	0.10 mg/L	0.32 mg/L	0.19 mg/L	0.45 mg/L	0.31 mg/L
WC270.113	Orthophosphate as P	0.010 mg/L	0.079 mg/L	0.024 mg/L	0.059 mg/L	0.016 mg/L	0.15 mg/L	0.020 mg/L

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Chemical Analytical Results

	Sample Reference	LJ-0802-326-01 -GJ0640 GW1	LJ-0802-326-02 -GJ0640 GW3	LJ-0802-326-03 -GJ0640 GW4	LJ-0802-326-04 -GJ0640 GW5	LJ-0802-326-05 -GJ0640 GW6	LJ-0802-326-06 -GJ0640 GW7	LJ-0802-326-07 -GJ0640 GW8
	Sample Point	Water Sample 01	Water Sample 02	Water Sample 03	Water Sample 04	Water Sample 05	Water Sample 06	Water Sample 07
	Date Collected	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008
	Date Received	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008
	Date Testing Completed	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008
WC280.4	Sulphate as SO4	110 mg/L	2.9 mg/L	2800 mg/L	1.5 mg/L	8.6 mg/L	17 mg/L	78 mg/L
WCX.4 41&SCX.4	Aluminium as Al - Total	68000 µg/L	26000 µg/L	110000 µg/L	18000 µg/L	11000 µg/L	15000 µg/L	160000 µg/L
	Iron as Fe - Total	180000 µg/L	9300 µg/L	320000 µg/L	7200 µg/L	6500 µg/L	13000 µg/L	25000 µg/L

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Job Description: GJ0640

Ph: 07 5578 9944

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Chemical Analytical Results

	Sample Reference	J-0802-326-11 -SW 5	J-0802-326-12 -SW6	J-0802-326-13 -SW8	LJ-0802-326-08 -GJ0640 GW9	LJ-0802-326-09 -GJ0640 GW10	LJ-0802-326-10 -GJ0640 GW11
	Sample Point	Water Sample 11	Water Sample 12	Water Sample 13	Water Sample 08	Water Sample 09	Water Sample 10
	Date Collected	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008
	Date Received	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008
	Date Testing Completed	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008
WC205.	Alkalinity - Total as CaCO3	64 mg/L	64 mg/L	41 mg/L	47 mg/L	< 5.0 mg/L	< 5.0 mg/L
WC220.4	Chloride as Cl	6000 mg/L	4100 mg/L	1600 mg/L	600 mg/L	24 mg/L	19 mg/L
WC250.232	Nitrite + Nitrate as N	< 0.01 mg/L	1.4 mg/L	0.08 mg/L			
WC250.54	Total Kjel. Nitrogen as N	0.56 mg/L	0.40 mg/L	0.42 mg/L			
WC250.65_WC	Total Nitrogen as N	0.57 mg/L	1.8 mg/L	0.50 mg/L	1.5 mg/L	5.0 mg/L	4.8 mg/L

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Chemical Analytical Results

	Sample Reference	J-0802-326-11 -SW 5	J-0802-326-12 -SW6	J-0802-326-13 -SW8	LJ-0802-326-08 -GJ0640 GW9	LJ-0802-326-09 -GJ0640 GW10	LJ-0802-326-10 -GJ0640 GW11
	Sample Point	Water Sample 11	Water Sample 12	Water Sample 13	Water Sample 08	Water Sample 09	Water Sample 10
	Date Collected	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008	25/02/2008
	Date Received	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008	26/02/2008
	Date Testing Completed	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008	7/03/2008
WC250.65_WC	Total Phosphorus as P	0.15 mg/L	0.15 mg/L	0.18 mg/L	0.21 mg/L	0.31 mg/L	0.21 mg/L
WC270.113	Orthophosphate as P	0.011 mg/L	0.013 mg/L	0.019 mg/L	0.010 mg/L	0.072 mg/L	0.029 mg/L
WC280.4	Sulphate as SO4	800 mg/L	560 mg/L	220 mg/L	71 mg/L	5.0 mg/L	3.6 mg/L
WCX.4 41&SCX.4	Aluminium as Al - Total	1200 µg/L	640 µg/L	800 µg/L	31000 µg/L	24000 µg/L	21000 µg/L
	Iron as Fe - Total	3000 µg/L	1600 µg/L	2200 µg/L	19000 µg/L	12000 µg/L	6100 µg/L

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Authorised for release: _____

Date: 7/03/2008

9) Attachment 1 – Groundwater Management Plan

GILBERT+SUTHERLAND
agriculture · water · environment

Groundwater Management Plan
Cobaki Lakes Concept Plan

Prepared for
Leda Manorstead Pty Ltd

April, 2008

Document control

Document:	**GJ0640_GWMP_RDC1F.doc**	Gilbert & Sutherland P/L ABN 56 077 310 840
Title:	**Groundwater Management Plan, Cobaki Lakes Concept Plan**	Originating Office: Robina
Project Manager:	C.Anderson	Eastside 5/232 Robina Town Centre Drive, Q4230 PO Box 4115, Robina Q4230 Telephone 07 5578 9944 Facsimile 07 5578 9945 gsrobina@bigpond.com
Author:	D.Carrick	
Client:	Leda Manorstead Pty Ltd	Also at Kawana and Brisbane
Client Contact:	Reg van Rij	
Client Reference:	**Cobaki Lakes GWMP**	
Synopsis:	This management plan establishes responsibilities and procedures for the management of groundwater during the construction and operational phases of the proposed development of Cobaki Lakes, Cobaki.	

Revision History

Revision #	Date	Edition By		Approved By	
1	11/04/08	D.Carrick		C.Anderson	L.Varcoe

Distribution

	Revision Number									
Distribution	1	2	3	4	5	6	7	8	9	10
LEDA Manorstead Pty Ltd	2									
G&S Library and file	2									

Summary

Gilbert & Sutherland (G&S) was commissioned by Leda Manorstead Pty Ltd to prepare an indicative Groundwater Assessment and Management Plan (GWMP) for the Cobaki Lakes Concept Plan. This GWMP provides initial, indicative management strategies and measures, however it is intended that this GWMP would be amended and expanded at the detailed design phase for each stage of development.

This document constitutes the Groundwater Management Plan and provides details of management measures proposed during the construction and operational phases of the development.

Table of contents

1) Groundwater management plan

The principal objective of this management plan is to provide mitigation measures to minimise the potential impacts of the development scenario.

Additionally, the management plan provides information on specific site management issues relating to potential environmental impacts from the development during the construction and operational phases.

The control measures detailed in this management plan have been developed to minimise impacts on the environment and achieve the following objectives:

- Appropriate stewardship of natural resources,
- Protection of downstream flora and fauna habitats,
- Confirmation of the success of impact control measures by the means of monitoring during the construction of each stage,
- Compliance with statutory requirements, and
- Preservation of the existing groundwater conditions.

1.1 Implementation

This management plan requires the Developer to mitigate the potential environmental impacts associated with the lake construction works.

It is intended that the management plan will provide a set of performance criteria and guiding principles with which the engineering designs for the development will comply. The plans and specifications forming part of the construction contract for each stage should also include these performance criteria.

1.2 Management plan structure

This management plan acknowledges the environmental impacts associated with the development and provides strategies to mitigate them.

Each control strategy is based upon proven environmental management methods and is presented as a commitment. The commitments made within this document will form the basis of future assessments, which will be made available to Tweed Shire Council for review.

The management plan is based on a series of tables for both the construction and operational phases of the development. The person responsible for the implementation of the measures detailed is written on the table itself. The tables then detail the issue, the performance criteria, the implementation strategy, monitoring, auditing, reporting, failure identification and the corrective action. The detachable pages within each section detail the provisions of the Groundwater Management Plan. The format is presented below for reference purposes.

#.# Title

Person responsible	This is the person who has accepted the responsibility of implementing the GWMP provisions detailed on this page

Issue	The Issue with which the table deals
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies or tasks (to nominated operational design standards) that will be implemented to achieve the performance criteria
Monitoring	The monitoring requirements which will measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements, which will verify implementation of, agreed construction and operation phase environmental management strategies and compliance with agreed performance criteria.
Reporting	Content, timing and responsibility for reporting and auditing of monitoring results.
Identification of incident or failure	The circumstances under which the agreed performance criteria are unlikely to be met and environmental harm is likely to result.
Corrective Action	The action to be implemented in case a performance requirement is not reached and the company(s) responsible for action.

An objective of the tabular format is to allow for change and allow the management plan to be a working document. If items need altering, changes may be made (after the appropriate consultation with the statutory authorities) to the individual tables.

1.2.1 General commitments

Commitment 1
The Proponents undertake to comply with the environmental implementation strategy as contained within the approved Management Plan on a stage by stage basis.

Commitment 2
The Proponents undertake to fulfil all commitments made in this management plan and to carry out their activities on the project site in accordance with relevant current statutory requirements and approved amendments.

1.2.2 Definitions

In this management plan the terms have the following meanings:

- **Management plan** means the approved Groundwater Management Plan and includes any amendments that may be approved from time to time.
- **Development** means the development of the site including lake construction.
- **TSC** means Tweed Shire Council .
- **Proponent** means the person undertaken the development of the land and includes the person nominated by the Proponent as having the responsibility for implementing the provisions of the management plan.
- **ESCP** means erosion sediment and control plan.

1.3 Management of potential impacts – background and construction phase

The management plan requires the Proponent to mitigate the potential environmental impacts associated with the Cobaki Lakes Concept Plan. It is anticipated that as each stage of the detailed design is completed, similarly detailed groundwater assessments will be completed for each stage.

Groundwater at the site should be assessed before and during the construction phase and care should be taken when treating and disposing of any dewatered groundwater associated with the works. Treatment would be required prior to disposal into recharge trenches or into existing surface water bodies.

The following detachable pages detail the provisions of this management plan for the construction phase.

1.3.1 Background groundwater monitoring

Person responsible	Proponent

Issue	To determine the existing groundwater conditions at the site (levels and quality) and examine any seasonal variations that may result from increased precipitation. This would serve as 'baseline' data and allow comparison with groundwater level and quality results recorded during the construction and operational phase of works at the site.
Operational policy	To manage site earthworks so that any potential impacts on the current groundwater regime (including levels and quality) are minimised.
Performance criteria	Groundwater level monitoring is to be undertaken on a monthly basis prior to construction works at the subject site. Groundwater quality monitoring will be undertaken monthly in accordance with the Murray-Darling Basin Groundwater Quality Sampling Guidelines (1997) for the following parameters: • pH (field measurement) • EC (field measurement) • Dissolved oxygen (field measurement) • Temperature (field measurement) Laboratory analysis for the following parameters should also be performed (as per the Acid Sulfate Soils Management Advisory Committee (ASSMAC) Guideline): • Calcium • Magnesium • Total and dissolved iron • Dissolved manganese • Filtered aluminium • Bicarbonate • Carbonate • Chloride • Sulfate Laboratory analysis for total acidity (titratable) should also be undertaken on a monthly basis to determine the total potential acidity hazard that may be associated with groundwater at the site.
Implementation strategy	• Groundwater level monitoring is to be undertaken on a monthly basis from the established monitoring locations prior` to the commencement of construction. • Groundwater quality monitoring is to be undertaken on a monthly basis from the established monitoring locations prior to the commencement of construction, with analysis performed at a NATA accredited laboratory.
Monitoring	Background groundwater monitoring should be conducted at the monitoring locations for the parameters shown above.

Auditing	The consultant will audit the results and submit a background groundwater quality report to Council prior to the commencement of construction works.
Reporting	A background report to TSC including raw data, a results summary and a discussion comparing results with ANZECC guidelines.

1.3.2 Construction phase monitoring of groundwater seepage

Person responsible	Contractor's Site Manager, Environmental Consultant

Issue	Management of groundwater seepage quality entering excavation areas.
Operational policy	To minimise and manage the generation of acidic waters entering the on-site excavation areas through seepage. To provide for monitoring and treatment of these waters prior to disposal.
Performance criteria	Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering. All waters discharged from the excavation areas to the recharge trenches during the construction phase should comply with the following criteria:

Water Quality Parameter	Release Criteria	Criteria Type
pH	6.5 – 8.5	Range
DO	Set by background	Range
EC	Set by background	Range
Oil & Grease	None visible	Maximum

Where the discharge of dewatered groundwater to on-site or nearby drains and waterways is intended, water quality will need to satisfy these performance criteria. Monitoring of these waters will be undertaken by the environmental consultant on a monthly basis.

Laboratory analysis for the following parameters should also be performed in accordance with the Acid Sulfate Soils Management Advisory Committee (ASSMAC) Guideline if the pH <6.5.

- Bicarbonate
- Calcium
- Carbonate
- Chloride
- Colour
- Dissolved magnesium
- Filtered aluminium
- Magnesium
- Sulfate
- Total and dissolved iron
-

Implementation strategy	1. The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least). 2. Dewatered groundwater will undergo appropriate treatment to ensure compliance with the above criteria prior to release into recharge trenches. Where disposal to surface water bodies is intended monitoring will be undertaken in accordance with the performance criteria. 3. Records of the measured pH, time of monitoring, calibration records and treatment measures employed are to be kept on site for inspection by the environmental consultant and TSC. 4. The total acid risk of seepage waters shall be determined from the total acidity (titratable) results measured during the background monitoring program. These results will be considered during the preparation of a treatment program for any dewatered acidic groundwater. 5. Outside the construction area of each stage existing surface water conditions shall be maintained.

	6. If acidic seepage waters are encountered, the batter slopes of the excavation face should be subjected to blanket liming as required at the predetermined rate (See ASMP provisions). 7. The addition of liquid lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate. 8. Where recharge trenches are required, the base and sides of the trench should also be blanket limed at a predetermined rate prior to the disposal of dewatered groundwater.
Monitoring	• Carry out daily pH monitoring of seepage waters entering excavations during the construction phase prior to disposal into recharge trenches. • Where disposal to surface water bodies is intended, monitoring will be undertaken by the environmental consultant in accordance with the performance criteria.
Auditing	• A visual inspection of the contractors monitoring and treatment records would be undertaken to verify sufficient monitoring and treatment is being undertaken. • Management to audit water quality results quarterly to verify that discharges comply with the performance criteria.
Reporting	A record of all monitoring results and treatment procedures is to be kept on-site and made available for review at all times. A monthly report collating and detailing all monitoring results and treatment procedures is to be provided and made available for review by TSC and EPA on request.
Identification of incident or failure	• Degradation of groundwater quality at the monitoring points to below the 'Performance Criteria' levels (to be derived following baseline monitoring). • Apparent visual changes in surface water conditions. • Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	• Locate the source of the contaminant/level variations. • Take all possible actions to contain and control the contaminant/level variations. • Investigate the cause of the contamination/level variations in consultation with the environmental consultant and take action to remediate the cause and prevent a recurrence in accordance with the consultant's recommendations. • Undertake increased monitoring until the recorded value/s meets the performance criteria.

1.3.3 Construction phase groundwater monitoring

Person Responsible	Contractor's Site Manager, Environmental Consultant

Issue	Groundwater monitoring
Operational policy	To establish stable groundwater conditions and verify that development management is appropriate.
Performance criteria	Water quality objectives for the construction phase of works will be derived from the 20th and 80th percentiles of background water quality data as outlined in the ANZECC (2000) guidelines; these would incorporate seasonal variations in levels and quality. These proposed objectives would be submitted to TSC for review and approval prior to implementation.
Implementation strategy	Monitoring of groundwater monitoring (levels and quality) levels should be undertaken monthly at each location during the construction phase to determine any effect the site activities may have on groundwater levels.
Monitoring	Carry out monthly groundwater level and quality monitoring at the specified locations.
Auditing	The environmental consultant is to audit water quality to ensure that no deleterious effects are resulting from the site actitives.
Reporting of Monitoring Results	• Quarterly reports are to be submitted to TSC • Reports to include raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines. • Result sheets to be compiled for monitoring results. All results to be kept on site for inspection by local and state government officers at all times. • In the event of actual or potential environmental harm, the statutory authorities shall be notified.
Identification of incident or failure	• Degradation of groundwater quality at the monitoring points to below the 'Performance Criteria' levels (to be derived following baseline monitoring). • Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	Locate the source of the contaminant/level variations. Take all possible actions to contain and control the contaminant/level variations. Investigate the cause of the contamination/level variations in consultation with the environmental consultant and take action to remediate the cause and prevent a recurrence in accordance with the consultant's recommendations.

1.3.4 Construction phase erosion control

Person Responsible	Contractor's Site Manager, Consulting Engineer

Issue	Erosion control
Operational policy	To prevent the displacement of sediment and soil across and offsite during storm events.
Performance criteria	Offsite discharges to comply with requirements for suspended sediments as detailed in Table 1.3.6. No visual indication of erosion on stages under construction, including evidence of rilling (an indicator of sheet erosion).
Implementation strategy	Erosion and sediment control devices shall be installed prior to the start of work in each stage in accordance with the approved ESCP Drawings. All erosion and sediment control measures shall be maintained until the completion of the stage to ensure water in the active construction area is adequately treated prior to being discharged into completed areas. No site disturbance shall commence until the appropriate approvals have been obtained. Where possible, the construction program shall be scheduled to minimise the potential for soil loss to occur. Where construction activities cannot be altered, additional controls shall be implemented in the areas of high erosion potential. Runoff and erosion controls shall be installed prior to clearing and include: • Diversion of upslope runoff around cleared and/or disturbed areas in a way that minimises erosion, minimises the upslope catchment and diverts waters to a legal point of discharge. • Sediment control fences or other measures at the downslope perimeter of cleared and/or disturbed areas. • Maintenance of all erosion control measures at operational capacity until land is effectively rehabilitated. Temporary erosion measures are to be employed onsite during construction where reasonably deemed necessary by TSC from an assessment of slope and soil type. Such measures shall be maintained at, or above, their design capacity. Such measures should be in accordance with the recommendations in the Blue Book (Landcom, 2004. Managing Urban Stormwater: Soils and Construction). On stages where more than 1,000m^2 are to be disturbed, runoff controls are also to include: • the use of barrier fencing; • the utilisation of exclusions zones; and • minimising slope lengths of disturbed, uncontrolled areas. Stripped topsoil shall be separated from subsoil materials and shall only be stripped from the areas designated on the appropriate plans.

	Stockpiled soil should be stored taking into account the following considerations: • Stockpiles are not to be located on public footpaths, nature strips, roads, road shoulders or any other public land; • They will be located at least 2m away from any hazard areas; • They will be protected from upslope surface flows; and • Downslope sediment filters will be provided. Excess spoil may be retained onsite provided the stockpile area is prepared by stripping topsoil from beneath the fill site for further use in revegetation. Outside the construction area of each stage, existing surface water conditions should be maintained wherever possible. All stockpiles, including preload, should be seeded within a fortnight of final forming with an appropriate mix.
Monitoring	Regular site inspections shall be undertaken to monitor the effectiveness of sediment and erosion controls. A site inspection and monitoring program shall include: • weekly site inspections; • inspections immediately following rainfall events that cause runoff; and • inspections immediately before site closure. Surface water quality to be monitored during rainfall events in accordance with Table 1.3.6.
Auditing	Regular site inspections shall be carried out in accordance with the above monitoring requirements. Additional visual inspections to be carried out weekly and after rainfall events to verify that control measures are in place and properly maintained.
Reporting of Monitoring Results	Signed site inspection records, original test results, weekly and other result sheets shall be kept on site and made available on request to TSC officers and other relevant statutory authorities.
Identification of incident or failure	Signs of erosion on site. Damaged or failed erosion control devices. Decline in water quality as identified by environmental consultant.
Corrective action	Apply remedial measures to improve sediment and erosion control including the incorporation of additional measures, including but not limited to hay bales, silt fences and flocculation of water quality control ponds. Should additional measures prove unsuccessful, consultation with an environmental consultant and/or construction site erosion and sedimentation control specialist.

1.3.5 Construction phase sediment control

Person Responsible	Contractor's Site Manager, Consulting Engineer

Issue	Sediment control
Operational policy	To prevent the displacement of sediment and soil across and offsite during storm events.
Performance criteria	Offsite discharges to comply with requirements for suspended sediments as detailed in Table 1.3.6.
Implementation strategy	All sediment control measures and facilities must be installed and stabilised in accordance with the approved ESCP Drawings prior to the start of construction activities. No site disturbance shall commence until the appropriate approvals have been obtained. In accordance with Table 1.3.4, temporary erosion measures (e.g. silt fences) are to be employed onsite during construction where reasonably deemed necessary by TSC from an assessment of slope and soil type. Such measures should be in accordance with the recommendations in the Blue Book (Landcom, 2004. Managing Urban Stormwater: Soils and Construction). Silt fence geotextiles are to be replaced when damaged or permanently blocked. Level markers shall be installed within all sediment ponds. Sediment shall be cleaned out of sediment ponds when accumulated sediment volume reaches 70%. Removed materials must be disposed of in a manner that does not cause pollution. Where practical, surface waters from undisturbed lands shall be diverted away from construction areas. When sediment controls are required outside the construction site: • where increased stormwater runoff is likely to accelerate erosion of any downstream watercourse, the necessary remedial work shall be undertaken; • all immediate downstream drainage inlets shall have appropriate controls installed in accordance with the approved engineering drawings; • all disturbed areas on other property are to be reinstated to the original condition; and Outside the construction area of each stage, existing surface water conditions to be maintained wherever possible.
Monitoring	Regular site inspections shall be undertaken to monitor the effectiveness of sediment and erosion controls. A site inspection and monitoring program shall include: • weekly site inspections; • inspections immediately following rainfall events that cause runoff;

	and • inspections immediately before site closure. Surface water quality to be monitored during rainfall events in accordance with Table 1.3.6.
Auditing	Regular site inspections shall be carried out in accordance with the above monitoring requirements. Additional visual inspections to be carried out monthly and after rainfall events to verify that control measures are in place and properly maintained.
Reporting of Monitoring Results	Signed, site inspection records, original test results, weekly and other result sheets shall be kept on site and made available on request to TSC officers and other relevant statutory authorities.
Identification of incident or failure	1. Falling water quality as identified by environmental consultant. 2. Build-up of sediment.
Corrective action	Apply remedial measures to improve sediment and erosion control including the incorporation of additional measures, including but not limited to, silt fences and flocculation of water quality control ponds. Should additional measures prove unsuccessful, consultation with an environmental consultant and/or construction site erosion and sedimentation control specialist.

1.3.6 Construction phase surface water monitoring

Person Responsible	Contractor's Site Manager, Consulting Engineer

Issue	Surface water controls.
Operational policy	To establish background water quality conditions and maintain these conditions wherever practicable during the construction phase.
Performance criteria	Water quality objectives for the construction phase of works will be derived from the 20th and 80th percentiles of background water quality data as outlined in the ANZECC (2000) guidelines; these would incorporate seasonal variations in levels and quality. These proposed objectives would be submitted to TSC for review and approval prior to implementation.
Implementation strategy	• Stormwater control will be achieved by directing as much runoff as practicable to the water quality control areas as shown on the approved plans. • Monthly and during rainfall events (defined as >25mm in any 24 hour period) samples are to be collected from the upstream sampling location, downstream sampling location and water quality control pond discharge point and analysed at a NATA registered laboratory for the above parameters. • Where sediment problems are identified, settling in the water quality control ponds shall be aided by dosing with flocculation agents. • During disturbance of the site, surface water runoff shall be directed to a suitability sized sedimentation pond.
Monitoring	Surface water monitoring will be conducted within the onsite drains, up and down gradient of the site. Monitoring for pH, electrical conductivity, suspended solids, turbidity, dissolved oxygen, litter and gross pollutants and oil and grease will be conducted monthly and during rainfall events. Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at predetermined monitoring locations upgradient and downgradient of the site. If iron floc, sediments or iron staining are observed at the discharge points, samples should also be taken for laboratory analysis and discharge halted until water has been treated to adequate levels. Iron indicator strips will be used if practicable. Sample recovery and in-situ analysis will be performed by a NATA accredited sampler and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	Environmental consultant to audit water quality results to ensure all discharges comply with the performance criteria.
Reporting of Monitoring Results	Result sheets to be compiled for monitoring results relating to water quality of water bodies. These results to be kept onsite for inspection by local and state government officers.

	Monthly reports to be submitted to TSC until completion of works. These reports will be submitted to TSC within 30 working days upon receipt of the laboratory results. The water quality reports will be prepared by a suitably qualified and experienced environmental consultant. These reports will detail: • the results for each of the environmental indicators monitored; • an assessment of the monitoring results against the release criteria; • an evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria; and • recommendations that are relevant to ensuring a high level of water quality is maintained. Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided.
Identification of incident or failure	The results of the water quality monitoring indicating concentrations exceeding the release limits specified in the "performance criteria" for a single water quality parameter.
Corrective action	All development activities taking place at the time of incident/failure shall be reviewed to verify compliance and, if necessary, construction methods and procedures shall be adjusted. Specific strategies to be implemented are as follows: <u>pH</u> In the event that the pH of waters falls outside the target range, such waters will be contained and the pH adjusted to within the target range prior to release. The treatment of waters shall involve the use of hydrated lime mixed into a slurry and pumped and mixed over the surface of the sedimentation pond. Monitoring of the pH level shall be carried out immediately prior to release. Rainfall data will also be assessed at such times to determine the impact that rainfall has had on the water quality of the site and discharging waters. <u>Suspended solids and turbidity</u> If total suspended solids exceed the site specific target the waters will be contained onsite for a period sufficient to allow suspended solids to settle out prior to release, or treated with a flocculent. After gypsum has been applied, the stored waters will be retested immediately prior to discharge. Erosion control devices will be immediately inspected and cleaned if necessary. Additional devices will be installed if a need is detected to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas will be reviewed with regard to the sediment and silt control provisions in Tables 1.3.4 and 1.3.5. <u>Dissolved oxygen</u> In the event that dissolved oxygen levels drop below the site specific

	target, the waters will not be released until visual inspections for algae have been carried out. If algae is present, further laboratory tests will be carried out to determine the type of algae in the waters. A general investigation will be carried out of the flow conditions of the affected waters, to assess the flow rates and volume of water passing through the monitoring locations. <u>Litter and gross pollutants</u> In the event that litter and gross pollutants with a dimension greater than 5mm are observed, this material will be cleaned up and appropriately disposed of as soon as practicable. The contractor shall inform staff of the appropriate waste disposal procedures.

1.4 Management of potential impacts – operational phase

1.4.1 Intent

This part of the management plan specifies those matters which must be complied with by the Proponent during the operational phase being the period after construction works for the 'on maintenance' period.

1.4.2 Operational phase groundwater monitoring

Person Responsible	Contractor's Site Manager, Environmental Consultant

Issue	Groundwater monitoring
Operational policy	To establish stable groundwater conditions and verify that development management is appropriate.
Performance criteria	Performance criteria/trigger levels for the 'Operational' phase shall reflect those established for the Construction Phase monitoring period. Groundwater levels and quality will reflect background levels at the completion of the 'Operational' period.
Implementation strategy	• Monitoring of groundwater levels should be undertaken during the operational phase to determine the response of groundwater levels to development. • Groundwater quality and level sampling will be undertaken until acceptable water quality criteria have been established.
Monitoring	• Carry out groundwater level and quality monitoring quarterly at the locations specified. • To revert to construction phase provisions if problems are identified. • These provisions will conclude at the end of the 'Operational' period unless monitoring indicates quality and/or groundwater levels outside acceptable criteria.
Auditing	The environmental consultant is to audit water quality to ensure that no deleterious effects are resulting from the excavation and dewatering operations at the site.
Reporting of Monitoring Results	• Quarterly reports to TSC including raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines. • Result sheets to be compiled for monitoring results. All results to be kept on site for inspection by local and state government officers at all times. • In the event of actual or potential environmental harm, the statutory authorities shall be notified.
Identification of incident or failure	• Degradation of groundwater quality at the monitoring points to below the 'Performance Criteria' levels (to be derived following baseline monitoring). • Apparent visual changes in surface water conditions. • Variations in groundwater levels beyond typical seasonal fluctuations.

Corrective action	• Locate the source of the contaminant/level variations. • Take all possible actions to contain and control the contaminant/level variations. • Investigate the cause of the contamination/level variations in consultation with the environmental consultant and take action to remediate the cause and prevent a recurrence in accordance with the consultant's recommendations. • Undertake increased monitoring until the recorded value/s meets the performance criteria.