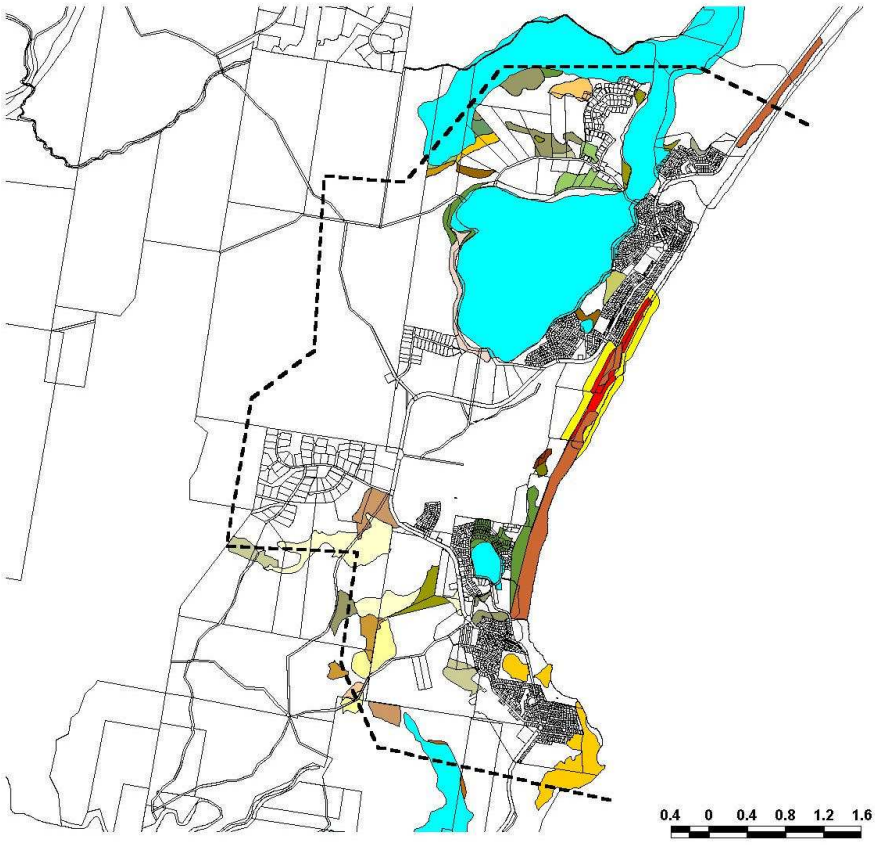

Area 14
Master Planning Study

Property.shp
Study area boundary.shp
Sepp14.shp
Sigveg.shp
30021/R
30041/R
30042/R
30051/L
30061/R
35211/R
35212/R
40021/RW
40022/92020/RW
40022/RW
40031/W
40032/W
40051/W
40052/W
40092/40982/W
40092/R
40111/W
40121/RW
40122/RW
40981/W
40982/55030/W
40982/W
40991/40981/W
40991/W
56042/40022/RW
90100/R
90300/R
92090/40052/W
Sepp26.shp
Buffer
Littoral Rainforest

N
W E
S

Figure 1. Significant Ecological Communities

Cadastre supplied by Hastings Council under licence from the Land Information Centre. Vegetation mapping is based on work of Ecovision (1998).

prepared by:
BIOLINK PTY. LTD.
NATURAL HISTORY & ENVIRONMENTAL CONSULTANTS
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TEL / FAX: 02 6679 5091

APRIL 2003

11.6 APPENDIX 6. SOIL STUDY IN AREA 14 – SOIL TYPES

Soil Landscape Descriptions of Area 14

ba BURRAWAN *Residual Landscapes*

Landscape— Gently undulating rises and low hills, on sediments of the Camden

Haven Group (Rec). Relief 10 – 30 m, elevation 5 – 40 m, slopes 3 – 10%. Tall openforests,

often cleared for grazing, horticulture and urban development.

Soils—Well-drained, 90 – 150 cm, Red/Brown Kurosols/Dermosols (Red or Brown

Podzolic Soils), with imperfectly-drained Mottled Yellow Kurosols (Yellow Podzolic

Soils) on lower slopes.

Significant Soil & Land Qualities— Soils with low wet bearing strength, organic

topsoils, high erodibility, low subsoil permeability, strong acidity, aluminium toxicity

potential. Hardsetting surfaces, localised poor drainage, localised high run-on,

localised seasonal waterlogging, water erosion hazard, and foundation hazard.

bl BELMORE *Swamp Landscapes*

Landscape— Extensive flat seasonally inundated plain on Holocene estuarine

lagoon sediments of Lake Innes and Lake Cathie, often inundated. Sedgelands and

open water.

Soils— > 200 cm, poorly drained, sandy Sulphidic Hydrosols (Humic Gleys) and

Sulphidic Organosols (Acid Peats).

Significant Soil & Land Qualities— Organic soils with low wet bearing strength,

sodicity, low permeability, acid sulphate soils, strong acidity, high aluminium toxicity

potential, salinity. Poor drainage, high flood hazard, seasonal waterlogging,

permanently high watertables, foundation hazard, soil fire hazard.

ca CAIRNCROSS *Transferral Landscapes*

Landscape—Narrow open depressions below low hills, grading to broad drainage

plains, on slope-wash and valley infill clays and silts. Slopes <4%, relief <2 m,

elevation 5 – 10 m. *Eucalyptus tereticornis* and *E. robusta* woodlands and open

swamp forests, often partly cleared.

Soils— Poorly drained, > 300 cm, Mottled Brown or Grey Kurosols (Gleyed Podzolic

Soils) and Sodosols (Soloths).

Significant Soil & Land Qualities— Soils with high subsoil plasticity, shrink-swell

potential, organic topsoils, low wet bearing strength, sodicity, low permeability, strong

acidity, aluminium toxicity potential, low fertility. Poor drainage, hardsetting surface,

high run-on, localised flood hazard, seasonal waterlogging, erosion hazards,

foundation hazard.

cy CROWDY BAY *Aeolian Landscapes*

Landscape— Low inner-barrier beach-ridge plain on Pleistocene back-barrier sand

(Qad). Relief 1 – 2 m, elevation 2 – 10 m, slopes < 3%. Complexes of mallee

woodlands, wallum shrublands and sedgelands; occasionally cleared for residential

development and sand mining.

Soils— >300 cm, rapidly drained Aeric Podosols (Podzols), and poorly-drained

Humic Aquic Podosols (Humus Podzols).

Significant Soil & Land Qualities— Sandy soils with high erodibility, high

permeability, very low available water-holding capacity, low fertility. Rapid drainage,

groundwater pollution hazard, localised seasonal waterlogging, high wind erosion

hazard, non-cohesive soils, localised low moisture availability, high landscape fire

hazard.

---

ha HARRINGTON *Aeolian Landscapes*

Landscape— Level backbarrier sandplains on Pleistocene clayey sands with

seasonally high water tables. Local relief <1 m, elevation 1 – 2 m, slopes < 3%. Open

(dry sclerophyll) forests, occasionally cleared and disturbed by urban development.

Soils— > 300 cm, imperfectly drained Semiaquic Podosols (Podzols) and Aquic

Podosols (Humus Podzols).

Significant Soil & Land Qualities— Sandy soils with high erodibility, strong acidity,

low available water-holding capacity, low fertility. Localised impeded drainage,

seasonal waterlogging, groundwater pollution hazard, localised acid sulphate soils,

high wind erosion hazard, non-cohesive soils, low moisture availability, high

landscape fire hazard.

lo LORNE *Erosional Landscapes*

Landscape— Rolling hills of the Lorne Basin Hills, dominantly on lithic sandstones

and conglomerates of the Camden Haven Group (Rec). Relief 90 – 200 m, elevation

up to 500 m, slope range 20 – 33%. Tall open-forests, often cleared for grazing.

Soils— Moderately well drained, 80–180 cm, catenary sequences of Red Kurosols

(Red Podzolic Soils) on upper slopes and Brown Kurosols (Yellow Podzolic Soils) on

lower slopes.

Significant Soil & Land Qualities— Soils with low wet bearing strength, organic

topsoils, high erodibility, strong acidity, and aluminium toxicity potential. Localised

high run-on, hardsetting surfaces, locally shallow soils, water erosion hazard, and

foundation hazard.

mo MORIPO *Erosional Landscapes*

Landscape— Rolling low hills, on metadolerites (Pdk) & dacites (Dlw). Slopes

moderate (10 – 33%) but slope variants range from < 10% up 50% slope. Elevation

and relief up to 150 m. Tall open forests, often cleared for grazing and rural

residential development.

Landscape Variant mor— Residual variant. Undulating rises, gradients <10%,

elevation and relief up to 40 m.

Soils— Moderately well drained, stony, 50 – 150 cm, Brown and Yellow Dermosols

(Prairie Soils, Xanthozems, and soils similar to Yellow or Brown Earths) and Brown

Chromosols (Yellow Podzolic Soils).

Significant Soil & Land Qualities— Stony soils with strong structure, high

erodibility, neutral to moderate alkalinity. Gully erosion risk, localised shallow soils,

localised high run-on, localised seasonal waterlogging, foundation hazard.

th THRUMSTER *Residual Landscapes*

Landscape— Undulating to rolling rises and low hills, on Palaeozoic metamorphic

complexes. Relief 10 – 50 m, elevation 10 – 60 m, slopes 3 – 15%. Tall open forests

with subtropical rainforest, extensively cleared for urban development, grazing and

horticulture.

Soils— 200 – 300 cm, well drained Red Ferrosols (Krasnozems) on crests, tending

shallower on steeper sideslopes, with 200 – 300 cm, imperfectly drained Mottled

Brown Kurosols (Red Podzolic Soils) downslope.

Significant Soil & Land Qualities— Soils with strong structure, strong acidity,

aluminium toxicity potential, high plasticity, high topsoil fertility. Productive arable

land, deep soils, localised rill erosion risk, localised seasonal waterlogging, localised

mass movement risk, woody weeds.

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xx DISTURBED TERRAIN *Disturbed Landscapes*

Landscape— Level to hummocky terrain, extensively disturbed by human activity,

including complete disturbance, removal or burial of soil. Variable relief and slopes.

Includes quarries, tips, land reclamation and large cut and fill features. Original

vegetation cleared, and weeds may be abundant.

Landscape variant xxm— Materials variant. Unconsolidated sandy or gravelly

materials.

Soils— Various Anthroposols. Original soil has been removed, greatly disturbed or

buried. Landfill includes soil, rock, building and waste materials.

Significant Soil & Land Qualities— Soils with high variability which may include

foundation hazard, unconsolidated low bearing strength materials, impermeability,

poor drainage, very low fertility, toxic materials and wind erosion hazard. Sources of

sediment and groundwater contamination.

Soil Profile from SPADE

reference test pit No. 1 on Fig 2.0

Site Location: Pacific Drive 400m E of Housten Mitchell Drive.

Map Reference:

AMG Grid Reference 483940E, 6507340N; Longitude

152.830761, Latitude -31.568741; CAMDEN HAVEN (9434)

1:100,000 sheet

Profile Details:

Soil Landscapes of the Camden Haven 1:100 000 Sheet

Survey, Profile 227, collected by Michael Eddie on August

25, 1999

Physiography:

hillcrest under wet sclerophyll forest on dolerite lithology and

used for volun./native pasture. Slope 7% (measured),

elevation 20 m. Surface condition is self mulched, profile is

well drained, erosion hazard is slight, and no salting evident

Soil Type: Melanic-Mottled Eutrophic Brown Dermosol (ASC), Prairie

Soil(GSG)

Soil Description:

Layer 0 Coarse fragments are common (10-20%), as substrate,

coarse gravel (20-60 mm),cobbles (60-200 mm)

Layer 1

00.00 - 00.12 m

A Horizon

clay with strong pedality(polyhedral, 10-20 mm, roughfaced

peds), abundant (>100/10x10cm) roots (<1mm),

field pH is 6. Coarse fragments are common (10-20%),

as substrate, pans are not evident, segregations are not

evident; gradual (50-100 mm) boundary to ...

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Layer 2
00.12 - 00.30 m
BC Horizon
silty clay with strong pedality(angular blocky, 10-20 mm, smooth-faced peds), common (10-25/10x10cm) roots (<1mm), field pH is 7. Coarse fragments are abundant (50-90%), as substrate, coarse gravel (20-60 mm),cobbles (60-200 mm),stones (200-600 mm), pans are not evident, segregations are not evident; gradual (50-100 mm) boundary to ...
Layer 99
? m strong mod. weathered rock dolerite
reference test pit No. 2 on Fig 2.0
Site Location: 200m W Spring Ridge Rd turnoff
Map Reference:
AMG Grid Reference 482800E, 6508500N; Longitude 152.818768, Latitude -31.558258; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details:
Soil Landscapes of the Camden Haven 1:100 000 Sheet Survey, Profile 220, collected by Michael Eddie on December 02, 1998
Physiography:
hillcrest under dry sclerophyll forest on dolerite lithology and used for logged native forest. Slope 12% (measured), elevation 35 m, aspect south. Surface condition is gravelly, firm, profile is well drained, erosion hazard is slight
Soil Type: Haplic Brown Dermosol (ASC), Yellow Podzolic Soil(GSG)
Soil Description:
Layer 0
Coarse fragments are common (10-20%), as parent material, fine gravel (2-6 mm),gravel (6-20 mm),coarse gravel (20-60 mm)
Layer 1
00.00 - 00.14 m
A Horizon
sandy clay with weak pedality(polyhedral, 5-10 mm, earthy), many (25-100/10x10cm) roots (<1mm), field pH is 6.5. Coarse fragments are few (2-10%), as parent material, fine gravel (2-6 mm),gravel (6-20 mm), pans are not evident, segregations are not evident, not evident; abrupt (5-20 mm) boundary to ...
Layer 2
00.14 - 00.55 m
B Horizon
sandy clay with moderate pedality(sub-angular blocky, 10-20 mm, smooth-faced peds), few (1-10/10x10cm) roots (<1mm), field pH is 6.5. Coarse fragments are many (20-50%), as parent material, gravel (6-20 mm),coarse gravel (20-60 mm), pans are not evident, segregations are not evident

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Layer 99
00.55 m moderately strong slightly weathered rock dolerite
reference test pit No. 3 on Fig 2.0
Site Location: LAKE CATHIE - W EDGE OF SWAMP
Map Reference:
AMG Grid Reference 484200E, 6508760N; Longitude 152.833523, Latitude -31.555933; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details: ACID SULPHATE SOILS - CAMDEN HAVEN Survey, Profile
78, collected by Trevor Flewin on September 30, 1994
Physiography:
swamp under swamp complex on lacustrine,clay lithology and used for National/State Parks. elevation 1 m. Surface condition is soft, profile is poorly drained, erosion hazard is slight, and no salting evident
Soil Type: Regolithic Sulphidic Hemic Organosol (ASC), Acid Peat Soil(GSG)
Profile Field
Notes: Meleluca quinquenervia scattered, rush dominant.
Soil Description:
Layer 0 Coarse fragments are not evident
Layer 1
00.00 - 00.68 m
P Horizon
hemic peat, abundant (>100/10x10cm) roots (<1mm), many (25-100/10x10cm) roots (1-2mm), field pH is 5.5. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Hemic to sapric peat, thick rush mat on surface, H2S smell evident.; sharp (<5 mm) boundary to ...
Layer 2
00.68 - 01.60 m
C strong gleying
Horizon
clay with massive structure, common (10-25/10x10cm) roots (<1mm), few (1-10/10x10cm) roots (1-2mm), field pH is 9. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Soft clay, very silky feel, high organics content, faint H2S smell.; clear (20-50 mm) boundary to ...
Layer 3
01.60 - 01.80 m
2D strong
gleying Horizon
clay with massive structure, few (1-10/10x10cm) roots (<1mm), field pH is 8.5. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Grey clay with orange mottles 2 - 10%.

reference test pit No. 4 on Fig 2.0

Site Location: N OF BONNY HILLS - HOUSING ESTATE

Map Reference:

AMG Grid Reference 484031E, 6506385N; Longitude 152.831704, Latitude -31.577358; CAMDEN HAVEN (9434) 1:100,000 sheet

Profile Details: ACID SULPHATE SOILS - CAMDEN HAVEN Survey, Profile 51, collected by Trevor Flewin on August 05, 1994

Physiography:

plain in stagnant alluvial plain under unknown on marine,sand lithology and used for urban. Slope 1% (estimated), elevation 5 m. Surface condition is soft, profile is poorly drained, erosion hazard is slight, and no salting evident

Soil Type: Acidic Tenosolic Redoxic Hydrosol (ASC), No suitable group(GSG)

Profile Field

Notes: Urban development zone, artificial lakes.

Soil Description:

Layer 0 Coarse fragments are not evident

Layer 1

00.00 - 00.25 m

clay loam,clay loam with weak pedality(polyhedral, 1-2 mm, earthy), many (25-100/10x10cm) roots (<1mm), few (1-10/10x10cm) roots (1-2mm), field pH is 5. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Large structure unidentifiable with auger, slaked slightly.; abrupt (5-20 mm) boundary to ...

Layer 2

00.25 - 00.36 m

clay with weak pedality(polyhedral, 2-5 mm, earthy), many (25-100/10x10cm) roots (<1mm), few (1-10/10x10cm) roots (1-2mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are not evident; abrupt (5-20 mm) boundary to ...

Layer 3

00.36 - 01.50 m

clay with massive structure, few (1-10/10x10cm) roots (<1mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are common (10% - 20%), fine (< 2 mm), not identified; clear (20-50 mm) boundary to ...

Layer 4

01.50 - 01.80 m

sandy clay with massive structure, few (1-10/10x10cm) roots (<1mm), field pH is 6. Coarse fragments are not evident,

pans are not evident, segregations are not evident. Layer notes are Stiff clay, few to nil roots.; abrupt (5-20 mm) boundary to ...

Layer 5

01.80 - 01.95 m

clayey sand with massive structure(sandy), none roots (<1mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Slight H2S smell. Wet bolus.

Layer 6

01.95 - 02.10 m

sandy clay with massive structure(sandy), none roots (<1mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are many (20% - 50%), not identified. Layer notes are Orange segregations are firm (colour is dominant mottle), strong H2S smell.; clear (20-50 mm) boundary to ...

reference test pit No. 5 on Fig 2.0

Site Location: Unknown

Map Reference:

AMG Grid Reference 483738E, 6505850N; Longitude 152.828607, Latitude -31.582181; CAMDEN HAVEN (9434) 1:100,000 sheet

Profile Details: OBSCRALNE - CAMDEN HAVEN Survey, Profile 13,

collected by Mitch Tulau on April 21, 1998

Physiography:

hillcrest under dry sclerophyll forest on sandstone-lithic lithology and used for timber/scrub/unused. Surface condition is firm, profile is mod. well drained, erosion hazard is slight, and no salting evident

Soil Type: Yellow Kurosol (ASC), Yellow Podzolic Soil(GSG)

Soil Description:

Layer 1

00.00 - 00.10 m

A1 Horizon

dark sandy loam with weak pedality(crumb, 2-5 mm, roughfaced peds). Layer notes are Brownish black sandy loam.; wavy clear (20-50 mm) boundary to ...

Layer 2

00.10 - 00.30 m

A2 Horizon

brown sandy clay loam with weak pedality(sub-angular blocky, 50-100 mm, earthy). Layer notes are Dull light brown sandy clay loam.; wavy clear (20-50 mm) boundary to ...

Layer 3

00.30 - 00.80 m

B2 silicate clay

Horizon

orange sandy clay with moderate pedality(sub-angular blocky, 20-50 mm, smooth-faced peds). Layer notes are

Orange sandy clay.; irregular gradual (50-100 mm) boundary to ...
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Layer 4
00.80 - 01.50 m

BC Horizon
orange sandy clay with weak pedality(sub-angular blocky, 50-100 mm, smooth-faced peds). Layer notes are Orange sandy clay.

11.7APPENDIX 7 - ARCHAEOLOGICAL HERITAGE REPORT

Jacqueline Collins
(Consultant Archaeologist)
Adise Pty Ltd
9 Unique Close
Dunbogan
New South Wales 2443

Lake Cathie-Bonny Hills Stage 1A Environmental Study

Aboriginal Heritage Assessment

March 2003

Prepared on behalf of :

Deicke Richards
PO Box 10047
Brisbane
Adelaide Street
Queensland 4000

TABLE OF CONTENTS

1 INTRODUCTION

Hastings Council has developed an Urban Growth Strategy (2001) which proposes how continuing population growth in the Hastings Local Government Area can be accommodated for the next 20 years. Under the Strategy, the population of the Lake Cathie-Bonny Hills area (designated 'Area 14') could increase substantially using a combination of current land reserves and selected rezonings from within Urban Investigation Areas. This report was prepared for Hastings Council on behalf of Deicke Richards and forms the Aboriginal heritage component of an Environmental Study for Stage 1A of the identified Urban Investigation Areas. The Stage 1A area is currently zoned rural (1(a1)) and low-density residential (2(a4)) under Hastings Local Environmental Plan 2001.

In accordance with specifications of planningNSW, the Environmental Study aims to classify the Stage 1A area in terms of opportunities and constraints, and recommends development control objectives and measures that would be warranted in order to protect the integrity of the natural and social environment. Depending on the results of the study, parts of the Stage 1A area may be rezoned for future urban purposes. To provide the level of information necessary for Council's landuse planning requirements and comply with the provisions of the National Parks and Wildlife Act (1974) and Environmental Planning and Assessment Act (1979), this Aboriginal heritage assessment includes:

- A review of National Parks and Wildlife Service (NPWS) records and relevant literature to identify typical conditions for site type/location in the Lake Cathie-Bonny Hills locality and the potential for the Stage 1A area to contain Aboriginal cultural materials;
- Liaison with the Birpai and Bunyah Local Aboriginal Land Councils to determine whether any future rezoning proposal would be likely to adversely affect any culturally-significant sites/places;
- Selective field inspection of the Stage 1A area to establish whether visible evidence of Aboriginal activity occurs;
- An assessment of the impact that any future urban development may have on the cultural and archaeological values of the Stage 1A area; and
- Provision of management recommendations appropriate to the Stage 1A area's known and potential Aboriginal heritage resource.

1.1 Location of the Stage 1A Environmental Study area

The Stage 1A Environmental Study area is situated 0.75 to 2.1km inland of the ocean between the coastal towns of Lake Cathie and Bonny Hills, approximately 18km south of Port Macquarie on the NSW mid-north coast (Figures 1 and 2). It comprises 69ha of land, encompassing Lots 1 and 4 DP 255923, Lots 1 and 2 DP 811601, Lots 2 and 3 DP 706357, Lot 3 DP 634929, Lot 5 DP 594793, and Lots 33 and 34 DP 803810 in the Parish of Queenslake, County Macquarie. A 2.2ha section of the area (Lots 1 and 2 DP 811601 and Lot 3 DP 634929) adjoins the northern boundary of Ocean Drive on the northern outskirts of Bonny Hills, but the majority lies 2km further north just south of the township of Lake Cathie and is bounded to the south and south-east by Ocean Drive, to the south-west by Houston Mitchell Drive, to the west by Burrawan State Forest, and to the north by both developed and undeveloped land, and the Lake Innes Nature Reserve (Figure 3).

1.2 Summary of results

No archaeological sites or areas of potential archaeological deposit were identified during field survey of the Stage 1A area, nor are there particular Aboriginal concerns with the area. On the basis of Aboriginal consultation, literature review and the results of the field inspection, the Stage 1A area is assessed to have little further archaeological potential. In view of this perceived low level of Aboriginal cultural heritage sensitivity, no specific development control measures are called for, nor would further archaeological investigation be warranted ahead of any future urban development.

In the event that urban development does proceed at any time, however, it is recommended that all contractors engaged in vegetation clearing and initial earthworks be advised of their legal requirements under the terms of the National Parks and Wildlife Act (1974). Should any materials thought to be of Aboriginal origin be detected during any stage of development, work must immediately cease in their locality and appropriate management advice sought from both the National Parks and Wildlife Service and the relevant Local Aboriginal Land Council. Work should not resume in the subject locality until formal written clearance has been given by both organisations.

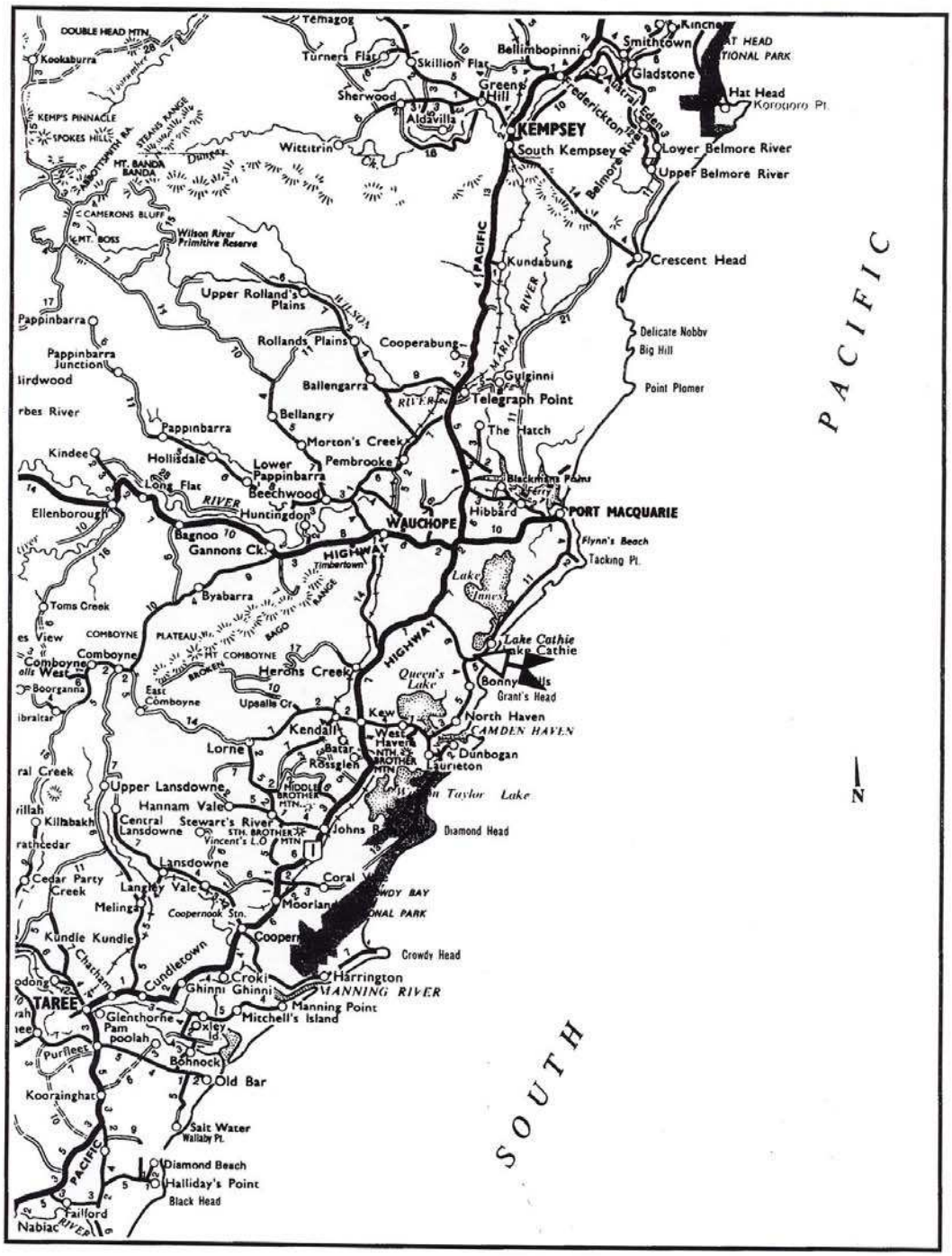

FIGURE 1: General location of the Environmental Study area on the NSW mid-north coast

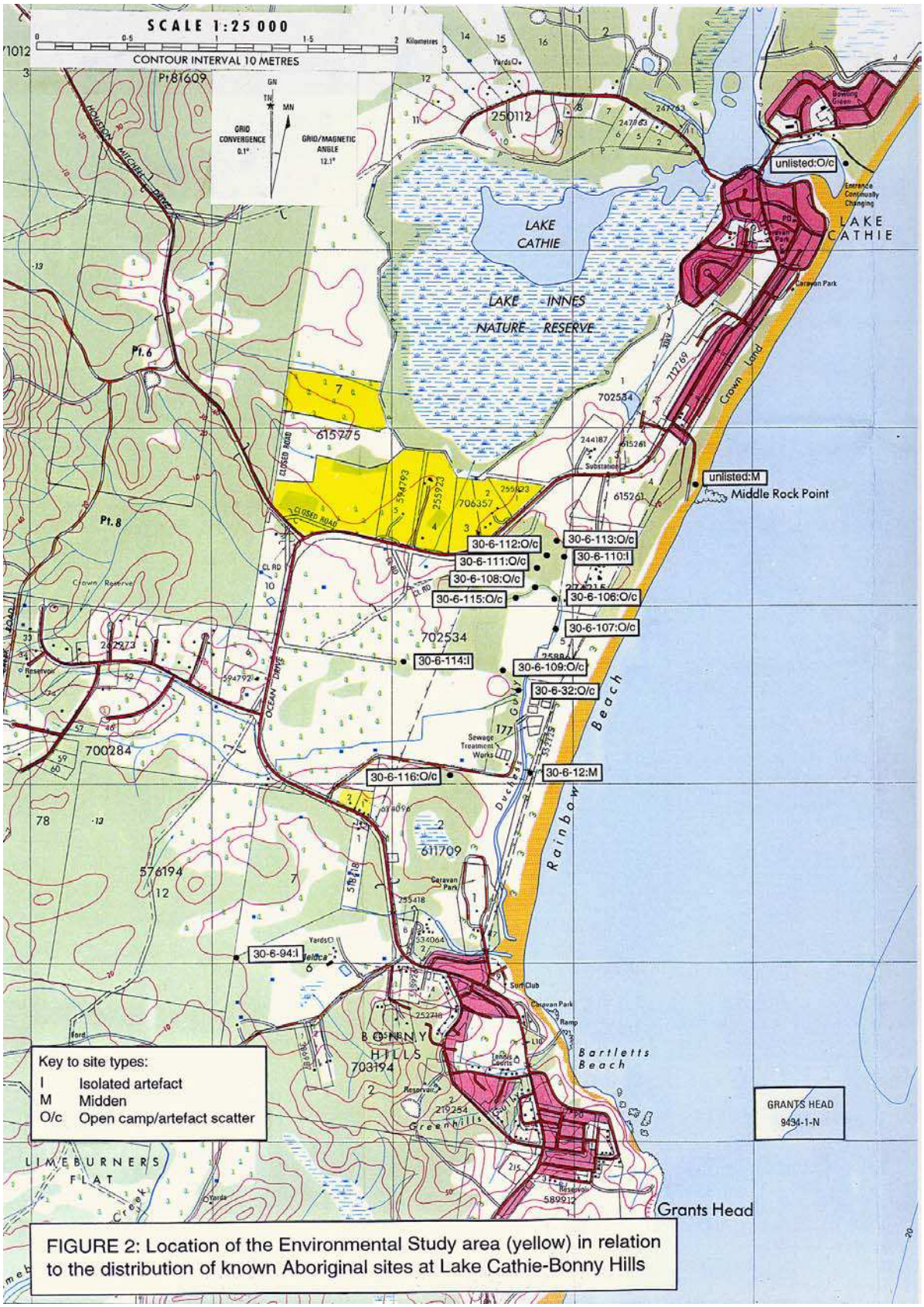

FIGURE 2: Location of the Environmental Study area (yellow) in relation to the distribution of known Aboriginal sites at Lake Cathie-Bonny Hills

Lake Cathie-Bonny Hills, Stage 1A Environmental Study - *Aboriginal Heritage Assessment*

FIGURE 3: Environmental Study area showing Lot details and 2m topographic contour intervals

2 ABORIGINAL INVOLVEMENT

The Lake Cathie-Bonny Hills area comprises part of the territories administered by the Birpai and Bunyah Local Aboriginal Land Councils (LALCs), broad representative bodies incorporated under the NSW Aboriginal Land Rights Act (1983). The vast majority of the Stage 1A area lies in Birpai LALC country, with only the southern 2.2ha section falling within Bunyah country. The Birpai and Bunyah LALCs were contacted at commencement of the assessment and in the absence of any specific Bunyah concerns with the small southern area it was decided that the field survey would focus on the northern area. The field survey was subsequently conducted with the assistance of Birpai LALC Senior Sites Officer Lindsay Moran. On completion of the survey, the results were discussed with Lindsay Moran, Bunyah LALC Administrator Mike Dibbs and Bunyah LALC Sites Officer Amos Donovan, and recommendations presented in Section 10 were developed through this discussion.

With the recent death of Elder William (Gulah) Holten, knowledge and custodianship of sites across a wide part of the area formerly inhabited by Birpai speakers has been passed to Lindsay Moran and his brother William ('Billo') Moran. Lindsay and William Moran (the Mingaletta Corporation) have applied for recognition of Native Title over part of the claimable section of the Hastings coastline and thus claim direct descent from traditional owners of the district. Consultation with Lindsay Moran revealed that the Stage 1A Environmental Study area is not known to contain any sites of spiritual, ceremonial or otherwise cultural importance, although a number of archaeological sites considered to be of high Aboriginal social significance occur in the Ocean Fields area closer to Rainbow Beach, and an unmodified site associated with traditional ceremonial activities (Jolly Nose Hill or 'Googic') lies little more than 2km further inland (cf Collins 1995a:20).

Correspondence prepared by Lindsay Moran on behalf of the Birpai LALC/Mingaletta Corporation is reproduced as an Appendix of this report.

3 ENVIRONMENTAL CONTEXT

Straddling the boundary between a rises and an alluvial plain landsystem (Speight 1990), the 66.8ha northern section of the Stage 1A area incorporates the northern fall of an undulating coastal ridge which curves around the southern extremity of Lake Innes Nature Reserve to form the watershed between the Cathie Creek estuarine system and Duchess Creek basin to the south. The area ranges from near sea level on flats bordering the Nature Reserve, to 18m AHD along parts of the ridgeline followed by Houston Mitchell Drive and Ocean Drive on the southern perimeter. The ridge is dominated by broad low-gradient hillslopes which grade gradually away to the flats, the only notable landform elements being a hillcrest adjacent to Houston Mitchell Drive in the south-west, and a spur which trends northward through the centre of the area (Figures 3 and 4). The ridge is based on the schist, phyllite, greywacke and slate of the Port Macquarie Block. These have decomposed to form clay soils with a compact light grey A horizon, littered in places with angular fragments of the parent rocks.

The majority of the northern area has been cleared for grazing and residential purposes and currently supports open grassland. Dense stands of mostly regrowth casuarina and melaleuca forest cover alluvial flats fringing Lake Innes Nature Reserve, and a pocket of regrowth dry sclerophyll forest occurs on the hillcrest adjacent to Houston Mitchell Drive. Few mature trees of an age sufficient to have been marked by traditional Aboriginal people remain in the area.

Lake Cathie is a small back barrier tidal lagoon surrounded by sedges, rushes and a band of swamp sclerophyll woodland (NPWS 1994:40). As is evident on Figure 2, the lagoon itself lies within Lake Innes Nature Reserve at least a kilometre north of the Stage 1A area.

The small section of study area (2.2ha) edging Ocean Drive at Bonny Hills reaches a maximum elevation of 26m AHD and sits on the northern upper slope of a coastal hill system which defines the southern catchment of Duchess Creek. This area has been cleared for residential purposes and is based on mudstone, sandstone and conglomerate of the Grants Head Formation (Tamworth-Hastings 1:250,000 mapsheet). Grey duplex soils occur at the surface. No natural stone outcrops with the potential to have been either inhabited or quarried by Aboriginal people are present anywhere in the Stage 1A area.

4 CULTURAL CONTEXT

As with other parts of Australia, Aborigines of the NSW mid-north coast operated within a series of nested social groupings. The hearth group, comprising a man, his wife or wives and their children, formed the basic socio-economic unit and several hearth groups would often co-operate as a highly flexible 'band' which would coalesce and then disperse as conditions demanded (Godwin 1990:97). In turn, groups of bands formed land-owning 'clan' groups. The size, composition and location of individual bands within the clan estate varied in response to social and economic considerations. In resource-rich coastal areas clans with at least 100 members occupied reasonably small territories (Henderson 1851; Hodgkinson 1845), the boundaries of which were defined and generally known. Groups of clans speaking a mutually-intelligible language then appear to have formed relatively unstructured 'tribes'. According to linguistic evidence, Lake Cathie-Bonny Hills was home to speakers of the Birpai language (Eades 1979; Crowley 1976:42; Enright 1932:102; Radcliffe-Brown 1929:400; Brown 1898:88), although some writers have suggested that the Birpai may have represented a dialectic rather than a full language group (eg Holmer 1966:1; Enright 1932:76; Mathews 1896:320).

Surveyor-General John Oxley (1820:333), who travelled down the coast from Port Macquarie and skirted along the northern shore of Queens Lake (1.75km south-west of Bonny Hills) in 1818, "saw many large canoes on the lake" and noted that "the Aborigines seem(ed) very numerous". Estimates for the lower Macleay Valley further north place the pre-contact Aboriginal population at between three and six people per $2km^2$ of coastal lands (Coleman 1981:1) and this density of settlement can reasonably be expected for Lake Cathie-Bonny Hills, particularly given the similarly rich environment provided by the coastline, the Cathie Creek estuarine system and its extensive swamps, and the hilly forested hinterland. Oxley (1820:332-334) was clearly impressed by the area's productivity, commenting on its excellent timber and good grass. There were "plenty of kangaroos", "a great number of black swans, ducks etc" and "plenty of fresh water in swamps".

The movement of Aboriginal groups occurred on two levels- that related to the everyday subsistence/settlement round, and that related to the larger-scale network of ceremonial and social obligations. Despite often long-ranging transit to attend ceremonies (eg Fitzpatrick 1914:71,124), early reports are sufficient to dispel theories regarding any largescale seasonal shifts in population between the coast and interior (cf Coleman 1982; Henderson 1851; Hodgkinson 1845), and resource-rich environments like Lake Cathie-Bonny Hills are likely to have been occupied year-round. During the early spring of 1818, at a time when "a large party

of natives" resided in bark huts on the shore of Queens Lake, for instance, Oxley (1820:307-328) had also observed "abundant signs" of Aborigines and their camps along the full length of the Hastings Valley. On leaving Port Macquarie to sail north in late autumn 1819, Parker King (1822:175) noted that the country behind Smoky Cape was "lined with natives fires". Life along the mid-north coast thus seems to have been fairly settled, prompting Cunningham (1827:185) to write of the "better order of things obtaining amongst Aboriginal people at Port Stephens and north". Like Cunningham, Parker King describes the substantial paperbark huts constructed by local groups. These had domed roofs, an entry on the sheltered side away from sea winds, and were capable of holding 8-10 people (Lang 1847:403). That the Aborigines encountered by Oxley on Queens Lake had in their possession "arms and utensils of every description", further promotes the notion of a reasonably sedentary lifestyle.

Although Captain Cook had reported smoke from Aboriginal campfires on the Camden Haven in 1770 (extract from the log book of Captain Cook in Camden Haven Historical Society 1991:7), it was not until Oxley's party travelled down the Hastings Valley in 1818 that the first direct contact between Europeans and the area's Birpai inhabitants occurred. On his journey south, Oxley (1820) camped on Bonny Hills headland near a freshwater spring, but no reference is made to Aborigines in this locality.

Following initial exploration, sustained and unavoidable contact with Europeans was effected with the establishment of Port Macquarie as a penal settlement in 1821. By 1828 limeburners' camps were operating along the northern shore of Queens Lake and at the foot of North Brother Mountain close to the present town of Laurieton (Camden Haven Learning Exchange 1987:5; Camden Haven Historical Society 1991:13). Little information is available for the Lake Cathie-Bonny Hills-Camden Haven area between the late 1820's and 1860, and it is thought to have remained as an isolated outpost of Port Macquarie, visited by limeburners, cedar cutters, escaped convicts and graziers in search of free pasture (Camden Haven Learning Exchange 1987:6). On riding from Lake Innes in 1844, Boswell (1993:110) described cattle grazing in the valley to the south of Bonny Hills and a ship at anchor on the Camden Haven River. In the following year Hodgkinson passed along the western shore of Queens Lake and failed to report any form of historical settlement. He did, however, meet Aboriginal people who were well acquainted with Europeans and whom spoke some English (Camden Haven Historical Society 1991:6). The first permanent European settler occupied land at Laurieton (Peach Grove) in 1872, and by 1890 the Camden Haven had come to be regarded as one of the strongholds of the northern timber trade.

Apart from a brief reference to Aboriginal women bringing a gift of fish to a European resident in 1873 (diary of C. Iver in Camden Haven Historical Society 1991:38), no mention is made of the local Aborigines after Hodgkinson's report of 1845. Although groups in the general study locality could have potentially maintained their traditional lifestyle with little disruption up until the 1870's, the population is likely to have already been decimated by measles (Blomfield 1981:61) and smallpox, which reached Port Macquarie as early as 1831 (Campbell 1985:337). There is a belief that at least some of the Aboriginal people at Bonny Hills were massacred by early settlers near Greenhills Gully, in the vicinity of the present Bonny Hills tennis courts, and that Aboriginal skeletal remains may survive in this area (W. Twomey pers comm).

In the 1890's two Aboriginal Reserves were gazetted in Port Macquarie (McGuigan 1984:40), but it is not known whether people from Lake Cathie-Bonny Hills were moved onto them. During the late 1930's, however, around six Aboriginal families are known to have camped for an extended period beside Greenhills Gully while the men mustered cattle for a local landowner (Bartlett 1991).

A valuable photographic record of Aboriginal life in the Hastings region has been left by Thomas Dick, who employed Birpai people to re-enact various tasks using traditional equipment. The Dick photographs were taken between 1910 and 1927 (McBryde 1985) and include shots of Aborigines grinding axes on a sandstone outcrop at Bonny Hills, and men spearing fish beside a bark canoe near the mouth of Duchess Creek.

5 ARCHAEOLOGICAL CONTEXT

5.1 Known Aboriginal sites in the Lake Cathie-Bonny Hills area

As listed and described in Table 1, 16 Aboriginal sites are known to occur within 'Area 14', which encompasses coastal land south from the southern end of Lighthouse Beach (Lake Cathie) to the southern side of Grants Head (Bonny Hills), inland to the base of the Jolly Nose escarpment (Waterloo Creek Road). The sites comprise 11 open camps/stone artefact scatters, three isolated stone artefacts and two shell middens. All but three of these sites occur in the 'Ocean Fields' area between Ocean Drive and Rainbow Beach (see Figure 2).

All of the known open camps and middens lie within a kilometre of the coast, and most commonly occur on sand-based ground close to water courses, particularly the freshwater reach of Duchess Creek. Two small artefact scatters (#30-6-111 and #30-6-112) have been recorded in alluvium fringing the coastal sand plain. The largest sites in the area include a coastline midden above a rock platform at Middle Rock Point (not registered), and scatters containing over 100 visible artefacts near the mouth of Cathie Creek (not registered), on a quarried dune immediately inland of Duchess Creek (#30-6-109), and on the footslope of a bedrock hill on the southern edge of the Duchess Creek basin (#30-6-116).

5.2 Past surveys in the Lake Cathie-Bonny Hills area

Almost 300ha of 'Area 14' has been covered during past archaeological surveys conducted in response to various development proposals, although the actual area effectively searched for archaeological evidence is not known (Table 2).

In 1970, Starling included Rainbow Beach between Lake Cathie and Bonny Hills in her extensive survey of the northern NSW coastline which aimed to assess the impact of sandmining activities on archaeological sites. Starling recorded Site #30-6-12 along this stretch of beach, stating that "shelly horizons outcrop for up to 10 yards over 4.5 miles of dune. Some have small talus deposits below them, most appear to follow an old surface. Narrow low dune partly stabilised by scrub with eroding east face above indurated sand cliff. Soaks behind c 200 yards. Pipi shell deposit, occasionally charcoal, fire-shattered pebbles, few flakes, unworked pebbles" (Starling 1971 in Happ and Bowdler 1983:6).

Three of the Area 14 surveys have focussed on proposed services easements. These include a pipeline route running parallel to the coastline which traversed hillslopes and flats in the vicinity of Rainbow Beach (Coleman 1981), and a telecommunications route along the inland margin of Ocean Drive north from Lake Cathie (Haglund 1982). No archaeological evidence was detected in the study vicinity during either survey. The more recent inspection of a 15m wide and 10.5km long pipeline easement between the Pacific Highway and Bonny Hills Reservoir resulted in the recording of an isolated quartz core (#30-6-94) on the lower slope of a bedrock hill inland of Bonny Hills (Collins 1995a). This latter survey included a transect along the southern margin of Houston Mitchell Drive opposite the south-western section of the northern Stage 1A Environmental Study area, but no archaeological material was found in that locality.

TABLE 1: Character of known Aboriginal sites in 'Area 14'

NPWS site no	Site type	Location	No artefacts	Further potential	Exposure	Environmental context
30-6-012	small midden	Rainbow Beach	unknown	limited	erosion	thin pipi horizon exposed in foredune scarp
30-6-032	artefact scatter	Ocean Fields	3	limited	gully	artefacts within creek bed gravels
30-6-094	isolated artefact	Bonny Hills	1	no	track	footslope of coastal hill near swamp
30-6-106	artefact scatter	Ocean Fields	20	yes	sand extraction	sand plain near creek and creek bank
30-6-107	artefact scatter	Ocean Fields	5	limited	clearing	sandy creek bank
30-6-108	artefact scatter	Ocean Fields	11	yes	drain/sand extraction	sand plain near creek and creek bank
30-6-109	artefact scatter	Ocean Fields	115	yes	clearing/sand extraction	sand rise and sand foot of bedrock knoll
30-6-110	isolated artefact	Ocean Fields	1	no	pipeline easement	alluvial lowland
30-6-111	artefact scatter	Ocean Fields	2	possible	drainage channel	alluvial lowland
30-6-112	artefact scatter	Ocean Fields	2	possible	drainage channel	alluvial lowland
30-6-113	artefact scatter	Ocean Fields	3	limited	clearing	duplex soil footslope beside spring
30-6-114	isolated artefact	Ocean Fields	1	no	water wash	alluvial lowland
30-6-115	artefact scatter	Ocean Fields	14	limited	erosion	sand rise and creek bank
30-6-116	artefact scatter	Ocean Fields	c.150	yes	erosion	footslope of coastal hill
unlisted	artefact scatter	Lake Cathie	>100	yes	erosion	elevated dune terrace on estuary bank
unlisted	large midden	Middle Rock	unknown	yes	shell at surface	old dune above coastal rocks

TABLE 2: Previous archaeological survey coverage of 'Area 14'

Archaeologist/s	Date	Total survey area (ha)	Effective cover (ha)	No recorded sites in Area 14	Report
Starling	1971	not specified	not specified	1	A survey of the Aboriginal sites of the north coast of NSW 1970-71
Coleman	1981	1.5	not specified	0	A report on a proposed pipeline route & 5 reservoir sites between Port & Laurieton
Haglund	1982	0.1	not specified	0	Report on Aboriginal relics survey of Telecom cable route near Port Macquarie
Happ & Bowdler	1983	225.0	not specified	1	International sports & leisure village LES. Aboriginal sites survey
Bonhomme	1987	40.5	not specified	0	An archaeological survey of a proposed development area at Lake Cathie, NSW
Collins	1995	10.1	0.7	1	Hastings district water supply southern arm trunk main. Archaeological survey
Collins	1996	5.5	1.7	0	Proposed 40 lot residential subdivision area at Bonny Hills: Archaeological survey
*Collins	1996	130.0	5.4	11	Proposed Meridian residential subdivision, Bonny Hills: Archaeological assessment
TOTAL surveys	8	282.7		14	

* Includes part area surveyed by Happ & Bowdler 1983

An additional survey of a further 69ha of land in Area 14 has been completed since preparation of this report (Lake Cathie-Bonny Hills Stage 1B Environmental Study. Cultural Heritage Assessment [Collins 2003])

No sites were detected during survey of a 5.5ha area encompassing bedrock hillslopes and their adjoining flats on the northern outskirts of Bonny Hills (Collins 1996b), or within a 50ha land parcel fronting Cathie Creek at Lake Cathie (Bonhomme 1987).

One open campsite (#30-6-32) was recorded during survey of a 225ha area (now generally known as 'Ocean Fields') stretching west from the coastline to Ocean Drive between Lake Cathie and Bonny Hills (Happ and Bowdler 1983). The site consisted of three silcrete artefacts (two cores and a flake) found on a lag of ochre nodules, cobbles, pebbles and sand in the bed of a small tributary of Duchess Creek, and a silcrete flake in a spill of sand down the northern bank of the tributary some 15-20m further downstream (Happ and Bowdler 1983:16). In the belief that low-lying ground would have "little potential for habitual Aboriginal occupation", the survey concentrated on high land flanking Ocean Drive, including the southern half of the ridge system bordering the northern section of the Stage 1A area, and slopes adjoining its small southern section. No archaeological evidence was found in these areas, but surface visibility remained poor as a result of dense vegetation. Happ and Bowdler also inspected Site #30-6-12 along Rainbow Beach. Evidence of the midden was reportedly "very sparse indeed", confined as it was to four *in situ* pipi lenses, each 1-3cm thick and 10cm-1m in length, sitting in a dark grey organic layer 50cm-1m below the top of the dune scarp. No artefactual material was observed, although one lens contained charcoal and split cobbles (Happ and Bowdler 1983:15).

In 1996(a), the northern 130ha section of Ocean Fields was resurveyed by Collins in response to a residential subdivision proposal. By this time much of the area had been cleared and offered considerably improved survey conditions. The survey resulted in the recording of 169 stone artefacts at 9 separate locations within the study area itself. In addition, one small open campsite (#30-6-107) was found immediately east of the study area, and a larger campsite (#30-6-116) recorded on a footslope further south near Bonny Hills. With the exception of a single isolated artefact (#30-6-114) near the southern boundary in the west, and an extensive artefact scatter on a sand extraction pit in the south-east (#30-6-109), the sites were associated with exposed flats in the north-east part of the area near Duchess Creek. On the basis of field observations and the distribution and context of the recorded artefacts, it was considered highly likely that further archaeological materials would be present beneath the current ground surface. Given the obvious sensitivity of coastal flats targeted for development, a subsurface investigation was recommended to establish the density, stratigraphic and disturbance context of any further occupational materials. It was also recommended that two of the artefact scatters lying beyond the boundary of the proposed subdivision (#30-6-106 and #30-6-109) be protected and stabilised prior to commencement of any development works. Due to the previous

recording of midden lenses along Rainbow Beach and the discovery of artefacts on the eastern bank of Duchess Creek (#30-6-107), it was further recommended that any planned pedestrian access to the beach remain confined to an existing track/bridge across Duchess Creek, and an existing cutting through the foredune (Collins 1996a:38-44).

6 ARCHAEOLOGICAL POTENTIAL OF THE STUDY AREA

6.1 Constraints to site preservation

Most of the Stage 1A area has been cleared for grazing and residential purposes and currently supports either regrowth forest or open grassland. Some of the alluvial flats have been ploughed, and despite its rural amenity, parts of the area have clearly suffered a moderate to high level of surface disturbance. Lot 4 DP 255923 between Ocean Drive and Lake Innes Nature Reserve, for instance, is a former dairy farm which had substantial areas developed for bean plantations, whilst the crest of the Lot 5 DP 594793 spur was modified for use as an airstrip (see Lot numbers, Figure 4). A number of farm dams have been excavated on the hillslopes and flats, and buildings, roads/driveways and cultivated lawns and gardens occur on all but Lots 33 and 34 DP 803801 in the western section of the northern area.

While any vulnerable above-ground Aboriginal sites like ceremonial grounds and marked trees are likely to have been destroyed during the initial process of land clearing, the degree of spatial integrity maintained by open surface sites will be linked to the types and frequency of mechanical interference they have suffered. Open campsites affected by clearing activities only, have the capacity to be as well preserved as any equivalent sites in logged forests. Artefacts on ploughed land, on the other hand, will have been moved and segregated within the topsoil profile, and spread along the axis of cultivation. However, few of these artefacts are likely to have been broken, and despite disturbance, ploughed sites may still be of scientific significance (cf Boismier 1989:137-141; Dunnell and Simek 1995; Hawkins 1998; Lewarch and O'Brien 1981; Roper 1976).

Of least potential archaeological value are those parts of the Stage 1A hillslopes and northern spur crest which have been modified through the construction of roads/driveways, houses, sheds and other buildings, landscaping, and the installation of underground services. Any surface cultural materials which may have occurred in such areas will have been either redeposited elsewhere, or dispersed from their original place of deposition.

6.2 Potential site types

On the basis of information gained through a review of ethnohistorical and archaeological sources (Sections 4 and 5) there is some potential for undetected Aboriginal sites to occur within the Stage 1A Environmental Study area. In tandem with the environmental and disturbance context of the area, known site distributions suggest that the following types of sites would be most likely to survive:

Stone artefact scatters (open campsites)
This type of site can range from as few as two stone artefacts to an extensive scatter containing a variety of tools and flaking debris, sometimes with associated materials such as bone, shell, ochre, charcoal and hearth stones. An artefact scatter does not necessarily mark a place where actual camping was carried out, but may instead be the product of specialised and/or short-term activities involving some level of stoneworking (eg the manufacture or rejuvenation of a single tool during hunting, or whilst in transit from one camp to another) (Hiscock 1988:19). Artefact scatters may occur as surface concentrations or as dateable stratified deposits, and can provide information on such things as patterns of Aboriginal landuse, movement and exchange.

Isolated stone artefacts
These can be located anywhere in the landscape and represent either the remnant of a dispersed artefact scatter (open campsite), or the simple loss or random discard of artefacts.

Shell Middens
These sites are generally found near water sources and are essentially the remains of Aboriginal meals of shellfish. Aboriginal middens differ from natural shell beds in that they comprise predominantly mature specimens of edible shellfish species. They may also contain faunal remains, stone artefacts and charcoal and ash from cooking fires. On the north coast human burials have also been recorded in direct association with shell deposits.

While middens are the most common type of coastal site in the Hastings region, a large number of middens have been destroyed by sandmining and natural erosion, and continue to be destroyed ahead of coastal development. As a result, undisturbed examples are now relatively rare. Extensive midden sites are known to have been situated along the Rainbow Beach foredune and at Middle Rock Point. Given that the eastern extremity of the Stage 1A area lies only 750m inland of the beach, there is some possibility that this type of site may be present.

Scarred trees

These are trees which bear scars caused through the removal of bark or wood for making material items such as canoes, shields and containers, or which have been marked for other reasons (eg toe-holds to aid climbing). Scarred trees are usually associated with domestic activities. They may occur anywhere there are suitable tree species, and be found where mature specimens still exist.

6.3 Predicting site locations

It has long been recognised that archaeological sites tend to recur in favourable environmental settings. Predictive models take advantage of these redundancies by exploiting contrasts between environmental characteristics of places where sites do and do not occur. Providing the data is good it is possible to make predictions from a relatively small sample of known locations to a much broader area (Warren 1990:201).

Predictions presented in this section draw on those developed by Collins (1995b), who analysed the distribution and context of 48 pre-contact/traditional occupation sites (isolated artefacts, artefact scatters and middens) recorded during a 10% sample survey of a 4,200ha subcoastal area near Port Macquarie. On the basis of Collins' (1995b:67-68) model and the disturbance history and specific environmental character of the Stage 1A area, the following predictive statements can be made in relation to its potential archaeological resource.

- Although their survival probability is low, scarred trees may be present wherever ecologically mature trees survive.

- Because the study area lies well within easy travelling distance of the coastline, any evidence of Aboriginal occupation is expected to take the form of low-density scatters of stone artefacts and/or shell, reflecting the itinerant activities of groups hunting or gathering away from their main camp. These sites are most likely to occur on well-drained ground close to the Lake Innes Nature Reserve and the small stream channel in the north-west, on the hillcrest adjacent to Houston Mitchell Drive, and on intact parts of the spur between Ocean Drive and the Nature Reserve, particularly the lower northern end of this spur.

Although artefact and midden scatters will only be detectable where their constituent cultural material coincides with a surface exposure, any materials which may occur in previously

cultivated areas will have been dispersed and churned within topsoil. In some locations artefacts may have been covered by alluvial sediments.

- Isolated stone artefacts may occur anywhere but are most likely to be concentrated in their distribution to the areas outlined above for artefact and midden scatters.

Due to the effects of existing residential development, clearing, and ploughing over parts of the area, most artefacts will have suffered post-depositional disturbance and may be concealed within the churned topsoil.

- Although the lower sections of the hillslope elements represent well-drained ground within a reasonable distance of potential seasonal water sources, almost all of the slopes are gradual and do not offer any level locations which are likely to have been preferentially occupied by Aboriginal groups. With the possible exception of scarred trees and isolated artefacts, the hillslopes are unlikely to contain archaeological evidence.

7 FIELD SURVEY

7.1 Survey strategy

In view of the likely types and distribution of archaeological sites and the visibility constraints imposed by surface vegetation across much of the Stage 1A area, it was considered that blanket survey coverage would have been neither effective nor warranted. Instead, a sampling strategy was adopted which took advantage of the high visibility transects provided by vehicle and livestock tracks, coupled with systematic coverage of all available surface exposures on potentially sensitive topographic elements as identified in the Section 6.3 predictive model. In addition to the detailed surface survey, a general reconnaissance was made across the entire area in order to locate and inspect any mature trees for evidence of Aboriginal marking.

Approximately one third of the 2.2ha southern section of the Stage 1A area is covered by buildings, gardens and lawns, and given the low predicted sensitivity of its constituent hillslope, field survey effort was directed towards the 66.8ha northern section of the area near Lake Cathie.

7.2 Survey method and details

The field survey was conducted on foot with the assistance of Birpai LALC Senior Sites Officer and Mingaletta Native Title applicant Lindsay Moran on the 25th of October 2002. The weather was fine and lighting was conducive to the detection of archaeological materials. A logbook was maintained to record relevant environmental observations, and photographs taken to document the various levels of surface exposure and visibility. Selected Plates have been included in this report to offer the reader a general overview of survey conditions.

The survey was undertaken using a combination of parallel transects and single traverses, with the distance between surveyors tailored to suit the type of exposure being inspected. On linear features such as vehicle and livestock tracks, the surveyors walked abreast. Elsewhere, the inspection was carried out by the two surveyors walking up to five metres apart, resulting in coverage of a 10m wide strip.

7.3 Survey coverage

The 9.3ha of land covered for surface evidence, representing a 13.5% sample of the total Stage 1A study area, is shaded on Figure 4. Summary details of the survey areas are presented in relation to landform elements represented within each surveyed allotment in Table 3. The given area measurements have been simply calculated by multiplying the length of each survey block or transect by its width to offer a rough indication of the relative size of the survey units.

The concept of coverage analysis has been developed as a means of specifying the proportion of a surveyed sample which permitted the detection of sites. With respect to the more unobtrusive types of sites such as scatters and isolated stone artefacts, site detection can be partially or even completely impaired by surface vegetation, flood-deposited, slope-washed and wind-blown sediments, modern land modification, gravelly surfaces and/or poor lighting conditions (Witter 1992:85-87). Thus, in any archaeological survey there is a bias against observing surface materials.

To provide data sufficient for evaluating the potential for undiscovered sites, variables constraining site detection were estimated for all surveyed landforms. These include an estimation of the mean frequency with which surface exposures were encountered, as well as an estimation of the quality of visibility on those exposures (mean frequency of bare ground suitable for artefact detection). Once the variables of exposure and visibility are taken into

account, it is estimated that 10.5% of the surveyed sample was subject to effective survey coverage (Table 3). This amounts to an overall effective coverage of 1.4% of the total Stage 1A area, including 3.5% of all crests, 1.8% of hillslopes, 0.7% of alluvial flats and 20% of the stream channel and its adjoining banks (Table 4). With the exception of those on aggrading alluvial flats, all of the ground surface exposures inspected during the survey are considered to have been at least moderately conducive to artefact detection, with high quality exposures present on crests, particularly that adjacent to Houston Mitchell Drive.

TABLE 3: Summary of survey coverage (ref. Figure 4)

Landform element	Surveyed area (m^2)	% of natural surface exposed	% visibility on exposures	Effective coverage (m^2)	No sites recorded
Lot 2 DP 706357					
Hillslope	2,230	5	100	111.5	0
Alluvial flat	1,600	0	0	0.0	0
Lot 3 DP 706357					
Hillslope	200	20	100	40.0	0
Alluvial flat	4,600	20	100	920.0	0
Lot 4 DP 255923					
Crest	3,345	5	90	150.5	0
Hillslope	3,400	50	100	1,700.0	0
Alluvial flat	5,450	5	100	272.5	0
Lot 5 DP 594793					
Crest	8,300	5	100	415.0	0
Hillslope	2,350	0	0	0.0	0
Alluvial flat	7,500	0	0	0.0	0
Lot 33 DP 803801					
Hillslope	12,400	10	90	1,116.0	0
Alluvial flat	8,350	5	90	375.8	0
Stream channel	800	20	100	160.0	0
Lot 34 DP 803801					
Crest	6,000	10	80	480.0	0
Hillslope	18,100	20	100	3,620.0	0
Alluvial flat	8,200	5	100	410.0	0
TOTAL	92,825 (13.5% of total)		(10.5% of survey area, 1.4% of total)	9,771.3	0

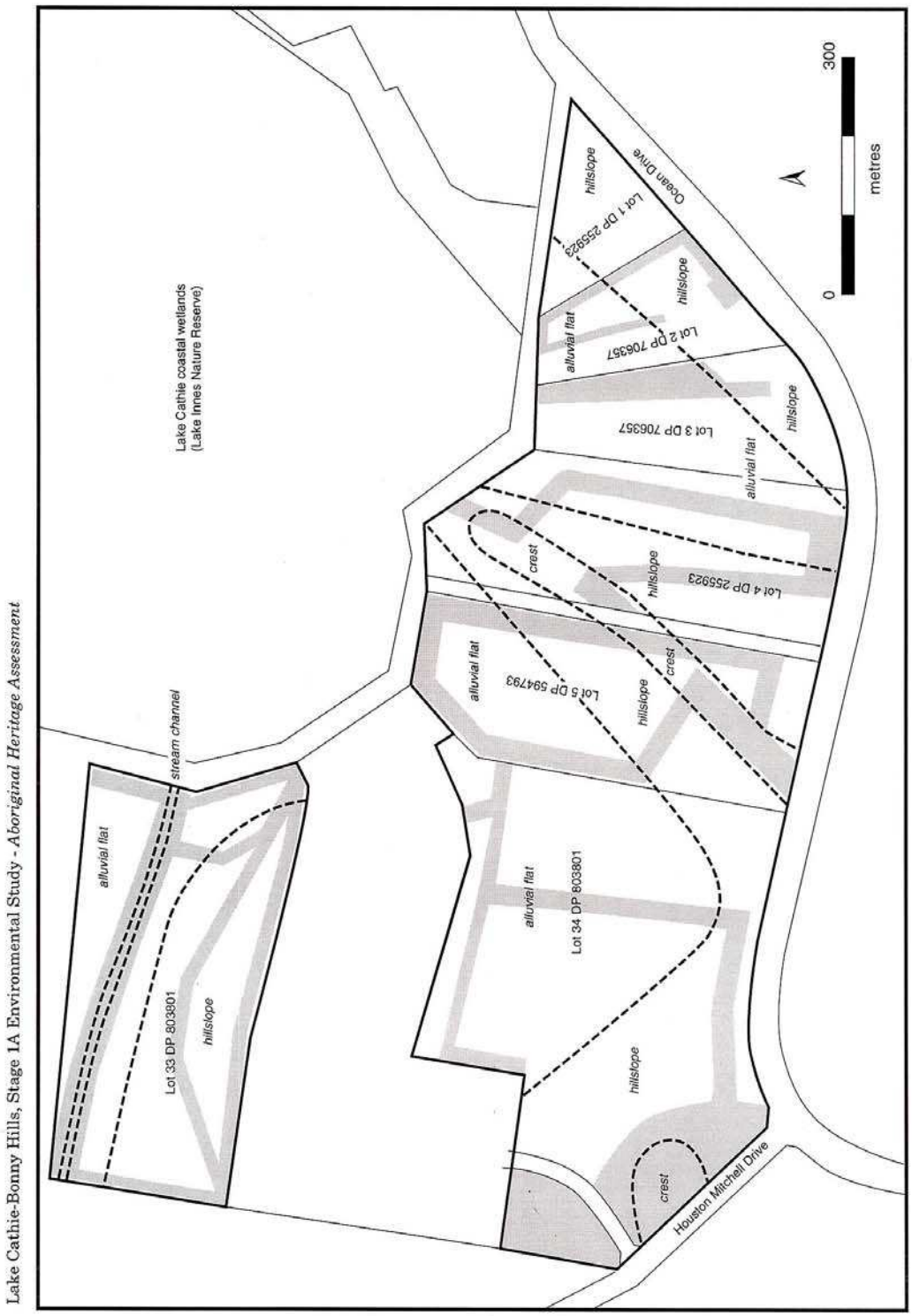

FIGURE 4: Landform elements and areas covered during the field survey

PLATE 1: General visibility on ridge crest, Lot 34 DP 803801

PLATE 2: General visibility on upper slope, Lot 2 DP 706357

PLATE 3: Track exposure on mid-slope, Pt Lot 4 DP 255923

PLATE 4: Typical general visibility of alluvial flats, Lot 5 DP 594793

Although grass cover severely limited the degree of inspection which could be carried out on hillslopes and flats, given its topographic character and disturbance history, and the amount of ground actually covered on foot, the surveyed sample is considered satisfactory for the purposes of assessing the overall level of archaeological sensitivity of the Stage 1A area, and the potential effects that any future urban development may have on its archaeological resource.

TABLE 4: Survey coverage of landform elements

Landform element	Total surveyed (ha)	Total effective cover (ha)	Total area of element type (ha)	% effective cover	No sites recorded
Crest	1.765	0.1045	3.000	3.5	0
Hillslope	3.868	0.6588	36.500	1.8	0
Alluvial flat	3.570	0.1978	29.420	0.7	0
Stream channel	0.080	0.0160	0.080	20.0	0
TOTAL	9.280	0.9771	69.000	1.4	0

7.4 Survey results

No artefacts, midden shell, scarred trees or areas of potential archaeological deposit were identified during the field survey.

8 CONCLUSIONS

As outlined in Section 6.3, the archaeological record of the Stage 1A area was predicted to be of a low-density nature only, reflecting the low level cultural discard of groups engaged in itinerant resource exploitation activities. Based on past results, this evidence was expected to be largely confined in its distribution to crests, the banks of the small stream channel running through the north-west section of the area, and well-drained ground close to the Lake Innes Nature Reserve. However, no cultural materials were found in such a context despite intensive search of numerous high quality compact clay exposures on the forested hillcrest beside Houston Mitchell Drive, water erosion features, cattle tracks and bank cuttings along the stream channel, and animals tracks and diggings on the terminal end of the central northern spur adjacent to the Nature Reserve.

In view of the survey findings and the fact that over 95% of the Stage 1A area comprises hillslopes and flats (Table 4) devoid of any micro-topographic features (terraces, rises, mid-slope benches etc) which are likely to have attracted Aboriginal occupation in their own right, the area as a whole is assessed to have a low level of archaeological sensitivity. As detailed in Section 7.3, however, it is estimated that as little as 1.4% of the Stage 1A area was subject to effective coverage and although its archaeological resource is unlikely to be large, at least some site locations will probably have gone undetected. Even so, the study area contains no surface stone materials suitable for tool production, and despite the constraints imposed by surface vegetation, at least some evidence of any dense and/or spatially extensive artefact or shell scatter should have been detectable on exposures offered by potentially sensitive landform elements. It is thus concluded that any future urban development, regardless of its nature or intensity, would be highly unlikely to affect any sites or materials of high cultural or archaeological significance.

In tandem with the Middle Rock Point and Rainbow Beach middens, the 12 Aboriginal site locations recorded in the Ocean Fields area further east (Collins 1996a; Happ and Bowdler 1983), suggest an Aboriginal landuse strategy which focussed on the coastline and productive coastal fringes. With its shoreline pebble beds, backswamps, and permanent stream with an estuarine reach surrounded by littoral rainforest, Ocean Fields seems to have offered preferred camping conditions for Aboriginal groups who could have scheduled short hunting and gathering excursions into areas like Stage 1A within the mainstream economy of their coastal camps. This type of landuse strategy would be unlikely to result in the discard of anything more than the occasional artefact or very small artefact scatter in the subcoastal forests, and may account for the perceived low archaeological potential of areas like that assessed in this report. It is notable that past surveys of coastal hinterland land parcels in the Lake Cathie-Bonny Hills locality have reached similar conclusions, resulting in either no sites detected (Collins 1996b, Bonhomme 1987), or the detection of small artefact occurrences of between one and five artefacts (eg Collins 1993, 1995).

9 STATUTORY OBLIGATIONS

Aboriginal sites and places of significance to Aboriginal people in NSW are protected by legislation. As stated by Bowdler (1983:17), "the emplacement of such legislation is confirmation that the people of this state recognise the scientific, historic and social value of the material evidence of their past". Generally, all Aboriginal objects in NSW are protected under the provisions of the National Parks and Wildlife Act (1974).
Under the terms of the Act, an Aboriginal object (previously a relic) is defined as:

> "any deposit, object or material evidence, not being a handicraft made for sale, relating to indigenous and non-European habitation of the area that comprises New South Wales, being habitation both prior to and concurrent with the occupation of that area by persons of European extraction" (Section 5[1])

In accordance with the Act an Aboriginal object may not be disturbed, defaced, damaged or destroyed without written authority from the NPWS Director-General. The provisions apply to all Aboriginal cultural materials regardless of their previous disturbance history. Should any proposed development require the destruction of Aboriginal cultural material, a Heritage Impact Permit must first be granted by the Director-General. Such a permit is normally only issued following review of a specialist report, assessment of the site's significance, advice from the local Aboriginal community and consideration of all alternative conservation options. Except where destruction of an Aboriginal site or object is or will be demonstrably unavoidable, the Director-General's policy is to require conservation within its original location and context.

10 RECOMMENDATIONS

As there were no Aboriginal sites or areas of potential archaeological deposit found during the survey, site-specific significance assessment and management recommendations are not necessary, and given the perceived low sensitivity of the Stage 1A Environmental Study area, no additional future archaeological survey or investigation is considered to be warranted. However, should parts of the area be rezoned to allow urban development to proceed at any time, it is recommended that the following precautionary measure be implemented.

➢ All contractors engaged in vegetation clearing and/or initial earthworks in areas targeted for development should be advised of their legal requirements with regard to Aboriginal cultural materials. Under the terms of the National Parks and Wildlife Act (1974) it is illegal for any person to knowingly disturb, deface, damage or destroy, or to permit the disturbance, defacement, damage or destruction of an Aboriginal object without first obtaining written consent to do so from the NPWS Director-General. This means that should any materials thought to be of Aboriginal origin be detected during any stage of development, work must immediately cease in their locality. Appropriate management advice should then be sought from both the NPWS Northern Zone Cultural Heritage Unit at Coffs Harbour and the appropriate Local Aboriginal Land Council (Birpai or Bunyah). Work should not resume in the subject locality until formal written clearance has been given by both of these organisations.

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GLOSSARY

ALLUVIAL PLAIN
A level landscape unit with extremely low relief. There may be frequently active erosion and aggradation by channelled and overbank stream flow, or the landforms may be relict to these processes (Speight 1990:48).

ALLUVIUM
General term for detrital deposits made by rivers or streams (Lapidus 1987:18).

ARCHAEOLOGICAL SITE
A place containing cultural materials of sufficient quality and quantity to allow inferences about human behaviour at that location (Plog *et al* 1978:383).

ARTEFACT
Any object having attributes as a consequence of human activity (Dunnell 1971).

BANK
A very short, very wide slope, moderately inclined to precipitous, forming the marginal upper parts of a stream channel and resulting from erosion or aggradation by channelled stream flow (Speight 1990:25).

BENCH
A short, gently or very gently inclined minimal mid-slope landform element eroded or aggraded by any agent (Speight 1990:25).

CONGLOMERATE
A coarse-grained clastic sedimentary rock, composed of rounded fragments or particles at least 2mm. in diameter (granules, pebbles, cobbles, boulders), set in a fine-textured matrix of sand or silt and commonly cemented by calcium carbonate, silica, iron oxide or hardened clay (Lapidus 1987:119).

CREST
Landform element standing above all or most points in the adjacent terrain. Usually smoothly convex (Speight 1990:13).

DUNE
A moderately inclined to very steep ridge or hillock built up by the wind (Speight 1990:30).

ESTUARY
A stream channel close to its junction with the sea, where the action of channelled stream flow is modified by tides and waves (Speight 1990:30).

HILL
Part of a landsystem of high relief with gently inclined to precipitous slopes. Fixed, shallow erosional stream channels, close to very widely spaced, form a non-directional or convergent integrated tributary network (Speight 1990:51).

HILLCREST
A very gently inclined to steep crest, smoothly convex, eroded mainly by creep and sheet wash (Speight 1990:31).

HILLSLOPE
A gently inclined to precipitous slope, commonly simple and maximal, eroded by sheet wash, creep, or water-aided mass movement (Speight 1990:31).

LANDFORM ELEMENT
A topographic feature of 40m. or more in maximum dimension which forms part of a larger unit, the landform pattern (Speight 1990:9).

LOWER SLOPE
A slope landform element not adjacent below a crest or flat but adjacent above a flat or depression (Speight 1990:11-34).

MID-SLOPE
A slope landform element not adjacent below a crest or flat and not adjacent above a flat or depression (Speight 1990:11-34).

PLAIN
A large very gently inclined or level element, of unspecified geomorphological agent or mode of activity (Speight 1990:32).

PODZOLIC SOIL
Soils with a strongly bleached eluvial horizon (Charman 1978:108).

RIDGE
A compound landform element comprising a narrow spine crest and its immediately adjoining slope with the spine length being greater than the width (Speight 1990:19).

RISES
A landform pattern of very low relief (9-30m) and very gentle to steep slopes. The fixed erosional stream channels are closely to very widely spaced and form a non-directional to convergent, integrated or interrupted tributary pattern (Speight 1990:55).

SILCRETE
A siliceous duricrust composed of sand and gravel cemented by opal, chert and quartz, formed by chemical weathering and water evaporation (Lapidus 1987:472).

SPUR
Landform element comprising a lower, subsidiary ridge leading down from a locally dominant ridge or crest (Packard 1992:100).

STONE ARTEFACT
Fragment of stone which generally possesses one or more of the following characteristics:
• Positive or negative ring crack
• Distinct positive or negative bulb of force
• Definite eraillure scar in position beneath a platform
• Definite remnants of flake scars (i.e.dorsal scars and ridges)
These traits indicate the application of an external force to a core, and are characteristic of the spalls removed by humans using direct percussion. Stone artefacts which have none of the above may be identified as such if they possess ground facet/s characteristic of human industry (Hiscock 1984:128).

STREAM CHANNEL
A linear, generally sinuous open depression, in parts eroded, excavated, built up and aggraded by channelled stream flow. This element comprises stream beds and banks (Speight 1990:33).

SWAMP
An almost level, closed, or almost closed depression with a seasonal or permanent water table at or above the surface, commonly aggraded by overbank stream flow (Speight 1990:33).

UPPER SLOPE
A slope landform element adjacent below a crest or flat but not adjacent above a flat or depression (Speight 1990:11-34).

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APPENDIX

Report from the Birpai Local Aboriginal Land Council/
Mingaletta Aboriginal Corporation

Archaeological Report.

Lake Cathie Bonny Hills Stage 1A Environmental Study

Aboriginal Heritage Assessment

Location of Archaeological Survey

The study area is between the coastal towns of Lake Cathie and Bonny Hills which is approximately 18 km South of Port Macquarie.

The Survey area covered an area of 69 hectares comprising of Lots 1 and 4 DP255923, Lots 2 and 3 DP 706357 Lot 3 DP 634929 Lot 5 DP 594793 and Lots 33 and 34 DP 803810 and Lot 3 DP 634929.
These Lots adjoin the northern boundary of Ocean Drive on the northern outskirts of Bonny Hills. The larger area lies approximately 2 kms further north but south of Lake Cathie It is bounded to the South and South-east by Ocean Drive. to the South West by Houston Mitchell Drive and then to the West by Burrawan State forest, the north of the survey area is covered with develooped, undeveloped land and the Lake Innes Nature Reserve.

The Survey

The survey was traversed on foot by myself and by Mrs Jackie Collins the Archaeologist employed to do the survey It was conducted on the 25th October 2002.
All observations were recorded by Jackie Collins who used a logbook and photographs were used to rcord all relevant data.

Results

No archaelogical sites or areas of potential archaeological deposits were found during the survey. Therefore in regards to Aboriginal concerns with the area it has been concluded that no further investigation is warranted ahead of any future urban development.

However it must be noted that if, any archaeological material is unearthed during said development that all work would cease and the appropriate authorities be contacted

Yours in Unity

Lindsay James Moran
Senior Sites Officer/Mingaletta Native title claimant

11.8 APPENDIX 8. ARDILL PAYNE ENGINEERING REPORT

Greater Lake Cathie and Bonny Hills

Area 14 Master Planning Area

&

Stage 1a Urban Investigation Area

Draft
Infrastructure Assessment Report

December 2002

Ardill Payne & Partners
Consulting Civil & Structural Engineers,
Project Managers, Town Planners and Surveyors
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Contents

Introduction

Ardill Payne and partners have been commissioned, as a member of a consultancy group to investigate various aspects pertaining to constraints to future urban development of the Lake Cathie/Bonny Hills region designated Area 14 and more particularly the area described as Stage 1a Urban Investigation.

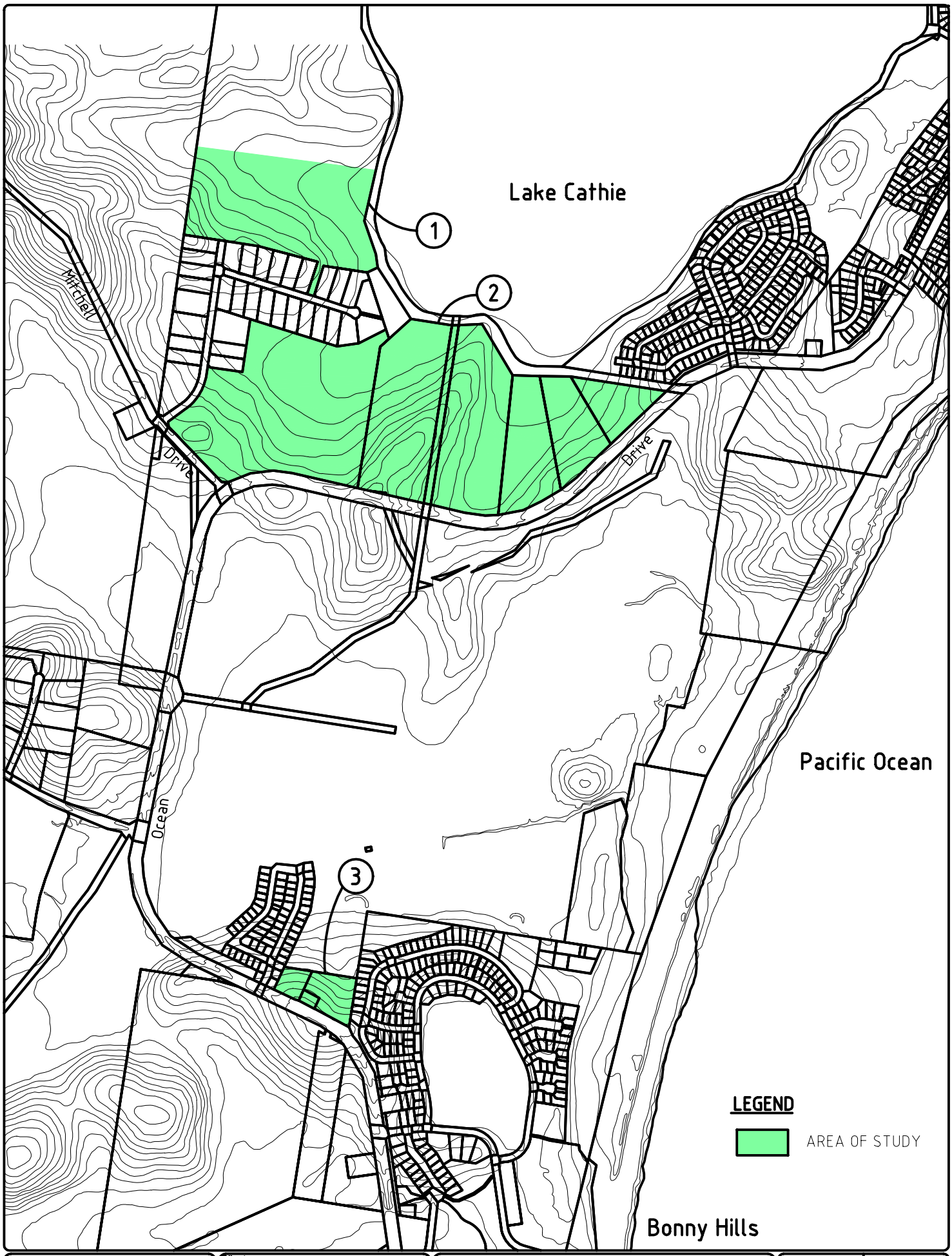
The matters to be addressed in this report are as follows

- Soils and geotechnical constraints
- Acid Sulfate soil
- Hydrology, drainage, flooding and water quality
- Water supply and sewerage
- Access and Road Network
- Power and Telephone Services

This report is based on the following

- Desktop audits of various studies, documents and mapping provided by Hastings Council,
- Workshops involving Council staff, Government Agencies and Authorities,
- Public meeting and workshop and
- site inspections.

Fig 1, Site Locality Map, identifies the 3 segments of the study area, Area 14, within the Lake Cathie/Bonny Hills coastal area and highlights access routes to the study area.



Project: Figures Associated with Lake Cathie - Bonny Hills Draft Local Enviromental Study 2002	**Client:** Hastings Council **Title:** Site Locatity Mapping Plan	**ARDILL PAYNE & PARTNERS** Consulting Civil & Structural Engineers Project Managers & Town Planners 79 Tamar Street, P.O. Box 20, BALLINA NSW 2478 Telephone: 02 6686 3280 Facsimile: 02 6686 7920 Email: info@ardillpayne.com.au	Design Drawn MJM Date 28-2-03 Checked Job No. 5551 Scale at A3 1:10000 Datum AHD Filename 5551fig-1.0 Approved Dwg. No. Fig1.0 Issue

Soil Landscapes and Geotechnical Assessment

Fig 2.0 details soil landscape zones extracted from draft 1:100,000 mapping of soil landscapes of the Camden Haven currently being prepared by Department of Land and Water Conservation and has yet to be ratified prior to formal publication.

The soil landscapes for Area 14 are described later in this report

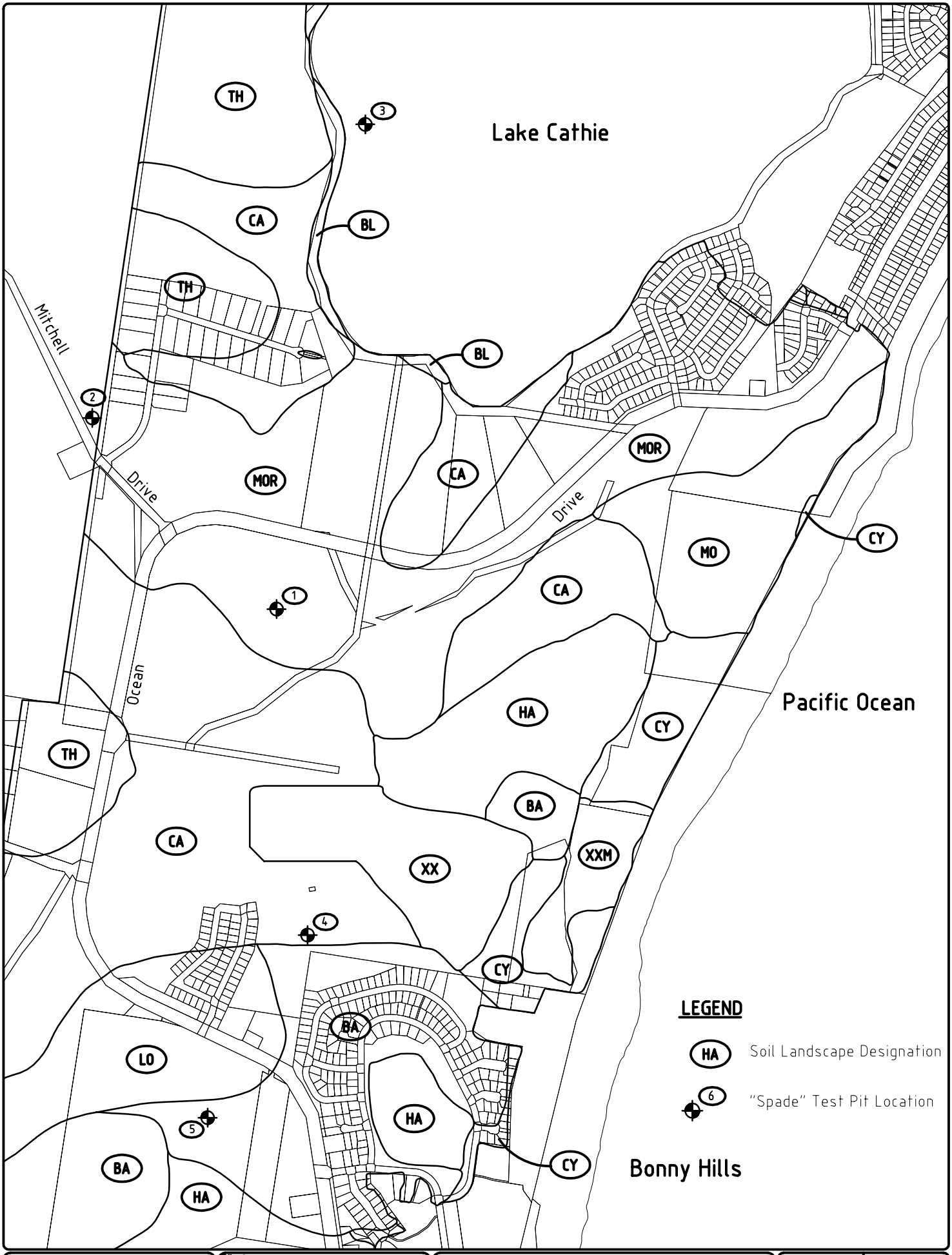
Fig 2.0 also shows a number of individual soil sample assessments recorded within the Department of Land and water Conservation's NSW Soil and Land Information System. Detail reports generated by the Department's Internet database - Soil Profile Attribute Data Environment (SPADE) for 4 samples in generally close proximity to the study area are included in this assessment.

Generally the higher elevations of segments 1 and 2 contain moderately well drained soils of strong structure although they do have the potential to become seasonally waterlogged and are subject to erosion. Detail soils investigation should be carried out to determine foundation requirements for future development.

The lower regions of segments 1 and 2, generally following natural gully lines, are characterised by poorly drained soils with high subsoil plasticity, low wet bearing strength and strong acidity. They are also subject to seasonal waterlogging and have the potential to create erosion and foundation hazards.

Segment 3 has moderately well drained soils with low wet bearing strength. The soils in this area also have the potential to create erosion and foundation hazards.

Whilst the soils in the study area do require further investigation to determine appropriate design parameters for future development construction works associated with building foundation, road pavements and drainage infiltration they are not expected to have any significant limiting factor that would preclude future development from occurring.



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Title:	Soil Landscapes Mapping Plan

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Soil LandscapeDescriptions of Area 14

ba BURRAWAN *Residual Landscapes*

Landscape— Gently undulating rises and low hills, on sediments of the Camden Haven Group (Rec). Relief 10 – 30 m, elevation 5 – 40 m, slopes 3 – 10%. Tall open-forests, often cleared for grazing, horticulture and urban development.

Soils—Well-drained, 90 – 150 cm, Red/Brown Kurosols/Dermosols (Red or Brown Podzolic Soils), with imperfectly-drained Mottled Yellow Kurosols (Yellow Podzolic Soils) on lower slopes.

Significant Soil & Land Qualities— Soils with low wet bearing strength, organic topsoils, high erodibility, low subsoil permeability, strong acidity, aluminium toxicity potential. Hardsetting surfaces, localised poor drainage, localised high run-on, localised seasonal waterlogging, water erosion hazard, and foundation hazard.

bl BELMORE *Swamp Landscapes*

Landscape— Extensive flat seasonally inundated plain on Holocene estuarine lagoon sediments of Lake Innes and Lake Cathie, often inundated. Sedgelands and open water.

Soils— > 200 cm, poorly drained, sandy Sulphidic Hydrosols (Humic Gleys) and Sulphidic Organosols (Acid Peats).

Significant Soil & Land Qualities— Organic soils with low wet bearing strength, sodicity, low permeability, acid sulfate soils, strong acidity, high aluminium toxicity potential, salinity. Poor drainage, high flood hazard, seasonal waterlogging, permanently high watertables, foundation hazard, soil fire hazard.

ca CAIRNCROSS *Transferral Landscapes*

Landscape—Narrow open depressions below low hills, grading to broad drainage plains, on slope-wash and valley infill clays and silts. Slopes <4%, relief <2 m, elevation 5 – 10 m. *Eucalyptus tereticornis* and *E. robusta* woodlands and open swamp forests, often partly cleared.

Soils— Poorly drained, > 300 cm, Mottled Brown or Grey Kurosols (Gleyed Podzolic Soils) and Sodosols (Soloths).

Significant Soil & Land Qualities— Soils with high subsoil plasticity, shrink-swell potential, organic topsoils, low wet bearing strength, sodicity, low permeability, strong acidity, aluminium toxicity potential, low fertility. Poor drainage, hardsetting surface, high run-on, localised flood hazard, seasonal waterlogging, erosion hazards, foundation hazard.

cy CROWDY BAY *Aeolian Landscapes*

Landscape— Low inner-barrier beach-ridge plain on Pleistocene back-barrier sand (Qad). Relief 1 – 2 m, elevation 2 – 10 m, slopes < 3%. Complexes of mallee woodlands, wallum shrublands and sedgelands; occasionally cleared for residential development and sand mining.

Soils— >300 cm, rapidly drained Aeric Podosols (Podzols), and poorly-drained Humic Aquic Podosols (Humus Podzols).

Significant Soil & Land Qualities— Sandy soils with high erodibility, high permeability, very low available water-holding capacity, low fertility. Rapid drainage, groundwater pollution hazard, localised seasonal waterlogging, high wind erosion hazard, non-cohesive soils, localised low moisture availability, high landscape fire hazard.

ha HARRINGTON *Aeolian Landscapes*

Landscape— Level backbarrier sandplains on Pleistocene clayey sands with seasonally high water tables. Local relief <1 m, elevation 1 – 2 m, slopes < 3%. Open (dry sclerophyll) forests, occasionally cleared and disturbed by urban development.
Soils— > 300 cm, imperfectly drained Semiaquic Podosols (Podzols) and Aquic Podosols (Humus Podzols).
Significant Soil & Land Qualities— Sandy soils with high erodibility, strong acidity, low available water-holding capacity, low fertility. Localised impeded drainage, seasonal waterlogging, groundwater pollution hazard, localised acid sulfate soils, high wind erosion hazard, non-cohesive soils, low moisture availability, high landscape fire hazard.

lo LORNE *Erosional Landscapes*

Landscape— Rolling hills of the Lorne Basin Hills, dominantly on lithic sandstones and conglomerates of the Camden Haven Group (Rec). Relief 90 – 200 m, elevation up to 500 m, slope range 20 – 33%. Tall open-forests, often cleared for grazing.
Soils— Moderately well drained, 80–180 cm, catenary sequences of Red Kurosols (Red Podzolic Soils) on upper slopes and Brown Kurosols (Yellow Podzolic Soils) on lower slopes.
Significant Soil & Land Qualities— Soils with low wet bearing strength, organic topsoils, high erodibility, strong acidity, and aluminium toxicity potential. Localised high run-on, hardsetting surfaces, locally shallow soils, water erosion hazard, and foundation hazard.

mo MORIPO *Erosional Landscapes*

Landscape— Rolling low hills, on metadolerites (Pdk) & dacites (Dlw). Slopes moderate (10 – 33%) but slope variants range from < 10% up 50% slope. Elevation and relief up to 150 m. Tall open forests, often cleared for grazing and rural residential development.
Landscape Variant mor— Residual variant. Undulating rises, gradients <10%, elevation and relief up to 40 m.
Soils— Moderately well drained, stony, 50 – 150 cm, Brown and Yellow Dermosols (Prairie Soils, Xanthozems, and soils similar to Yellow or Brown Earths) and Brown Chromosols (Yellow Podzolic Soils).
Significant Soil & Land Qualities— Stony soils with strong structure, high erodibility, neutral to moderate alkalinity. Gully erosion risk, localised shallow soils, localised high run-on, localised seasonal waterlogging, foundation hazard.

th THRUMSTER *Residual Landscapes*

Landscape— Undulating to rolling rises and low hills, on Palaeozoic metamorphic complexes. Relief 10 – 50 m, elevation 10 – 60 m, slopes 3 – 15%. Tall open forests with subtropical rainforest, extensively cleared for urban development, grazing and horticulture.
Soils— 200 – 300 cm, well drained Red Ferrosols (Krasnozems) on crests, tending shallower on steeper sideslopes, with 200 – 300 cm, imperfectly drained Mottled Brown Kurosols (Red Podzolic Soils) downslope.
Significant Soil & Land Qualities— Soils with strong structure, strong acidity, aluminium toxicity potential, high plasticity, high topsoil fertility. Productive arable land, deep soils, localised rill erosion risk, localised seasonal waterlogging, localised mass movement risk, woody weeds.

xx DISTURBED TERRAIN *Disturbed Landscapes*

Landscape— Level to hummocky terrain, extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Variable relief and slopes. Includes quarries, tips, land reclamation and large cut and fill features. Original vegetation cleared, and weeds may be abundant.

Landscape variant xxm— Materials variant. Unconsolidated sandy or gravelly materials.

Soils— Various Anthroposols. Original soil has been removed, greatly disturbed or buried. Landfill includes soil, rock, building and waste materials.

Significant Soil & Land Qualities— Soils with high variability which may include foundation hazard, unconsolidated low bearing strength materials, impermeability, poor drainage, very low fertility, toxic materials and wind erosion hazard. Sources of sediment and groundwater contamination.

Soil Profile from SPADE

reference test pit No. 1 on Fig 2.0

Site Location:	Pacific Drive 400m E of Housten Mitchell Drive.
Map Reference:	AMG Grid Reference 483940E, 6507340N; Longitude 152.830761, Latitude -31.568741; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details:	Soil Landscapes of the Camden Haven 1:100 000 Sheet Survey, Profile 227, collected by Michael Eddie on August 25, 1999
Physiography:	hillcrest under wet sclerophyll forest on dolerite lithology and used for volun./native pasture. Slope 7% (measured), elevation 20 m. Surface condition is self mulched, profile is well drained, erosion hazard is slight, and no salting evident
Soil Type:	Melanic-Mottled Eutrophic Brown Dermosol (ASC), Prairie Soil(GSG)

Soil Description:

Layer 0	Coarse fragments are common (10-20%), as substrate, coarse gravel (20-60 mm),cobbles (60-200 mm)
Layer 1 00.00 - 00.12 m A Horizon	clay with strong pedality(polyhedral, 10-20 mm, rough-faced peds), abundant (>100/10x10cm) roots (<1mm), field pH is 6. Coarse fragments are common (10-20%), as substrate, pans are not evident, segregations are not evident; gradual (50-100 mm) boundary to ...

Layer 2 00.12 - 00.30 m BC Horizon	silty clay with strong pedality(angular blocky, 10-20 mm, smooth-faced peds), common (10-25/10x10cm) roots (<1mm), field pH is 7. Coarse fragments are abundant (50-90%), as substrate, coarse gravel (20-60 mm),cobbles (60-200 mm),stones (200-600 mm), pans are not evident, segregations are not evident; gradual (50-100 mm) boundary to ...
Layer 99 ? m	strong mod. weathered rock dolerite

reference test pit No. 2 on Fig 2.0

Site Location:	200m W Spring Ridge Rd turnoff
Map Reference:	AMG Grid Reference 482800E, 6508500N; Longitude 152.818768, Latitude -31.558258; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details:	Soil Landscapes of the Camden Haven 1:100 000 Sheet Survey, Profile 220, collected by Michael Eddie on December 02, 1998
Physiography:	hillcrest under dry sclerophyll forest on dolerite lithology and used for logged native forest. Slope 12% (measured), elevation 35 m, aspect south. Surface condition is gravelly, firm, profile is well drained, erosion hazard is slight
Soil Type:	Haplic Brown Dermosol (ASC), Yellow Podzolic Soil(GSG)

Soil Description:

Layer 0	Coarse fragments are common (10-20%), as parent material, fine gravel (2-6 mm),gravel (6-20 mm),coarse gravel (20-60 mm)
Layer 1 00.00 - 00.14 m A Horizon	sandy clay with weak pedality(polyhedral, 5-10 mm, earthy), many (25-100/10x10cm) roots (<1mm), field pH is 6.5. Coarse fragments are few (2-10%), as parent material, fine gravel (2-6 mm),gravel (6-20 mm), pans are not evident, segregations are not evident, not evident; abrupt (5-20 mm) boundary to ...
Layer 2 00.14 - 00.55 m B Horizon	sandy clay with moderate pedality(sub-angular blocky, 10-20 mm, smooth-faced peds), few (1-10/10x10cm) roots (<1mm), field pH is 6.5. Coarse fragments are many (20-50%), as parent material, gravel (6-20 mm),coarse gravel (20-60 mm), pans are not evident, segregations are not evident

Layer 99 00.55 m	moderately strong slightly weathered rock dolerite

reference test pit No. 3 on Fig 2.0

Site Location:	LAKE CATHIE - W EDGE OF SWAMP
Map Reference:	AMG Grid Reference 484200E, 6508760N; Longitude 152.833523, Latitude -31.555933; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details:	ACID SULPHATE SOILS - CAMDEN HAVEN Survey, Profile 78, collected by Trevor Flewin on September 30, 1994
Physiography:	swamp under swamp complex on lacustrine,clay lithology and used for National/State Parks. elevation 1 m. Surface condition is soft, profile is poorly drained, erosion hazard is slight, and no salting evident
Soil Type:	Regolithic Sulphidic Hemic Organosol (ASC), Acid Peat Soil(GSG)
Profile Field Notes:	Meleluca quinquenervia scattered, rush dominant.

Soil Description:

Layer 0	Coarse fragments are not evident
Layer 1 00.00 - 00.68 m P Horizon	hemic peat, abundant (>100/10x10cm) roots (<1mm), many (25-100/10x10cm) roots (1-2mm), field pH is 5.5. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Hemic to sapric peat, thick rush mat on surface, H2S smell evident.; sharp (<5 mm) boundary to ...
Layer 2 00.68 - 01.60 m C strong gleying Horizon	clay with massive structure, common (10-25/10x10cm) roots (<1mm), few (1-10/10x10cm) roots (1-2mm), field pH is 9. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Soft clay, very silky feel, high organics content, faint H2S smell.; clear (20-50 mm) boundary to ...
Layer 3 01.60 - 01.80 m 2D strong gleying Horizon	clay with massive structure, few (1-10/10x10cm) roots (<1mm), field pH is 8.5. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Grey clay with orange mottles 2 - 10%.

reference test pit No. 4 on Fig 2.0

Site Location:	N OF BONNY HILLS - HOUSING ESTATE
Map Reference:	AMG Grid Reference 484031E, 6506385N; Longitude 152.831704, Latitude -31.577358; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details:	ACID SULPHATE SOILS - CAMDEN HAVEN Survey, Profile 51, collected by Trevor Flewin on August 05, 1994
Physiography:	plain in stagnant alluvial plain under unknown on marine,sand lithology and used for urban. Slope 1% (estimated), elevation 5 m. Surface condition is soft, profile is poorly drained, erosion hazard is slight, and no salting evident
Soil Type:	Acidic Tenosolic Redoxic Hydrosol (ASC), No suitable group(GSG)
Profile Field Notes:	Urban development zone, artificial lakes.

Soil Description:

Layer 0	Coarse fragments are not evident
Layer 1 00.00 - 00.25 m	clay loam,clay loam with weak pedality(polyhedral, 1-2 mm, earthy), many (25-100/10x10cm) roots (<1mm), few (1-10/10x10cm) roots (1-2mm), field pH is 5. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Large structure unidentifiable with auger, slaked slightly.; abrupt (5-20 mm) boundary to ...
Layer 2 00.25 - 00.36 m	clay with weak pedality(polyhedral, 2-5 mm, earthy), many (25-100/10x10cm) roots (<1mm), few (1-10/10x10cm) roots (1-2mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are not evident; abrupt (5-20 mm) boundary to ...
Layer 3 00.36 - 01.50 m	clay with massive structure, few (1-10/10x10cm) roots (<1mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are common (10% - 20%), fine (< 2 mm), not identified; clear (20-50 mm) boundary to ...
Layer 4 01.50 - 01.80 m	sandy clay with massive structure, few (1-10/10x10cm) roots (<1mm), field pH is 6. Coarse fragments are not evident,

	pans are not evident, segregations are not evident. Layer notes are Stiff clay, few to nil roots.; abrupt (5-20 mm) boundary to ...
Layer 5 01.80 - 01.95 m	clayey sand with massive structure(sandy), none roots (<1mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are not evident. Layer notes are Slight H2S smell. Wet bolus.
Layer 6 01.95 - 02.10 m	sandy clay with massive structure(sandy), none roots (<1mm), field pH is 6. Coarse fragments are not evident, pans are not evident, segregations are many (20% - 50%), not identified. Layer notes are Orange segregations are firm (colour is dominant mottle), strong H2S smell.; clear (20-50 mm) boundary to ...

reference test pit No. 5 on Fig 2.0

Site Location:	Unknown
Map Reference:	AMG Grid Reference 483738E, 6505850N; Longitude 152.828607, Latitude -31.582181; CAMDEN HAVEN (9434) 1:100,000 sheet
Profile Details:	OBSCRALNE - CAMDEN HAVEN Survey, Profile 13, collected by Mitch Tulau on April 21, 1998
Physiography:	hillcrest under dry sclerophyll forest on sandstone-lithic lithology and used for timber/scrub/unused. Surface condition is firm, profile is mod. well drained, erosion hazard is slight, and no salting evident
Soil Type:	Yellow Kurosol (ASC), Yellow Podzolic Soil(GSG)

Soil Description:

Layer 1 00.00 - 00.10 m A1 Horizon	dark sandy loam with weak pedality(crumb, 2-5 mm, rough-faced peds). Layer notes are Brownish black sandy loam.; wavy clear (20-50 mm) boundary to ...
Layer 2 00.10 - 00.30 m A2 Horizon	brown sandy clay loam with weak pedality(sub-angular blocky, 50-100 mm, earthy). Layer notes are Dull light brown sandy clay loam.; wavy clear (20-50 mm) boundary to ...
Layer 3 00.30 - 00.80 m B2 silicate clay Horizon	orange sandy clay with moderate pedality(sub-angular blocky, 20-50 mm, smooth-faced peds). Layer notes are Orange sandy clay.; irregular gradual (50-100 mm) boundary to ...

Layer 4 00.80 - 01.50 m BC Horizon	orange sandy clay with weak pedality(sub-angular blocky, 50-100 mm, smooth-faced peds). Layer notes are Orange sandy clay.

Acid Sulphate Soils

Hastings Council Acid Sulfate Mapping, see Fig 3, indicates that the vast majority of the study area is not likely to be influenced by the presence of actual or potential acid sulfate soils. Those areas, which may be affected, are generally the lower lying areas adjacent natural gully lines and costal lowland. Mapping highlights these areas as having category 2 or 5 influence from acid sulfate soils.

Category 2 - Works below natural ground surface, works by which the watertable is likely to be lowered.

Category 5 - Works by which the watertable is likely to be lowered to below 1 metre AHD in adjacent Class 1, 2, 3 or 4 land.

Specifically, Category 2 soils encroach into segment 2 around the edge of Lake Cathie. It is unlikely that any development works would require any further category 2 works investigation as these areas would be incorporated into environmental buffer zones along the lake edge.

Category 5 soils mapping indicates the potential presence of acid sulphate soils in the northern portion of segment 1 area and generally consistent with the swamp oak/paperbark timbered zone fringing an existing gully draining to Lake Cathie.

Low lying gully areas within segment 2 study area are also mapped as category 5 soils.

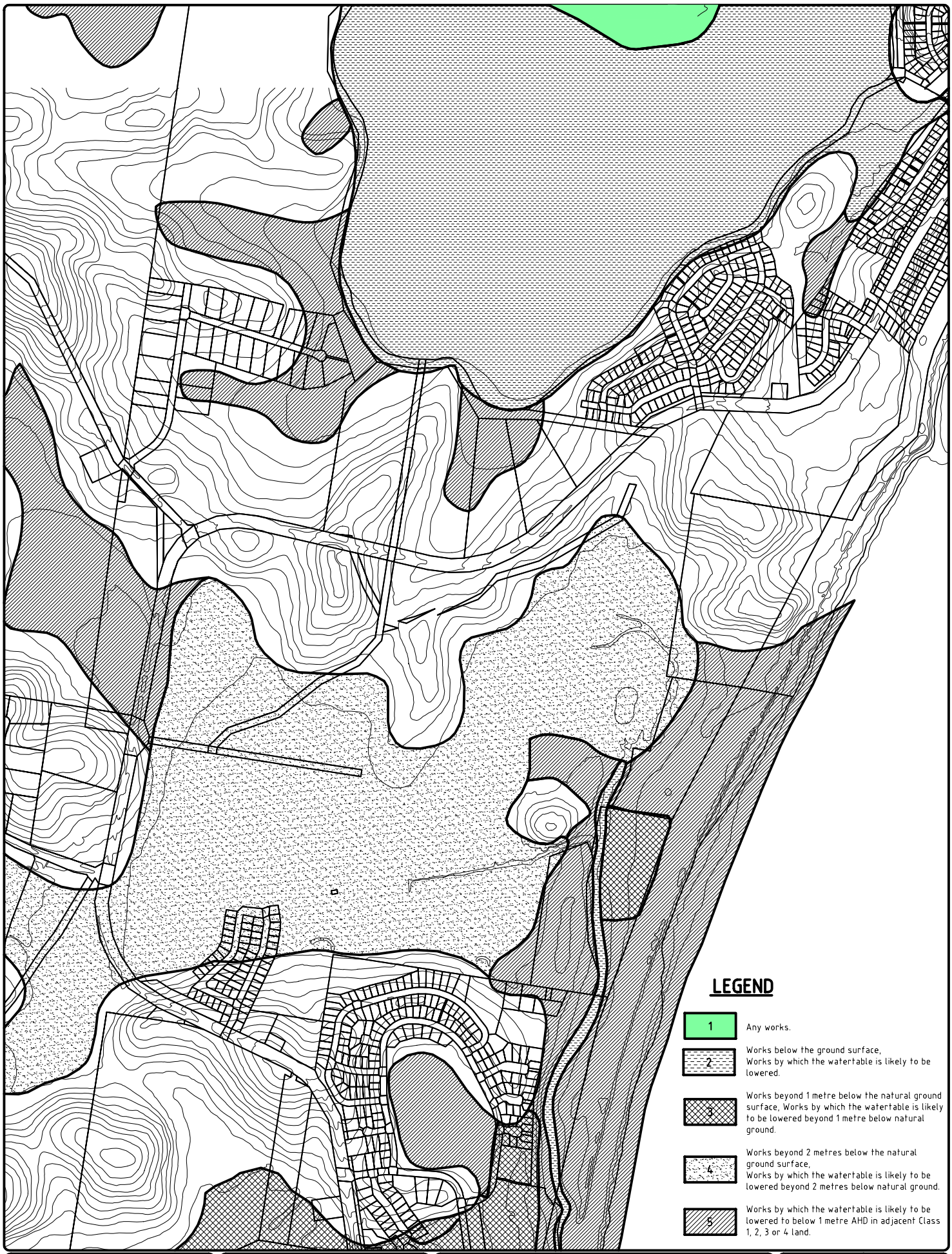
Mapping also indicates that the balance of segment 1 and 2 and the whole of segment 3 areas are not influenced by acid sulphate soils.

A review of natural drainage patterns and contours indicate that stormwater drainage is unlikely to impact acid sulfate soils due to the fact that these works are unlikely to affect ground water levels.

Sewerage reticulation works (particularly sewer pumping stations) may require further investigation into acid sulfate soils parameters. Regardless of their presence, proponents of development may accept that there will be a disturbance of acid sulphate soils associated with infrastructure construction and proceed to assess the potential impacts of disturbing these soils prior to developing a management strategy and obtaining development consent.

Alternatively, proponents may undertake field and laboratory testing to verify whether acid soils are present or not. If not present, they may proceed with their proposal. If acid sulphate soils are present assessment of impacts and development of a management strategy will be necessary.

Acid Sulphate soil mapping indicates there are no major constraints to preclude urban development from within the study areas which accords with the " area 14 " masterplan.



Project:
Figures Associated with Lake Cathie - Bonny Hills Draft Local Enviromental Study 2002

Client:
Hastings Council

Title:
Acid Sulfate Mapping
Mapping Plan

ARDILL PAYNE & PARTNERS
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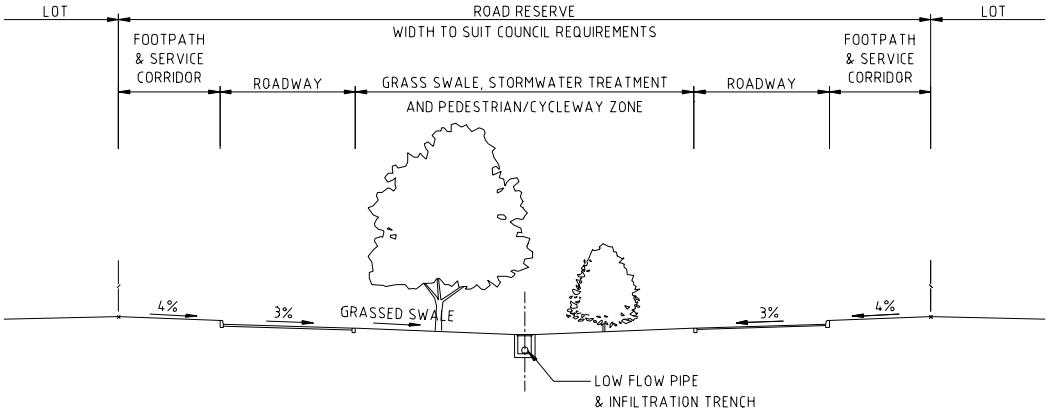
Design		Scale at A3	1:10000
Drawn	MJM	Datum	AHD
Date	28-2-03	Filename	5551fig-3.0
Checked		Approved	
Job No.	5551	Dwg. No.	Fig3.0
		Issue	

Stormwater Drainage and Water Quality

There is a need to prepare a local stormwater management strategy in advance for any new urban area. This is important for both water quality and drainage management. Particularly important are the high standards required by National Parks and Wildlife Service in relation to water quality where urban runoff has the potential to enter closed lake systems such as Lake Cathie.

The LES study areas have the potential to incorporate dual open space drainage corridors and other water sensitive urban design concepts such as detailed in the figure below.



TYPICAL CROSS SECTION OF ROADWAY SYSTEM WITH CENTRAL SWALE

The use of grass swale zones within road corridors is ideally suited to the two gully areas traversing segment 2. These swales would, in addition to providing a medium for nutrient stripping, carry stormwater runoff to the lower areas of the site. The provision of on-site “dry” detention basins in these lower regions would provide for additional nutrient stripping as well as controlling runoff volumes prior to entering Lake Cathie. Appropriately placed gross pollutant traps at the outlet of the swales would assist in pollution removal.

Where the construction of central grass swales is not possible due to topography, such as in segment 1 development area, grass swales and detention basins should be provided within buffer zones and designed in such a way as to capture and treat runoff from the urbanised areas.

Design and construction of detention basins may be influenced by potential acid sulphate soils as evidenced from acid sulphate soil mapping. This may require specific investigations to determine appropriate floor levels for basins.

Where possible at-source control of stormwater should be encouraged. The use of household rainwater tanks, water efficient landscaping and on-site detention to assist in stormwater management is canvassed in Hastings Council's Draft Development Control Plan No.48 – Energy Efficient Water Wise Residential Buildings.

Therefore, urban development within the LES area is not precluded by Stormwater Drainage Issues.

Flooding

Council's flood mapping indicated the study area is not subject to flooding. Therefore flooding does not constrain or preclude the future urbanisation of the site.

Water Supply

Lake Cathie/Bonny Hills is currently serviced by a trunk main from Transit Hill reservoir in Port Macquarie (fed by Port Macquarie supply). This main in addition to serving the Lake Cathie/Bonny Hills area provides water service to communities south to Camden Haven and inland to Kendall (collectively these areas are called the Southern Arm Communities). This 450mm trunk main can supply approximately 17 ML/day to the southern arm system under gravity.

Long range planning, by Hastings Council, for water supply has involved the provision of adequate storage capacity for coastal towns along with a distribution network that has the flexibility to cater for future growth.

Council has identified that in the short term distribution capacity is adequate to provide water to the existing urban parts of area 14. However, in the longer term water supply augmentation is required.

Council is currently involved in water supply upgrade for the region which involves the construction of a new storage facility (Cawarra Dam), pumping stations and delivery trunk mains. These upgrades have been designed to cater for projected population growth within the shire as outlined in Hastings District Water Supply Augmentation Review of Concept Report dated 1991. That report accounted for a population projection of 10480 (for area 14) in the year 2011 in formulating the water supply upgrade requirements.

That report identified that peak daily demand for the Southern Arm Communities is predicted to rise from 14.9 ML/day in 1991 to 33.5 ML/day in 2011 with an ultimate demand of 38.7 ML/day.

A comparison with population predictions between the HUGS 2001 and the Hastings District Water Supply Augmentation Review of Concept reports is provided in the table below.

year	Hugs 2001 population	Water Supply report 1999 population	Water Supply report 1999 daily demand
1986	6,707 *	6,537	n/a
1996	10,260 *	11,078	17.8 ML/d
2006	n/a	18,783	28.2 ML/d
2011	n/a	22,770	33.5 ML/d
2021/ultimate	20,610 *	26,290	38.7 ML/d

* includes 10% of coastal residue population identified in hugs report and adopts the “medium” growth option (2021 - 21,710 ep for high growth option).

The above table indicates that the augmentation proposed in Councils report will when completed have excess capacity to that required by current population predictions. The table also shows that the existing trunk main servicing the southern arm communities is currently at or near capacity under peak day demands.

Council is advancing with augmentation and works have been completed on Cawarra Dam wall and take-off tower. Council's Corporate plan 2002 to 2005 identifies that filling of the dam and commissioning of dam pumping station and balance tanks is scheduled for completion by December 2004. A new trunk feeder main from the dam to area 14 is due to be constructed and operational in 2005.

Council has also outlined a commitment to ongoing monitoring of water quality in accordance with NHMRC guidelines and to implement demand management initiatives.

Given the current time schedule for augmentation and Council's ongoing commitment to service improvement the provision of water supply would not hinder the urbanisation of segments 1, 2 & 3.

Sewerage

The existing nearby developed areas are connected to Council's reticulated sewer system via a network of gravity mains and pumping stations for ultimate processing of sewerage at the treatment plant located to the south of Lake Cathie village area and to the east of the study site generally. The treatment Plant currently discharges treated effluent to the dunal system in the coastal zone adjacent the nearby beach.

Council's Corporate Plan 2002 to 2005 has identified a commitment to the ongoing process of developing effluent management strategies to provide

concepts for implementation to meet the requirements of the Hastings Urban Growth Strategy.

The HUGS 2001 set forward a timetable for as follows

Table 3B. Area 14 (Lake Cathie and Bonny Hills)	Timing
B1. **Defer approvals for additional housing** (other than on existing vacant lots and currently approved lots)	Until STP capacity above 6,000 *ep* is approved & under construction.
B2. **Environmental Study, Structure Plan and Staging Plan** for future rezonings to increase total Area 14 population to around 11,000.	Start now.
B3. **Seek approval for STP expansion to 12,000 *ep*** capacity on the basis of a staged implementation.	Start now.
B4. Finalise design & commence construction of STP expansion to 9,000 *ep* capacity.	Follow on from 3.
B5. **Consents for subdivision and multi-dwelling development may now be granted**, within limit of total capacity of 9,000 *ep*. (Current zoned reserves could accommodate around 10,000 people)	Follow on from 4.
B6. **Proceed with staged construction of STP to 12,000 *ep*** capacity and link with regional effluent management scheme.	Follow from 3, and subject to development activity.
B7. **Rezonings & Consents** may be granted for total population around 11,000 (12,000 *ep*).	Follow on from 6 (upon start of construction).
Notes: *ep* means equivalent person - refer to Table 1 in Section 9 for explanation.	

Once again Council's Corporate Plan identifies the Lake Cathie/Bonny Hills Treatment Plant upgrade works being scheduled to occur in the period 2003 to 2005.

Conventional gravity sewers are deemed appropriate for all segments of the study area. Segments 1 and 2 may require the provision of additional sewer pumping stations if detailed design investigations reveal it is impracticle to gravitate to or augment capacity of the existing pumping stations in nearby developed areas. An assessment of existing contours information reveals development likely to occur in segment 3 should be able to gravitate to existing sewer infrastructure associated with nearby residential development.

From a sewerage infrastructure aspect there appears no reason to preclude urban development from within the study area

Access and Road Network

Road access to the area is gained from Port Macquarie, to the north, along Ocean Drive through Lake Cathie proper and from Camden Haven area to the south along Ocean Drive through Bonny Hills.

In addition the area is directly accessed via Houston Mitchell Drive from the Pacific Highway to the west. This road is generally narrow and winding in nature and may require improvements to cater for increased traffic demands generated from future development.

In 2001 SMEC Australia Pty Ltd undertook a roads and traffic study for Council. This study has established a road hierarchy plan for all existing roads. This plan recognises Ocean Drive as being retained as the Arterial Road for the area providing a key link to Port Macquarie and Laurieton. The study also recognises the need for a Bonny Hills By-pass.

Collector through roads should provide for bus access and distribution of traffic to lower order connecting roads within the development areas. The alignment and geometry of bus route streets need to be designed to facilitate bus movement without encouraging high traffic speeds. Designs also need to ensure through traffic utilised the arterial road, Ocean Drive.

All intersection and road designs must reflect the volume and size of vehicles expected to utilise the network and have due regard for safety.

The road network needs to provide a high level of internal accessibility with good connections for vehicle, pedestrian and cycle movement to urban activity centres. There needs to be appropriate traffic management systems to restrain vehicle speeds where necessary and create safe conditions for all users.

Roading may be utilised as part of a buffering system for urban development to the more sensitive areas adjacent Lake Cathie. In addition modification to design elements of Ocean Drive may be required to ensure continuity of wildlife corridors. This may be achieved by the installation of an appropriate wildlife tunnel or similar structure.

Power and Telephone Services

The existing residential areas and surrounding rural areas are serviced by Country Energy and Telstra for power and telephone services respectively.

Both power and telephone services will require augmentation to cater for an expanded population consistent with normal processes required of any urbanisation of vacant land.

The provision of these services is not deemed to preclude development of the study area.

Conclussion

It is beyond the scope of this report to quantify the final extent and capacity of infrastructure services within the development area and as such further detailed design would be required to accompany any future development application.

However, Investigations to date reveal no major constraints to future urban development within the study area allowing for appropriately designed infrastructure.