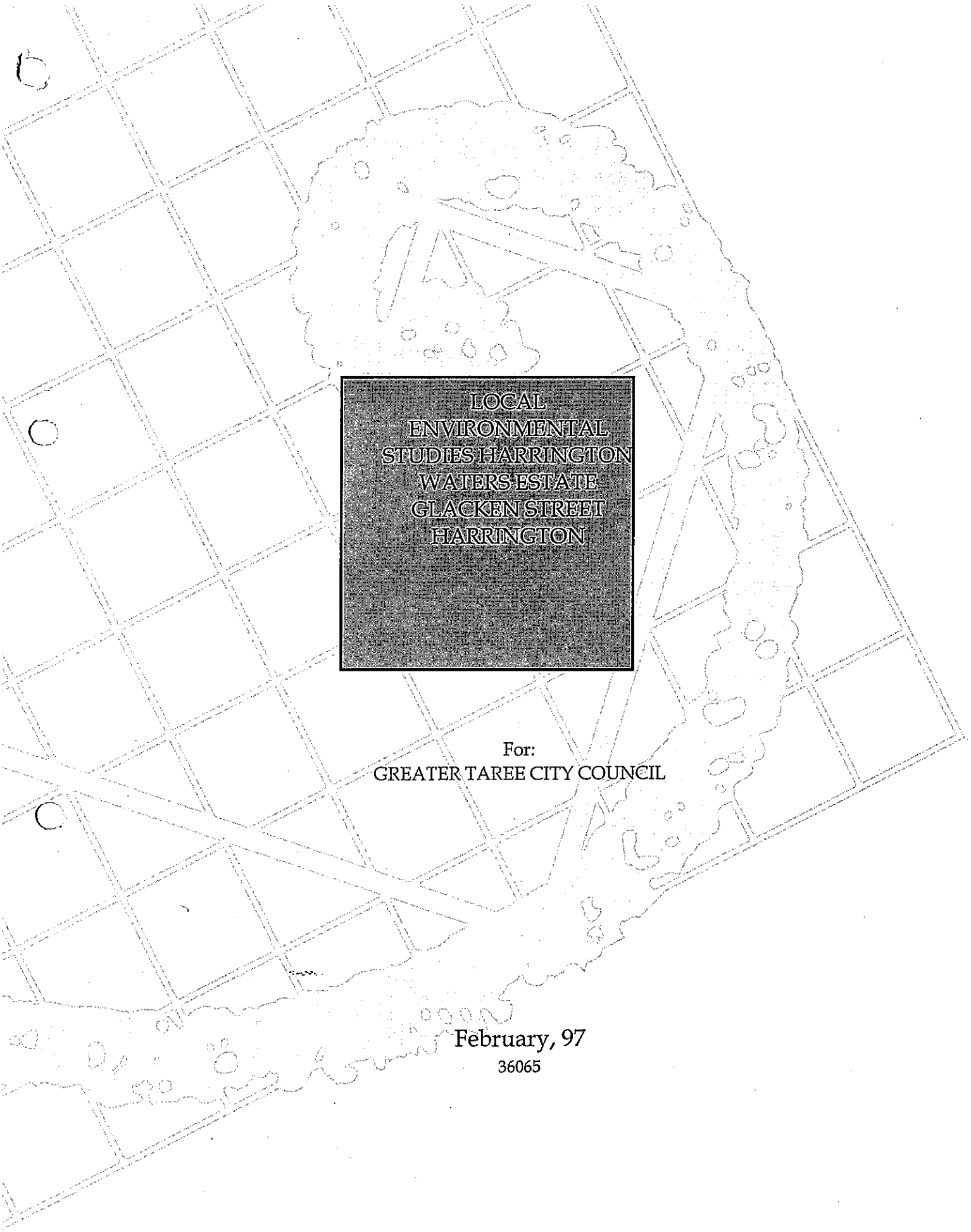

LOCAL ENVIRONMENTAL STUDIES HARRINGTON WATERS ESTATE GLACKEN STREET HARRINGTON

For:
GREATER TAREE CITY COUNCIL

February, 97
36065

ERM Mitchell McCotter Pty Ltd. A.C.N. 002 773 248. A member of the Environmental Resources Management Group.

This report was prepared in accordance with the scope of services set out in the contract between ERM Mitchell McCotter Pty Ltd (ERMMM) and Greater Taree City Council. To the best of our knowledge, the proposal presented herein accurately reflects the Council's intentions when the report was presented. However, the passage of time, application of regulators conditions or impacts of future events could modify the outcomes described in this document. In preparing the report, ERMMM used data, surveys, analyses, designs, plans and other information provided by the individuals and organisations referenced herein. While checks were undertaken to ensure that such materials were the correct and current versions of the materials provided, except as otherwise stated, ERMMM did not independently verify the accuracy or completeness of these information sources.

Approved by:	ANTHONY JOHN FISH
Position:	Project Director
Signed:	
Date:	27/2/97

ERM Mitchell McCotter Quality System

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Chapter 1

INTRODUCTION

1.1 BACKGROUND

Greater Taree City Council has resolved to prepare a draft Local Environmental Plan to facilitate urban expansion at two specific locations in the coastal village of Harrington. This report is an Environmental Study prepared under Section 57 of the Environmental Planning and Assessment Act 1979.

This report will assess and determine the suitability of the two study sites for urban expansion, conservation and other purposes and will make recommendations for the implementation of Local Environmental Plans.

1.2 LOCATION OF THE STUDY SITES

Two areas of land are examined in this report. These areas are known as Harrington Waters Estate and Glacken Street.

Harrington Waters Estate is located southwest of the village of Harrington with frontage to Harrington Road and comprises land which is currently being grazed by cattle. The location of Harrington Waters Estate is illustrated in *Figure 1.1*. The owners of this land have submitted a preliminary concept plan to Council to develop the land for the purposes of tourist-orientated development, residential housing and a golf course.

Glacken Street is located to the northwest outskirts of the village of Harrington and is currently not used for any particular purpose. The location of Glacken Street is also shown in *Figure 1.1*. The owners of this land have indicated to Council their desire to develop the land for residential housing.

1.3 CONSULTATION

A number of government authorities and community organisations have an interest in the future development of the study sites. Consequently, the following authorities and organisations were consulted and their responses considered during the preparation of this study:

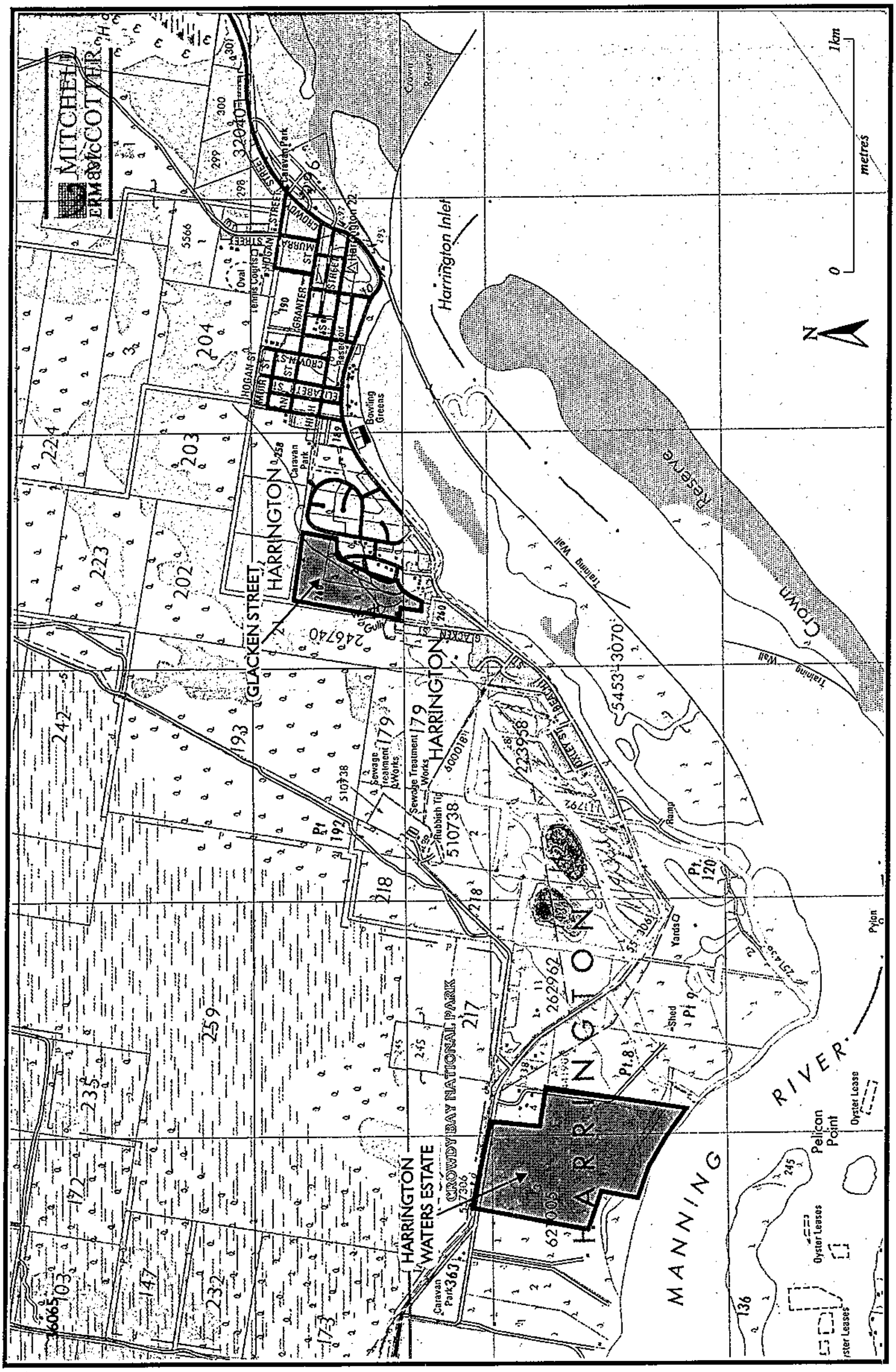

Figure 1.1 LOCATION MAP

- NorthPower;
- NSW National Parks and Wildlife Service;
- NSW Public Works;
- NSW Department of Agriculture;
- Environment Protection Authority;
- Department of Land and Water Conservation; and
- Purfleet Local Aboriginal Land Council.

Copies of the responses received from these organisations are attached as *Appendix A*.

1.4 SCOPE AND PURPOSE OF THE STUDY

Greater Taree City Council has identified that various planning and environmental issues associated with the study sites may have a bearing upon the extent of development possible and are likely to influence further investigation of the study sites.

This report examines the extent to which planning and environmental issues will restrict development potential on the study sites. This report also makes recommendations on the preferred future landuses for each site and the need for further investigations prior to the rezoning of land.

1.5 STRUCTURE OF THE REPORT

Chapter two describes the environmental characteristics of Harrington and the study sites and explains the investigative methods used to assess the issues associated with development of each site. Chapters three and four assess the environmental impacts associated with the development of each site, discuss the opportunities and constraints for development on each site and recommend the extent of rezoning that should occur for each site.

Chapter 2

ENVIRONMENTAL CHARACTERISTICS AND INVESTIGATIONS

2.1 FLOODING

2.1.1 *Rainfall and Evaporation*

The study sites receive high rainfall which is typical of the mid-north coast of New South Wales. Rainfall in the Harrington area is similar to that at Taree, the nearest recording station, which has a mean annual rainfall of approximately 1,184 millimetres. High rainfall and related flooding on the mid-north coast is usually associated with an east coast low pressure system. Typically, the wettest months are December to April whilst August and September have the lowest rainfall. Evaporation is highest between November and February and lowest over winter. Evaporation exceeds rainfall during the months August to February. Annual rainfall distribution is shown in *Figure 2.1.*

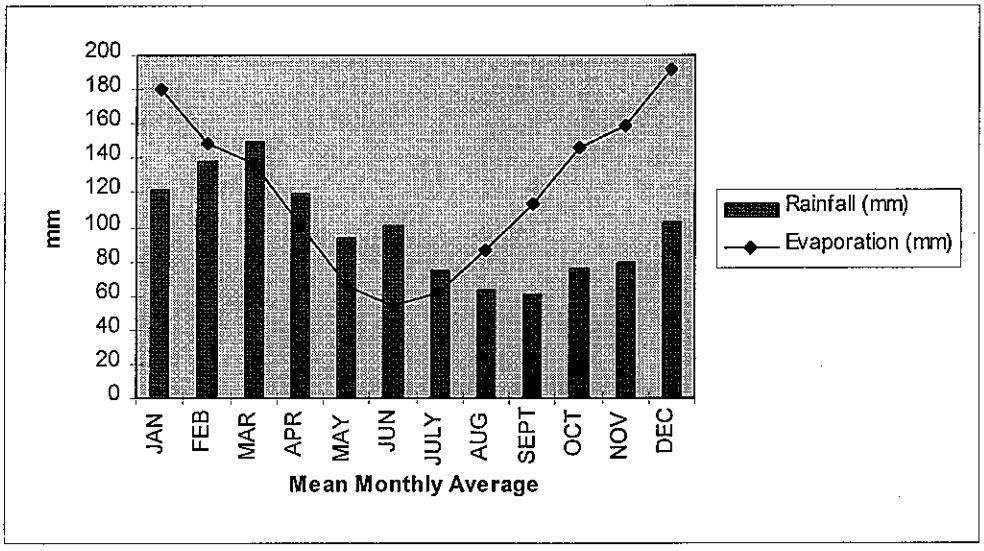

Figure 2.1 Annual Rainfall Distribution

Using the procedures described in *Australian Rainfall and Runoff* (Institution of Engineers, 1987), rainfall intensities for a range of design storms have been estimated for Harrington (*Table* 2.1).

Table 2.1 HARRINGTON DESIGN RAINFALL INTENSITIES

DURATION	RAINFALL INTENSITY (mm/hr)				
	2 YEAR*	5 YEAR*	10 YEAR*	20 YEAR*	100 YEAR*
10 Minutes	98	122	135	154	195
30 Minutes	58	73	81	93	118
1 Hour	40	50	56	64	82
12 Hours	8.6	11.2	12.7	14.7	19.3
24 Hours	5.7	7.4	8.4	9.7	12.8

* *Average Recurrence Interval*

2.1.2 *Flooding Characteristics*

The flooding characteristics of the Manning River catchment have been well documented. Investigations include the *Manning River Floodplain Management Study* (Greater Taree City Council, 1996), *Environmental Studies for Proposed Canal Development, Harrington* (Oceanics Australia, 1983), *Manning River Flood Study* (Public Works Department, 1991), *Harrington Manning River Dredge Assessment* (WBM Oceanics Australia, 1993), and *Peakhurst Property Harrington Flooding Characteristics* (WBM Oceanics Australia, 1994). Flooding characteristics of the Manning River at Harrington were obtained from these sources.

The study sites are located within the Harrington Floodplain Management Area boundary of the Manning River floodplain. The landscape is generally flat and lies entirely within the extent of the 1% Annual Exceedence Probability (AEP) flood level. The representative flood level at Harrington for the 1% AEP flood is 2.26 metres above the Australian Height Datum (AHD)(GTCC,1996).

The impacts of flooding and proposed mitigation measures necessary for each study site are discussed in Sections 3.1 and 4.1 respectively.

2.2 WATER QUALITY

2.2.1 *Existing Water Quality Parameters*

The study sites drain into the Manning River which subsequently flows into the Pacific Ocean. To date there have been no water quality data collected from the sites, however there are water quality data for the Manning River in the vicinity of the study sites as shown in *Tables 2.2 & 2.3.*

Groundwater quality from bores to the north of Harrington Village (bore numbers 4094 & 4095) was assessed by the former Water Resources Commission (1978). Test results from this study indicated that the quality of groundwater in the area is good.

Table 2.2 WATER QUALITY IN THE MANNING RIVER - PHYSICAL CHARACTERISTICS

Date	Time	Temp (oC)	Cond. (uS/cm)	Salinity (g/L)	DO (% Sat)	pH	SECCHI (m)	Max Depth (m)
5/3/83	1025	25.1	44000	28.1	102.0	---------	1.1	3.5
11/10/84	1235	23.4	34700	23.9	97.0	8.0	2.5	5.5
29/11/84	0840	22.1	31400	15.5	105.2	7.6	1.2	5.8
10/1/85	0940	23.9	46000	32.1	---------	8.0	3.0	8.0
28/2/85	1030	24.2	8950	5.0	88.4	6.9	0.6	7.5
18/4/85	1420	22.3	38000	25.7	107.8	7.6	1.5	4.7
19/9/85	0905	17.3	34800	19.8	103.5	7.2	2.0	9.2
14/11/85	0855	21.5	32000	23.5	109.4	8.0	2.3	6.5
13/3/86	1530	21.6	48000	32.0	81.0	8.1	2.0	8.0
26/6/86	1015	14.0	31000	21.9	80.7	7.7	2.3	--------

Source: Oceanics Australia, 1983; SPCC, 1987

Table 2.3 WATER QUALITY IN THE MANNING RIVER - CHEMICAL CHARACTERISTICS

Date	Time	NH3-N (mg/L)	TKN (mg/L)	NOx-N (mg/L)	Total N (mg/L)	Ortho-P (mg/L)	Total-P (mg/L)	NFR (mg/L)	VSS (mg/L)	Turbidity (NTU)	Chl a (NTU)	N:P Ratio
5/3/83	1025	0.09	0.49	<0.02	0.58	0.04	0.08	6	-	-	3.3	7.25
11/10/84	1235	-	.12	.01	0.13	.012	.031	1.9	1.55	1.5	3.0	4.19
29/11/84	0840	-	.14	.001	.141	.0073	-	6.7	2.1	3.2	7.0	-
10/1/85	0940	-	.00	.01	.012	.014	.024	11.5	1.9	3.0	4.1	.50
28/2/85	1030	.06	.52	.05	.57	.02	.058	10.0	2.8	8.5	1.6	9.83
18/4/85	1420	.06	.07	.01	.08	.027	.052	4.1	1.3	0.7	5.2	1.54
19/9/85	0905	.04	.25	.01	.26	.038	.041	2.7	1.1	1.3	1.8	6.34
14/11/85	0855	.04	.51	.01	.52	.012	.031	5.0	3.0	1.6	3.8	16.77
13/3/86	1530	.03	.28	.001	.28	.021	.034	6.0	5.2	2.0	2.4	8.26
26/6/86	1015	.07	.36	.07	.43	.012	.042	2.2	-	2.5	1.8	10.24

Source Oceanics Australia 1983; SPCC, 1987

The principal water quality issues related to urban runoff from the study sites are concerned with the potential export of a range of contaminants in runoff discharged to the downstream riparian environment. Pollutants in stormwater are generally grouped according to their water quality impact as follows:

- suspended solids which include dust and soils;
- nutrients (mainly phosphorus and nitrogen);
- biological and chemical oxygen demand (BOD and COD);
- pH (change from neutral);
- micro-organisms;
- toxic organics (such as pesticides);
- toxic trace metals;
- oils and surfactants;
- water temperature (change from existing); and
- litter.

Water quality parameters for stormwater discharges are based on guideline values which secure ecological sustainability with an adequate degree of safety (Lawrence, 1995). A summary of target water quality parameters for stormwater runoff is presented in *Table 2.4.*

The impacts upon water quality in the Manning River resulting from development of the study sites, and proposed mitigation measures are discussed in Section 3.2 and 4.2 respectively.

Table 2.4 URBAN RUNOFF AND DESIRABLE DRY WEATHER WATER QUALITY

PARAMETER	URBAN RUNOFF CONCENTRATION	DESIRABLE QUALITY RURAL	URBAN
Suspended Solids (mg/L)	150-650	<10	<10
BOD_5 (mg/L)	10-60	<2	<2
Oil and Grease (mg/L)	1-10	No visible oil or grease (typically <1)	
Faecal Coliforms (org/100ml)	10^3 - 10^6	<200	<200
Nutrients (mg/L)			
Total phosphorus	0.1-1.5	<0.05	<0.05
Total nitrogen	0.5-3.0	<0.5	<0.5
Heavy Metals (ug/L)			
Cadmium	6	<0.2	<0.4
Lead	200	<12	<25
Zinc	200	<50	<125

Source: *SPCC (1989)*

2.3 ACID SULFATE SOILS

Acid sulfate soils are acidic soil horizons which result from iron sulfide (primarily iron pyrite) accumulations in the soil. Pyrite is accumulated in low energy environments containing waterlogged soils, usually less than three metres above sea level. These areas are rich in organic matter and have been flushed by dissolved sulfate, usually from sea water. When exposed to the air, through drainage or excavation, these sulfides oxidise to produce sulfuric acid. If the amount of acid exceeds the neutralising capacity of the soil allowing the pH to drop to below 4, these soils are considered *actual* acid sulfate soils. *Potential* acid sulfate soils are soils rich in pyrite that have not yet oxidised and so do not, in their current state, pose a risk to the environment. Any disturbance of these potential acid sulfate soils which leads to the oxidation of the soil will lead to the development of actual acid sulfate soils (EPA, 1995).

Acid sulfate soils are found in sand, peat and clay, although the most extensive of these is acid sulfate clays. Acid sulfate soils represent a unique management case where the potential or actual soil problems are so severe that they can dominate most other aspects of land development (Dent, 1986).

The presence of acid sulfate soils is an important issue which requires preliminary environmental investigation.

Acid sulfate soil risk maps have been produced by the Department of Land and Water Conservation. Those maps do not differentiate between potential and actual acid sulfate soils, but rather group them as one mapping unit. The risk maps give the likely risk of the presence of acid sulfate soils and have been used as an indicator of high, low or zero probability of occurrence within a particular area. Those maps provide a useful first indicator as to the likely presence of acid sulfate soils.

The acid sulfate soil risk map was examined to determine the likelihood of acid sulfate soils occurring in the study sites. The risk map shows low and high probability of acid sulfate soil occurrence for the study sites in three acid sulfate soil landforms.

The impacts of development upon potential acid sulfate soils of the study sites and proposed mitigation measures to contain such soils are discussed in Sections 3.3 and 4.3 respectively.

2.4 SITE CONTAMINATION

A site inspection and examination of previous land uses has been undertaken to determine the potential for contamination at the study sites. The results of such investigation for each site are discussed in Sections 3.4 and 4.4 respectively.

2.5 ECOLOGY

2.5.1 Methodology

The study sites were examined on 2 November 1996. An analysis of vegetation and an opportunistic fauna survey were undertaken. Vegetation analysis involved a general description of the plant communities using qualitative field observations and interpretation from aerial photographs. The random meander technique was used to identify communities and habitats. This technique involves walking in a random manner through the site, visiting the full range of potential habitats and recording observed plant species. Plant communities have been classified using the structural characteristics of Specht (1981) as a basis. A list of observed plant species is contained in Appendix B. A list of fauna observed during the survey is contained in Appendix C.

Vegetation communities existing on each site are discussed in Sections 3.5.1 and 4.5.1 respectively. Fauna Habitats existing on each site are discussed in Sections 3.5.2 and 4.5.2 respectively.

2.5.2 Koala Habitat SEPP 44

State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44) aims to:

> *encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline.*

In the investigation of Koala habitat, potential Koala habitat is the trigger for a rezoning proposal. Potential Koala habitat is defined as:

> *areas of native vegetation where trees of the types listed in Schedule 2 (of the Policy) constitute at least 15 per cent of the total number of trees in the upper or lower strata of the tree component.*

Tree species, as listed in Schedule 2 of the Policy are given in *Table 2.5.*

Table 2.5 SCHEDULE 2 - FEED TREE SPECIES

Scientific Name	Common Name
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey Gum
Eucalyptus viminalis	Ribbon or Manna Gum
Eucalyptus camaldulensis	River Red Gum
Eucalyptus haemastoma	Broad-leaved Scribbly Gum
Eucalyptus signata	Scribbly Gum
Eucalyptus albens	White Box
Eucalyptus populnea	Bimble Box or Poplar Box
Eucalyptus robusta	Swamp Mahogany

Assessments of the likelihood of the presence of potential koala habitat were undertaken for the study sites and are presented in Sections 3.5.3 and 4.5.3 respectively.

2.5.3 *Conservation Value of Fauna Habitats*

In this report, the conservation value of fauna habitat communities has been determined by reference to:

- *Representativeness,* which describes whether the fauna habitats are unique, typical or common in the Harrington region;
- Local, regional and statewide *Reservation,* which is used as a measure of conservation value. Those habitat types with poor reservation (in reserves or national parks) have a higher conservation value;
- The *Degree of Naturalness,* which is used to indicate the extent of human influence and to identify the condition of the vegetation and habitats;
- The presence of *Special Natural Features,* which is used to indicate uniqueness in that unusual natural features might be present which may not be associated with a particular vegetation unit;

- *Habitat Links* from one habitat to another, which are features influencing the ability of an area to support viable animal populations; and
- The level of *Biological Diversity,* which indicates an area's biological richness.

Those threatened fauna species which may utilise each study site are listed in Sections 3.5.4 and 4.5.4.

The assessment of fauna habitat conservation values for each site is presented in Sections 3.5.5 and 4.5.5 respectively and will be used to help determine the development opportunities and constraints for the study sites.

2.6 BUSHFIRE MANAGEMENT

2.6.1 Methodology

The Department of Bushfire Services' *Planning for Bushfire Protection* has been used to consider the impact of bushfire on the proposed development. This method does not attempt to assign degrees of risk, rather it directs emphasis towards to overall effect of fire behaviour and site characteristics.

The Department of Bushfire Services approach considers both basic risks and additional factors related to human intervention, including:

(i) Are bushfires known to occur in the area and if so, to what size and extent?

(ii) Do the shrubs and grasses that form the understorey of the vegetation communities and hence the fuel bed, regularly dry out and burn readily?

(iii) Is the vegetation pattern such that extensive (rather than localised) native forests, woodlands or grasslands are found in the area (ie is it continuous)?

(iv) Are any gaps in native vegetation filled with pine plantations or crops? Will these crops burn in the bushfire season? If so, with more or less intensity and with greater or lesser resistance to control than the native vegetation they have replaced?

(v) Has recent development had little effect on the existing bushfire pattern?

(vi) Where the general fuel loadings are low or locally discontinuous, are aspect and slope likely to worsen the behaviour of any resultant bushfire ? (Department of Bushfire Services, 1991).

2.6.2 *Risk Assessment*

The multifactorial approach described above has been used to determine the post development bushfire risk for the study sites. Information relating to fire history and characteristics of the area has been obtained from the Harrington Local Brigade Captain, Rod Perkins.

The relevant issues under the multi-factorial approach listed are considered below:

i *Are bush fires known to occur in the area and if so, to what size and extent?*

According to Rod Perkins (*pers comm*, 1996), bushfires occurred in Crowdy Bay National Park every two to three years until 1991. In that year, an intense widespread bushfire occurred which required the attendance of 14 bushfire brigades. Since 1991, the National Parks and Wildlife Service (NPWS) and the local Bushfire Brigade have undertaken to reduce the bushfire hazard by fuel reduction burning. However, the hazard reduction burning is limited to the perimeter of the Park, specifically 50 to 100 metres inside the Park boundary. Therefore, the potential for large fires persists within this reduced fire hazard perimeter (Rod Perkins *pers comm*, 1996).

Significant bushfires that occur in the Park are generally widespread. The Park itself forms an arc from the township of Harrington to Crowdy Bay and so, fires that are lit in one section of the Park can follow this are due to high fuel loads produced throughout the seasons in the Park as well as the influence of coastal winds. These winds are north-easterly and south-westerly.

The main ignition source is arson and by accident where spot fires are lit which then escape and cause widespread burning (Rod Perkins, *pers comm*, 1996). It is likely that the influx of holiday visitors in dry times has led to an increase in fires in the Park. The development of houses in close proximity to the National Park also increases the risk of arson and accidental fires.

ii *Do the shrubs and grasses that form the understorey of the vegetation communities and hence the fuel bed, regularly dry out and burn readily?*

The vegetation of Crowdy Bay National Park varies considerably. Communities range from Forest and Woodland to Shrubland, Heathland, Grassland, Sedgeland, Fernland and Rushland. The most widespread community according to Griffith (1992) is Swamp Sclerophyll Forest and Woodland. As is indicated by the frequency of fires in Crowdy Bay National Park, it is likely that a significant portion of the groundcover and understorey components of these communities, hence the fuel bed is capable of drying out and producing high fuel loads which would burn readily.

As for the on site understorey and groundcover components post development, it is likely that insufficient fuel loads would exist to burn readily. However, the most significant risk to development would not be from on site factors, rather the source would most likely be fires in Crowdy Bay National Park and surrounding bushland. Sparks and embers originating from these bushfires are capable of travelling large distances, a result, according to the Department of Bushfire Services (1992) of the speed and intensity of the winds which usually accompany the fires. Inappropriately designed homes may catch on fire from these sparks and embers.

iii *Is the vegetation pattern such that extensive (rather than localised) native forests, woodlands or grasslands are found in the area (ie is it continuous)?*

The only continuous vegetation pattern in the vicinity of the study sites that is likely to create a bushfire risk, is Crowdy Bay National Park, as described above.

iv *Are any gaps in native vegetation filled with pine plantations or crops? Will these crops burn in the bushfire season? If so, with more or less intensity and with greater or lesser resistance to control than the native vegetation they have replaced?*

No pine plantations or crops exist in the vicinity of the study sites.

v *Where the general fuel loadings are low or locally discontinuous, are aspect and slope likely to worsen the behaviour of any resultant bushfire?*

The sites are generally flat with small depressions occurring throughout. Therefore, aspect and slope are unlikely to have an effect on the behaviour of bushfire.

The bushfire hazard and mitigation measures to protect each site are presented in Sections 3.6 and 4.6 respectively.

2.7 ARCHAEOLOGY AND HERITAGE

A review of past literature was undertaken to determine the likelihood of sites of archaeological significance on the study site. In addition, the Purfleet Aboriginal Land Council was consulted to gain their comments on the significance of the study sites.

The results of this investigation are discussed in Sections 3.7 and 4.7 respectively.

2.8 SERVICES

The relevant service providers were contacted and their advice sought regarding their ability to provide the required level of service to the study sites. Written comments were also sought regarding broad development opportunities and constraints applying to the area. The following service providers were contacted:

- NSW Public Works and Services Department;
- NorthPower;
- Telstra; and
- Greater Taree City Council.

The results of this consultation are presented in Sections 3.8 and 4.8 respectively.

2.9 COMMUNITY FACILITIES AND OPEN SPACE

2.9.1 Community Facilities

The *Draft Harrington Development Study* (Acacia 1996) (the 'Study') identified that as the population grows, Council would need to duplicate or extend existing facilities to maintain the existing rate of provision for and access to community facilities. Growth would increase the number of people within older age groups in Harrington. Community facilities and services which support and benefit them would also need to be extended or enhanced, to ensure equitable access is maintained.

Under the current Section 94 Community Facilities Plan for Harrington, Council levies contributions on residential development to provide a multi-purpose centre which would accommodate:

- Health Facilities;
- Aged Persons Recreation;
- Play Group;
- Equipment Storage;
- Library Services;

- Youth Recreation; and
- A Community Meeting Place.

The location of the multi-purpose centre in Harrington has not been determined. The Study recommended that a site on Beach Street would best support the needs of the existing Harrington community while being able to serve the needs of the future residents of Harrington Waters Estate and Spinnaker Bay Precincts.

The Study also reviewed potential sites for the location for a future hostel or nursing home. It recommended that land owned by Council, south of Harrington Road, could be consolidated with land at Harrington Waters Estate, directly to the west of the unnamed creek in Lot 1, to provide a site with sufficient area for a hostel or nursing home.

The consequences of the development of each site upon the provision of community facilities in Harrington are discussed in Sections 3.9.1 and 4.9.1 respectively.

2.9.2 *Open Space*

Council has developed public land for six categories of casual and structured open space uses. These uses are:

- Outdoor structured sporting facilities;
- Playgrounds;
- Foreshore parks such as beaches or reserves following river and creek banks;
- Bushland;
- Parkland; and
- Undeveloped public open space.

The location of open space and recreational facilities in Harrington is given in *Table 2.6.*

Table 2.6 PUBLIC OPEN SPACE

Name (classification)	Location	Area	Facilities
Dolphin Park Crescent Reserve (undeveloped)	Dolphin Park Crescent	0.39 ha	None.
Oxley Reserve (foreshore park)	Beach Street foreshore	7.46 ha	Fish cleaning tables, BBQs, boat ramp, car parking, benches, gardens, landscaping, shelters, tables, seats, toilets, lights, bus shelter, fences, play equipment.
Pilot Hill Reserve (parkland)	Pilot and High Streets	1.83 ha	Fencing, parking.
Esmond Hogan Park (sporting facilities)	Hogan Street	9.46 ha	Athletic fields, netball court, 2 tennis courts, leagues field, 2 cricket nets, cricket pitch, fences, seating, lighting, toilets, timber building.
Captain Cook Bicentenary Park (foreshore park)	Crowdy Street Foreshore	390 m^2	Gardens, shelters, tables, seats, benches.
Sandspit Islands (undeveloped)	Manning River	21.45 ha	None.

Source: Engineering Department, GTCC

In addition to these formally reserved and managed facilities, residents of Harrington enjoy access to nearby public beaches, the Harrington Lagoon, the Back Channel and the Manning River. The Harrington training wall provides access to the Manning River for fishing and walking. Car parking is provided where Pilot Street meets the foreshore and along Beach Street.

Council has specific goals for the provision of open space. These goals are:

- New open space must have a minimum area of 5,000 m^2 to reduce uneconomic maintenance costs and ensure useability.
- Open space with a minimum area of at least 5,000 m^2 should be available within 500 m of each household to ensure equitable access and reduced reliance on vehicles.
- Major areas of open space should be linked to residential areas so that pedestrians and cyclists can move between areas of open space.
- New open space should be located where the terrain is different from surrounding development so that it will be appealing and interesting.
- Linear and foreshore open space should, where possible, provide for pedestrian and bicycle movement, have external visibility and allow houses

to face the corridor to increase useability, decrease potential vandalism and provide safer areas for pedestrians and bicyclists.

Council has decided to prepare an Open Space and Recreational Facilities Study to identify a program for embellishment and funding of open space in Harrington in accordance with Council's goals and objectives.

The implications of Council's open space policies for each of the study sites are discussed in Sections 3.9.2 and 4.9.2 respectively.

2.10 TRAFFIC

2.10.1 Daily Traffic Volumes

Council and the RTA have not collected any traffic data for Harrington Road. Gutteridge, Haskins and Davey (1983) undertook a traffic study for a 48 hour period in 1983 which indicated that the average daily volume at that time was 1,325 vehicles. The population in 1983 was estimated to be 1,339, which was assumed to be equivalent to one vehicle trip per person per day.

Harrington experiences a seasonal increase in population. For 1996 the peak population was estimated to be 164% of the permanent resident population of 1,460 (Section 2.11). The estimated 1996 peak population of 2394 is the appropriate population figure to determine the maximum traffic volume and existing road capacity for Harrington Road.

Assuming that the road utilisation pattern is unchanged from 1983 ie one trip per person per day, then the 1996 peak season daily traffic volume is also 2394 vehicles per day (vpd). The peak hourly traffic volume is assumed to be 10% of the daily volume, or 239 vehicles per hour (AMCORD, 1995).

2.10.2 Existing Road Capacity

The operational performance of roadways is defined by the "*level of service*" (Ausroads, 1988a). Levels of service are qualitative measures of a number of factors such as travel speed, freedom to manoeuvre, road geometry and safety. The six levels of service for roadways are summarised in *Table 2.7*.

The traffic volume limits for each level of service are related to road features such as gradients, lane widths, directional traffic distributions, shoulder widths and the

percentage of heavy vehicles. The level of service volumes given in *Table 2.8* below apply for a two lane rural road along level terrain.

There are no data available regarding the percentage of heavy traffic that utilises Harrington Road. In the absence of specific data, heavy vehicle traffic volumes are assumed to be 2% of daily traffic volume. This is a typical figure for heavy vehicle traffic in an area with no significant industrial or agricultural activity. The directional split of traffic on Harrington Road is assumed to be 60/40 in the direction of peak traffic flow.

Table 2.7 LEVELS OF SERVICE

Level of Service	Conditions
A	A condition of free flow, with high speeds and low traffic volumes. Drivers can hold their desired speeds without experiencing delays.
B	A condition of stable flow, where drivers have reasonable freedom to select their speed. Traffic volumes at this level of service have been associated with target conditions for rural highways.
C	A condition of stable flow, where drivers are restricted in their freedom to select their own speed or to change lanes and overtake. Operating speeds are still reasonable.
D	Approaching unstable flow, with nearly all drivers being restricted. Comfort and convenience are low but may be tolerated for short periods. Fluctuations in conditions cause substantial drops in speed. This service volume corresponds to the tolerable capacity.
E	Traffic volumes near or at capacity. Flow is unstable and there may be momentary stoppages.

F	Forced flow operation at low speeds caused by demand exceeding capacity. There is stop/start operation, with long queues and delays. In the extreme, both speed and volume can drop to zero.

Source: Ausroads, 1988a

The existing road network in the vicinity of each site is described in Sections 3.10.1 and 4.10.1 respectively. The impacts of development of each site upon the existing road network are then discussed in Sections 3.10.2 and 4.10.2 respectively.

2.11 PLANNING AND DEMOGRAPHICS

2.11.1 Planning Framework

When considering land uses, Council implements legislation and policies of the State Government and its own planning and development controls. The following policies and legislation are relevant to future development at Harrington.

i. State Environmental Planning Policy No 14 – Coastal Wetlands

State Environmental Planning Policy No 14 protects coastal wetlands from land uses which can degrade them. Coastal wetlands maintain water quality by retaining and filtering runoff. They also provide breeding and foraging habitats for birds, fish and some mammals. Coastal wetlands are generally low-lying and inundated for extended periods, depending on rainfall patterns.

Land clearing, levy construction, draining or filling requires consent from the Council and the Department of Urban Affairs and Planning. Applications must be accompanied by an environmental impact statement.

ii. Hunter Regional Environmental Plan 1989

The *Hunter Regional Environmental Plan 1989* (NSW Government 1989) specifies policies for land use planning and development control for residential, rural, business, industrial and recreational land uses and environmental protection. The Plan establishes a hierarchy of regional, subregional and district centres for residential, commercial and community activities and development.

Proposed rezonings and development must generally be consistent with the Plan's objectives and requirements. Clause 9 requires that Council consider whether

adequate health, education and community facilities can be provided. Such facilities now exist and/or are planned for future augmentation as discussed in the recently exhibited *Draft Harrington Development Study* (Acacia 1996).

Clause 30 requires that Council not rezone rural land for urban uses unless, among other factors, the rezoning is of relatively minor significance or the land is included in an urban development program.

Clause 53 requires Council to consult with public authorities and consider their advice with respect to environmental hazards when preparing plans for urban, tourist or rural residential uses.

iii. Hunter Coastal Urban Settlement Strategy

The *Hunter Coastal Urban Settlement Strategy* (NSW Government 1994) aims to guide growth in coastal areas over the next twenty years to "ensure that the environmental attributes of the coastal area are maintained for future generations."

The Strategy has the following three principles

- To recognise environmental limitations to development;
- To concentrate population in existing centres; and
- To permit urban expansion at the perimeter of those centres which can expand economically and without environmental detriment.

Several locations in the Council area were identified as potential urban areas which could accommodate future growth. However, on the basis of data then available, Harrington was considered to have limited opportunity for long term expansion. The primary constraint is a lack of suitable flood free land.

The Draft Harrington Development Study identifies a structure for future development of Harrington. It expands on the objectives of the Strategy and supplements the Strategy's findings with further detailed information. This local environmental study would supplement previous investigations and allow the objectives of the Strategy to be implemented at Harrington.

iv. Greater Taree LEP 1995

Greater Taree Local Environmental Plan 1995 (Greater Taree City Council 1995a) consolidated and revised previous local environmental plans, including *Greater Taree LEP 43* which regulated land use in Harrington until 1995.

Land uses are considered by reference to zone objectives and specific development criteria. The Plan is a performance-based document which is flexible and can accommodate merit-based assessment.

Tourist oriented developments are consistent with rural zone objectives, however, residential development is not. This study's recommendations, if accepted, would be implemented by preparing an amending draft local environmental plan for development and conservation at both study sites.

v. Greater Taree DCP 1995

Greater Taree Development Control Plan 1995 (Greater Taree City Council 1995b) consolidated and revised a number of specific development control plans regulating rural, rural residential and residential development in Greater Taree. It also regulates development with respect to heritage matters, flooding, hazardous or sensitive areas, access and other environmental considerations. The DCP allows consideration of proposals on merit and requires that departure from performance and prescriptive controls be justified and produce better outcomes than could be achieved under its controls.

The DCP would be used to assess proposed forms of development in future development applications at the study sites. Any concept plans for development of the study sites that evolve to detailed designs should incorporate the DCP's requirements and guidelines.

vi. Greater Taree Subdivision Development Control Plan

Greater Taree Subdivision Development Control Plan (Greater Taree City Council 1994a) provides guidelines for urban subdivision. It details requirements for subdivision design, hazards, access, landscaping, services, drainage and environmental protection. If the study sites are rezoned and detailed plans for the subdivision are lodged, they should be consistent with the provisions of the Plan.

vii. Greater Taree Residential Development Control Plan

Greater Taree Residential Development Control Plan (Greater Taree City Council 1994b) provides guidelines for a variety of residential housing forms, including dual occupancy and medium density developments. It reviews design principles, density, height, setback, open space, landscaping, privacy and other issues relevant to residential housing development. If the study sites are rezoned and detailed plans for the subdivision are lodged, they should be consistent with the provisions of the Plan.

viii. Harrington Environmental Study 1982

Council engaged GHD to prepare the Harrington Environmental Study (GHD 1982). The environmental study was the basis for preparing Greater Taree Local Environmental Plan No 43 which regulated land use until 1995.

The environmental study investigated opportunities and constraints to development caused by population growth, flooding, environmental features and service availability. It recommended a land use strategy which provided for expansion of urban, commercial and community land uses. The recommendations included a special residential zone for the proposal by Peakhurst to construct a canal estate.

The environmental study suggested that the then future demand for residential lots was driven by people seeking housing for holiday and retirement accommodation. Population forecasts between 1981 and 2001 were based on growth rates between 5.5 and 7.0 per cent per year. These growth rates did not occur, notwithstanding an ample supply of zoned and partly developed land. Consequently, an expansion of retail floor space, supported by increased expenditure from higher populations levels, has not materialised to the extent anticipated.

The relevance of each of these policies to development at each site is identified in Section 3.11 and 4.11 respectively.

2.11.2 Demographics

Selected data from Council's records and the Australian Bureau of Statistics are presented to gain an understanding of the population's characteristics. Unless otherwise noted, data are from the 1991 Census.

i. Population

The population of Harrington was 1,400 in 1991 and is estimated to be 1,460 in 1996. The annual growth rate between 1991 and 1996 was about 0.8 percent.

Between 1961 and 1991, the population grew from 488 to 1,400 people. During this time, high annual growth rates of up to eight percent occurred between 1971 and 1981. Since 1981, growth has been more subdued.

ii. Age

Harrington's age structure is substantially different from most other localities in Greater Taree. It has a high proportion of people over 55 years of age which reflects

its role as a place people find attractive for retirement. The median age was about 53 years in 1986, and declined to about 49 years in 1991. It is estimated to be about 48.5 years in 1996. This contrasts with other centres in Greater Taree, other than Hallidays Point, where the median age varied between 30 and 35 years.

In 1986, about 52 percent of the population was over 55 years of age. Between 1986 and 1991, that proportion declined to about 46 percent. Importantly, during that time, the 20 to 39, and the 40 to 54 year old age groups increased their proportion of the total population. This may indicate that as well as being attractive to retirees, younger age groups are settling in Harrington. It would be difficult, however, to identify this as a trend, based on only one census period.

Comparisons with Greater Taree and NSW highlight the unique age structure of Harrington. For example, the 0 to 19 age groups account for about 18 percent of Harrington's population, while in Greater Taree, these age groups account for about 31 percent of the population.

iii. Households

There were 652 households in Harrington in 1991 and the residents predominantly formed one-family households. Within this group, there were about 231 families comprising couples without offspring, followed by 125 two-parent families and then 40 one-parent families. There were 156 lone-person households.

iv. Income

a. Individual Income

Yearly individual incomes in 1991 were modest in Harrington. About 60 percent of individuals had yearly incomes equal to or less than $12,000 and about 8 percent of individuals had yearly incomes equal to or greater than $25,000.

In comparison, about 51 percent of Greater Taree individuals had yearly incomes equal to or less than $12,000 and about 13 percent had yearly incomes equal to or greater than $25,000.

b. Household Income

Yearly household incomes in 1991 were also modest in Harrington. About 25 percent of households had yearly incomes equal to or less than $12,000 while about 64 percent had yearly incomes equal to or less than $25,000. About 10 percent of households had yearly incomes equal to or greater than $40,000.

In comparison, about 50 percent of Greater Taree households had yearly incomes equal to or less than $25,000 and about 16 percent of households had yearly incomes equal to or greater than $40,000.

v. Labour Force

a. Employment

There were 1,225 people over the age of 15 in Harrington in 1991. Of these, 776 people, about 63 percent, were not in the labour force. In comparison, about 45 percent of Greater Taree's population was not in the labour force.

There were 431 people in the labour force in Harrington. Of these, 325, or about 75 percent, had either part or full time employment. In comparison, about 84 percent of the labour force in Greater Taree had either part of full time employment.

b. Industry

The largest single industry providing employment for workers in Harrington was the wholesale and retail trade, and accounted for about 21 percent of all employment. Manufacturing, community services and recreational, personal and other services provided more than 40 percent of remaining employment. Traditional resource-based industries, such as agriculture, forestry, fishing and mining, provided less than 6 percent of employment.

The 1991 Census did not identify the location of employment by industry, but car ownership rates and the number of people who use cars to travel to work indicate that most employment is located away from Harrington.

c. Occupation

Tradespersons, and labourers and related workers, are the occupations with the greatest number of employees and account for about 37 percent of all employment. They are followed by sales and personal service workers, managers and administrators, and clerks, who account for an additional 45 percent of employment. The balance of employment, about 18 percent, is held by professionals, para-professionals and plant and machinery operators and drivers.

d. Worker Status

About 72 percent of all workers in Harrington earn a wage or salary. About 19 percent are self employed and the remaining nine percent are employers or unpaid helpers. In Greater Taree, these proportions are nearly identical. Both Harrington

and Greater Taree have a higher proportion of workers who are self employed, and a lower proportion of salary and wage workers, than NSW as a whole.

e. Method of Travel to Work

Most employed people use a car to drive to work. On the day of the census in 1991, 148 people drove a car to work and 24 were passengers in cars. Interestingly, 33 people walked to work, while six rode bicycles and 18 worked from home. This indicates that Harrington businesses and industries provide employment for a portion of the labour force.

vi. Housing and Occupancy

a. Housing Structure

About 77 percent of Harrington's private housing is comprised of separate houses. The remainder is evenly distributed between semi-detached or terrace houses, flats and apartments, and caravans in caravan parks. Flats and apartments also include flats attached to existing houses, commonly known as granny flats.

b. Vacancy

There were 648 private separate houses in 1991, of which 501 were occupied and 147 were vacant on census night. This gives a household vacancy rate of about 23 percent which is common in coastal location where seasonal or holiday use of houses is expected.

c. Occupancy

Occupancy rates show the number of people who live in a private dwelling or unit. There were 1,145 people residing in 501 occupied private houses, giving an occupancy rate of about 2.3 people per occupied private house. Semi-detached and terrace houses had a rate of about 1.65, while flats and apartments had a rate of about 2.2. Caravans in caravan parks had an occupancy rate of 1.57 people per occupied caravan. The overall occupancy rate was 2.2 people per occupied private dwelling.

d. Ownership

About 65 percent of private occupied houses, terraces, flats, apartments or caravans were owned outright and an additional 9 percent were being purchased. A further 19 percent were being rented. In comparison, about 51 percent of residences in Greater Taree were owned and a further 20 percent were being purchased. About 22 percent of accommodation was rented.

e. Building Activity

New Dwelling Approvals

Council's dwelling approval statistics show that the number of new dwellings approved between 1981 and 1995 varied significantly from year to year. However, there was a period of peak activity in 1981 and again in 1988.

Between 1981 and 1985, an average of 17.2 new dwellings were approved each year. Between 1985 and 1990, the figure declined slightly to 15.6 per year. However, between 1991 and 1995, the figure fell to 6.4 per year.

A rough estimate of the relationship between supply and demand can be made from approvals for new dwellings and estimated yearly increases in population, using the following assumptions:

- Vacancy and occupancy rates remain constant;
- Population increases are distributed evenly within each census period; and
- There is only a short lag time between dwelling approvals and the population that will reside in them (this precludes any significant component of speculative building).

The impacts of development at each site on the demography of Harrington are discussed in Sections 3.11 and 4.11 respectively.

The hydraulic impacts of some fill options for Harrington, including the Harrington Waters site have been modelled by GTCC using the ESTRY hydraulic model (*Figure 6* in GTCC, 1996a). This model found that filling a larger area that included the site would result in an 0.01 metre rise in the 1% AEP flood level, which would not adversely affect any existing dwellings.

The effect on flood characteristics of fill on the site has not been modelled. It is unlikely that raising the surface level of the site would adversely affect the hydraulics of the main river channel due to the results outlined above and the small size of the site in relation to the Manning River floodplain.

Filling of the site may adversely affect adjacent landowners to the north and west if adequate drainage works are not constructed. The adequacy of drainage proposals for the site needs to be assessed at DA and Engineering Design Stages.

Design surface levels provided to Council by the land owner indicate that the main drainage channel through the site will be filled and surface water flows diverted into an artificial lake system which will discharge into the Manning River. Development of the site will lead to higher runoff and concentration of runoff into these artificial waterways, which will consequently result in higher flows. If inadequately designed the outlet of the artificial lake may cause backwater flooding across the western side of the site upstream to the small bridge over Harrington Road. The adequacy of the design needs to be assessed at DA stage.

3.1.3 Mitigation Measures

Development of the site for residential purposes will involve filling to raise the level of housing 0.5 metres above the 1% AEP flood level. The provision for an 0.5 metre freeboard must be made to provide a margin of protection in the event of a 1% AEP flood. When considering the Design Flood Level, Council has adopted the medium sea level rise scenario postulated by the Inter-governmental Panel on Climate Change, which corresponds to a rise of approximately 0.25 metres over a fifty year planning horizon (GTCC, 1996a).

As the proposed development is located on a floodplain, it will be necessary to adopt management strategies in the event of an extreme flood event. Harrington Road is flood prone and the community will be subjected to disruption of services and isolation during major flooding. GTCC has developed appropriate management strategies including early warning systems, flood refuge areas and flood proofing of buildings in the Harrington area.

Appropriate drainage works would be required to direct stormwater flow around or through the filled areas. The type of drainage works required would depend on the

Chapter 3

ENVIRONMENTAL ASSESSMENT HARRINGTON WATERS ESTATE

3.1 FLOODING

3.1.1 Natural Landforms and Drainage

The soils of the site are sandy and highly pervious. The water table is close to the surface throughout the site.

Approximately 60% of the site is currently covered by sedgeland vegetation and *Casuarina* forest, with the forested areas generally following the two major drainage channels through the site. During the site inspection, undertaken on 3 December 1996, the water table was at the surface in low lying areas, with standing water up to 200 millimetres in depth. These drainage areas occur in the north and south of the site and flow into the Manning River. The middle of the site is drier than the surrounding areas and is covered by grassland vegetation. From the level of water in drainage channels adjacent to the grassland areas, it is assumed that the water table is less than one metre below the surface.

The site is located entirely within the 1% AEP contour and it is likely that significant portions of the site would be prone to flooding from the Manning River.

3.1.2 Impacts

The effect of urbanisation on rural catchments is to increase runoff potential through changes in catchment storage and runoff response characteristics. This is due to the reduced storage potential of impermeable areas which consequently results in greater stormwater runoff.

In order to utilise the site for residential housing it would be necessary to raise the existing land surface to ensure that floor levels are above the 1% AEP flood level. The flood study undertaken by GTCC (1996) found the level of this flood in the vicinity of the site to be approximately 2.26 metres AHD.

degree to which water flows are restricted by filling of the site. In particular, development design must ensure that the lake outlet is sufficient to discharge peak flows from the 1% AEP flood event such that backwater flooding does not exceed drainage capacity at the Harrington Road bridge or significantly affect upstream properties to the north and west. These design issues need to be addressed at DA and Engineering design stages.

3.2 WATER QUALITY

3.2.1 Existing Water Quality

The site drains to the Manning River which subsequently flows into the Pacific Ocean. To date there have been no water quality data collected from the site, however, there are water quality data for the Manning River in the vicinity of the site. Current landuse of the site does not pose water quality problems, however, development of the site has potential to increase pollutant export towards the Manning River.

3.2.2 Impacts

Urbanisation of water catchments has short and long term impacts on water quality. Short-term impacts are associated with earthworks during the construction phase and can lead to considerable erosion and sedimentation of downstream waterbodies. Long-term impacts are associated with the change in quality, quantity and peak flow rates of stormwater runoff reaching the downstream receiving waters.

The impact of uncontrolled development of the site could cause damage to downstream SEPP 14 wetlands and other riparian environments. Lack of stringent erosion and sediment controls would eventually cause sediment deposition in these environments and may lead to significant alterations to riparian hydrological regimes.

The site represents a very small proportion of the Manning River catchment and as such, change in land use is unlikely to significantly affect water quality in the Manning River. However, unless appropriate mitigation measures are implemented the impact of residential development of the site would be likely to significantly affect the quality of runoff from the site and the incremental effect of uncontrolled runoff from many developments within the catchment would be significant.

3.2.3 *Mitigation Measures*

There is a strong interaction between surface water and groundwater at the site due to the proximity of the groundwater to the surface. It is important that appropriate controls be put into place to prevent further degradation in the quality of groundwater and water in the Manning River, and to safeguard the ecological quality of associated ecosystems.

To protect the integrity of groundwater, downstream SEPP 14 wetlands and the lower Manning River riparian environment from potential impacts of urbanisation, five specific mitigation measures should be implemented to achieve the target water quality parameters presented in *Table 2.4*. These measures include:

- at source controls to minimise the amount of material washed off construction zones by on-site activities. This involves the implementation of a comprehensive soil and water management plan for each sub-catchment to minimise the quantity of sediment that is eroded from disturbed areas during storms. This component is particularly important during the construction phase when retention systems (wet basins, constructed wetlands) could be used as major sedimentation basins, complemented with a host of upstream sediment control measures. Once the major earthworks, such as roadworks and establishment of utility services, have been completed the retention systems could be modified to fulfil their final design function;

- the use of major gross pollutant traps (GPTs) in trunk drainage, designed to trap litter and debris before it enters pre-sedimentation basins;

- the removal of coarse sediment in pre-sedimentation basins in order to prevent the retention systems being overloaded with sediment. The basins can form part of the inlet zone of the retention systems;

- the use of retention systems upstream of the SEPP 14 wetlands and Manning River. The ponds should be designed to contain runoff for sufficient time to allow particulate matter to settle, nutrients to be taken up and purification mechanisms to operate on other potential contaminants before discharging to the river and wetlands; and

- treated runoff from the retention systems and other overland flows should be discharged to receiving waters through buffer zones consisting of endemic vegetation.

The above mitigation measures should be included in a comprehensive soil and water management plan for the site. The plan should be designed to meet the requirements of the Department of Housing, Department of Conservation and Land

Management and Environment Protection Authority. Generally, the plan should aim to incorporate guidelines outlined in the following documents:

- Urban Erosion and Sediment Control, Greenbook II 1992, (CaLM, 1992);
- Soil and Water Management for Urban Development (NSW Department of Housing, 1993); and
- Managing Urban Stormwater (NSW EPA, 1996).

3.3 ACID SULFATE SOILS

3.3.1 *Acid Sulfate Soil Risk Maps*

The acid sulfate soil risk map was examined to determine the likelihood of acid sulfate soils occurring in the study site. The risk map shows low and high probability of acid sulfate soil occurrence for the study site in three acid sulfate soil landforms as shown in *Figure 3.1*. These classifications are discussed below.

i High Probability of Acid Sulfate Soils

Soils with a high probability of occurrence of acid sulfate soil material within the profile indicate that the environment of soil deposition has been suitable for the formation of acid sulfate soil materials. Within these areas acid sulfate soils are widespread or sporadic and may be close to the surface or buried by alluvium or windblown sediments. Two landforms present at Harrington Waters Estate have a high probability of acid sulfate soils. These are estuarine channel soils at an elevation of between 0 and 1 metres below the ground surface and alluvial plain soils at an elevation of between 1 and 3 metres below the ground surface.

ii Low Probability of Acid Sulfate Soils

Where the environment of soil deposition has not been suitable for the formation of acid sulfate materials or acid sulfate soils are highly localised or sporadic, they have been classified as having a low probability of occurrence. Acid sulfate soil materials may be close to the surface or buried by alluvium or windblown sand. One landform present at Harrington Waters Estate has a low probability of acid sulfate soils. This is the Pleistocene aged aeolian sandplain at an elevation of between 1 and 3 metres below the ground surface.

3.3.2 *Impacts*

Activities to be undertaken during the development of the Harrington Waters Estate site that may result in the exposure of acid sulfate soils to the environment are:

- excavation which directly exposes acid sulfate soils to oxygen resulting in the development of sulfuric acid;
- the application and compaction of fill on the site may alter the groundwater regime of the site, which in turn may lead to the exposure of acid sulfate soils due to lowering of the groundwater table; and
- the construction of drainage throughout the site may reduce infiltration of surface water and cause a lowering of the groundwater table. This may lead to the subsurface exposure of acid sulfate soils.

The consequence of exposing acid sulfate soils to the atmosphere is the production of sulfuric acid which in turn leads to the liberation of toxic concentrations of dissolved metals. Consequently this leads to land and water degradation with significant effects on engineering works (including the types of concrete and steel required, the design of roads and drainage systems), agricultural systems (including the choice of crops, lime and fertiliser requirements), economic and social planning and negative effects on aquatic ecosystems.

3.3.3 *Mitigation Measures*

Development of the site should be concentrated as much as practical in the areas of low probability of acid sulfate soils. Due to the high probability of acid sulfate soils occurring at some sections of the site, before development can proceed in these areas, a more rigorous soil survey and sample analysis program is necessary in areas where exposure of acid sulfate soils may occur.

Depending on the proposed development, the EPA (1995) suggests that an assessment will need to be made of the potential for acid generation, the likely quantities of acid which may be discharged and the vulnerability of any natural water body (including groundwater) that may be affected by the acid generated. The level of investigation will depend upon the level of disturbance proposed and the sensitivity of the surrounding environment.

Soil characteristics to be assessed, at a minimum, should include:

- soil profile and landscape descriptions;
- Net Acid Generating Potential (NAGP);

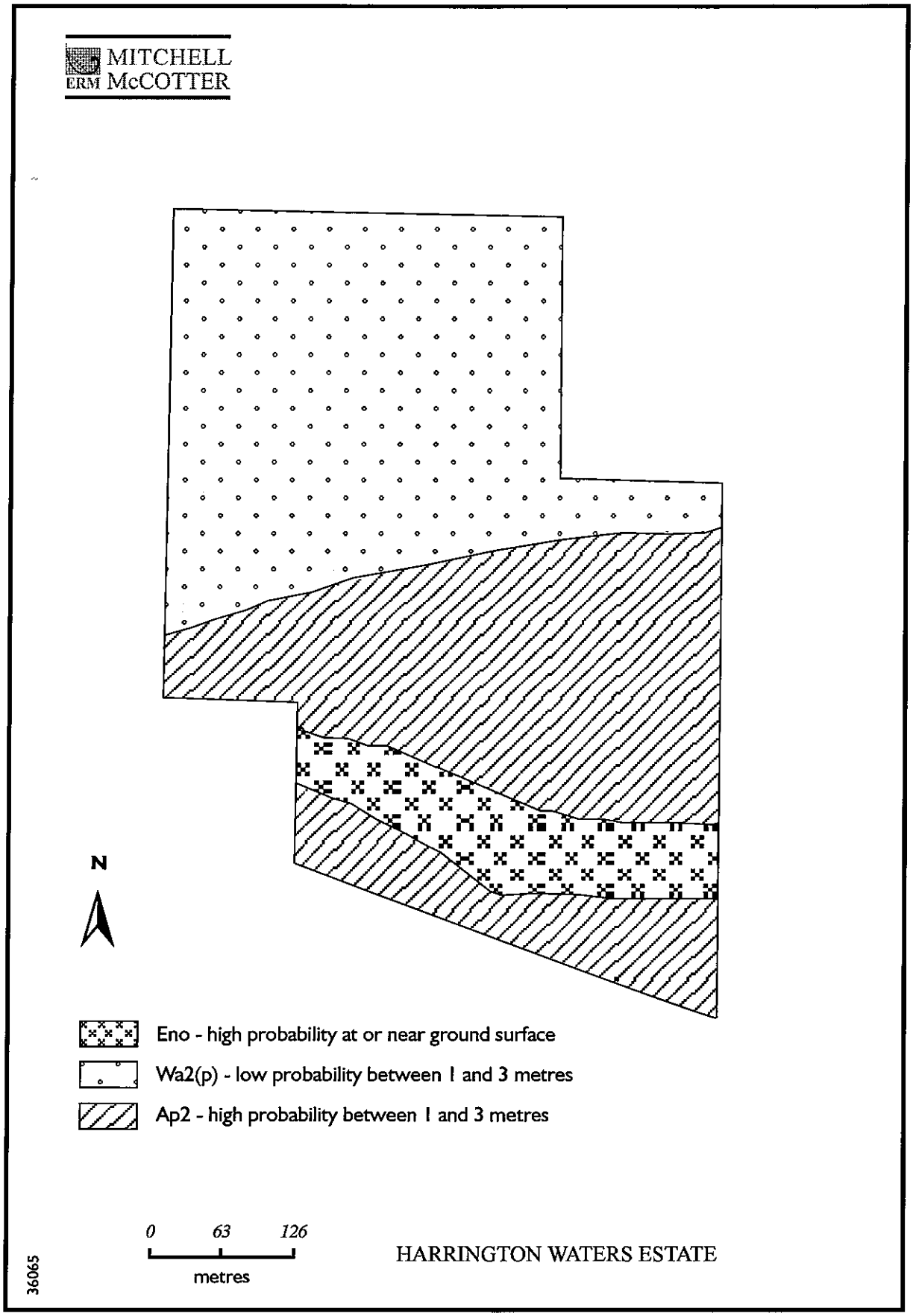

Figure 3.1 PROBABILITY OF ACID SULFATE SOIL OCCURRENCE

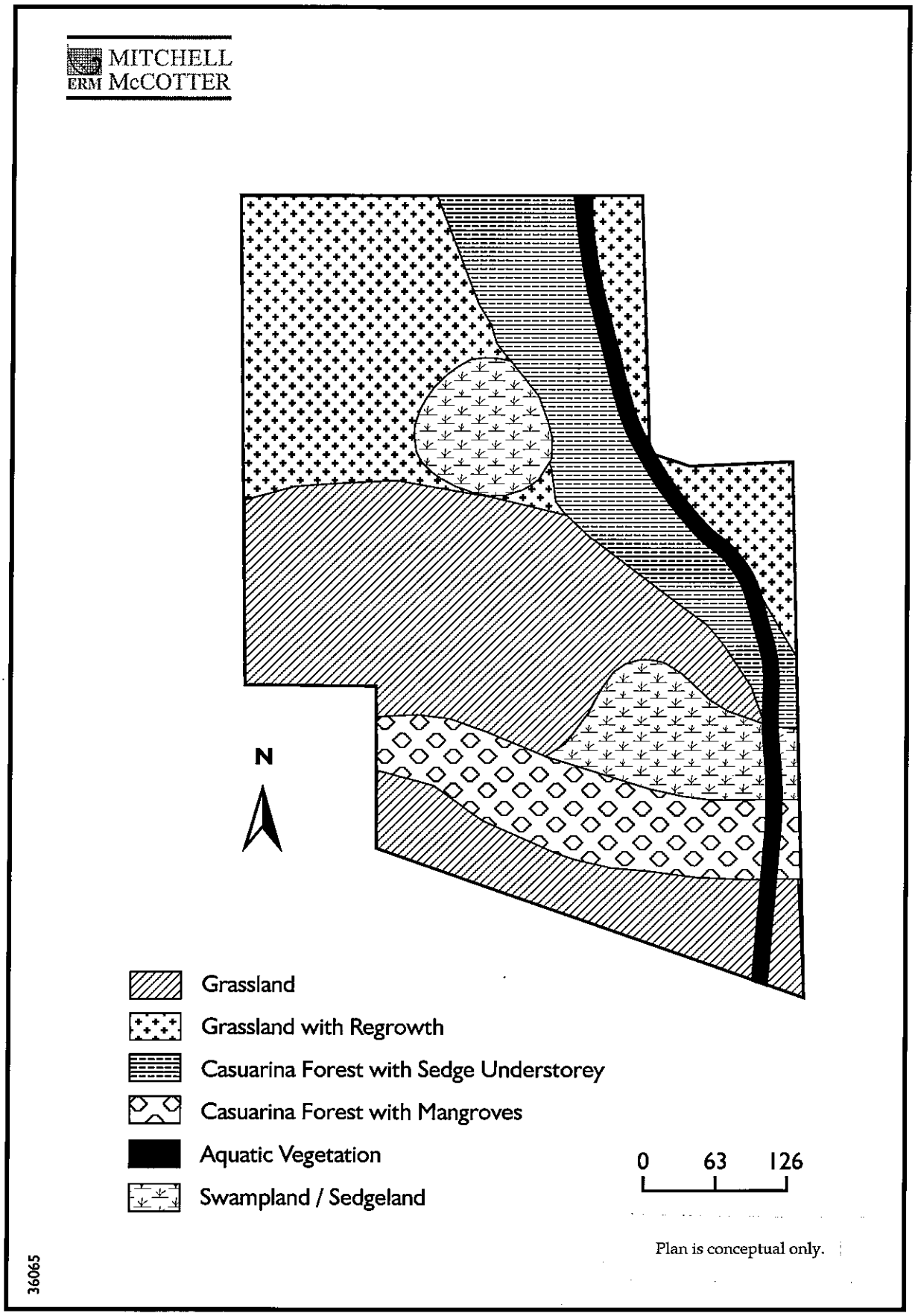

Figure 3.2 VEGETATION COMMUNITIES - HARRINGTON WATERS

- Leco-S (oxidisable sulfur); and
- pH before and after oxidation with hydrogen peroxide.

In addition water characteristics will need to be assessed. Analyses should include:

- pH;
- total dissolved solids;
- iron (total);
- aluminium (total); and
- soluble chloride to sulphate ratio.

3.3.4 *Management Strategies*

Management strategies will need to be established if the proposed development is likely to disturb acid sulfate soils to the extent that a significant risk exists to the surrounding environment through the lowering of the water table or through excavation, dredging, transport, handling, separation, neutralisation and storage. These strategies should demonstrate that the environmental impacts of such likely disturbances can be effectively managed.

3.4 SITE CONTAMINATION

Site inspection did not reveal any likely sources of contaminants. Previous land-uses have included logging and cattle grazing and the site continues to be used for cattle grazing. The potential for the Harrington Waters Estate site to be contaminated is low.

3.5 ECOLOGY

3.5.1 *Vegetation Communities*

Based on structural characteristics and floristic composition, six vegetation associations were identified on the site. These are described below and illustrated in *Figure 3.2.*

i. Grassland

Description: This community is the most extensive on the site and is a disclimax community which is the result of past clearing activities. Trees are scattered occasionally throughout this community. The major species include Paspalum (*Paspalum dilatatum*) and Kikuyu (*Pennisetum clandestinum*).

ii. Grassland with Regrowth

Description: This is a regenerating community which is likely to have been the same community as the Casuarina Forest with Sedge Understorey, prior to disturbance. It is very open in structure, has a sparse understorey and typically dense groundcover of pasture grasses and some sedges.

iii. Swampland/Sedgeland

Description: This is typically a sedgeland of low to medium height. It appears to occur in the depressions on the site. The southern portion is wetter than the northern portion, which appears to be more ephemeral. Occasional *Melaleuca spp.* occur throughout this community.

iv. Casuarina Forest with Sedge Understorey

Description: The majority of this community appears to be *Casuarina* regrowth. It is generally an open forest, 15-20 metres in height. The understorey is generally very sparse, while the groundcover is mostly dense, although it appears to have been grazed by domestic cattle.

Upper Canopy: This consists almost entirely of Swamp Oak (*Casuarina glauca*), although Forest Oak (*Allocasuarina torulosa*) and Black She-oak (*Allocasuarina littoralis*) are also present. Coast Morning Glory (*Ipomoea cairica*) occurs occasionally in the canopy as a scrambler.

Understorey: Lantana (*Lantana camara*) occurs occasionally, while Sword Grass (*Gahnia sieberana*) and Bracken (*Pteridium esculentum*) also occur.

Groundcover: This generally consists of sedges, pasture and native grasses.

v. Casuarina Forest with Mangroves

Description: This community occurs along the major watercourse on site. It displays some disturbance from domestic cattle, and weeds occur intermittently.

Upper Canopy: Swamp Oak (*Casuarina glauca*) is most common, however Broad-leaved Paperbark (*Melaleuca quinquenervia*) also occurs occasionally. The upper canopy is approximately 15 metres in height.

Understorey: River Mangroves (*Aegiceras corniculatum*) and Grey Mangroves (*Avicennia marina*) are dominant.

Groundcover: Ground cover is variable and includes Salt Couch (*Sporobolus virginicus*), Swamp Water Fern (*Blechnum indicum*) and Pennywort (*Hydrocotyle bonariensis*).

vi. Aquatic Vegetation

Description: This is a sparsely distributed community fringing the main drainage line. It generally consists of sedges and macrophytes. It is typically low in structure and minimally disturbed.

3.5.2 Fauna Habitats

The vegetation communities outlined above reflect differences in structure and plant species composition. The majority of animals choose habitat based primarily on structural differences of vegetation communities, rather than detecting specific plant species differences. This, of course excludes the Koala, which chooses habitat based mainly upon the presence of particular plant species.

Structural characteristics include the height of the dominant layer, the number of distinctive layers and the density of vegetation. Many specialised faunal groups may depend heavily upon the availability of specific habitat characteristics such as tree hollows, to survive. Any activity that changes the structure or cover of vegetation and consequently habitat characteristics may result in modifications to the composition of fauna within an area. Three fauna habitats have been identified on the site. These are discussed below.

i. Open Swamp Forest

Vegetation Communities: Casuarina Forest with Mangroves, Casuarina Forest with Sedge Understorey and Grassland with Regrowth.

Fauna Habitat Components: The abundance of Casuarinas in this community provides a food source for Cockatoos, including the threatened Glossy Black Cockatoo. The drainage component within part of this habitat provides a suitable

resource for reptiles and amphibians, as well as waders. The trees within this habitat provide a general sheltering and nesting resource.

Vegetation Condition: A large portion of this habitat appears to be regrowth. It is generally in good condition, although weed species occur throughout.

ii. Swamp

Vegetation Communities: Swampland/Sedgeland and Aquatic Vegetation.

Fauna Habitat Components: This provides a resource for amphibians and reptiles. It also provides a general water source for fauna.

Vegetation Condition: The vegetation in these communities generally has minimal disturbance.

iii. Herbland

Vegetation Communities: Grassland.

Fauna Habitat Components: This habitat provides a resource for grazing herbivores. Raptors may also use this habitat for foraging.

Vegetation Condition: This is a disclimax community resulting from past clearing.

3.5.3 Koala Habitat (State Environmental Planning Policy No. 44)

The only SEPP 44 tree species identified on the site was Swamp Mahogany (*Eucalyptus robusta*). There was only a minimal number of this tree species identified, therefore the site is unlikely to contain potential Koala habitat as defined by SEPP 44. Koalas in the local region are known to feed on Broad-leaved Paperbark (McLeod pers comm) which occurs occasionally over the site. Therefore, the site may provide a source of secondary Koala habitat.

3.5.4 Threatened Fauna

Table 3.1 lists those threatened fauna species which may utilise the site, including the habitat they would utilise if they occur. The species have been determined based upon the fauna habitat known to exist on the site, and species previously recorded within the region on the NPWS Atlas of Wildlife.

3.5.5 *Conservation Value of Fauna Habitats*

An assessment of the conservation values of the fauna habitats is detailed in *Table 3.2.*

The southern portion of the Swamp habitat is recommended for protection from development or disturbance. This portion should be retained as it has value for aquatic fauna and also possibly the threatened Eastern Chestnut Mouse. The southern portion of the Swamp habitat, particularly to the west of the aquatic vegetation community, has greater habitat values than the northern portion of the Swampland/Sedgeland, due to its more natural condition, and the fact that it is connected to the Casuarina Forest with Mangroves, which is to be protected from tree clearing. This gives connective value to the southern portion of the Swamp habitat, increasing its overall habitat value. The Casuarina Forest with Mangroves will also link to the creekline mangrove community to the east of the site which was previously recommended to be retained (ERM Mitchell McCotter, 1994).

Table 3.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
Glossy Black Cockatoo	*Calyptorhyncus lathami*	Forest and woodland.	Open Swamp Forest.	High due to suitable habitat on site and frequency of recordings in region.
Powerful Owl	*Ninox strenua*	Wet and dry sclerophyll forest, with optimum habitat being tall, dense mountainous eucalypt forest	Open Swamp Forest.	Moderate due to poor quality habitat on site, but frequently recorded in region.
Masked Owl	*Tyto novaehollandiae*	Forests, woodlands and caves.	Open Swamp Forest.	High due to suitable habitat on site and frequency of recordings in region.
Osprey	*Pandion haliaetus*	Estuaries, rivers, lakes or the ocean. Nests in tall dead trees in semi-open areas.	Open Swamp Forest and Herbland.	May use the site for foraging as it is known to have a nest on a nearby property.
Square-tailed Kite	*Lophoictinia isura*	Open forest and woodlands.	Open Swamp Forest and Herbland.	Moderate due to sub-optimum habitat on site and infrequently

Table 3.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
				recorded in region.
Black-necked Stork	*Ephippiorhynchus asiaticus*	River pools, swamps and intertidal flats.	Open Swamp Forest containing mangroves.	Moderate due to sub-optimum habitat on site, but frequently recorded in the region.
Australasian Bittern	*Botaurus poiciloptilus*	Swamps with dense reed beds.	Open Swamp Forest containing mangroves.	Moderate due to limited suitable habitat on site.
Black Bittern	*Ixobrychus flavicollis*	Mangroves, and streamside vegetation including small creeks in forests.	Open Swamp Forest containing mangroves.	Moderate due to sub-optimum habitat on site.
Lesser Sand Plover	*Charadrius mongolus*	Inter-tidal sand and mudflats in estuaries.	Open Swamp Forest containing mangroves.	Moderate due to poor quality habitat on site.
Pied Oystercatcher	*Haematopus longirostris*	Sandy beaches, mudflats and estuaries.	Open Swamp Forest containing mangroves.	Moderate due to poor quality habitat on site.
Terek Sandpiper	*Xenus cinereus*	Inter-tidal sand or mudflats often near	Open Swamp Forest	Moderate to poor quality of

Table 3.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
		mangroves or in tidal creeks.	containing mangroves.	habitat on site.
Swift Parrot	*Lathamus discolor*	Variety of woodland and dry sclerophyll forest.	Open Swamp Forest.	Moderate due to suitable habitat on site, and infrequently recorded in the region.
Turquoise Parrot	*Neophema pulchella*	Open Forest and timbered grasslands.	Open Swamp Forest.	Moderate due to suitable habitat on site, and infrequently recorded in the region.
Queensland Blossom Bat	*Syconycteris australis*	Rainforests, heathlands and melaleuca swamps.	Open Swamp Forest.	Moderate due to suitable habitat on site and frequency of recordings in the region.
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	A range of forest types and also mallee and open country.	Open Swamp Forest.	Moderate due to suitable habitat on site, and frequency of recordings in the region.
Little Bent-wing Bat	*Miniopteris australis*	Wet and dry sclerophyll forests and rainforests.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site and frequency of

Table 3.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
				recordings in region.
Eastern Little Mastiff Bat	*Mormopterus australis*	Sclerophyll forest and woodland. Forages in clearings.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site and frequency of recordings in region.
Greater Broad-nosed Bat	*Scoteanax ruepellii*	Wet and dry sclerophyll forests and rainforests.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site and frequency of recordings in region.
Great Pipistrelle	*Falsistrellus tasmaniensis*	Known from a variety of wooded habitats.	Open Swamp Forest.	Moderate due to some suitable habitat on site and frequency of recordings in the region.
Large Bent-wing Bat	*Miniopterus schreibersii*	Wet and dry sclerophyll forests and rainforests.	Open Swamp Forest.	High due to suitable habitat on site and frequency of recordings in region.
Squirrel Glider	*Petaurus norfolcensis*	Dry sclerophyll forests and woodland.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site and frequency of occurrence in region.

Table 3.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
Brush-tailed Phascogale	*Phascogale tapoatafa*	Dry and wet sclerophyll forests, usually in areas with sparse ground cover.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site and frequency of occurrence in region.
Tiger Quoll	*Dasyurus maculatus*	Wet and dry sclerophyll forest and rainforest.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site, but known to occur in the region.
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*	Heathland particularly wet heath and swampy areas.	Open Swamp Forest and Herbland.	High due to suitable habitat on site and known local occurrence.
Common Planigale	*Planigale maculatus*	Rainforest, sclerophyll forests and grasslands, marshlands and rocky areas.	Open Swamp Forest and Herbland.	Moderate due to some amount of suitable habitat on site.
Koala	*Phascolarctos cinereus*	Eucalypt forest and woodlands with feed tree species.	Open Swamp Forest.	Moderate due to sub-optimum habitat on site, but feed tree species present.

Table 3.2 FAUNA HABITAT CONSERVATION VALUES

	REPRESENTATIVENESS AND RESERVATION	DEGREE OF NATURALNESS AND SPECIAL NATURAL FEATURES	LEVEL OF DIVERSITY AND HABITAT LINKS	CONSERVATION VALUE
OPEN SWAMP FOREST	This forest type is typically found within the coastal and estuarine areas of the NSW north coast. This community is represented within significant areas reserved in Myall Lakes National Park to the south of the site (Myerscough and Carolin, 1986), and also has stands in Crowdy Bay National Park to the north of the site (Griffith, 1992). There has been a major reduction in the range of this forest type due to drainage and the clearing of floodplains (Benson, 1987). Griffith (1993) reports that stands of *Casuarina glauca* are inadequately reserved on the NSW north coast. Although there is generally poor reservation of this forest type, many areas now have protection under the provisions of SEPP 14.	Although large areas of this community are regrowth, it is generally in a natural condition. This habitat has an ephemeral creek.	This habitat has a relatively uniform age structure and is not particularly diverse because of past disturbance. The understorey is generally sparse and not highly diverse. There are very few logs and hollows for species dependant upon these resources. This community links up with narrow vegetated corridors on freehold land to the north. The most easterly portion of this habitat also links up with a narrow vegetated corridor leading to the south.	Moderate, although some communities within this habitat type warrant protection for their ecological values.

Table 3.2 FAUNA HABITAT CONSERVATION VALUES

	REPRESENTATIVENESS AND RESERVATION	DEGREE OF NATURALNESS AND SPECIAL NATURAL FEATURES	LEVEL OF DIVERSITY AND HABITAT LINKS	CONSERVATION VALUE
SWAMP	This community is well represented within the region with significant areas reserved within Myall Lakes National Park (Myerscough and Carolin, 1986) and some areas in Crowdy Bay National Park (Griffith, 1993). Griffith (1993) reports that this community is widespread but generally has a poor reservation. This vegetation type has some protection under SEPP 14.	The degree of naturalness within this community is generally high, although fringe areas appear to have been disturbed by cattle.	This habitat type is generally of moderate diversity, although it forms a linkage to the Casuarina Forest with Mangroves. This adds to the overall ecological diversity of the area.	The northern portion is of low conservation value, while the southern portion is of high conservation value.
HERBLAND	This habitat type is a disclimax community resulting from past clearing efforts, therefore an assessment of its representation and reservation is not applicable.	This habitat type is a disturbed community.	The level of biodiversity within this habitat type is low. There are no habitat links.	Low.

3.6 BUSHFIRE MANAGEMENT

3.6.1 Bushfire Hazard

Considering the current vegetative state of Harrington Waters Estate, it is likely that the groundcover and understorey components of the existing communities would readily burn. The understorey on site consists primarily of immature mangroves, casuarinas and melaleucas. These species have a high tannin content, therefore, would burn readily and intensely. Groundcover species are likely to dry out to some degree, particularly the dry land grass species.

The close proximity of Harrington Waters Estate to Crowdy Bay National Park which has a known history of frequent intense bushfires has resulted in the site being considered as having a moderate to high bushfire risk in its undeveloped state. However, the location of the site in close proximity to the Manning River (a good source of water to combat fire if the need arose) and the ready access into the site from Harrington Road following development, have reduced the risk to moderate provided that the mitigation measures outlined below are adopted.

3.6.2 Mitigation Measures

Prevention of fires on the subject site should be one of the primary aims for development design. The Department of Bushfire Services' (1991) *Planning for Bushfire Protection* discusses strategies which will assist in reducing the overall risk of fire. These methods should be considered in any future development and subdivision design for the site and include:

- the inclusion of perimeter access tracks;
- road design standards that will provide adequate internal access for fire fighting vehicles; and
- staging development so that initial development occurs on the hazard perimeter.

3.7 ARCHAEOLOGY AND HERITAGE

The literature review indicated that a Potential Archaeological Deposit (PAD) exists on the study site (Brayshaw, 1994). The Local Aboriginal Land Council referred to the literature and concurred that this was the extent of the known archaeological significance of the study site. *Figure 3.3* indicates the location of the PAD.

This PAD was described as:

Map Ref: 46671 647254 Cundletown 1:25,000

Location: Towards the western edge of the study area, along an elevated bank overlooking and about 1m above a depression parallel to the river and through which water would periodically flow. Ground visibility in this well grassed area is zero. Depending on disturbance, the area of potential could be >100m long and perhaps 50m wide. The conformation and elevation of this area is similarly to that adjacent to the bulldozed area are Site H5.

It was recommended that *PAD 1 should be subjected to subsurface investigation to determine whether cultural material is present and if so what light it may throw on Aboriginal usage of the area.*

Should development in the area of the PAD require excavation, it is recommended that further investigation and consultation with the Local Aboriginal Land Council be undertaken to determine the significance of the PAD.

3.8 SERVICES

i. Public Works and Services

NSW Public Works and Services Department advises that it has no comment to make regarding the site at this time.

ii. Electricity and Water

NorthPower's water division advises that reticulated town water supply is available to the site and that the availability of water supply should not be a constraint to development.

NorthPower's electricity division advises that there is existing subtransmission/distribution system infrastructure adjacent to the site that should adequately service the electricity requirements of the proposed development.

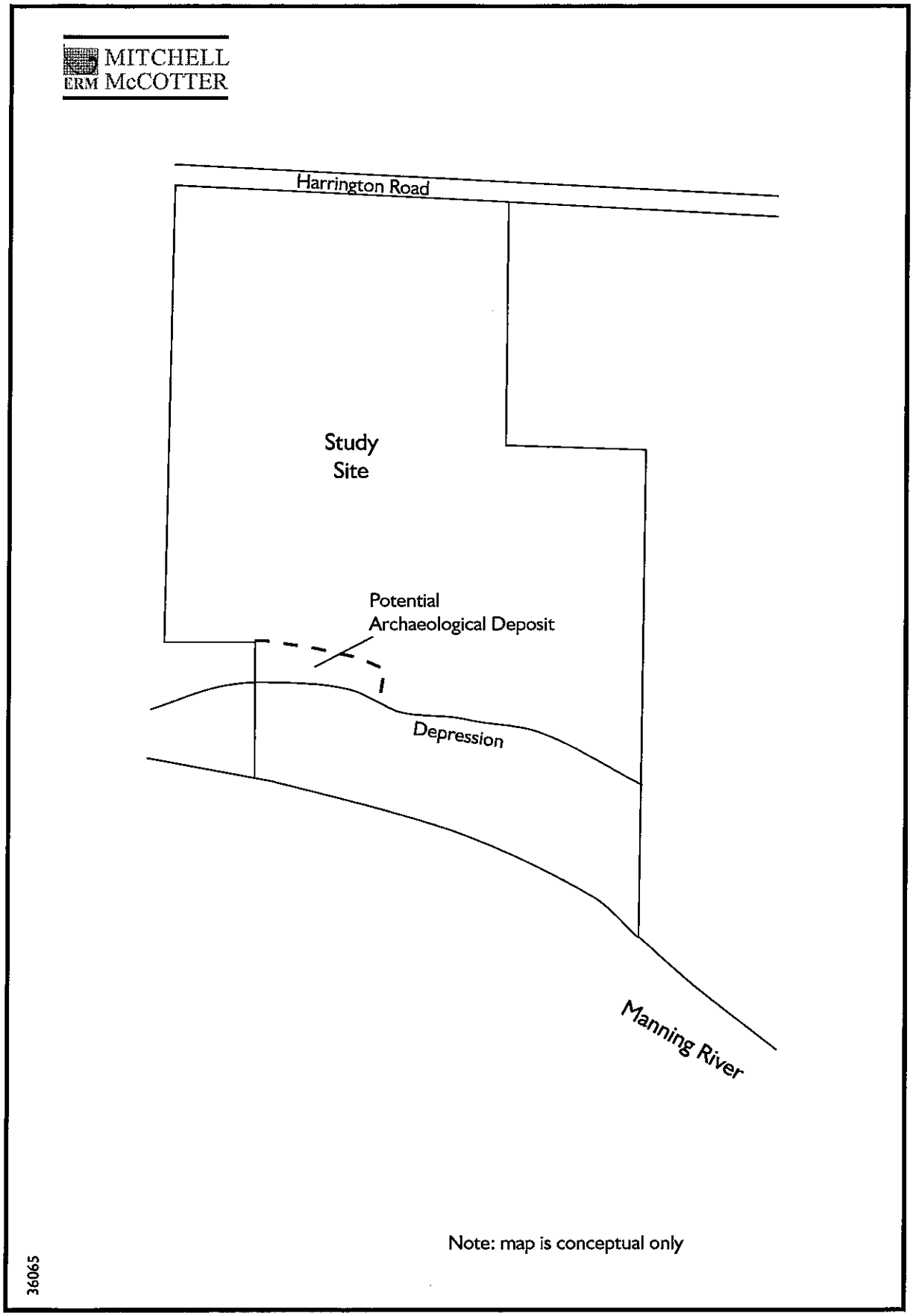

Figure 3.3 LOCATION OF POTENTIAL ARCHAEOLOGICAL DEPOSIT

iii. Telephone

Telstra advises that there is telecommunications plant adjacent to the site and that telephone services can be provided in accordance with its standard policy *"External Cabling of Estates and Property Developments"*. Telstra also makes the comment that community and infrastructure costs will be reduced if the development gradually proceeds outward from established areas.

iv. Sewerage

Greater Taree City Council's wastewater treatment works (WWTP) at Harrington has the capacity to treat sewage generated by 4,800 equivalent persons, which is sufficient capacity to treat the anticipated additional loading generated by development of the site. The population of Harrington is expected to stabilise at 4,500 equivalent persons in the year 2045 (GTCC, 1996). However, the development of the site has not been incorporated into strategic planning for the Harrington WWTP. As a consequence, the capacity of pumps 8 and 11 may need to be upgraded.

The developer will be required to provide sewerage infrastructure to connect to the existing system and to contribute to the costs of headworks required for further augmentation. These costs are likely to include a contribution to effluent management.

3.9 COMMUNITY FACILITIES AND OPEN SPACE

3.9.1 Community Facilities

If Council adopts the recommendations of the Draft Harrington Development Study (Acacia 1996), there would be no need to dedicate land for community facilities at Harrington Waters Estate. The development of a hostel or nursing home is not a responsibility of Council and a prospective developer would need to acquire the land from Council and the developer of Harrington Waters Estate.

3.9.2 Open Space

The foreshore of the Manning River and areas adjacent to the proposed golf course would provide suitable opportunities to provide open space which conforms to Council's open space goals and objectives. Council should also ensure that at least one playground is provided, either in parkland with a minimum area of 5,000 m^2 and within 500 m of any household, or in wider areas of foreshore reserve, at

Harrington Waters Estate. Given that most future residents of Harrington Waters Estate are likely to be in older age groups, it would be desirable to develop linear open space for a range of casual uses such as walking, cycling, scenic appreciation and fishing. Council should ensure that they are accessible to people with reduced personal mobility. Open space should be provided at Council's current provision rate of 2.83 ha per thousand people in new areas. Pedestrian paths and cycleways should be planned to link with adjacent public open space areas and should provide safe and interesting access to the Beach Street foreshore reserve.

3.10 TRAFFIC

3.10.1 Existing Road Network

The road network in the vicinity of the site is illustrated in *Figure 3.4*. The proposed site for future development is located between Harrington Road and the Manning River. The northern boundary of the site has frontage of approximately 720 metres onto Harrington Road, which will provide the primary access route to the site both from Taree and the village of Harrington.

Entering and approach sight distances along Harrington Road are in excess of 250 metres in both directions. The pavement width on Harrington Road is 6.8 metres with an average shoulder width of 1.5 metres. The speed limit along Harrington Road is 100 kilometres per hour.

3.10.2 Road Capacity

Table 3.3 shows daily traffic volumes for Levels of Service A to F inclusive for Harrington Road.

Table 3.3 DAILY TRAFFIC VOLUMES FOR HARRINGTON ROAD LEVELS OF SERVICE

Level of Service	Range of Daily Traffic Volume (AADT)	Summary of Traffic Conditions
A	0 - 2,900	Free Flow
B	2,501 -5,700	Stable Flow
C	5,701 -9,350	Stable Flow, Restricted Speeds

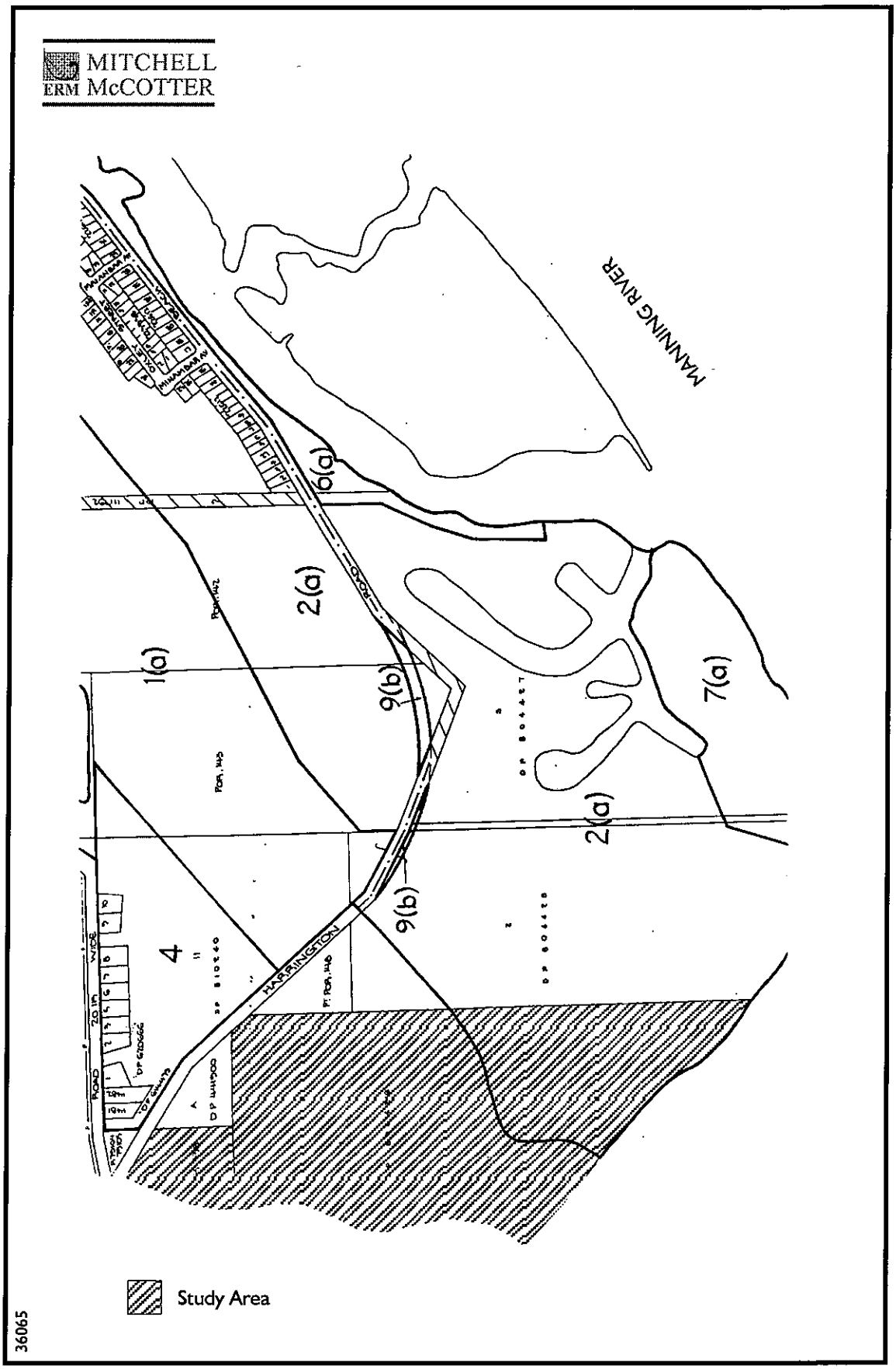

Figure 3.4 LOCAL ROAD NETWORK

D	9,351 - 15,000	Approaching Unstable Flow Conditions
E	15,001 - 24,300	Unstable Flow
F	> 24,300	Forced Flow

The estimated current peak season daily traffic volume on Harrington Road (2,394 vehicles per day) is within the limits of level of service A. The existing road network provides adequate capacity for a peak season daily traffic volume of 506 vehicles per day at level of service A. Traffic volumes would be expected to reach level of service B in the near future due to growth in the existing population.

For roads in rural villages a level of service D is the minimum acceptable level of service. To reach the upper limit of this level of service traffic volumes would have to increase by approximately 12,600 vpd.

The road network has spare capacity to accommodate an increase in daily traffic volume of 506 vpd during peak season at a level of service A, although the road network has spare capacity of approximately 12,600 vpd to reach a level of service D. The RTA has determined that the standard rate of traffic generation for a residential subdivision is 9 trips per lot (*RTA, 1993*). Using this figure, the current road network can accommodate an increase of approximately 1,400 residential lots without the need for upgrading.

3.11 PLANNING AND DEMOGRAPHICS

3.11.1 Planning Context

The Draft Harrington Development Study (Acacia,1996) identifies that tourist-oriented recreational facilities at Harrington Waters Estate west of the unnamed creek would be consistent with existing rural zone objectives, however, residential development would require a change in zoning. The Study recommends that residential growth should occur primarily in the Harrington Waters Estate and Spinnaker Bay precincts. The proposed development would therefore be consistent with the Study, which is considered to be an urban development program as identified by the Hunter REP 1989.

Proposed development would be affected by 1% AEP flooding and potential acid sulphate soils. Council has previously granted consents for dredging a sufficient quantity of sand to fill proposed development areas at Harrington Waters Estate

above 1 in 100 year flood levels. It has also granted consent for residential uses east of the unnamed creek.

Proposed residential development would be consistent with Council's previous decisions to enable the development of a range of land uses at Harrington Waters Estate. Acid sulfate soils are capable of being managed if encountered during filling or construction. Proposed residential, commercial and recreational developments would be consistent with the objectives of the Hunter REP 1989.

The Harrington Waters Estate development could appeal to a market segment which may have otherwise overlooked Harrington, primarily because it has the potential to market an integrated leisure and recreation based package which will appeal, among other things, to the retirement sector. It could create a market for higher-priced residential accommodation in Harrington because it offers water views and access which are not found in other new subdivisions or developments.

Development opportunities at Harrington Waters Estate would provide a range of housing and affordability.

3.11.2 Demographics

Council expects a population increase of 180 people by 2011 which is modest and would require about eight houses or units per year for fifteen years, or a total of 120 houses or units. This increase could be accommodated in initial releases at Harrington Waters Estate or subsequent releases at Spinnaker Bay. Land which is currently zoned would be more than adequate to accommodate forecast population growth to 2011.

It is highly likely that the developer of Harrington Waters Estate expects growth to be considerably higher than Council's predictions. If population growth is higher than projected, it would be expected that Harrington Waters Estate or Spinnaker Bay would accelerate subdivision construction. Provided that at least one of the two continues to release lots, there is adequate capacity to accommodate population growth rates of up to about 2.5 percent per year until at least 2011. This would only occur with significant increases in migration, for example, if Harrington Waters Estate or Spinnaker Bay were highly successful in sales to new market sectors.

The residential component of the proposed development would facilitate expected development yields at Harrington Waters Estate. Council considered the impacts of Harrington Waters Estate in determining the development application for 550 lots or dwellings in 1993. It has also planned infrastructure using this yield.

Harrington Waters Estate is expected to be most attractive to people who are retired. They are likely to be at least 50 year of age and have good personal mobility. The proportion of residents who are in the work force, or are raising families, would be expected to be low because opportunities for employment are limited in the area.

Council expects that the median age of Harrington residents will decline from 49.2 years in 1991 to 48.5 years in 1996 and 44.7 years by 2001. This contrasts with other centres (except Hallidays Point) in Greater Taree in which the median age is rising slightly and ranges between 30 and 35 years.

A decline in median age would indicate that the population will require facilities and services geared more towards the needs of younger age groups. However, because the median age is and will remain relatively higher than most other centres, it would be important to continue to meet the needs of older age groups.

3.12 LAND CAPABILITY ASSESSMENT

3.12.1 Opportunities and Constraints

The owners of the site have indicated to Council their intention to develop the site as a golf course and associated residential subdivision. Development areas for buildings will require filling of the site to above the 1% AEP flood level. Such filling, to the extent that is indicated in the preliminary concept plans, is unlikely to cause environmental hazards that cannot be effectively mitigated and managed.

Areas of the site that are suitable for development and areas requiring conservation are shown in *Figure 3.5* and discussed below.

i. A - Suitable for Development

This area of the site is the most suitable area for residential and golf course development. Ecological value of this area is low and the probability of acid sulfate soils is also low. Any excavation (eg for installation of services, drainage or dams) will require careful management so that if acid sulfate soils are exposed no detrimental environmental impact occurs. In this area testing for acid sulfate soils should be undertaken prior to any excavation.

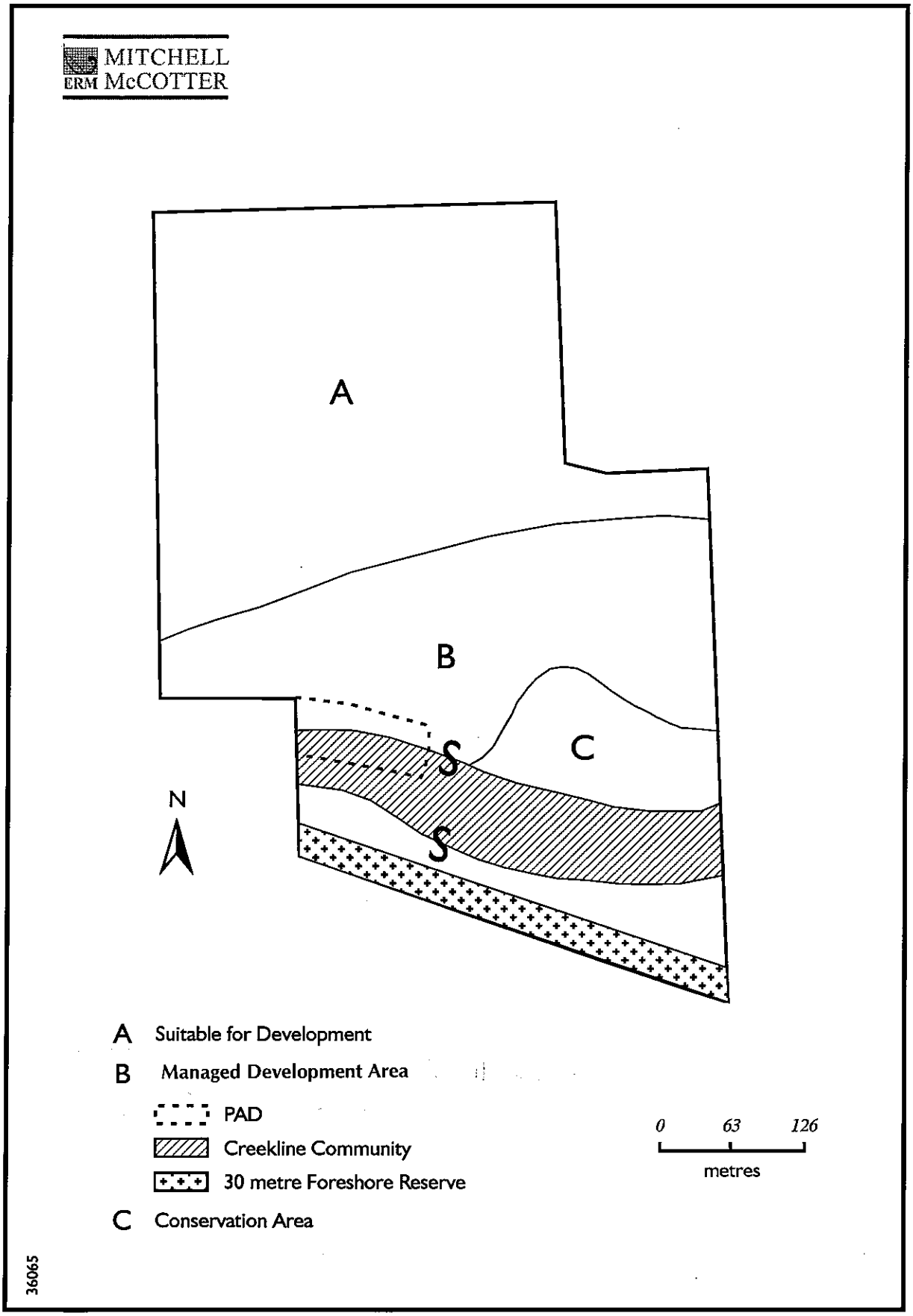

Figure 3.5 DEVELOPMENT AND CONSERVATION AREAS

ii. B - Managed Development Area

Residential and golf course development (including the construction of the clubhouse) can occur in this area, however careful design and construction management is necessary to ensure the following issues are addressed.

Acid Sulfate Soils

This area has a high probability of acid sulfate soils between 0-3 metre of the surface. In these areas, a more rigorous soil survey and sample analysis program is necessary where exposure of acid sulfate soils may occur through excavation. Filling of land in this area can occur.

Archaeology

A Potential Archaeological Deposit (PAD) is located in this area. If development is likely to disturb the surface in the vicinity of the PAD, further investigation and consultation with the Local Aboriginal Land Council will be necessary to determine its archaeological significance.

Creekline Protection

The creekline community should be retained in as natural state as possible and tree clearing along the ephemeral creek in this area should be restricted and mangroves protected.

Foreshore Link

A 30 metre wide foreshore area should be retained. This area will provide a link with the foreshore reserve that will be provided along the bank of the Manning River to the east of the site.

iii. C - Conservation

This area is the southern portion of the Swamp habitat. This area needs to be retained for the purpose of preserving small mammal and aquatic bird habitat. This area should not be altered in any manner, and particular emphasis needs to be placed upon maintaining the existing hydrological regime in this area so that the floristic structure and composition remains unchanged.

It is noted that the concept plan for development of the site proposed a lake system adjacent to and forming part of this Swamp habitat. Any alteration to the drainage channel in the eastern part of the site to divert water into the lake system will lead to a change in the characteristics of the Swamp habitat and a decrease in its habitat

value. It is recommended that the drainage system on the site be designed to include a lake, to the north of the Swamp habitat, which drains into the Swamp habitat. Such design should ensure that the hydraulic characteristics of flows from the lake will retain the characteristics of the Swamp habitat.

3.12.2 Recommendations

Residential, golf course and tourist orientated development is appropriate for the site, however design changes to the preliminary concept plan will be necessary to accommodate the findings of this report. It is recommended that Council consider a combined development application and rezoning request for the site. The following zoning of the site under the provisions of Greater Taree LEP 1995 are recommended:

Areas A and B	2(a) Residential, 6(b) Open Space Private (for the golf course) and 6(a) Open Space Recreation (for the foreshore reserve.
Area C	7(a) Environmental Protection Habitat

Chapter 4

ENVIRONMENTAL ASSESSMENT GLACKEN STREET

4.1 FLOODING

4.1.1 Natural Landforms and Drainage

The site is bounded by a natural swamp forest to the west and an artificially enlarged drainage channel of Wards Creek to the east. The drainage line from the natural swamp converges with the drainage channel and forms a small lagoon at the southern boundary of the site which flows into the Manning River. The flow of water out of the lagoon is limited by the capacity of the culvert under Beach Street adjacent to the Manning River.

The soils of the site are sandy and highly pervious, however the water table is close to the surface throughout the site, which impedes drainage. The portion of the site that carries Open Forest vegetation is higher than the rest of the site and hence the water table is lower.

The site is subject to flooding from Ward's Creek (GTCC, 1996). The flood study undertaken by GTCC (1996) found the level of the 1% AEP flood to be 2.26 metres AHD in the vicinity of the site. Filling of the site above the 1% AEP flood level would be necessary to allow development.

4.1.2 Impacts

The effect of urbanisation of rural catchments is to increase runoff potential through changes in catchment storage and runoff response characteristics. This is due to the reduced storage potential of impermeable areas which consequently results in greater stormwater runoff.

In order to utilise the study site for residential housing it would be necessary to raise the existing land surface to ensure that floor levels are above the 1% AEP flood. The hydraulic impacts of various landfill scenarios in the upper reaches of Ward's Creek (not including the site) were modelled by GTCC using the ESTRY hydraulic model

(*Figure 6* in GTCC, 1996). The model found that fill in that area could raise the level of the 1% AEP flood by between 0.01 metres and 0.28 metres. The impact of the larger rise in flood level would be to increase the flood hazard to all existing flood prone properties and to make a further 76 houses flood affected.

Although the subject site was not included in the modelled fill scenarios it is a hydraulically sensitive area due to its location adjoining Wards Creek, and also because a tributary of the creek flows through the site. Because of the siting and characteristics of the land, it is not practical to predict the likely hydraulic impacts of filling the site without further flood modelling which is beyond the scope of this study. A small area in the southwestern corner of the site has been filled previously and further minor filling of that part of the land would not be likely to cause significant adverse hydraulic impacts.

In addition, filling of the site would restrict the flow of water from the Wards Creek catchment into the Manning River. The drainage channel of Wards Creek is very confined and would tend to create a bottleneck for the flow of flood water. In order to pass peak flood flows through the filled area extensive drainage works would be required. If filling of the site were to occur (other than in the southwest corner of the site), further flood modelling and assessment would be necessary to assess the specific design requirements and hydraulic impacts of those drainage works.

As the study site is located between two arms of a river as defined by the *Rivers and Foreshores Improvement Act 1948,* approval to place fill may be required from Department of Land and Water Conservation. If development is proposed, it will be necessary to undertake a comprehensive assessment of the hydrological effects of the proposal on Wards Creek, the Manning River and surrounding areas in order to meet the Department's requirements for approval.

4.2 WATER QUALITY

4.2.1 Existing Water Quality

The site drains to Wards Creek and then the Manning River which subsequently flows into the Pacific Ocean. To date there have been no water quality data collected from the site, however there are water quality data for the Manning River in the vicinity of the site.

Current landuse of the site does not pose water quality problems, however, development of the site has potential to increase pollutant export towards Wards Creek and the Manning River.

4.2.2 *Impacts*

Urbanisation of water catchments has short and long term impacts on water quality. Short-term impacts are associated with earthworks during the construction phase and can lead to considerable erosion and sedimentation of downstream waterbodies. Long-term impacts are associated with the change in quality, quantity and peak flow rates of stormwater runoff reaching the downstream receiving waters.

The impact of uncontrolled development of the site could cause damage to downstream SEPP 14 wetlands and other riparian environments. Lack of stringent erosion and sediment controls would contribute to sediment deposition in these environments and may lead to significant alterations to riparian hydrological regimes.

The site represents a very small proportion of the Manning River catchment and as such, change in land use is unlikely to significantly affect water quality in the Manning River. However, substantial drainage works in Wards Creek would be necessary to reduce the impacts of filling the site. These drainage works are likely to disturb acid sulfate soils in the locality and have an adverse impact upon water quality.

4.3 ACID SULFATE SOILS

4.3.1 *Acid Sulfate Soil Risk Maps*

The acid sulfate soil risk map was examined to determine the likelihood of acid sulfate soils occurring in the study site. The risk map shows low and high probability of acid sulfate soil occurrence for the site in two acid sulfate soil landforms as shown in *Figure 4.1*. These classifications are discussed below.

i High Probability of Acid Sulfate Soils

Soils with a high probability of occurrence of acid sulfate soil material within the profile indicates that the environment of soil deposition has been suitable for the formation of acid sulfate soil materials. Within these areas acid sulfate soils are widespread or sporadic and may be close to the surface or buried by alluvium or windblown sediments. One landform present at the Glacken Street Site has a high probability of acid sulfate soils. This is the aeolian sandplain within 1 metre of the ground surface.

Additionally, Wards Creek itself is shown to have a high probability of occurrence of Acid Sulfate Soils below water level.

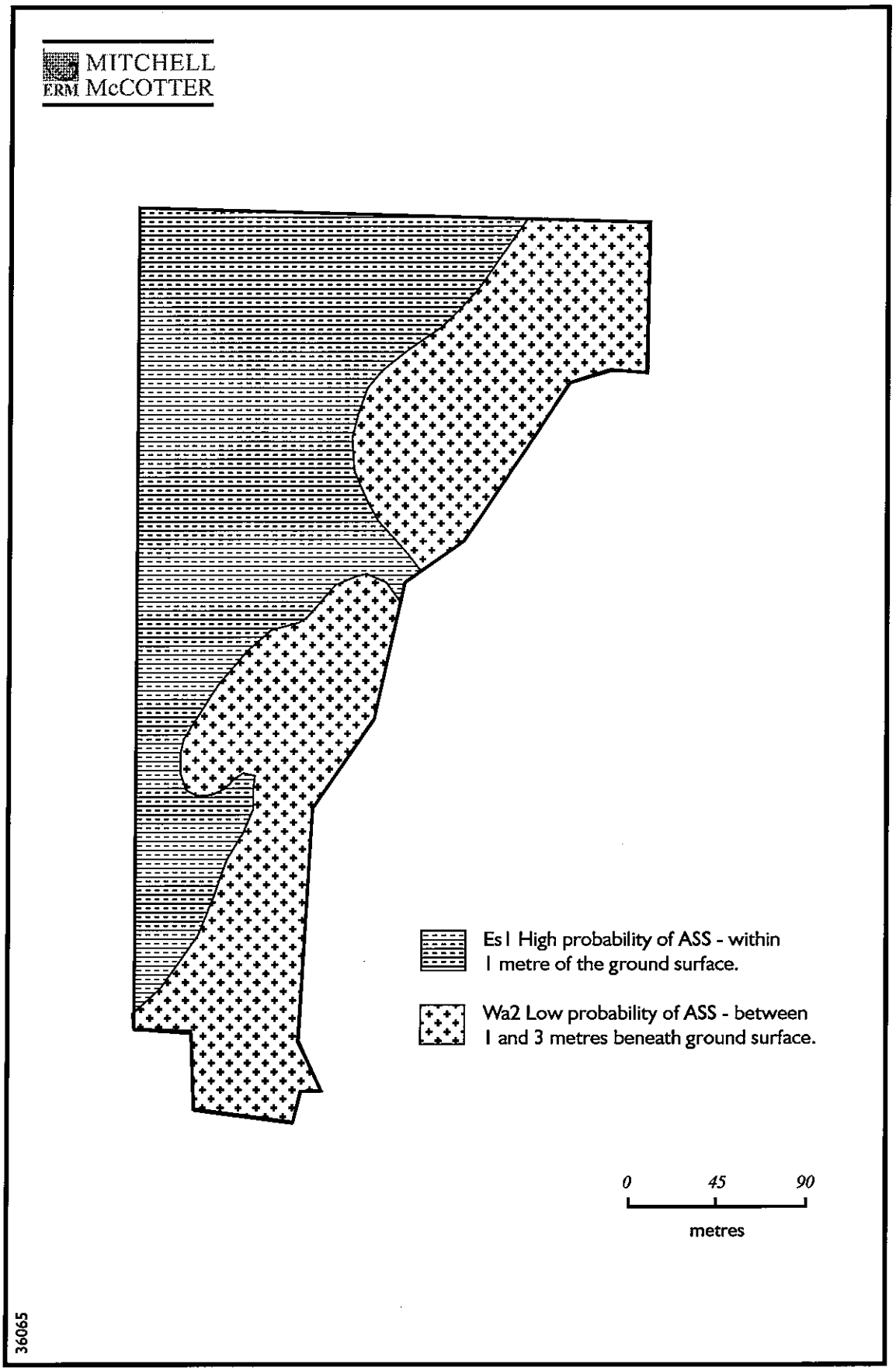

Figure 4.1 PROBABILITY OF ACID SULFATE SOIL OCCURRENCE

ii Low Probability of Acid Sulfate Soils

Where the environment of soil deposition has not been suitable for the formation of acid sulfate materials or acid sulfate soils are highly localised or sporadic, they have been classified as having a low probability of occurrence. Acid sulfate soil materials may be close to the surface or buried by alluvium or windblown sand. One landform present at the Glacken Street site has a low probability of acid sulfate soils. This is the aeolian sandplain at an elevation between 1 and 3 metres below the ground surface.

4.3.2 Impacts

Activities to be undertaken during the development of the Glacken Street site that may result in the exposure of acid sulfate soils to the environment are:

- excavation for services on site and drainage works in Wards Creek which directly expose acid sulfate soils to oxygen or which may lower groundwater levels, resulting in the development of sulfuric acid; and
- the application and compaction of fill on the site may alter the groundwater regime of the site, which in turn may lead to the exposure of acid sulfate soils through a drop in groundwater levels.

The likelihood of exposing these soils from the above activities is high at the Glacken Street site due to the close proximity of these soils to the ground surface (just below water level and within 1 metre of the ground surface). In addition, deep drainage already exists at the Glacken Street site and has resulted in the drainage of the highly permeable sandy soils, therefore lowering the groundwater table. Additional lowering of the groundwater as a result of filling the site or additional drainage would reduce groundwater recharge and may cause the subsurface exposure of the acid sulfate soils.

The consequence of exposing acid sulfate soils to the atmosphere is the production of sulfuric acid which in turn leads to the liberation of toxic concentrations of dissolved metals. Subsequently this leads to land and water degradation with significant effects on engineering works (including the types of concrete and steel required, the design of roads and drainage systems), agricultural systems (including the choice of crops, lime and fertiliser requirements), economic and social planning and negative effects on aquatic ecosystems.

4.3.3 *Mitigation Measures*

The scope of this study did not include testing of soils on or near the site for Acid Sulfate potential. Based on the investigations to date, a comprehensive testing and analysis program should be carried out before any development occurs to determine the site specific potential for acid generation and the environmental and economic feasibility of managing any potential acid problems.

Depending on the proposed development, the EPA (1995) suggests that an assessment will need to be made of the potential for acid generation, the likely quantities of acid which may be discharged and the vulnerability of any natural water body (including groundwater) that may be affected by the acid generated. The level of investigation will depend upon the level of disturbance proposed and the sensitivity of the surrounding environment.

Soil characteristics to be assessed, at a minimum, should include:

- soil profile and landscape descriptions;
- Net Acid Generating Potential (NAGP);
- Leco-S (oxidisable sulfur); and
- pH before and after oxidation with hydrogen peroxide.

In addition water characteristics will need to be assessed. Analyses should include:

- pH;
- total dissolved solids;
- iron (total);
- aluminium (total); and
- soluble chloride to sulphate ratio.

4.3.4 *Management Strategies*

Management strategies will need to be established if the proposed development is likely to disturb acid sulfate soils to the extent that a significant risk exists to the surrounding environment through the lowering of the water table or through excavation, dredging, transport, handling, separation, neutralisation and storage. These strategies should demonstrate that the environmental impacts of such likely disturbances can be effectively managed.

4.4 SITE CONTAMINATION

A site inspection and examination of previous land uses has been undertaken to determine the potential for contamination at the Glacken Street site.

Site inspection failed to uncover any likely sources of contamination. Previous land uses have included logging and cattle grazing. In more recent times the site has been unused. The potential for contamination at the Glacken Street site is considered to be low.

4.5 ECOLOGY

4.5.1 Vegetation Communities

Based on structural characteristics and floristic composition, three main vegetation communities were identified on the site. Each community is described below and shown in *Figure 4.2.*

i. Blackbutt/Smooth Barked Apple Dry Open Forest

Description: This community is a heavily disturbed open forest that occurs over approximately five hectares of the eight hectare site. The canopy is sparse with many individuals exhibiting signs of dieback. There are many introduced species present. The most abundant of these are Morning Glory (*Ipomoea cairica*), Lantana (*Lantana camara*) and Pennywort (*Hydrocotyl bonariensis*).

Upper Canopy: The upper canopy is dominated by Blackbutt (*Eucalyptus pilularis*) and Smooth Barked Apple (*Angophora costata*). The height of the upper canopy is approximately 20 metres. There are a few Mangroves (*Avicennia marinia*) growing along the tidal creek that forms the eastern boundary of the site. Swamp Oak (*Casuarina glauca*) and *Melaleuca species* are present at the intergrade between this community and the swamp forest community.

Understorey: The mid-understorey layer is sparse with no dominant species. Species present are Pampas Grass (*Cortaderia selloana*), *Melaleuca species,* Coastal Wattle (*Acacia sophorae)* and *Banksia integrifolia.* The understorey in the eastern section of this community is dominated by Blady Grass (*Imperata cylindrica*) and Bracken (*Pteridium esculentum*). In the southern and western sections Sword Grass (*Gahnia sieberiana*) and Phragmites (*Phragmites australis*) dominate. There are a number of exotic understorey species occurring in this community such as Lantana

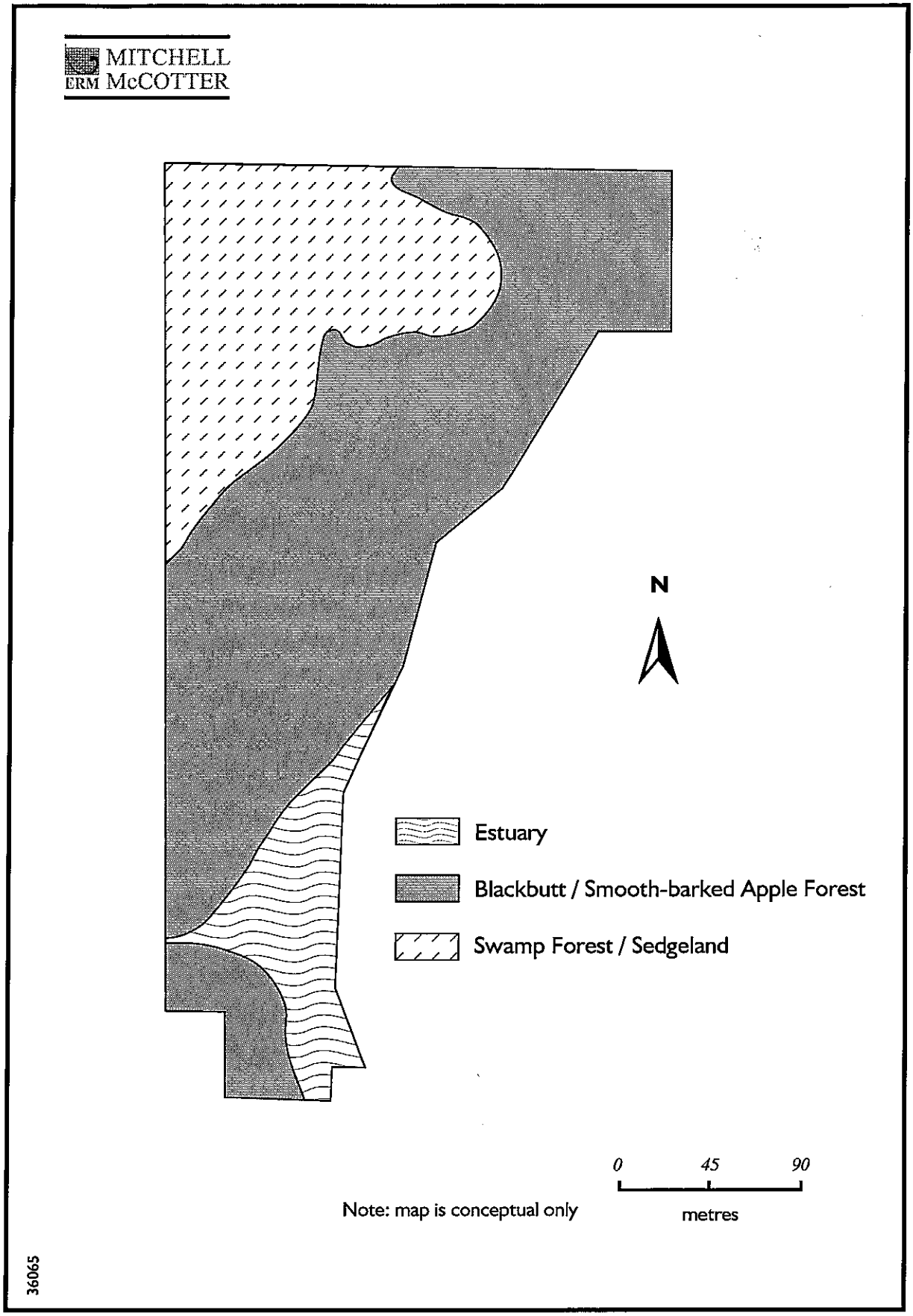

Figure 4.2 VEGETATION COMMUNITIES - GLACKEN STREET

(*Lantana camara*), Fireweed (*Senicio madagascariensis*) and Scotch Thistle (*Onorpardum acanthium*).

Groundcover: Groundcover is sparse in the eastern section of the site and is dominated by introduced species such as Kikuyu (*Pennistum clandestinum*), Buffalo Grass (*Stenotaphrun secundatum*) and Pennywort (*Hydrocotyl bonariensis*). In the western and southern section of the site groundcover is of medium density and is dominated by Kangaroo Grass (*Themeda australis*), Whiskey Grass (*Andropogan virginicus*) and Common Maidenhair (*Adiantum aethiopsicum*).

ii. Swamp Forest/Sedgeland

Description: This community is restricted to the low lying western section of the site and occupies about 2.5 hectares. The canopy is closed allowing little growth of understorey species except where powerlines run through the community. The canopy has been removed under the powerlines and this has allowed a sedgeland to develop.

Upper Canopy: The upper canopy is dominated by Broad Leaved Paperbark (*Melaleuca quinquenervia)* which reaches a height of approximately 25 metres. At the intergrade between Swamp Forest and Open Forest Swamp Oak (*Casuarina glauca)* and Prickly Leaved Tea Tree (*Melaleuca stypheloides)* are present.

Understorey: There are no mid-understorey species present in this community. The understorey is dominated by sedges such as Sword Grass (*Gahnia sieberiana), Baumea articulata, Baumea juncea* and *Schoenus apogon.*

Groundcover: The groundcover is dense and dominated by Salt Water Couch (*paspalum vagiantum),* Couch (*Cynodon dactylon)* and Swamp Water Fern (*Blechnum indicum).*

iii. Estuarine Community

Description: This community is heavily disturbed. Wards Creek drainage reserve, which runs down the eastern side of the site, flows into the Manning River. A lagoon covering approximately 0.75 hectares occurs on the site where the creek and river meet. This lagoon also receives runoff from the Swamp Forest area. The estuarine vegetation of this community is severely degraded with only a small number of Grey Mangroves *(Avicennia marina)* remaining.

4.5.2 *Fauna Habitats*

The vegetation communities outlined above reflect differences in structure and plant species composition. The majority of animals choose habitat based primarily on structural differences of vegetation communities, rather than detecting specific plant species differences. This, of course excludes the Koala, which chooses habitat based mainly upon the presence of particular plant species.

Structural characteristics include the height of the dominant layer, the number of distinctive layers and the density of vegetation. Many specialised faunal groups may depend heavily upon the availability of specific habitat characteristics such as tree hollows, to survive. Any activity that changes the structure or cover of vegetation, and consequently habitat characteristics, may result in modifications to the composition of fauna within an area. Three fauna habitats have been identified on the subject site. These are discussed below.

i. Open Forest

Vegetation Communities: Blackbutt/Smooth-barked Apple Dry Open Forest.

Fauna Habitat Components: The Blackbutts in this community may provide a food source for the Koala. A high number of flowering plant species in the canopy and understorey may provide a food source for nectivorous fauna.

Vegetation Condition: This habitat is generally heavily disturbed, with evidence of dieback and an abundance of introduced plant species. No hollows in the trees were observed during the site inspection.

ii. Swamp Forest

Vegetation Communities: Swamp Forest/Sedgeland.

Fauna Habitat Components: The dominance of Broad-leaved Paperbark in this community provides a food source for nectivorous fauna. It may also provide a food source for the Koala. The groundcover may provide a resource for fauna requiring a damp environment. The groundcover provides a resource for small mammals which require a dense groundcover for shelter.

Vegetation Condition: The vegetation is generally in a natural condition, with few areas of disturbance.

iii. Estuary

Vegetation Communities: Estuarine Community.

Fauna Habitat Components: This provides a habitat, incorporating both food and shelter, for aquatic fauna.

Vegetation Condition: This habitat is heavily disturbed and appears to only recently be undergoing natural regeneration.

4.5.3 Koala Habitat (State Environmental Planning Policy No. 44)

The only SEPP 44 tree species identified in the site was Swamp Mahogany (*Eucalyptus robusta*). There was only a minimal number of this tree species identified in the site. Therefore the study site is unlikely to contain potential Koala habitat in accordance with SEPP 44. Koalas in the local region are known to feed on Broad-leaved Paperbark (McLeod pers comm).

4.5.4 Threatened Fauna

Table 3.2 lists those threatened fauna species which may utilise the site, including the habitat they would utilise if they occur. The species have been determined based upon the fauna habitat known to exist in the site, and species previously recorded within the region on the NPWS Atlas of Wildlife.

4.5.5 Conservation Value of Fauna Habitats

An assessment of the conservation values of the fauna habitats using the above criteria is detailed in *Table* 4.2.

The Swamp Forest habitat is recommended for conservation.

Table 4.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
Green and Golden Bell Frog	*Litoria aurea*	Vegetation within or at the edges of permanent water - streams, swamps, lagoons, dams and ponds.	Swamp Forest and Estuary.	Moderate. Habitat on site but rarely recorded in region.
Wallum Froglet	*Crinia tinnula*	Acid paperbark swamps and wet heath.	Swamp Forest.	Moderate. Suitable habitat on site but rarely recorded in the region.
Glossy Black Cockatoo	*Calyptorhyncus lathami*	Forest and woodland.	Open Forest.	High due to suitable habitat on site and frequency of recordings in region.
Powerful Owl	*Ninox strenua*	Wet and dry sclerophyll forest, with optimum habitat being tall, dense mountainous eucalypt forest.	Open Forest.	Moderate due to poor quality habitat on site, but frequently recorded in region.
Masked Owl	*Tyto novaehollandiae*	Forests, woodlands and caves.	Open Forest.	High due to suitable habitat on site and frequency of recordings in region.
Osprey	*Pandion haliaetus*	Estuaries, rivers, lakes or the ocean. Nests in tall dead trees in semi-open areas.	Estuary for foraging.	May use the estuary for foraging as it is known to have a nest on a nearby property.
Square-tailed Kite	*Lophoictinia isura*	Open forest and	Open Forest.	Moderate due to habitat

Table 4.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
		woodlands.		suitability on site, but infrequently recorded in region.
Black-necked Stork	*Ephippiorhynchus asiaticus*	River pools, swamps and intertidal flats.	Estuary and Swamp Forest.	High due to suitable habitat on site and the frequency of recordings of this species in the region.
Australasian Bittern	*Botaurus poiciloptilus*	Swamps with dense reed beds.	Swamp Forest	Moderate due to limited suitable habitat on site.
Black Bittern	*Ixobrychus flavicollis*	Mangroves, and streamside vegetation including small creeks in forests.	Estuary.	Low due to ephemerality of creeks on site.
Lesser Sand Plover	*Charadrius mongolus*	Inter-tidal sand and mudflats in estuaries.	Estuary.	Moderate due to poor quality habitat on site.
Pied Oystercatcher	*Haematopus longirostris*	Sandy beaches, mudflats and estuaries.	Estuary.	Moderate due to poor quality habitat on site.
Terek Sandpiper	*Xenus cinereus*	Inter-tidal sand or mudflats often near mangroves or in tidal creeks.	Estuary.	Moderate to poor quality of habitat on site.
Comb-crested Jacana	*Irediparra gallinacea*	Swamps, lakes and lagoons.	Swamp Forest and Estuary.	Moderate - High due to some good quality habitat on site.

Table 4.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
Swift Parrot	*Lathamus discolor*	Variety of woodland and dry sclerophyll forest.	Open Forest.	Moderate due to suitable habitat on site, but infrequently recorded in the region.
Turquoise Parrot	*Neophema pulchella*	Open Forest and timbered grasslands.	Open Forest.	Moderate due to suitable habitat on site, but infrequently recorded in the region.
Regent Honeyeater	*Xanthomyza phrygia*	Eucalyptus-dominated woodlands and dry sclerophyll forests with large mature trees.	Open Forest.	Moderate due to suitable habitat on site, but infrequently recorded in region.
Queensland Blossom Bat	*Syconycteris australis*	Rainforests, heathlands and melaleuca swamps.	Swamp Forest.	Moderate due to suitable habitat on site and frequency of recordings in the region.
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	A range of forest types and also mallee and open country.	Swamp Forest and Open Forest.	Moderate due to suitable habitat on site, and frequency of recordings in the region.
Little Bent-wing Bat	*Miniopteris australis*	Wet and dry sclerophyll forests and rainforests.	Open Forest.	High due to suitable habitat on site and known occurrence in region.
Eastern Little Mastiff Bat	*Mormopterus australis*	Sclerophyll forest and woodland. Forages in clearings.	Open Forest.	Moderate due to suitable habitat on site and frequency of recordings in region.

Table 4.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
Greater Broad-nosed Bat	*Scoteanax ruepellii*	Wet and dry sclerophyll forests and rainforests.	Open Forest.	High due to suitable habitat on site and known occurrence in region.
Great Pipistrelle	*Falsistrellus tasmaniensis*	Known from a variety of wooded habitats.	Open Forest and Swamp Forest.	Moderate due to some suitable habitat on site, but infrequently recorded in the region.
Large Bent-wing Bat	*Miniopterus schreibersii*	Wet and dry sclerophyll forests and rainforests	Open Forest.	High due to suitable habitat on site and known occurrence in region.
Squirrel Glider	*Petaurus norfolcensis*	Dry sclerophyll forests and woodland	Open Forest.	High due to suitable habitat on site and frequency of occurrence in region.
Brush-tailed Phascogale	*Phascogale tapoatafa*	Dry and wet sclerophyll forests, usually in areas with sparse ground cover.	Open Forest.	High due to suitable habitat on site and frequency of occurrence in region.
Tiger Quoll	*Dasyurus maculatus*	Wet and dry sclerophyll forest and rainforest.	Open Forest and Swamp Forest.	Moderate due to poor quality of habitat on site, but known to occur in the region.
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*	Heathland particularly wet heath and swampy	Swamp Forest.	High due to suitability of habitat on site and frequency of recordings in the region.

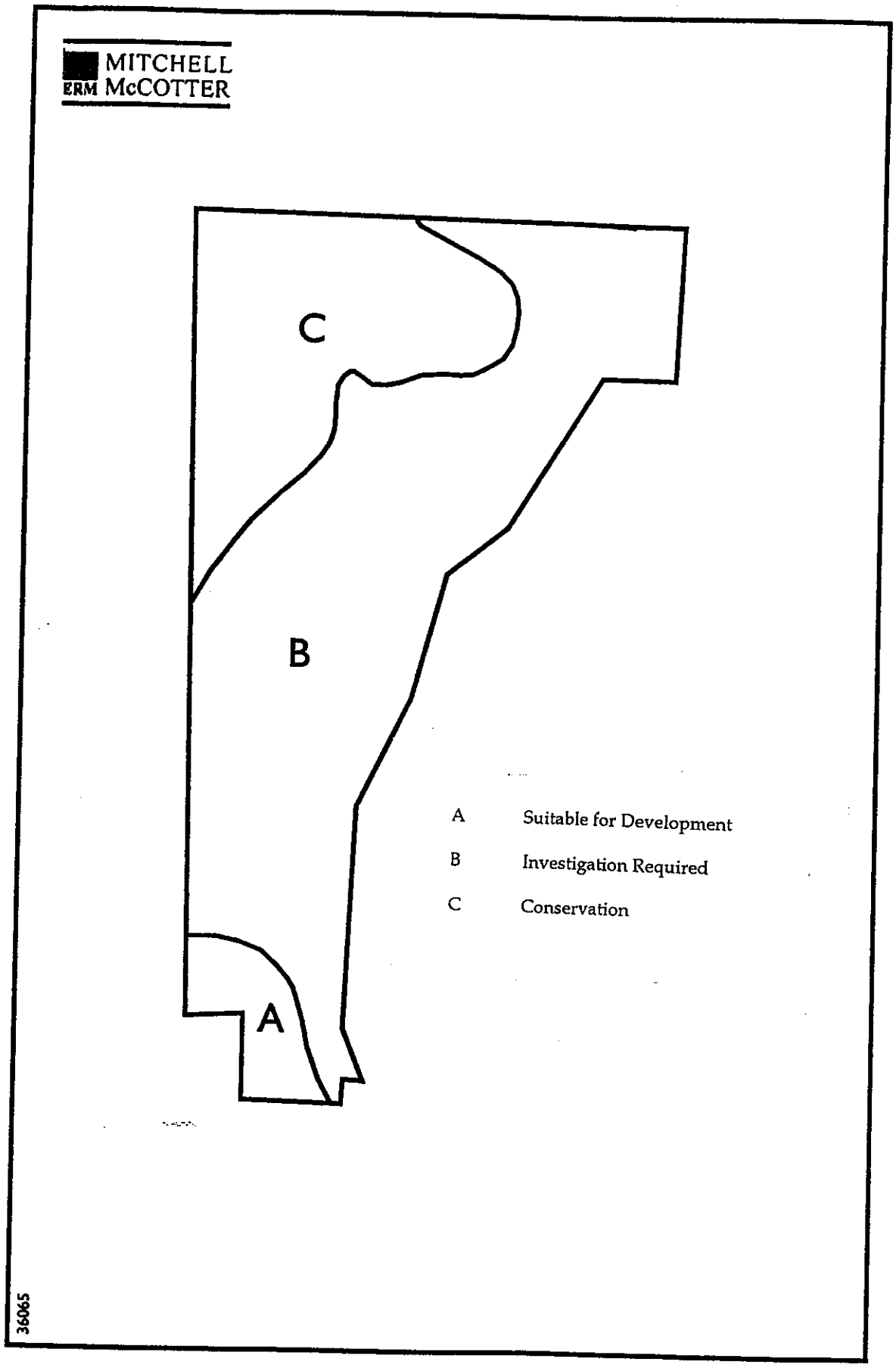

Figure 4.4 DEVELOPMENT AND CONSERVATION AREAS

4.12 LAND CAPABILITY ASSESSMENT

4.12.1 Opportunities and Constraints

The site would require filling to above the 1% AEP flood level to allow residential development to occur. Such filling has potential to create environmental hazards. These hazards include:

- an increase in flood levels at other properties in the locality during a major flood event;
- adverse impacts on the hydraulic regime of Wards Creek;
- the likelihood of exposing acid sulfate soils during the construction of substantial drainage works in Wards Creek that would be necessary to pass peak flood flows; and
- a further lowering of the water table caused by filling the site or additional drainage and subsequent possibility of sub surface exposure of acid sulfate soils.

Areas of the site that are suitable for rezoning for urban development, areas requiring further detailed investigation and areas requiring conservation are shown in *Figure 4.4* and discussed below.

A - Suitable for Development

This area has been filled in the past and appropriate management controls for environmental impacts of development can be determined through the Development Application process. Ecological value of this area is low and potential acid sulfate soils problems should be able to be identified and managed. Some further filling of this area will be required, however drainage works necessary to serve any development will not need to be substantial.

B - Investigation Required

Before rezoning of this area for urban development is contemplated, further flooding, hydraulic and acid sulfate investigations are required. These should include flood modelling of the impacts of filling and site specific acid sulfate soil tests and groundwater analysis to determine the extent and manageability of potential Acid Sulfate problems.

C - Conservation

The Swamp Forest habitat on site should be preserved for its high ecological value. The major purpose of preserving the Swamp Forest habitat is to maintain its function as an ecological buffer to sensitive land, including Crowdy Bay National Park, to the north west of the site. Particular emphasis should be placed on preserving the current water table level in the Swamp Forest so that the floristic structure and composition of this habitat remains unchanged.

4.12.2 Recommendations

Development of the site can only be achieved if filling is undertaken. Residential development of Area A as shown in *Figure 4.4* is considered to be the only appropriate development for the site at this stage. It is recommended that Area A be rezoned 2(a) Residential under the provisions of Greater Taree LEP 1995.

It is further recommended that Area C be rezoned 7(a) Environmental Protection Habitat and that rezoning to residential of Area B may occur if flood modelling, groundwater analysis and acid sulfate soils testing determine that potential flooding and acid sulfate impacts will be manageable.

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Table 4.1 LIKELIHOOD OF THREATENED FAUNA AND FLORA SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT	HABITAT ON SITE IN WHICH THEY ARE LIKELY TO OCCUR	LIKELIHOOD OF OCCURRENCE
		areas.		
Common Planigale	*Planigale maculatus*	Rainforest, sclerophyll forests and grasslands, marshlands and rocky areas.	Open Forest and Swamp Forest.	Moderate due to some amount of suitable habitat on site.
Long-nosed Potoroo	*Potorous tridactylus*	Coastal heath and dry and wet sclerophyll forests.	Open Forest.	Moderate. Although there is suitable habitat on site, it has been infrequently recorded in the region.
Koala	*Phascolarctos cinereus*	Eucalypt forest and woodlands with feed tree species.	Swamp Forest and Open Forest.	High due to presence of feed tree species.

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Table 4.2 FAUNA HABITAT CONSERVATION VALUES

	Representativeness and Reservation	Degree of Naturalness and Special Natural Features	Level of Diversity and Habitat Links	Conservation Value
OPEN FOREST	This forest type is representative of dry forest occurring along the near coastal strip on the Mid North Coast of NSW and can be found reserved within Myall Lakes National Park (Myerscough and Carolin, 1986). This habitat type also occurs in the Pacific Palms and Forster area (personal observation) as well as Crowdy Bay National Park (Griffith, 1994). Blackbutt forests and Smooth-barked Apple forests have been recorded as inadequately reserved on the NSW North Coast (Griffith, 1993) and statewide reservation is also classed as inadequate (Benson 1987).	This community is extensively disturbed at all levels of the strata. This habitat has no special natural features.	This habitat has a relatively diverse age structure with mature and immature trees as well as some heath species. The understorey is generally sparse and not highly diverse. There are very few logs and hollows for species dependant upon these resources. The site is surrounded by forested land which links up with nearby Crowdy Bay National Park.	Low.
SWAMP FOREST	This forest type is found within the coastal and estuarine areas of the north and central coasts and is sparsely distributed throughout the Port Stephens to Newcastle area (Callaghan *et al*, 1994). The community is represented with significant areas reserved in Myall Lakes National Park to the south of the site (Myerscough and Carolin, 1986; Hitchcock, 1974). Much of this habitat type now has some protection under SEPP 14 coastal wetlands.	This habitat type is very natural with minimal disturbance. This habitat has no special natural features.	The level of biodiversity within this habitat type is relatively high. The site is surrounded by forested land which links up with nearby Crowdy Bay National Park.	High
ESTUARY	This vegetation type is widespread throughout the Port Stephens area and other estuarine areas along the coast of NSW. The Lower Myall River and Corrie Island (at the mouth of the Myall River) have been identified by the Northern Shores of Port Stephens Regional Environmental Study as highly significant due to the presence of mangroves, saltmarsh and mudflats providing significant habitat for fauna. Griffith (1993) and Benson (1987) report that there is poor reservation of this community due to reserve boundaries ceasing at the mean high tide level. Greater Taree City Council has a tree preservation order on Mangroves, regardless of size and this offers protection to these species within this community type. Estuarine areas, specifically saltmarshes and mudflats also come under the protection of SEPP 14 Coastal Wetlands.	This habitat is highly disturbed and has no special natural features.	Due to the highly disturbed nature of this habitat type, the level of biodiversity is low. The site is surrounded by forested land which links up with nearby Crowdy Bay National Park.	Low due to disturbance, although estuaries are known to be significant as a fisheries resource.

4.6 BUSHFIRE MANAGEMENT

4.6.1 Bushfire Hazard

The close proximity of the site to timbered areas and Crowdy Bay National Park which has a known history of frequent intense bushfires has resulted in the site being considered as having a moderate to high bushfire risk. However, the location of the site in close proximity to Wards Creek, the lagoon where Wards Creek meets the Manning River and the ready access into the site from Glacken Street, has reduced the risk to moderate provided that the mitigation measures outlined below are adopted.

4.6.2 Mitigation Measures

Prevention of fires on the subject site should be one of the primary aims for development design. The Department of Bushfire Services' (1991) *Planning for Bushfire Protection* discusses strategies which will assist in reducing the overall risk of fire. These methods should be considered in any future development and subdivision design for the site and include:

- the use of fire protection zones;
- road design standards that will provide adequate internal access for fire fighting vehicles; and
- staging development so that initial development occurs on the hazard perimeter.

4.7 ARCHAEOLOGY AND HERITAGE

No items or sites of Aboriginal significance are known to occur on the site, however, the Local Aboriginal Land Council and NPWS have indicated that this does not exclude the possibility of sites/items occurring. A literature search indicated that no archaeological surveys have been undertaken on the study site in the past.

Prior to the preparation of detailed design, the Local Aboriginal Land Council will need to be consulted and further archaeological investigations undertaken.

of these roads have kerb and guttering. The speed limit in Harrington is 60 kilometres per hour.

4.11 PLANNING AND DEMOGRAPHICS

The Draft Harrington Development Study (Acacia,1996) identifies that residential development of the site would require a change in zoning. The Study recommends that residential growth should occur primarily in the Harrington Waters Estate and Spinnaker Bay precincts, however infill residential development may be achievable at Glacken Street. The proposed development would therefore be consistent with the Study, which is considered to be an urban development program as identified by the Hunter REP 1989.

Intensive residential development of the entire site would require filling to above the 1% AEP flood level. Such filling is likely to cause substantial environmental hazards to the environment and surrounding properties. Consequently, intensive residential development of the site is not considered to be consistent with the Hunter REP 1989 in that the management of the environmental impacts of intensive development would be difficult to achieve.

Residential development of the southern part of the site would not cause significant environmental hazards and is considered to be of minor significance. Appropriate management controls for environmental impacts of minor development can be implemented, therefore such scale of development is considered to be consistent with the Hunter REP 1989.

Minor residential development at Glacken Street would not alter the demographics of Harrington.

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NSW Department of Housing (1993)
Soil and Water Management for Urban Development prepared by Morse McVeyend Associates, Picton New South Wales.

NSW Government (1989)
Hunter Regional Environmental Plan 1989. Department of Planning, Newcastle.

4.8 SERVICES

i. Public Works and Services

NSW Public Works and Services Department advises that it has no comment to make regarding the site at this time.

ii. Electricity and Water

NorthPower's water division advises that reticulated town water supply is available to the site and that the availability of water supply should not be a constraint to development.

NorthPower's electricity division advises that there is existing Subtransmission/Distribution system infrastructure adjacent to the site that should adequately service the electricity requirements of the proposed development.

iii. Telephone

Telstra advises that there is telecommunications plant adjacent to the site and that telephone services can be provided in accordance with its standard policy *"External Cabling of Estates and Property Developments"*. Telstra also makes the comment that community and infrastructure costs will be reduced if the development gradually proceeds outward from established areas.

iv. Sewerage

In addition to the comments made in Section 3.8.1, review of GTCC's *Sewerage Service Strategies for Harrington* (1996) revealed that Council has not made provision for the development of the study site in planning strategies for Harrington. The site is adjacent to the catchment for pump station 7, however Council has assumed that this station will not contribute any future sewer loadings. The developer will be required to provide sewerage infrastructure and contribute to headworks costs associated with augmentation.

4.9 COMMUNITY FACILITIES AND OPEN SPACE

4.9.1 Community Facilities

If Council adopts the recommendations of the Draft Harrington Development Study (Acacia,1996), there would be no need to dedicate land for community facilities at Glacken Street.

4.9.2 Open Space

Embellishment should focus on creating recreational opportunities which satisfy the needs and interests of all age groups. Some land which should not be developed, due to environmental constraints, could be considered for low impact, casual recreational uses. The foreshore of Wards Creek may offer opportunities for linear open space or pedestrian links between the wetlands and Beach Street.

However, Council may decide not to acquire additional land for open space. Instead, it may choose to embellish existing foreshore and park land. Dedication of land for public open space would then not be needed at Glacken Street.

4.10 TRAFFIC

4.10.1 Existing Road Network

The road network in the vicinity of the study site is illustrated in *Figure 4.3*. The proposed site for future development is bounded by Glacken Street, High Street and a drainage reserve that separates the site from existing residential areas to the east.

Access to the site may be either by continuation of the existing portions of Glacken Street and High Street along existing road reserves, or from Jabiru Drive. The roads likely to be affected by the proposed development are Glacken Street, High Street, Scott Street, Jabiru Drive and Beach Street, which becomes Harrington Road on the western approach to Harrington.

Beach Street is a wide, relatively straight road with kerb and guttering. The pavement is 10.2 metres wide and in good condition. Entering sight distances and approach sight distances along Beach Street at the intersections with Glacken Street, Scott Street and Jabiru Drive are in excess of 250 metres in both directions. The width of pavement in Jabiru Drive, Scott Street and Glacken Street is 10.2 metres. All

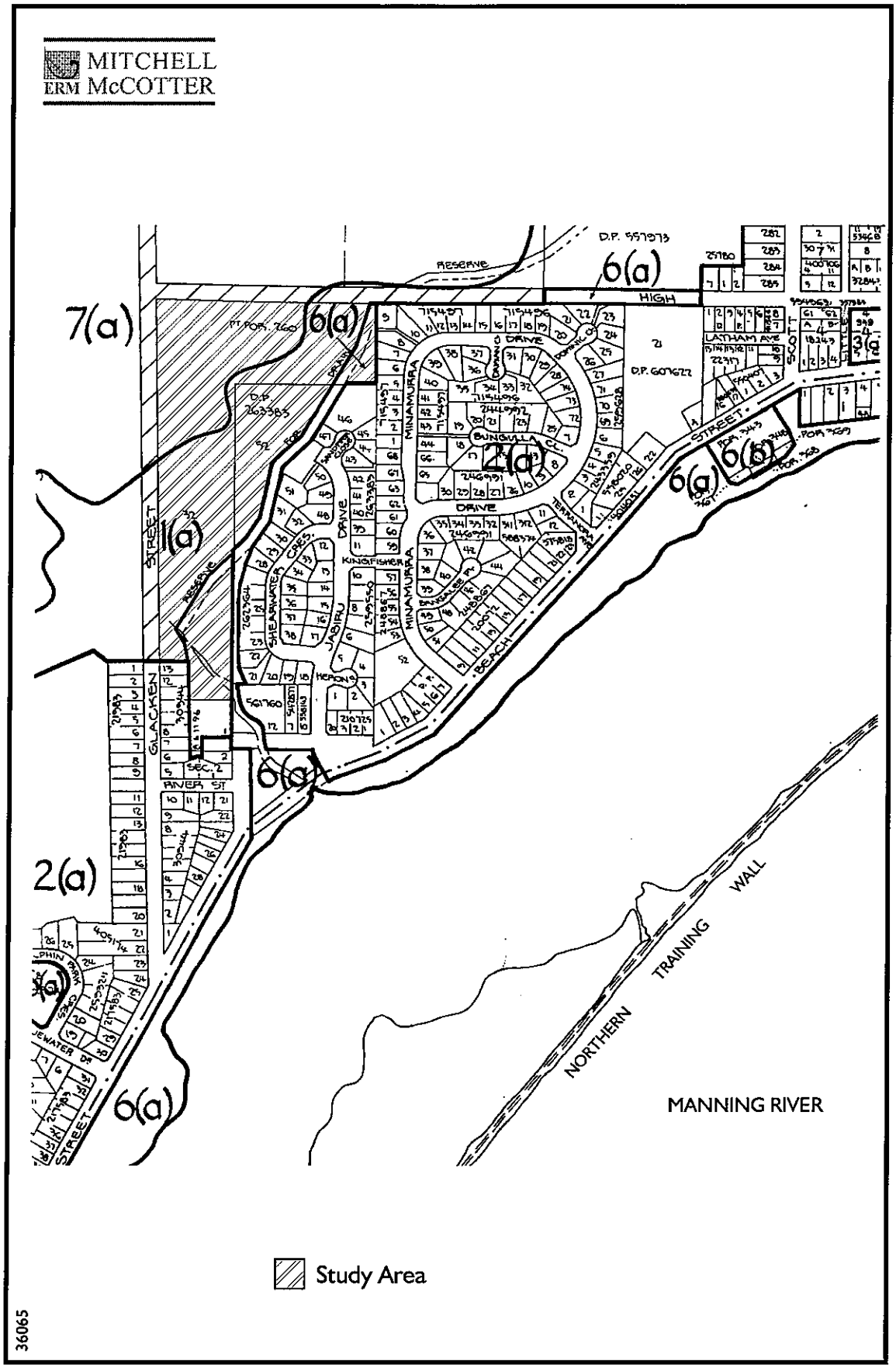

Figure 4.3 LOCAL ROAD NETWORK

NSW Government (1990)
NSW Coast - Government Policy. Department of Planning, Sydney.

NSW Government (1994)
Hunter Coastal Urban Settlement Strategy. Department of Planning, Newcastle.

Oceanics Australia (1983)
Environmental Studies for Proposed Canal Development Harrington, NSW.

Public Works (1991)
Flood Study Manning River.

Roads and Traffic Authority (1993)
North Coast Road Strategy, Summary Report.

Roads and Traffic Authority (1993)
Guide to Traffic Generation Developments.

State Pollution Control Commission (1987)
Water Quality in the Manning River Northern Rivers Study No 7.

Water Resources Commission (1978)
The Manning Valley Groundwater Investigation Hydrogeological Report No 1978/4.

WBM Oceanics Australia (1994)
Peakhurst Property Harrington Flooding Assessment. Prepared for Mitchell McCotter and Associates.

White, I and Melville, MD (1993)
Treatment and Containment of Potential Acid Sulphate Soils: Report to the Roads and Traffic Authority. Technical Report S1, CSIRO Centre for Environmental Mechanics, Australia.

Willing and Partners (1995)
Sutherland Shire Council Gross Pollutant Traps Design Manual.

Willing and Partners (1996)
Draft Manning Flood Plain Management Study. Prepared for Greater Taree City Council.

APPENDICES

Appendix A

GOVERNMENT AUTHORITY RESPONSES

NorthPower
PO BOX 374
57 - 61 ALBERT STREET
TAREE NSW 2430
TELEPHONE (065) 52 0444
FACSIMILE (065) 52 0455

YOUR REF:
OUR REF: GWA:JB

31 October 1996

ERM Mitchell McCotter
Suite 6/221 Victoria Street
Taree NSW 2430

Dear Tony,

RE: HARRINGTON LOCAL ENVIRONMENTAL STUDY

Thankyou for your advice of the above study commencing.

I am pleased to advise that a normal town water supply is available to both study areas and that availability of water supply should not be a constraint to development.

Yours Faithfully

GW Allen
Water Engineer

ERM Mitchell McCotter Quality System

Date received	5.11.96		
Referred to	T.F.	Ref. No.	3605

☐ refer to verification record
☑ verification not required

Signature: _____ Date: _____
Project Manager

PUBLIC WORKS

DEPARTMENT OF PUBLIC WORKS & SERVICES

Operations Division
North Coast Region

PO Box 675
Maher Road
Port Macquarie NSW 2444
Telephone (065) 820 563
Facsimile (065) 820 482

Contact: Mr Mick Donohoe
Our Ref: TR.1 - taree\ermmitmc.l
Your Ref: 36065

Attention: Mr Tony Fish
ERM Mitchell McCotter
PO Box 487
TAREE NSW 2430

Dear Tony

NORTH COAST REGION: PORT MACQUARIE OFFICE
HARRINGTON LOCAL ENVIRONMENTAL STUDY

In response to your letter of the 20th October 1996 regarding Harrington Local Environmental Study, thank you for the opportunity to comment.

The Department of Public Works and Services wishes to advise that at this time we have no comment on the Study.

Yours faithfully

for: 8 NOV 1996

M DONOHOE
Client Manager
Hastings Council.

ERM Mitchell McCotter Quality System

Date received	11.11.96		
Referred to	TF	Ref. No.	36065

☐ refer to verification record
☑ verification not required

Signature: _____ Date: 11/11/96
Project Manager

quality service . value . innovation

Should you wish to discuss any of these matters further, please do not hesitate to contact Sonya Ardill, Environmental Planning Officer, on (066) 598 221.

Yours faithfully

Matt Cameron
Manager Environmental Planning

for DIRECTOR-GENERAL

19 November, 1996

ERM Mitchell McCotter
PO Box 487
TAREE NSW 2430

FAXED 19-11-96

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Our reference: 1442/96.1344/sa
Your reference: 36065 LB:TF

ERM [illegible] Quality System
Date: 22.11.96
L. Bhamra
☐ Refer to verification record
☑ verification not required
Signature: [signature] Date: 22/11/96
Project Manager

Attn: Tony Fish

Dear Sir/Madam

HARRINGTON LOCAL ENVIRONMENTAL STUDY

Thankyou for your letter of 20 October 1996 requesting comments on those issues to be covered in the above local environmental study. Those matters which the National Parks and Wildlife Service (NPWS) considers need to be addressed are detailed in the attachment. Please note that this attachment comprises a general list only, and that these issues may apply to a lesser or greater degree depending on site specifics. The NPWS is particularly interested in the following.

- Areas of native vegetation, with special reference to vegetation communities or plant species which are threatened or are of a local, regional or statewide significance (including ROTAP species).
- Areas of potential significance for native fauna with special reference to habitat likely to be significant for threatened fauna species or fauna of a local, regional or statewide significance.
- Areas of archaeological potential and Aboriginal heritage values.

If any areas within your study area possess attributes such as those identified above, the NPWS recommends that detailed surveys be undertaken to determine the natural and/or cultural values of the area and potential impacts on these values.

The NPWS considers that any future development of these areas should be determined in light of the environmental constraints of the sites specifically and the area generally. The NPWS does not support development of wetlands which is not consistent with maintaining their ecological and hydrological integrity. Any development proposal should avoid any direct or indirect impacts on wetlands or other areas of environmental significance.

Given their proximity to Crowdy Bay National Park, the NPWS considers the fire risks associated with urban development of these sites to be a major issue. Any future development of these areas should be planned so as to minimise the risk of fire hazard to and from the National Park.

Northern Zone
GIO House
24 Moonee Street
Coffs Harbour NSW
Australia
PO Box 914
Coffs Harbour 2450
Fax: (066) 516 187
Tel: (066) 515 946

Head Office
43 Bridge Street
Hurstville NSW
Australia
PO Box 1967
Hurstville 2220
Fax: (02) 585 6555
Tel: (02) 585 6444

LISA

TESTRA *

YOUR REF:36065
OUR REF:PMH

23rd NOVEMBER 1996
5

Commercial & Consumer
Area Development
29 Cochrane St
WEST KEMPSEY
N.S.W. 2440
Postal Address:
P.O.Box 99
WEST KEMPSEY. N.S.W. 2440

Telephone 065 622129
Facsimile 065 628732

Mr Tony Fish
ERM MITCHELL McCOTTER
Suite 6/221 Victoria St
TAREE. NSW. 2430.

Dear Sir,

RE : HARRINGTON LOCAL ENVIRONMENTAL STUDY.

I refer to your letter of 20th October 1996 (Ref 36065).

I wish to advise you that this Corporation has no telecommunictions plant within the boundaries of your study areas, however Telstra plant is adjacent to both sites.

The provision of telephone services to the study areas can be provided in accordance with our standard policy " External Cabling of Estates and Property Developments".

In order to allow for logical growth and to limit community and infrastruture costs, it is desirable to ensure that development occurs gradually outward from established areas.

Yours Faithfully,

P.M.Hollis.

Quality System
27.11.96
FAX TONY

Tony

NorthPower

P.O. Box 5118
Delivery Centre
Barton St
Port Macquarie
N.S.W. 2444

10 December 1996

ERM Mitchell McCotter
Suite 6/221 Victoria St
TAREE
2430

Att : Lisa Brown

Dear Lisa

Re : HARRINGTON LOCAL ENVIRONMENTAL STUDY

At present NorthPower has established Subtransmission / Distribution system infrastructure adjacent to the areas identified for the study that should adequately service the electricity requirements / development opportunities of this proposed development area. Given that specific land usage can not be identified at this point further evaluation as to the required augmentation to service the area will be necessary upon completion of the L.E.S.

With the development of area to be medium / long term it is envisaged that little will have to be done in the early stages with the existing distribution infrastructure capable of supporting the initial loading requirements, with only small system additions necessary. However as the area develops additional augmentation and addition to the system will be necessary to meet electricity demands, particularly in the Harrington waters Estate area. The level of augmentation required and it's costing will have to be addressed in more specific detail as plans become firm on completion of the study.

If any further assistance regarding this matter is required, please contact me on 829 302.

Yours faithfully

S.R. Holm

Steve Holm
Network Planning Officer - Port Macquarie.

File : Plan. / Prot. 13.1 - 96 / 21.

TOTAL P. 02

Appendix B

FLORA SPECIES LIST

HARRINGTON WATERS ESTATE AND GLACKEN STREET

HARRINGTON WATERS ESTATE

Casuarina glauca	Swamp Oak
Eucalyptus robusta	Swamp Mahogany
Melaleuca quinquenervia	Broad Leaved Paperbark
Melaleuca stypheloides	Prickly Leaved Tea Tree
Casuarina glauca	Swamp Oak
Blechnum indicum	Swamp Water Fern
Carex apressa	
Carex gaudichaudiana	
Cyperus sphaeroideus	
Gahnia sieberiana	Sword Grass
Isolepis species	
Juncus articulus	
Juncus continuus	
Juncus krausii subspecies australiensis	Sea Rush
Philydrum lanuginosum	Frogmouth
Pteridium esculentum	Bracken
Schoenus apogon	

Acetosa sigittata	Rambling Dock
Anagalis arvensis	Scarlet Pimpernal
Azolla pinata	
Cotula coronopifolia	Water Buttons
Cynodon dactylon	Couch
Goodenia ovata	
Hydrocotyl bonariensis	Pennywort
Lobelia alata	Angled Lobelia
Paspalum vaginatum	Salt Water Couch
Glycine clandestina	Glycine

Juncus planifolius	
Onorpordum acanthium	Scotch Thistle
Pimmelia linifolia	Rice Flower
Pomaderris andromedifolia	
Senecio madagasceriensis	Fireweed
Avena sativa	Oats
Acetosa sagittata	Rambling Dock
Agrostis avenacea	
Briza minor	Shivery Grass
Bromus unioloides	Prairie Grass
Hypochaeris radicata	Cats Ear
Lobelia alata	Angled Lobelia
Lythrum hyssopifolia	Hyssop Loosestrife
Ranunculus inundatus	
Stenotaphrun secundatum	Buffalo Grass
Taraxicum officianalis	Dandelion
Trifolium repens	White Clover
Viola hederacea	Ivy Leaved Violet
Avicennia Marina	Grey Mangrove
Aegiceras corniculatum	River Mangrove
Baumea articulata	
Baumea juncea	
Diarella caerulea	
Lepironia articulata	

GLACKEN STREET

Avicennia marinia	Mangrove
Casuarina glauca	Swamp Oak
Eucalyptus robusta	Swamp Mahogany
Melaleuca quinquenervia	Broad Leaved Paperbark
Melaleuca stypheloides	Prickly Leaved Tea Tree
Melaleuca quinquenervia	Broad Leaved Paperbark
Baumea articulata	
Baumea juncea	
Blechnum indicum	Swamp Water Fern
Dianella caerulea	Blue Flax Lilly
Gahnia sieberiana	Sword Grass
Lepriona articulata	
Leptospermum junipernum	
Restio pallens	
Schoenus apogon	
Cotula coronopifolia	Water Buttons
Cynodon dactylon	Couch
Paspalum vaginatum	Salt Water Couch
Ranunculus inundatus	
Raphanus raphonistrom	
no species present	
Angophora costata	Smooth Barked Apple
Eucalyptus pilularis	Blackbutt
Melaleuca linariifolia	
Acacia sophorae	Coastal Wattle
Banksia integrifolia	

Cortaderia selloana	Pampas Grass
Melaleuca decora	
Billerdiera scandens var sericata	Apple Dumplings
Dianella caerulea	Blue Flas Lilly
Gomphocarpus fruiticosus	Narrow Leaved Cotton Bush
Goodenia ovata	
Hibbertia obtusifolia	
Imperata cylindrica	Blady Grass
Indigophora australis	
Lantana camara	Lantana
Lomandra longifolia	Mat Rush
Onorpordum acanthium	Scotch Thistle
Ozothamnus diosmifolius	White Dogwood
Phragmites australis	Phragmites
Pteridium esculentum	Bracken
Senecio madagasceriensis	Fireweed
Verbena bonariensis	Purple Top
Wahlenbergia stricta	Tall Bluebell
Andropogon virginicus	Whiskey Grass
Adiantum aethiopicum	Common Maidenhair
Briza maxima	Quaking Grass
Cynodon dactylon	Couch Grass
Hydrocotyl bonariensis	Pennywort
Lobelia alata	Angled Lobelia
Paspalum dilatatum	Paspalum
Paspalum vaginatum	Salt Water Couch
Pennisetum clandestinum	Kikuyu
Stenotaphrun secundatum	Buffalo Grass
Taraxicum officianalis	Dandelion
Themeda australis	Kangaroo Grass
Viola hederacea	Ivy Leaved Violet
Kennedia rubicunda	Red Kennedy Pea
Glycine clandestina	Glycine
Ipomoea cairica	Morning Glory
Rubus parvifolius	Native Raspberry

Appendix C

FAUNA SPECIES LIST

HARRINGTON WATERS ESTATE AND GLACKEN STREET

HARRINGTON WATERS ESTATE

Crinia signifera	Common Toadlet
Acanthiza pusilla	Brown Thornbill
Colluricincla harmonica	Grey Shrike-thrush
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Cracticus torquatus	Grey Butcherbird
Eopsaltria australis	Eastern Yellow Robin
Geophaps lophotes	Crested Pidgeon
Gerygone olivacea	White Throated Warbler
Grallina cyanoleuca	Australian Magpie-lark
Gymnorhina tibecen	Australian Magpie
Hirundo neoxene	Welcome Swallow
Malurus cyaneus	Suberb Blue Fairy Wren
Oriolus sagittatus	Olive-backed Oriole
Pachycephala rufiventris	Rufous Whistler
Platycercus elegans	Crimson Rosella
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willy Wagtail
Threskiornis molucca	Sacred Ibis
Vanellus miles	Spur-winged Plover
Zosterops lateralis	Silvereye

GLACKEN STREET

Crinia signifera	Common Toadlet
Acanthiza pusilla	Brown Thornbill
Anas superciliosa	Pacific Black Duck
Anthochaera lunulata	Litte Wattlebird
Ardea sacra	Eastern Reef Eater
Cacatua roseicapilla	Galah
Chysococcyx basalis	Shining Bronze Cuckoo
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Coracina tenurirostris	Cicadabird
Dacelo novaeguineae	Laughing Kookaburra
Gerygone olivacea	White Throated Gerygone
Gymnororhina tibecen	Australian Magpie
Hieraaetus morphnoides	Little Eagle
Lichenostomus chrysops	Yellow-faced Honeyeater
Lichmera indistincta	Brown Honeyeater
Malurus cyaneus	Suberb Blue Fairy Wren
Meliphaga lewinii	Lewin's Honeyeater
Pachycephala rufiventris	Rufous Whistler
Pelecanus conspicillatus	Australian Pelican
Phylidonyris nigra	White-cheeked Honeyeater
Platycercus elegans	Crimson Rosella
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willy Wagtail
Smicrornis brevirostris	Weebill
Zosterops lateralis	Silvereye