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Soil Survey, Geotechnical Review Acid Sulfate Soils Assessment and Management Plan Cobaki Lakes Concept Plan

Prepared for
Leda Manorstead Pty Ltd

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Document control

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Synopsis:	This report provides a review of soil survey and geotechnical information and describes the methodology, management and results of an acid sulfate soil assessment for Cobaki Lakes. The report addresses in part the Environmental Assessment Requirements specified by the Director General of the NSW Department of Planning (DGRs) for the Cobaki Lakes Concept Plan.	

Revision History

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Summary

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.

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.

For the purpose of the concept plan, the level of geotechnical investigation already undertaken was considered appropriate. Detailed geotechnical investigations would be undertaken across the site in support of a detailed design and on a stage-by-stage basis at the time of building applications, however no geotechnical constraints have been identified that would preclude development as proposed by the concept plan.

The Acid Sulfate Soils Assessment (ASSA) was undertaken in accordance with the Acid Sulfate Soil Management Advisory Committee (ASSMAC) guidelines. The report considers the whole Cobaki Lakes site. The materials encountered during the ASSA were identified as acid sulfate soils which would require management (i.e. lime application or neutralisation of acidic soils) during any proposed excavation works to reduce potential impacts to the surrounding environment. The material which would be excavated during the construction of the proposed lakes would be suitable for use as fill, following appropriate neutralisation of ASS.

An ASS Management Plan (ASSMP) has been prepared and is included herein. While the ASSMP specifically addresses those areas of the site that represent the greatest ASS risk, it is equally applicable to any part of the site where the Cobaki Lakes Concept Plan calls for excavation during the construction phases, or where ASS could cause problems during the operational phase of the development.

This report finds that the constraints associated with the presence of ASS do not constitute an impediment to development in accordance with the Concept Plan and can be effectively managed through the implementation of the ASSMP, which includes provisions for lime neutralisation of soils, validation testing and monitoring.

Table of contents

Glossary

AASS	Actual Acid Sulfate Soils. These soils are formed when the pyrite in Potential Acid Sulfate Soils oxidises to produce sulfuric acid.
ASSMP	Acid Sulfate Soils Management Plan.
ASS	Acid Sulfate Soils. This is the collective term for both Actual Acid Sulfate Soils and Potential Acid Sulfate soils.
CRS	Chromium Reducible Sulfur (CRS) is an analytical method which quantifies sulfur in an inorganic (i.e. pyritic) form. This method is a suitable test to determine whether the oxidisable sulfur is from organic material or if it is from pyrite, and therefore formed under estuarine conditions.
PASS	Potential Acid Sulfate Soils. These soils contain pyrite and are usually undisturbed. When these soils are exposed the pyrite oxidises to produce sulfuric acid.
ASSMAC	Acid Sulfate Soil Management Advisory Committee
TAA	Titratable Actual Acidity. TAA is a measure of a soil's acidity prior to the complete oxidation of sulfidic material, including both pyritic and organic acidity.
TPA	Titratable Potential Acidity. TPA is the titratable oxidisable acidity, calculated from the complete oxidation of the soil.
TSA	Titratable Sulfidic Acidity. TSA is a measure of the soil acidity resulting from sulfidic material. This is a general indicator of the acidity produced from pyritic material.

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 Director General of the Department of Planning issued Environmental Assessment Requirements (DGRs) for the Cobaki Lakes Concept Plan on March 5, 2007. This report addresses acid sulfate soils and geotechnical issues and appropriate management strategies to address those issues arising from the concept plan.

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. GJ0640.5.1.

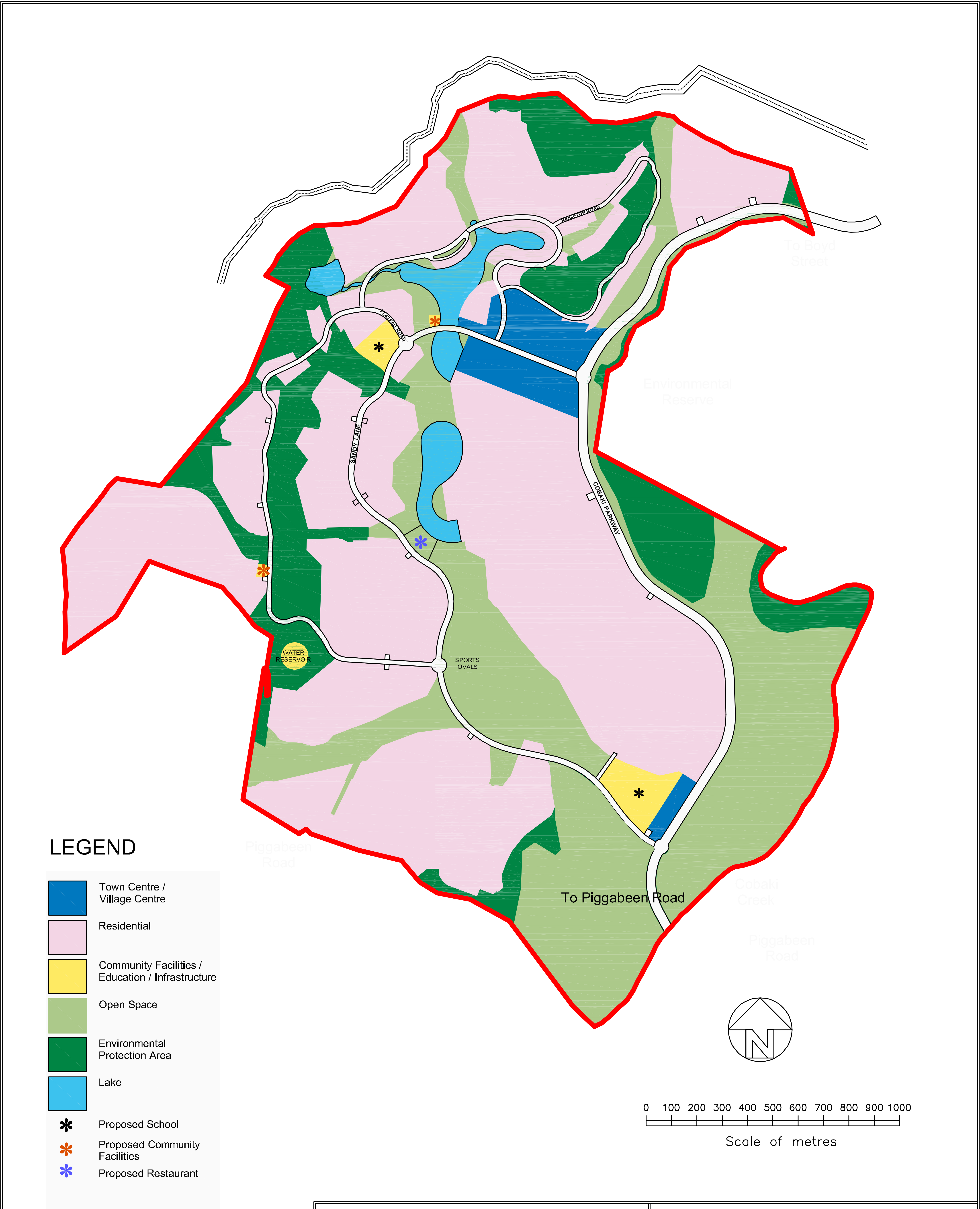
1.2 Previous investigations

Four (4) previous soil survey, geotechnical and acid sulfate related investigations have been undertaken to date on the Cobaki Lakes development site. These were:

- Golder Associates (February 1990) – Cobaki Community Development Geotechnical Investigation (89638236(N)).
- Golder Associates (October 1997) – Geotechnical Investigation, Cobaki Lakes – Marine Clay Investigation, Tweed Heads, NSW (97630024(D).
- Golder Associates (February 1991) – Cobaki Community Development, Acid Sulfate Soils, Preliminary Investigations (9069008(G)).
- Gilbert & Sutherland (May 1998) – Acid Sulfate Soil Assessment of Cobaki Lakes Estate, Cobaki (GJ9811-1.RH1.1).

The investigations are summarised in the following sections.

In addition to the above, four (4) additional geotechnical investigations were undertaken from 1974 to 1985. The most notable of these in terms of acid sulfate soils was the 1985 report by McDonald Wagner Pty Ltd which defined the boundary of very soft marine clay deposits. As these are discussed within the 1990 and 1997 Golder reports, they are not discussed further here.



Base Plan supplied by LEDA Manorstead Pty Ltd

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PROJECT
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COBAKI LAKES
CONCEPT PLAN

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2) Soil survey and geotechnical review

The DGR's require that specialist advice be provided with respect to geotechnical issues. A series of geotechnical and soil survey investigations were undertaken for the Cobaki Lakes site between 1974 and 1997.

This section provides a summary of the soil survey for the Cobaki Lakes site and relevant geotechnical information. A summary of these prior investigations is included below.

2.1 Soil Survey

Gilbert & Sutherland prepared a Soil Survey and Acid Sulfate Assessment for the entire Cobaki Lakes site in 1998. That report used soil data from 69 boreholes constructed across the site to determine the extent and spatial variability of the site's soils. The soil survey results are reproduced below.

2.1.1 Site description

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 most dominant feature of the site is the floodplain area extending north from Cobaki Creek and west of the central drain which bisects the low lying plains and the beach ridge area. A large portion of the floodplain area also extends to the east of the central drain and south of the beach ridge towards Cobaki Broadwater.

The floodplain area can be classed as supratidal and is subject to periodic inundation on spring tides, aided in part by its extremely low relief (0m AHD), its proximity to Cobaki Creek and the presence of the central drain. A network of surface drains is connected to the central drain which is fitted with a one-way flap valve where it joins Cobaki Creek. On spring tides however, the plain is still subject to inundation.

The areas of alluvial plain on the site extend west and north of the floodplain and are recognised by a slight increase in elevation towards the low hills to the north and west of the site.

2.1.2 Site slopes

The site slopes range from level (0%) in the floodplain and alluvial plain areas to moderately inclined (approximately 25%) in the low hills. The beach ridge plain, though elevated from the floodplain, is also essentially level.

2.1.3 Identification of site soils

Soils at the site were classified according to the Australian Soil Classification (Isbell, 1996) and are shown on figure 3.

A total of 5 main soil orders were identified at the site. These were:

- Hydrosols
- Podosols
- Kurosols
- Rudosols
- Organosols

A brief description of the characteristics of each soil order is given below (Isbell, 1996).

Hydrosols
These are soils that are inundated in the greater part of the profile for at least 2 to 3 months in most years.

Podosols
These are soils which possess either a Bs horizon (visible dominance of iron compounds), Bh horizon (organic-aluminium compounds) or Bhs horizon (organic-aluminium and iron compounds).

Organosols
These are soils with more than 0.4m of organic materials within the upper 0.8m of the profile.

Kurosols
These are soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2m of the B2 horizon is strongly acidic (pH 1:5 H^2O of <5.5).

Rudosols
These are soils with only rudimentary pedologic organisation.

2.1.4 Soil distribution

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

The majority of the soils occurring on the low lying floodplain areas were classed as Sulfidic Supratidal 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 back swamp 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 heath land. These soils consisted of an organic hemic peat to sapric/hemic peat layer of greater than 1m depth, with sand and silty clay horizons to the maximum 5m sampling depth in this area.

Kurosols and Rudosols, derived from weathered Neranleigh-Fernvale group metasediments, 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 A1 horizons with strong structure and 2-5mm sub angular blocky peds overlying yellowish brown light to heavy clay B2 horizons with weak to moderate structure and 5-10mm polyhedral to angular blocky peds.

The Rudosols were associated mainly with the ridge areas and consisted of very shallow silty loam A1 horizons overlying bedrock.

2.2 Geotechnical Constraints

2.2.1 Golder Associates (February 1990) Cobaki Community Development Geotechnical Investigation

Geotechnical constraints associated with the Cobaki Lakes Concept Plan site were initially identified by Golder Associates during a geotechnical investigation in February 1990.[1] That report delineates five (5) major geotechnical constraint categories on the site and a number of sub categories. Categories 1 to 4 describe the geotechnical constraints associated with the low lying areas of the site and are reproduced in Table 2.2.1 (over page). Category 5 (which is divided into four sub-categories) describes the geotechnical constraints associated with the hillside areas of the site, and is reproduced in Table 2.2.2 (over page).

Category 1 – Suitable for conventional development
Those parts of the Cobaki Lakes site described by Category 1 generally consist of relatively level ground, varying in elevation from RL2m to RL4m. Category 1 areas would be suitable for development in accordance with the Concept Plan. Any proposed structures that were unusually heavy or unusually movement sensitive would require pile foundations in areas underlain by organic material at depth.

Category 2 – Usable for conventional development
Category 2 areas are as described in Category 1 above with the addition of a surface veneer of high compressible peat and organic clay. Category 2 areas are considered usable for development in accordance with the Concept Plan following conventional development considerations such as improved local drainage and excavation of peat pockets with replacement of compacted fill.

Category 3 – Marginal conventional development
Category 3 areas are constrained for the purposes of conventional development however exhibit slightly better ground conditions than Category 4 (see below)

[1] Golder Associates (February 1990) – Cobaki Community Development Geotechnical Investigation (89638236(N)).

Table 2.2.1 Geotechnical constraint categories – low-lying areas (from Golder Associates, 1990)

Category	Description
1. Suitable (no treatment)	• High level footing suitable for houses and low rise development, without special design or treatment. • Sub grade CBR>=10% in sand, >4% in clay. • Excavated material would be of high quality for re-use on other parts, except high plasticity clays.
2. Usable (minimal treatment)	• High level footings suitable for houses and light commercial/industrial buildings with special design (e.g. stiff raft) or treatment (e.g. controlled filling or excavating shallow poor soils where appropriate, e.g. peat bogs). • Conventional building over two storeys will require special design, such as heavy stiff raft or pile foundation. • Sub grade CBR <5% unless filled by 1m+. • Excavated material would vary from soft to firm high plasticity clays to saturated clayey sand (good if dried).
3. Marginal (substantial treatment)	• High level footing systems unsuitable without special treatment. • Treatment for housing: Early filling, allowing several years of consolidation, or preloading for a typical period of 6-12 months. • Treatment for specially designed low-rise industrial commercial (e.g. raft or articulated): preloading as for houses. • High class structures: piles only – typical depths 10 to 15m. • Sub grade CBR <=2% unless area filled by 1m+. • Excavated material would vary from soft to firm high plasticity clays (poor) to saturated clayey sand (good if dried).
4. Difficult (not readily treated)	• Area underlain by deep, highly compressible alluvium. • Long term preloading or very early site filling required to permit housing with any shallow footing type. • Lighter commercial/industrial buildings as per houses. • High class structures require piling – typical depth 10 to 20m • Sub grade CBR <=1% unless area filled by 1m+. • Excavated material would vary from soft to very soft high plasticity clays (poor fill). Some saturated clayey sand (good if dried). • Fill would be difficult to separate into useable portions.

Table 2.2.2 Geotechnical constraint categories – hillside areas (from Golder Associates 1990)

Category	Description
5A.	• This zone generally comprises land of gentle colluvial and residual soil slopes of less than 10°. No natural stability problems exist apart from localised stream bank collapse.
5B	• The zone generally has convex moderate slopes between around 10-25°. There is expected to be considerable variation within this zone with some areas of Zone 5A (eg locally on ridge tops) and some areas of Zone 5C and 5D adjacent to gullies. A few natural instability areas would be expected at gullies or creek sides.
5C	• This zone generally would have concave moderate slopes between 10° to 25°. As such, it generally occurs in the areas dissected by streams and gullies and often has localised sections of Zone D within it (creek banks). This zone would be potentially subject to significant erosion and instability at the creek or gully sides.
5D	• This zone contains steep slopes generally greater than about 20°, identified as having potential general instability problems even when specially treated.

this could be specially treated to permit conventional development. Typical preparation required for Category 3 areas for the purposes of residential or light industrial/commercial development in accordance the Concept Plan would include either long term (2-3 years) compacted filling of the site, or accelerated consolidation by preloading (2-3 months). The site would then be suitable for development using normal designs such as stiffened raft-slabs or articulation.

Category 4 - Difficult conventional development
Areas of Cobaki Lakes classified as Category 4 are generally underlain by a variable depth of very soft, highly compressible alluvium, mainly very soft organic clay. Category 4 areas would require substantive preparation to render them suitable for residential or light industrial/commercial development in accordance with the Concept Plan. Such preparation would include either long term (2-3 years) compacted filling and preloading of the area, or the use of heavily stiffened raft-slab footings for light structures. In some cases where raft-slab footings are proposed, pre-treatment may not be required, provided overall structure settlement is acceptable. The use of deep foundations such as piles in Category 4 areas would also be acceptable.

Category 5 - Hillside areas
The Golders report divides Category 5 (hillside areas) into four sub-categories or 'zones' labelled 5A, 5B, 5C and 5D.

Development of Zone 5A would be expected to be straight forward, using normal planning, design and conventional construction techniques applicable to gently sloping or flat sites.

No major geotechnical problems exist in Zones 5B and 5C which would prohibit any well engineered development. The matters requiring engineering attention during the planning, design and construction phases in Zones 5B and 5C include maintenance of the overall stability of the zones and any local areas of potential instability. This would require special design of the zones if the area can not be avoided.

Preliminary investigations suggest that it would be prudent to adopt a policy of little or no general development of these steeply sloping areas (Zone 5D). Further detailed geotechnical investigations and planning of Zone 5D may allow suitable development so long as stable access could be provided to these sites.

The report is attached as Appendix 1.

2.2.2 Golder Associates (October 1997) Geotechnical Investigation, Cobaki Lakes – Marine Clay Investigation, Tweed Heads, NSW

Golder Associates Pty Ltd undertook a further geotechnical investigation of the site between May and August 1997 to define the extent of marine clay deposits in the area of the proposed central to the site.

Identification of site soils
Soil observations from 144 test pits at 58 locations with depths between 0.5 and 3.0m were combined with results from previous Golder Associates and other geotechnical studies to produce a plan showing the lateral extent of the marine clay deposits in the above area.

Golder Associates concluded that the extent of the marine clay around the perimeter of the study area is 'fairly irregular, with finger like deposits extending some distance up into foot hills, infilling old creek beds and local areas of lower topography'.

Test pits constructed in the 'Central Island' area of the site were dominated by the presence of sand deposits. However, the interface with marine clay was observed at several locations. A 'buried channel' of marine clay was identified to the south of the central island and previous studies had determined marine clay presence to the north of the island. The report concludes that more of these 'channels' may exist and that they might be connected.

Placement of fill across the areas containing layers of marine clay will induce consolidation settlement. The magnitude of this settlement can be estimated when proposed fill levels have been established. It may be possible to accept fill over thin layers of marine clay on residential allotments provided footings are designed to accommodate the anticipated settlement, e.g. as stiffened rafts. This would be a matter for detailed design at a later stage.

The report is attached as Appendix 2.

3) Acid Sulfate Soils Assessment

3.1 Background

A series of soil survey and acid sulfate soil investigations were undertaken for the Cobaki Lakes site between 1991and 1998.

The ASSMAC Guidelines advocate avoidance as the preferred management method for acid sulfate soils. This is because avoidance carries the least environmental risk. However, earthworks would be a necessary component of the works proposed for the site.

An investigation was therefore necessary to determine whether acid sulfate soils (ASS) were present and the best means of managing soil disturbance at the site. A summary of these prior investigations is included below.

3.2 Previous investigations

3.2.1 Golder Associates (February 1991) Cobaki Community Development, Acid Sulfate Soils, Preliminary Investigations

This assessment summarised the 1991 acid sulfate assessment (Stage 1 Preliminary Investigation) in addition to describing a (Stage 2) lime treatment trial initiated to investigate the feasibility of treatment by buffering with lime addition. The principal objectives of the investigations were to:

- undertake *an assessment of the feasibility of excavating lakes within low lying areas of the site where it was suspected that potential acid sulfate soils might occur, and the utilisation of such soils as fill in other site areas.*
- *enable a focus on planning strategies for remedial treatment or management of potential acid sulfate soils without detrimental impact upon the immediate and neighbouring environmental systems.*

Stage 1 Preliminary investigation
The Stage 1 preliminary investigation described in the report was undertaken as part of the 1991 geotechnical assessment by Golder Associates. This involved the construction of 24 test pits across the low lying areas of the site (below 1m AHD) and the subsequent testing of eight representative marine clay samples from four test pits.

The testing results revealed that seven of the eight samples tested were of 'high' acid sulfate potential with the remaining sample of 'low to moderate' acid sulfate potential. The report goes further in stating that six of the eight tested samples exhibited oxidisable sulfur in the range of 0.7 to 0.8% (dry soil).

Stage 2 Lime treatment testing/trial
This investigation was initiated to investigate the feasibility of the remedial practice of soil amelioration using lime addition.

A simple trial procedure was devised to simulate the expected field handling and placement procedures including the rate of lime required to buffer soil acidity resulting from complete pyrite oxidation.

Bulk samples from two locations within the above low lying areas were screened as per the Stage 1 Investigation and found to have an oxidisable sulphur content of 0.9%. A sub-sample of each was analysed for calcium carbonate while the remaining sample was divided into sub-samples and mixed with lime at rates from 5g/kg to 50g/kg. Change in pH was regularly monitored and oxidation was encouraged until the rate of pH change became extremely low.

Samples required a lime rate of between 5g and 20g/kg to maintain a soil pH of greater than 6.5.

The report concluded that lime treatment of acid sulfate soils was an effective method of controlling acidity.

The report is attached as Appendix 3.

3.2.2 Gilbert & Sutherland (May 1998) Acid Sulfate Soil Assessment of Cobaki Lakes Estate, Cobaki

This study involved the construction of 69 boreholes across the lower lying and beach ridge areas of the site utilising a vibro-core drill rig. The cores were constructed primarily at 200m centres.

A total of 247 samples were recovered from 69 cores and subsequently screened using the van Beers technique of rapid oxidation. Based on the screening results 167 samples were subjected to analysis using the full POCAS method.

Analytical results were graded into six categories according to level of oxidisable sulphur. These categories ranged from '1' (highest) to '6' (lowest).

The report identified the material with the highest acid sulfate potential as being located within the Holocene silty clays and sands of the flood plain areas. The lowest acid potential materials were found to be the beach ridge sands, alluvial plains and pre-transgressive and residual soils below the Holocene deposited sediments.

Category 1 materials were identified in the extreme south of the site to the east and west of the central drain, and adjacent to Cobaki Creek. These soils were generally characterised as marine silty clays and were found to extend to the maximum survey depth of 6.0m.

Materials recovered and analysed from the centre and north of the site were more variable and ranged from category 1 to 5. Category 1 materials were associated with narrow bands of silty marine clay while Category 2 to 5 materials were fine sands to medium marine deposited sands.

Category 6 materials were found on-site in the beach ridge sands to the east of the flood plain, soil of the alluvial plain and the pre-transgressive basement clays.

The assessment also included 3D modelling of ASS layers using the Quicksurf computer program. This assessment utilised the existing base plan, digital terrain model and detailed borelogs and ASS data to delineate the spatial and vertical extent of Category 1 to 6 materials on the site.

The report also included an Acid Sulfate Management Plan (ASMP) which detailed management measures for the identification and treatment of acid sulfate soils during the construction and operational phases of the development.

The report is attached as Appendix 4.

3.3 Acid sulfate soil implications for the Cobaki Lakes Concept Plan

The material identified as the highest risk was generally associated with low-lying areas within the open space areas at the south and the centre of the site. Minimal disturbance of these materials would occur under the Cobaki Lakes Concept Plan as the proposed lakes will essentially be constructed in a 'turkey nest' manner to minimise the excavation and exposure of ASS.

Drawing No. GJ0640.5.2 depicts areas of ASS identified in previous investigations overlaid on the Cobaki Lakes Concept Plan.

Where disturbance is necessary, the disturbed ASS can be adequately managed in accordance with the attached ASSMP.

Excavated ASS material would be placed on site in tracked lots and physically mixed with a neutralising agent such as fine agricultural lime. The treated material shall be utilised following appropriate validation testing in accordance with the ASSMAC guidelines.

No ASS constraints would preclude the development as proposed by the concept plan. With appropriate management exercised during the construction and operational phases of the development, no substantive off site impacts are anticipated.

4) Conclusions

4.1 Soil survey and geotechnical constraints

The previous investigations discussed above provide sufficient information for mapping of geotechnical constraints on the site. These geotechnical investigations have advised the layout of the concept plan.

For the purpose of the concept plan, the level of investigation already undertaken is considered appropriate. No geotechnical constraints have been identified that would preclude development as proposed by the concept plan.

Further detailed geotechnical investigations would be undertaken across the site in support of a detailed design. In addition, site specific, investigations would be undertaken on a site-by-site basis at the time of building applications.

4.2 ASSA

Multiple ASS investigations have been conducted at the Cobaki Lakes site to delineate the lateral extent and location of ASS.

The findings of previous studies confirm ASS material requiring varying degrees of treatment is present throughout the proposed areas of disturbance.

In summary, to date a total of 440 boreholes/test pits have been constructed across the Cobaki Lakes Concept Plan site (not including hand augered bores or penetrometer tests). Of these, a total of 93 were for acid sulfate delineation and testing purposes, with a further 237 for delineation purposes as part of the geotechnical investigations.
Of the 93 ASS bores/test pits constructed, a total of 257 samples were recovered for ASS testing, of which 177 samples were subject to detailed laboratory analysis.

As a result, likely areas of PASS have been spatially delineated and mapped on-site (Golder Associates 1997; Gilbert & Sutherland 1998).

Current NSW ASS guideline (NSW Acid Sulfate Soils Manual) requirements include testing of every 0.5m of soil depth profile and construction of boreholes at 50m centres along proposed linear disturbances.

Whilst, the assessments to date do not fully comply with these requirements, we consider the information is sufficient for purposes of a Concept Plan application.

The material identified as the highest risk was generally associated with low-lying areas dedicated as open space under the concept plan. Minimal disturbance of these materials would occur under the Cobaki Lakes Concept Plan.

Once detailed designs for the proposed lake area/s have been completed, further drilling could be undertaken to bring the number of boreholes and samples tested in line with the ASS guideline requirements. No ASS constraints would preclude the development as proposed by the concept plan. With appropriate management exercised during the construction and operational phases of the development, no substantive off site impacts are anticipated.

The constraints associated with the presence of ASS can be effectively managed through the implementation of the ASSMP attached as Appendix 5.