APPENDIX A

ASTORIA DEVELOPMENTS PTY LTD

PROPOSED SUBDIVISION

MCGREGOR AND GODLDING PROPERTIES, NORTH BOAMBEE

GEOTECHNICAL INVESTIGATION

N08502/01-AB

26 March 2003

clay profile. The clay profile itself appears to be 'tight' and of low overall permeability.

3.3 Geotechnical Units

On the basis of like geotechnical properties, slope angle and soil profile, the site has been divided into broad geotechnical units as outlined in Table 1, and illustrated on drawing N08502/01-4.

TABLE 1 – GEOTECHNICAL UNITS

UNIT	SOIL PROFILE*	SLOPE ANGLE	DRAINAGE
R_1	Residual	0° - 8°	Generally well drained, some moisture concentration in the base of ephemeral gullies.
R_2	Residual	8° - 14°	Well drained.
R_3	Residual	>14°	Well drained.
A	Alluvial	<5°	Generally poorly drained. Improved by man-made drains.
** - As described in Section 3.2.*			

4. SLOPE STABILITY ASSESSMENT

4.1 Basis of Assessment

The risk of slope instability has been assessed from the observed site conditions in accordance with the classification system formulated in Australian Geomechanics News, No 10, 1985 (See attached Table 2, Classification of Risk of Slope Instability for explanation of risk categories and implication for development).

The report provides an assessment of the risk of slope instability on the property. The report also recommends some geotechnical constraints for the site development in light of the assessed risk of slope instability. The onus is on the owner, potential owner, or interested party to decide whether the assessed level of risk is acceptable taking into account the likely economic consequences of the risk and the recommended geotechnical constraints.

This report should not be regarded as a site investigation report for the design of foundations, although general recommendations regarding foundation types have been made.

4.2 Evidence of Slope Instability

No evidence of overall slope instability was observed on the site at the time of the field work.

4.3 Assessed Risk of Slope Instability

Slope stability is controlled by slope angle, material strength, subsoil profile and surface and subsurface water concentration. On the basis of the above characteristics, the information regarding geotechnical units presented in Sections 3.1, 3.2 and Table 1, each of the geotechnical units has been assigned a level of risk of slope instability as shown in Table 3.

TABLE 3 – ASSESSED GEOTECHNICAL RISK OF SLOPE INSTABILITY

GEOTECHNICAL UNIT	ASSESSED INSTABILITY RISK CLASSIFICATION	COMMENT
R_1	Low	General constraints and recommendations of this report would apply.
R_2	Low	General constraints and recommendations of this report would apply.
R_3	Medium	Design residential development to accommodate slope. Minimise disturbance to slopes.
A	Very low	Design temporary and permanent batters in ponds or other improvements to accommodate geotechnical conditions.

4.4 Slope Stability Related Constraints on Development

Type of Structure:

There are no particular geotechnical constraints on the type of structures on Unit R_1 and Unit A terrain provided they are founded on footings designed and constructed in accordance with AS2870, Residential Slabs and Footings.

In Unit R_2 and R_3 areas, development should be designed to accommodate the natural slope profile.

Flexible structures of timber, brick veneer or similar construction preferred on these areas. Split level and suspended design is considered appropriate to limit slope modification.

Area for Development:

All of the site is considered feasible for development from a slope stability viewpoint.

Development should be undertaken in accordance with good hillside construction practice and sound engineering principles as presented in Table 4 and Figure 1 attached.

Foundation Type:

Strip / pad footings and raft slabs or pier and beam systems would be feasible from a slope stability viewpoint, although raft slabs are not suited to slopes steeper than 3H:1V, (ie Unit R_3) due to slope modifications required.

Foundations should be designed and constructed in accordance with the recommendations and advice of AS2870, Residential Slabs and Footings.

Many soils and weak rocks in the Coffs Harbour area soften appreciably on exposure to air and water and care should be taken to cast foundations onto undisturbed material. Concrete should be poured within twenty four hours of excavation or else a blinding layer of concrete should be used.

Excavation:

Excavations should preferably not exceed 1.5m in depth and should be supported by properly designed and constructed retaining walls or else battered at 1V: 2H or flatter and protected against erosion. Excavations in weathered rock below the level of drill rig refusal may be battered at 1V:1H.

Permanent or temporary excavations greater than 1.5m deep will require further detailed geotechnical assessment once the location and extent of such excavations are known. This assessment may involve:

- Borehole or test pits to below the depth of cut to assess material properties.
- Assessment of slope / retaining wall design parameters.
- Assessment of the need to provide temporary retention or special precautions during construction.
- Viewing of the excavation by a geotechnical engineer during bulk excavation.

Excavations should be designed for surcharge loading from slopes, retaining walls, structures and other improvements in the vicinity of the excavation

Exposed faces are likely to undergo rapid degradation or softening on exposure and batter protection or excavation retention measures should be implemented as soon as possible after exposure. An investigation by Coffey on the adjacent lot indicated wet fracture surfaces in test pits which indicate that rock fractures carry water and could therefore result in seepage into excavations, particularly on the footslopes of the larger hills. Adequate provision for drainage from the face of the excavations must therefore be provided to avoid build-up of water pressures behind the face of excavation.

Drainage measures should be implemented above and behind all temporary and permanent excavations to avoid concentrated water flows on the face of the cut or infiltration into the soil / rock profile behind the cut.

Filling:

The depth of unsupported fill on Unit R_2 and R_3 areas should not exceed 1.5m and should be battered at 1V:2H or flatter and protected against erosion. Fill batters greater than 1.5m high should be supported by an engineer designed retaining wall. Engineered site regrade or road embankment fills are not required to comply with this constraint if they are engineered for the specific conditions with appropriate geotechnical input.

Where fill is placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched or stepped into the natural slope.

Where site regrading is proposed, the following course of action should be taken:

- Strip existing topsoil, root affected material and deleterious material to spoil.
- Proof roll the exposed subgrade to highlight any soft, cohesive or excessively spongy areas which should be removed.
- Approved fill should be placed in layers not exceeding 300mm loose thickness and compacted to a minimum dry density ratio of 95% Standard (AS1289 5.1.1 or equivalent)
- Bench fill into the slopes profile if slopes are greater than 1V:8H (7°).

The expertise of the contractor, the nature of the fill material and the degree of supervision of the filling will determine the footing design required for any structures placed on the fill constructed in the manner discussed above.

Retaining Walls:

Retaining walls should be designed for surcharge loading from slopes, retaining walls, structures and other improvements in the vicinity of the wall. Adequate subsurface and surface drainage should be provided behind all retaining walls. Retaining walls should be designed by an experienced engineer familiar with the site conditions.

Access/Site Clearance:

Access and site modifications should comply with the recommendations above.

Drainage and Sewage Disposal:

All collected stormwater run-off should be piped into an interallotment drainage system or existing watercourse in a controlled manner that limits erosion.

Septic wastes should be connected to the reticulated disposal system.

Where fill is placed across an existing watercourse, a culvert of adequate size to accommodate flood flows should be installed. Subsoil drains should also be provided along the base of all gullies where fill is to be placed. The subsoil drains should discharge well beyond the fill in a controlled manner that prevents erosion.

5. EROSION

Soil erosion during and after construction on the site will require careful management, however, levels of erosion should be able to be maintained within normally acceptable levels by adopting good soil erosion and sedimentation control practices, including:

- Plan for soil and water management concurrently with engineering design and in advance of any earthworks.
- Minimise the area and duration of soil exposure by staged development or controlled clearing.
- Stockpile stripped topsoil for re-use and protect from erosion.
- Control stormwater runoff by diverting stormwater from denuded areas, minimising slope gradients, lengths and runoff velocities.
- Trap soil and water pollutants using silt traps, sediment basins, perimeter banks, silt fences and nutrient traps as appropriate.
- Quick rehabilitation of denuded areas.
- Promote regeneration of native vegetation in gullies and on steep slopes (>10°) previously cleared for grazing.

6. ACID SULFATE SOILS (ASS)

6.1 Background Information

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

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

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

APPENDIX B

ASTORIA DEVELOPMENTS PTY LTD

PROPOSED SUBDIVISION

NORTH BOAMBEE ROAD, NORTH BOAMBEE

ACID SULFATE SOIL ASSESSMENT

Coffey

N08183/02-AA

17 March 2003

N08183/02 AA DDM:DDM
17 March 2003

Astoria Developments Pty Ltd
Level 1, Suite 1
55 Grandview Street
PYMBLE NSW 2073

Attention: Geoff Smith

Dear Sir

RE: PROPOSED SUBDIVISION – NORTH BOAMBEE ROAD, NORTH BOAMBEE

ACID SULFATE SOIL ASSESSMENT

Please find enclosed our report on the Acid Sulfate Soil Assessment (ASS) of the development proposed for the North Boambee site. The report addresses ASS issues related to the proposed excavation of soil for construction of ponds associated with the development

Testing of the soils in the proposed pond excavation areas revealed results that would not be considered indicative of potential or actual Acid Sulfate Soils on the basis of ASSMAC Action Criteria for clay soils. Some results do, however, exceed more stringent criteria for sites on which more than 1,000 tonnes of soil is to be excavated. It is therefore recommended that some precautionary liming and monitoring of excavated soils be undertaken during construction. A management plan and work method can be prepared once construction sequences are known.

If you have any questions please contact the undersigned at any stage of the development should further assistance be required.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

STEVEN MORTON

Distribution:	Original	Coffey Geosciences Pty Ltd (File)
	1 Copy	Coffey Geosciences Pty Ltd (Library)
	3 Copies	Astoria Developments Pty Ltd

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Coffey

1. INTRODUCTION

This report describes the findings of a acid sulfate soil assessment undertaken by Coffey Geosciences Pty Ltd (Coffey) on the site of a proposed residential development located at Boambee, near Coffs Harbour, New South Wales. The work was commissioned by Geoff Smith of Astoria Developments Pty Ltd in a letter dated 10 February 2003.

The site is located on the northern side of North Boambee Road, about 1km southwest of the developed perimeter of Coffs Harbour (See Drawing No N08183/02-1). The proposed development involves approximately 260 residential lots and a retirement village. Development will include construction of eight artificial lakes in the low-lying central part of the site.

The purpose of the work conducted by Coffey was to assist with the Development Application submission to Coffs Harbour City Council by providing a report that addresses acid sulfate soil issues that might affect the development, particularly in relation to the excavation of proposed ponds and stormwater retention basins in the lower lying part of the site. This report is a supplementary report to N08183/01-AD , which was a geotechnical and capability assessment of the overall site. For a detailed discussion on the following issues, reference should be made to thew above mentioned report.

- Slope stability.
- Acid Sulfate Soils (ASS) (in different locations to the current assessment).
- Erosion.
- Foundation Conditions.
- Drainage and water table depth.
- Soil contamination due to past activities.
- Road construction and pavement subgrade conditions.

Coffey was provided with a plan of the location of the proposed ponds. This plan forms the basis of Drawing No N08183/02-1.

2. FIELD WORK

It is understood the proposed ponds will be excavated to depths of about 2m to 2.5m. The aim of the work was to sample and test soils over the proposed depth of excavation, and in the soils immediately below.

Field work was conducted on 24 February 2003, and consisted of the drilling of 16 boreholes to a minimum depth of 3m. The descriptions of the subsurface soils are shown on the attached Engineering Logs. Three disturbed samples were collected from each borehole at regular intervals for subsequent laboratory testing.

A 4WD mounted drill rig was used to drilled the boreholes. The boreholes were drilled in the full time presence of an Engineer from Coffey Geosciences Pty Ltd (Coffey), who located the boreholes, took the sample and produced engineering logs.

Engineering logs of the bore holes are presented in Appendix A, together with explanation sheets defining terms and symbols used in their preparation. Bore hole locations, which were measured from features shown on the contour plans provided, are shown on Drawing No N08183/02-1.

3. SITE CONDITIONS

For a detailed discussion on the geotechnical conditions reference should be made to Coffey report No N08183/01-AD

3.1 Surface Conditions

As shown on Drawing No N08183/01-1, the site is located on the northern side of North Boambee Road, about 1km southwest of the existing developed extent of Coffs Harbour. The site is accessed by a track that runs off North Boambee Road, about 500m west of the Pacific Highway.

Topographically it is situated within the alluvial floodplain of a tributary to Newports Creek, and the foothills of surrounding moderately to steeply undulating hills. The most significant hills on site are the footslopes of Roberts Hill in the northeast corner of the site, and an elongated hill that defines the western end of the southern boundary. Surface relief ranges from approximately RL 5m AHD in the southeast corner to approximately RL 60m AHD in the northeastern corner.

Slopes are generally even and convex. The majority of slopes range from 5° to 0°, grading onto the alluvial plain. In the northeastern corner of the site, slopes steepen to 10° to 20°.

The majority of the site is occupied by the alluvial flats which appear to represent an abandoned flood plain formed during a period of higher sea level than the present. This area contains a drainage course that appears to have been excavated in the past to improve site drainage. A series of man made surface drains have been excavated cross the flats, as tributaries to the main drainage channel, to improve drainage of this low-lying area. The drains contained water and shallow reed and grass vegetation at the time of the field work. The water did not contain evidence of organic, iron rich sediment or other features commonly associated with the presence of acid sulfate soils.

The flats and the majority of the surrounding hills have been cleared for cattle grazing and were vegetated by thick, long grasses with some scattered trees.

Existing development at the time of the field work consisted of a small fibro cottage and associated sheds in the northern part of the site. These buildings were in a dilapidated state at the time of the field work, and only accessible by a 4WD track.

No evidence of soil erosion was observed, probably due to the thick and well established vegetation.

3.2 Subsurface Conditions

The Dorrigo-Coffs Harbour 1:250,000 geology map indicates the elevated areas of the site to be situated within the Carboniferous Aged Brooklana Formation, consisting predominantly of siliceous argillite and slate, with minor siliceous greywacke. The low-lying flats are indicated as containing Quaternary Alluvium, consisting of sand, gravel and clay.

The boreholes drilled during the current investigation were all in the lower lying region of the site. Typical profiles are summarised below:

- TOPSOIL - Typically Silty CLAY, also Silty Sandy CLAY, of medium to high plasticity, dark grey-brown, with grass roots throughout.
- ALLUVIUM - Interbedded and interlensed Silty CLAY, and Sandy CLAY, grey, light grey, and yellow-brown mottled, with lenses and pockets of Clayey SAND, and alluvial silt. The alluvial soils generally became stiffer with depth, ranging from firm in the upper metre, though stiff, to very stiff with depth.
- RESIDUAL - Previous test pits located towards the edges of the alluvial flats encountered residual clay, very stiff, low to medium plasticity, underlying the alluvium.

Groundwater inflows were observed in some parts, generally consisting of localised seepage along fissures, or through sandy lenses, or through root paths. Seepage also occurred through some topsoil layers overlying the low permeability clay profile. The clay profile itself appears to be 'tight' and of low overall permeability.

4. ACID SULFATE SOILS (ASS)

4.1 Background Information

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

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

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

4.2 Significance of ASS

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

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

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

4.3 ASS Risk Map

Reference to the Coffs Harbour 1:25,000 Acid Sulfate Soil risk map published by NSW Department of Land and Water Conservation indicates part of the low lying alluvial flats on the site as containing Pleistocene deposits, with a low probability of acid sulfate soil occurrence, possibly occurring at depths of 1m to 3m below the current ground surface level.

4.4 ASS Sampling and Laboratory Testing

Samples were obtained at varying depths in all borehole locations. The samples were tightly sealed in plastic bags and placed on ice in esky containers while on site and during transport to our Newcastle laboratory. On return to the laboratory, the samples were screened for the presence of actual or potential ASS using laboratory methods 21Af and 21Bf of the ASSMAC laboratory guidelines (Ref 1). The results are presented in Appendix B. The following points are noted with regard to the screening test results:

- The pH of samples in a distilled water slurry ranged from 4.85 to 7.13. pH values of less than 4 are considered indicative of actual ASS.
- The pH of samples in 30% hydrogen peroxide ranged from 3.27 to 5.63. pH values of less than 3 in the test are generally considered indicative of potential ASS.
- Reaction temperatures ranged from 20.3°C to 25.7°C. Typically, oxidation of pyrite in hydrogen peroxide within a soil containing significant acid sulfate potential will produce temperatures in excess of 70°C.

Based on the results of the screening tests, the soils sampled and screened were not considered to be potential or actual ASS.

To confirm the above assessment, some samples were selected for more detailed Peroxide Oxidation Combined Acidity and Sulphur (POCAS) analysis. Samples were selected from each of the proposed ponds typically at depths approaching the base of the excavation. The testing was undertaken by ALS Environmental, a NATA registered specialist chemical laboratory. The test results are presented in Appendix B, and compared to ASSMAC (Ref 1) Action Criteria in Table 1.

TABLE 1 – RESULTS OF POCAS TESTING ON SELECTED SOIL SAMPLES

Sample Location	Sample Depth	S (pos) (%)	TAA (mol/tonne)	TPA (mol/tonne)	TSA (mol/tonne)	Oxidisable sulfur (S (%))	Required Liming Rates (kg lime / tonne soil)
BH1	2.8-3.0	<0.02	11	19	8	0.03	1.4
BH3	2.8-3.0	<0.02	<2	<2	<2	-	-
BH4	2.8-3.0	<0.02	33	43	10	0.07	3.2
BH6	2.8-3.0	<0.02	8	8	<2	-	-
BH7	0.8-1.0	<0.02	33	50	17	0.08	3.7
BH10	1.8-2.0	<0.02	39	41	2	0.065	3.0
BH9	1.8-2.0	<0.02	31	35	4	0.056	2.6
BH12	1.8-2.0	<0.02	28	28	<2	0.045	2.1
BH13	2.8-3.0	<0.02	18	20	2	0.03	1.4
BH14	1.8-2.0	<0.02	41	52	11	0.083	3.1
BH15	2.8-3.0	<0.02	33	43	10	0.07	3.2
BH16	1.8-2.0	<0.02	28	30	2	0.05	2.3
Action Criteria 1.		0.1	62	62	62		
Action Criteria 2.		0.03	18	18	18		

NOTES:

Action criteria 1 is for fine textured soil defined by ASSMAC (Ref 1.)

Action Criteria 2 Applies for situation with more than 1000 tonnes of soil to be disturbed

S (pos) = Percentage of Oxidisable Sulfur

TAA = Total Actual Acidity

TPA = Total Potential Acidity

TSA = Total Sulfidic Acidity

Action Criteria: Based on ASSMAC Assessment Guidelines August 1998

Liming rates shown include a factor of safety of 1.5 for incomplete mixing

4.5 ASS Management

Based on the results shown in Table 5, the soils would not be considered actual or potential ASS under ASSMAC guidelines for clay soils. However the potential acidity exceeds the more conservative Action Criteria (Ref. 1) for projects in which >1000 tonnes of soil will be disturbed. It is therefore recommended that some liming of spoil generated from the excavation of these lakes be undertaken as a precaution against acid generation. We understand the excavated spoil will be used as fill within the development. A practical method of liming that has been used successfully in the past by Coffey to prevent acid generation in excavated soils being used as fill is to lime the material upon spreading and prior to compaction. As stated in Table 1, liming rates for different areas of the site vary from 1.3 kg lime / tonne soil to 3.8 kg lime / tonne soil. An average liming rate of 2.7 kg lime / tonne soil is expected to be sufficient to prevent acid generation and runoff in the excavated soil. However it is recommended that pH testing be undertaken in conjunction with the liming of the soil to ensure that the liming is successfully buffering the acid generating capacity of the soil. Samples will need to be submitted for more detailed laboratory analysis to confirm the results. Liming rates will need to be increased if values less than pH 4 occur in soil that has already been treated.

In general soil needing to be neutralised should be spread in layers not more than 300mm thick. Lime should then be spread over each layer immediately after placement and be thoroughly mixed through the soil during the compaction process. A detailed work method and management can be prepared once contractor's construction sequences are known.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

STEVEN MORTON

REFERENCES

1. ASSMAC, Acid Sulfate Soil Manual, August 1998.