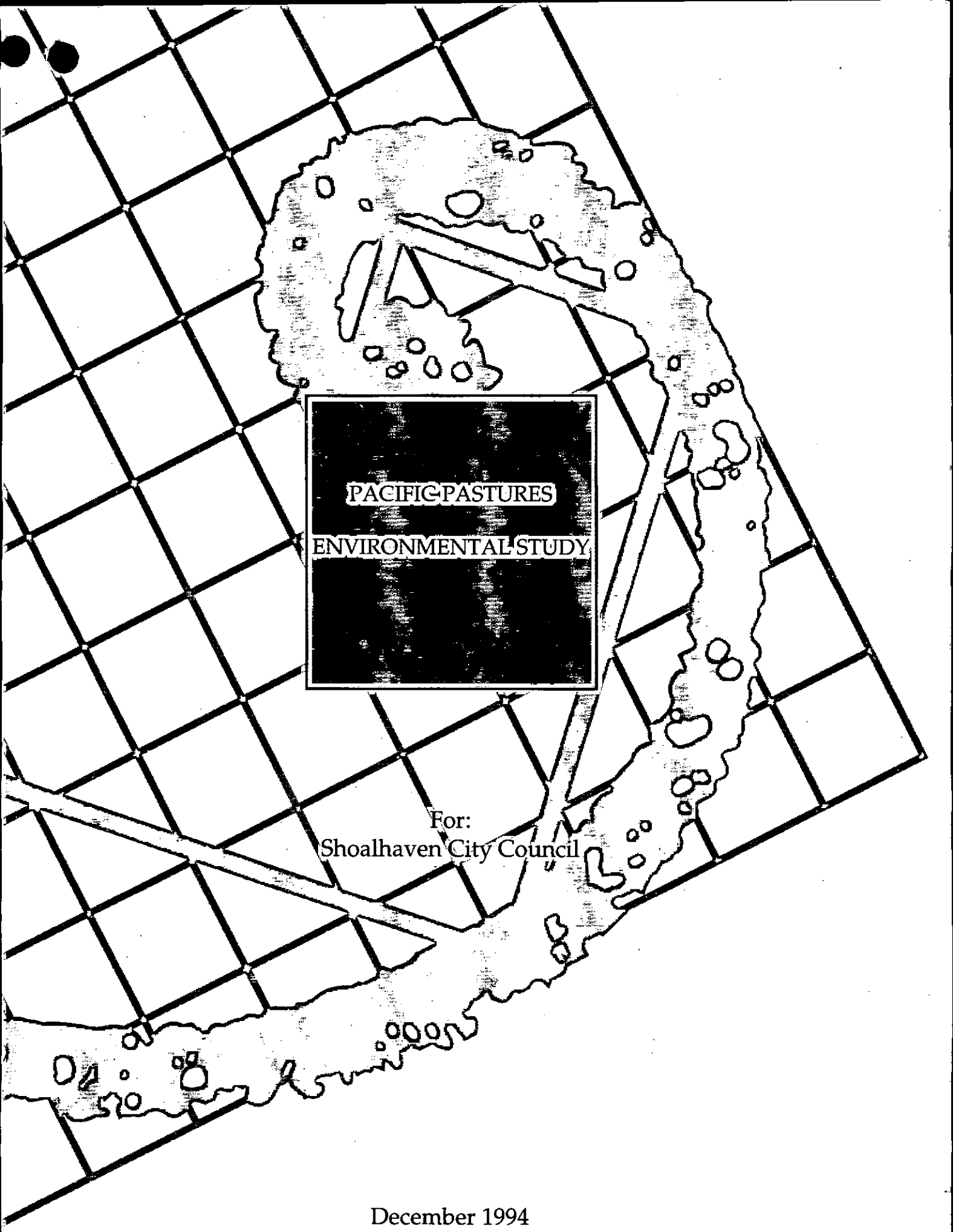

PACIFIC PASTURES ENVIRONMENTAL STUDY

For:
Shoalhaven City Council

December 1994
93152RP1

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

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Chapter 1

INTRODUCTION

This chapter presents a description of the study area, the development proposal, and an outline of the requirements of the relevant statutory authorities for the environmental study.

1.1 BACKGROUND

1.1.1 Purpose of Report

ERM Mitchell McCotter Pty Ltd has been commissioned by Shoalhaven City Council to prepare an environmental study, pursuant to Section 57 of the Environmental Planning and Assessment Act, 1979 (EP & A Act). The proposal is to rezone land situated near Tomerong to permit the development of dwelling houses on allotments of land smaller than 40 hectares. This report presents the findings and recommendations of the investigations carried out in accordance with the requirements of Council and the Department of Planning (DoP).

The report provides details of the study area, including its planning context, biophysical characteristics, the social environment and the availability of and need for infrastructure. Based on this information, an opportunities and constraints analysis has been conducted and conclusions and recommendations arising from the investigations presented.

The report has been prepared by ERM Mitchell McCotter Pty Ltd in conjunction with Elizabeth Mossop of the School of Landscape Architecture at the University of NSW and Navin Officer Archaeological Resource Management.

1.1.2 Study Area

The subject land is located approximately 1.5 kilometres east of Tomerong along Pine Forest Road, as shown in *Figure 1.1*. The study area is part of an established subdivision originally known as Jerberra Estate, but now more commonly referred to as Pacific Pastures following the formation of a progress association of the same name.

Most of the land is situated at an elevation of approximately 20 metres Australian Height Datum (AHD) rising to a small knoll of approximately 50 metres AHD. Two small creek systems traverse the site, one in the north-eastern corner and one in the south-western corner. The creeks join to the east of the subject land and discharge into the wetlands of Moona Moona Creek, Huskisson. The wetlands are subject to State Environmental Planning Policy No. 14 - *Coastal Wetlands* and are identified as wetland No. 325 (refer to *Figure 1.1*). A commercial pine forest plantation is situated to the north of the site.

The subdivision was registered with the Lands Titles Office on 30 June 1922. When originally registered, the estate consisted of 166 lots varying in size from approximately 860 square metres to 1.76 hectares. Of the total lots created, 102 have an area less than 4,000 square metres with the remaining lots ranging in size from 4,000 square metres to approximately 1.4 hectares, with one lot of 1.76 hectares. *Figure 1.2* shows the subdivision layout of the study area. Part of the original estate is not included in the study area as elected by the owner of those lots; the excluded area is demarcated on *Figure 1.2*.

A total of 153 lots are within the study area which covers approximately 84.9 hectares including roads. There is one legal dwelling and this is located on lot 50 with access to Bowen Street and Jerberra Road (refer to BA 89/0613 and BA 92/2247). There are a number of unauthorised dwellings within the study area.

Figure 1.2 shows the current location of Pine Forest Road. Its construction required the resumption of part of 13 lots fronting Pine Forest Road under the Public Roads Act for the road realignment. This has resulted in the formation of a series of residue lots with areas less than 600 square metres.

1.1.3 Proposed Development

Individual owners of the subject land have formed the *Pacific Pastures Progress Association.* The Association has made a number of submissions to Council requesting the preparation of a draft Local Environmental Plan (LEP), to permit residential development on all the allotments in the study area. The first submission was made to Council in August 1986 followed by further requests in April of 1989, November 1989 and May 1992.

After considering the Association's last request, Council resolved at its meeting of 15 December 1992, to prepare a draft LEP over the subject land and notify the Department of Planning under the provisions of Section 54 of the EP&A Act.

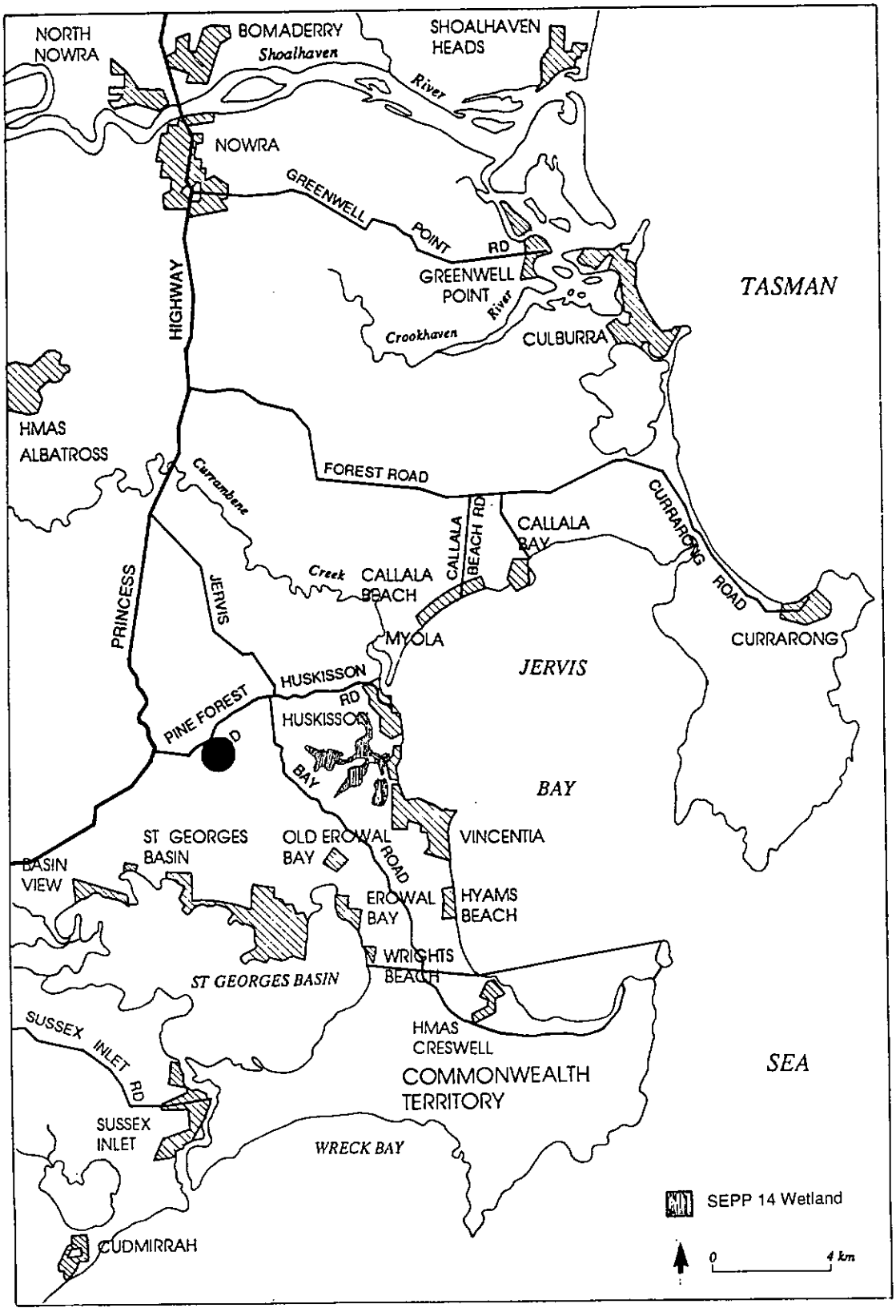


Figure 1.1 **LOCATION**

1.2 ENVIRONMENTAL STUDY REQUIREMENTS

1.2.1 Council's Brief

The primary objective of the environmental study is to investigate and evaluate whether the proposed rezoning and subsequent development of the site for residential purposes is an appropriate land use. In undertaking the environmental study, and having regard to the significance of the proposal, it has been necessary to identify all environmental constraints to development and weigh up conflicting local and regional priorities including planning policy, environmental issues, infrastructure and traffic issues.

This report considers the issues relevant to the determination of likely environmental impacts of the proposed development and discusses relevant statutory matters. Issues requiring further investigations are identified.

Matters which Council requires to be addressed include:

- local and regional planning implications;
- the desirability of small rural holdings;
- landscape and environmental attributes;
- bushfire risk;
- impacts on flora and fauna including wetlands;
- heritage assessment;
- social and urban infrastructure;
- traffic generation and the necessary standards of road construction;
- impact on adjoining wetlands; and
- capital and maintenance cost implications.

These issues are addressed in the following chapters under the headings of planning context, bio-physical environment, social environment, urban infrastructure and land capability.

1.2.2 *Department of Planning Requirements*

The DoP, by letter dated 22 January 1993, advised the Council of its requirements for the environmental study. These requirements are summarised as follows:

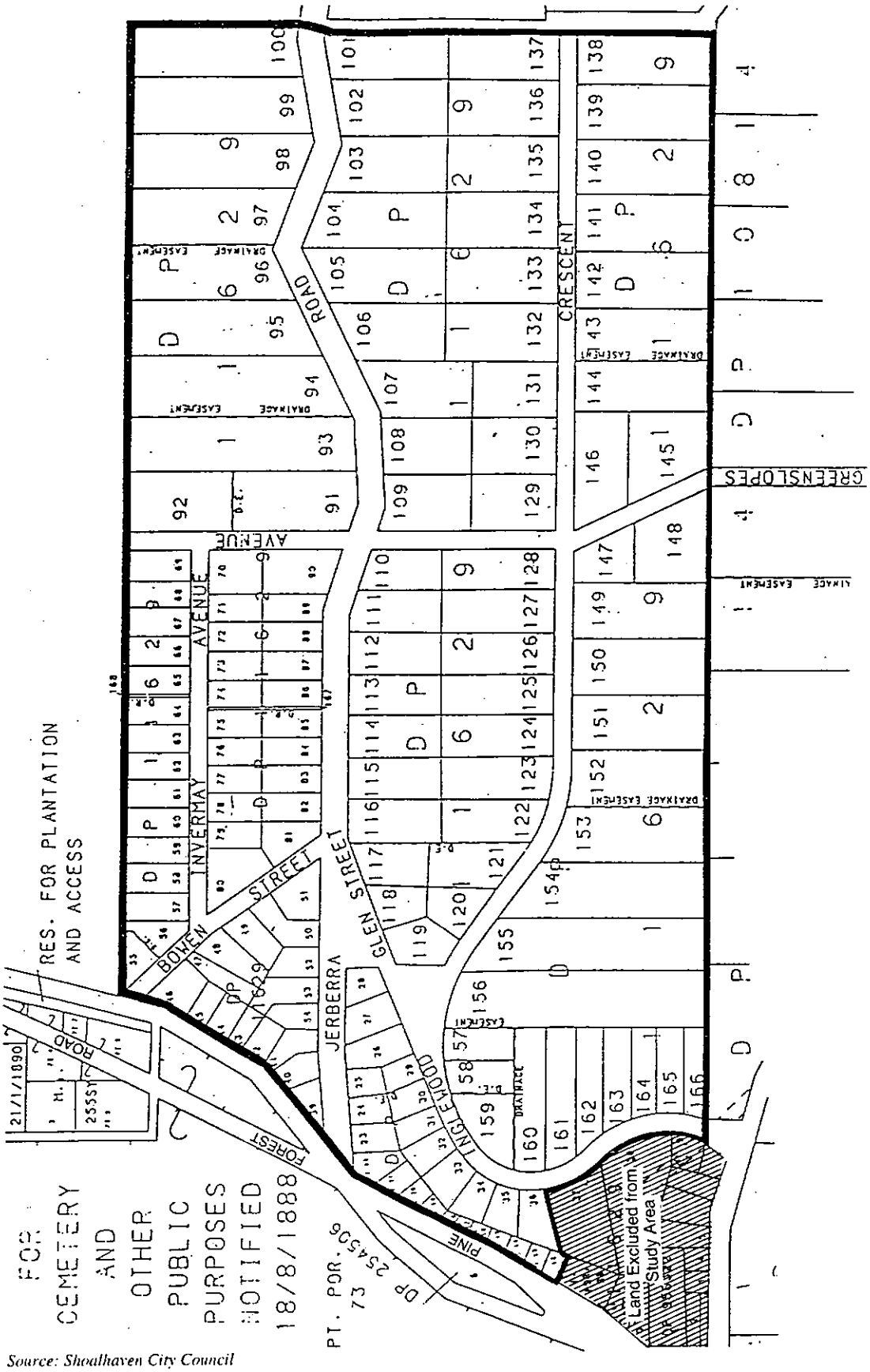
- justification for further urban expansion;
- the implications of the proposed rezoning with respect to the proposed Jervis Bay management strategy;
- the cost of providing physical infrastructure and an adequate level of community facilities;
- the implications of the proposed rezoning with respect to Council's Main Centre Strategy;
- the intensity of the preferred land use which could be sustained without causing significant environmental degradation;
- the implications of proceeding with the proposed rezoning with respect to other small rural subdivisions in the Jervis Bay area; and
- identification of on-going costs to Council and the State Government for service maintenance which might not be captured under section 94 of the EP & A Act.

Following commencement of the environmental study, a meeting was held on 22 September, 1993 with the Regional Manager of the DoP. Further issues were raised in this meeting and these were confirmed in the Department's correspondence dated 1 November, 1993 which is included in Appendix A.

1.2.3 *Requirements of Other Statutory Authorities*

As part of the investigations it has been necessary to consult with relevant statutory authorities to ascertain their views on the proposal and the statutory requirements and responsibilities relating thereto.

The authorities contacted include the Environment Protection Authority, the National Parks and Wildlife Service, the Department of Agriculture, the Department of Water Resources, the Department of Health, NSW Fisheries and the Department of School Education. The responses are included in Appendix B.



Source: Shoalhaven City Council

Figure 1.2 SUBDIVISION LAYOUT

Chapter 2

PLANNING CONTEXT

This chapter considers the regional and local planning context, specific provisions which apply to the study area are identified as well as the factors which need to be considered in a draft local environmental plan. Policies relating to old subdivisions are also examined.

2.1 REGIONAL PLANNING

The Department of Planning in conjunction with Council and the local community has developed a number of statutory instruments and advisory policy documents which relate to the Illawarra Region and the Jervis Bay locality. Many of these are of relevance to the study area and the proposal for residential development as discussed below.

2.1.1 Illawarra REP No. 1

Illawarra Regional Environmental Plan (REP) No. 1 was gazetted on 11 April 1986 with the primary aim of balancing development pressures and conservation objectives by appropriate allocation and management of land uses. To achieve these broad aims and objectives, the REP incorporates development standards and requirements for the preparation of local environmental plans (LEPs).

Relevant sections of the REP are given below in italics and a discussion of each clause as it relates to the study area shown in plain text.

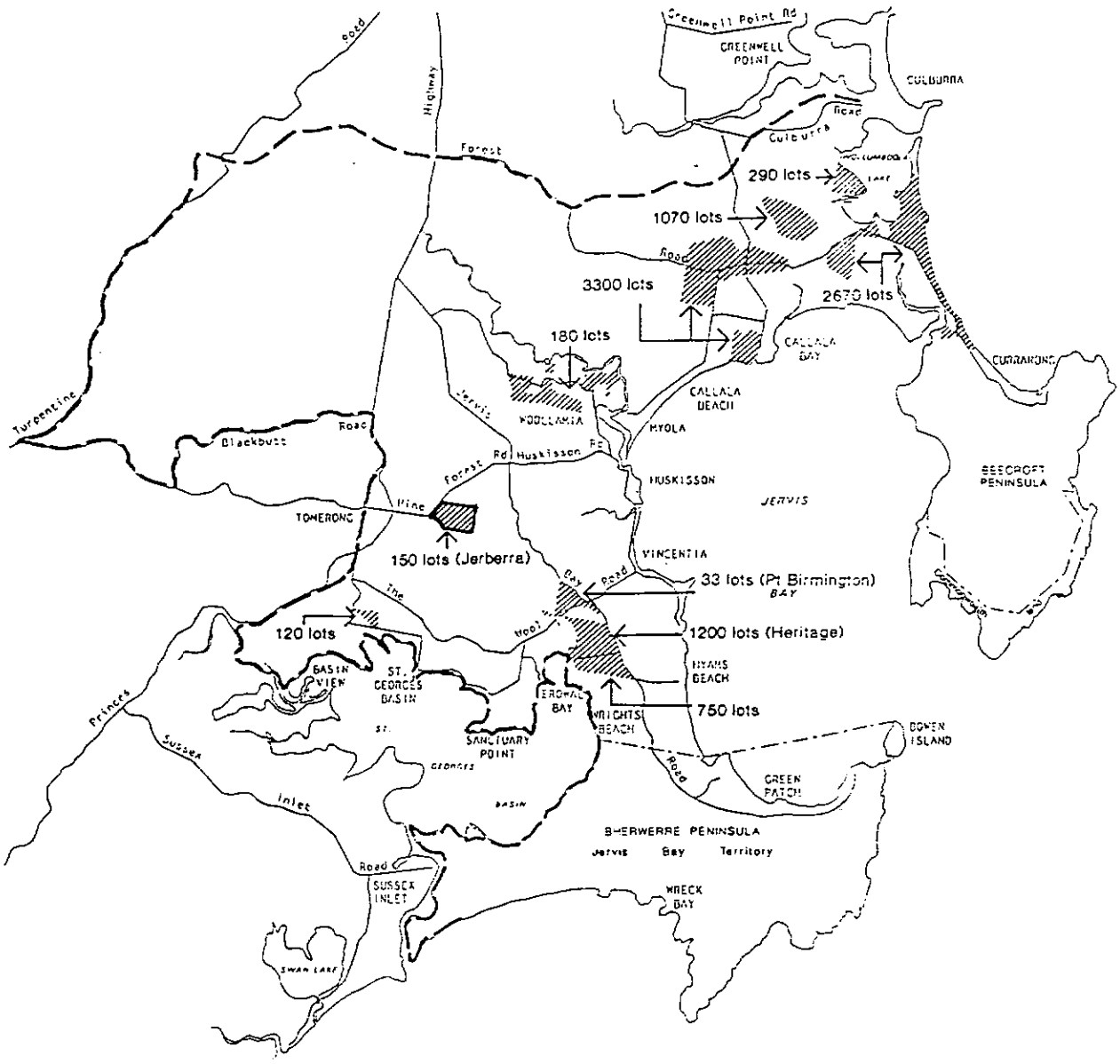
i. Objectives Relating to Rural Lands

Part II of the REP presents the following objectives for rural lands.

(a) to retain the productive capacity of prime crop and pasture lands;

(b) to protect valuable natural environments, as identified on sheets 1-10, 14, 15 and 17 of the map;

(c) to provide for wildlife movement between major protected wildlife habitats;



OLD NON-URBAN SUBDIVISIONS (REGISTERED)

NOTE: FIGURES ARE APPROXIMATE ONLY.

Source: *DoP, 1992*

MAP PREPARED BY SHOALHAVEN CITY COUNCIL
NOTE: MAPS ARE INDICATIVE ONLY

0 4km

Figure 2.1 REGISTERED (NON URBAN) SMALL LOT SUBDIVISIONS

(d) *to effectively manage the development of rural lands having regard to flood potential, bushfire risks, salinisation, soil degradation, erosion and weed infestation;*

(e) *to allow for the development of small rural holdings in appropriate locations;*

(f) *to prevent uneconomic demand for State Government services;*

(g) *to allow for future urban expansion;*

(h) *to retain the scenic attributes of rural areas; and*

(i) *to provide for developments which by virtue of their character require siting away from urban areas.*

The objectives presented above are of varying relevance to the study area. Objective (b) does not apply as the land has not been identified on the nominated sheets. The proposed residential development of the site does not require it to be sited away from urban areas and consequently objective (i) is not relevant. The other objectives are relevant and are discussed in greater detail in later chapters.

ii. Small Rural Holdings

Clause 21 of the REP enables Council to prepare draft LEPs to permit the creation of small rural holdings, that is, allotments of land with an area less than 40 hectares, which can be used for purposes other than agricultural. The land cannot be developed as a small rural holding if it is:

21(1) (a) *land of prime crop and pasture potential;*

(b) *land supporting rainforest vegetation species;*

(c) *wildlife corridor;*

(d) *land containing extractive materials;*

(e) *land potentially suitable for urban use;*

(f) *service corridor;*

(g) *airport buffer area;*

(h) *escarpment area,*

or its effect on such land is of relatively minor significance, or is demonstrated not to be inconsistent with the objectives for that land.

(2) A draft local environmental plan to provide for small rural holdings shall be prepared only after the consent authority has considered:

(a) *demand;*

(b) *accessibility;*

(c) *proximity to urban centres;*

(d) *provision of services;*

(e) *bushfire risk; and*

(f) *land capability.*

As will be demonstrated in later chapters, the study area does not have the attributes listed in Clause 21(1).

The matters for consideration by the consent authority listed in Clause 21(2) were also identified by Council and the DoP as relevant and have been addressed in Chapters 3, 4 and 5 of this report.

iii. Dwelling Houses on Rural Land

Clause 24 seeks to restrict the circumstances in which dwelling houses are permissible land uses on rural land and states that:

> 24 *A draft local environmental plan shall not contain provisions for the erection of dwelling-houses on rural lands other than in accordance with one or more of the following principles:*
>
> *(d) a dwelling-house may be erected on an allotment legally created and approved for that purpose under the previous planning provisions applying to the land;*

The previous planning provisions relating to this land were those contained in *Interim Development Order No. 1* which was gazetted 1964. Under this instrument restrictions existed which precluded the erection of dwellings, namely:

> *(e) a dwelling-house may be erected on an "existing holding" or "existing parcel" as defined in the relevant environmental planning instrument applying to the land at the appointed day;*

The terms "existing holdings" or "existing parcels" relate to concessional lot provisions and these are considered in the discussion on Shoalhaven LEP 1985.

iv. Rezoning of Land for Urban Purposes

Clause 26 restricts the circumstances in which a draft LEP can be prepared to rezone rural land for urban purposes in the following manner:

> 26. *A draft local environmental plan shall not rezone rural land for urban purposes unless:*
> *(a) such action is justified by an environmental study;*
> *(b) the draft local environmental plan is for land identified on the map as potentially suitable for urban use; or*
> *(c) the rezoning is of relatively minor significance.*

This report has been undertaken to address the first of the requirements, although in relation to the second, the site has not been identified as being potentially suitable for urban use. In isolation, the proposal to permit residential development on small to medium sized allotments in the context of Shoalhaven local government area is of minor significance. However, the land has not been identified on the map due to the existence of many other old subdivisions, and hence the rezoning could be considered a precedent and consequently not be described as "minor". The balance between considering the study area on its merits and giving consideration to precedent is important and is discussed in detail at the end of this chapter.

v. Ribbon Development

Pine Forest Road is a designated main road and as such the provisions of Clause 83(1) are relevant.

> *83. (1) A draft local environmental plan applying to land adjacent to a main or arterial road in a rural area shall retain existing provisions limiting permissible uses to low traffic generating development.*

The objective of the clause is to restrict or limit ribbon development along main roads in rural areas. As will be further discussed, similar provisions are contained within Shoalhaven LEP 1985.

2.1.2 Illawarra Region Landscape And Environment Study

The Illawarra Region Landscape and Environment Study was published in August 1981 by the Department of Environment and Planning as a background document for the Illawarra REP. The study identified 11 planning units, mapped at a scale of 1:100,000 of which the subject site falls within Unit 7, South Coast. The study was prepared at a macro-scale and categorised each unit on the basis of four criteria these being: Vegetation Conservation Value, Scenic Quality, Known Potential Pressures Affecting Environmental Attributes, and Boundaries/Policy Recommendations.

None of the findings of the above analysis are specifically directed at the study area. The study area is affected by the 1:250,000 regional analysis map relating to visual quality which identifies a visual horizon along Pine Forest Road. This suggests that a ridge runs along Pine Forest Road near the site. However, field investigations indicate that this is not the case and that a visual ridgeline runs down the centre of the site (refer to Chapter 4).

2.1.3 *Illawarra Coast*

Illawarra Coast is a discussion paper which was released by the DoP in August 1993. The primary function of the paper is to provide a background strategy to the NSW Government's Coastal Policy as it applies to the Illawarra region. Whilst the focus of the document is on the coast, valuable and contemporary commentary is given on a range of key issues facing the four local government areas within the region.

Of particular relevance to this study is the discussion on the Illawarra Urban Development Program and the availability of urban land in Shoalhaven Local Government Area:

> *"there is no shortage of residential land in Shoalhaven as 20 of the 29 coastal towns and villages have a long term supply in excess of 20 years available. However, it is recognised that these figures assume the willingness and ability of all landowners to develop their land when required, which may not always be the case.*
>
> *Of the 10 most popular areas identified above, seven have more than 25 years supply of urban land available and three have a supply ranging from 11 to 18 years. Nowra, which is the main growth centre, has about 50 years supply of urban land. There is no urgency for any major rezonings for urban land to occur for many years to come." (DoP 1993)*

The document also expresses concern about the costs associated with providing human services and physical infrastructure for rural residential developments.

> *"Rural residential development is one of the most expensive forms of housing development. Services to the rural dweller such as telephone, electricity, roads and school bus services are all subsidised by the general community, if not in the original provision of services, certainly in their maintenance. The real costs associated with rural residential development are rarely reflected in the purchase price of land or the land rates applied.*
>
> *The full cost of rural and urban development needs to be considered by local councils in the preparation of their development control plans dealing with developer contributions and in rating structures. This will be necessary to avoid ad hoc settlement patterns which cannot be afforded by the local community and public authorities." (DoP, 1993)*

The discussion paper suggests that there is an urgent need for councils to take a more co-ordinated approach in the release of rural residential land. In relation to landscape quality, the study strongly discourages the emergence of "ribbon development".

Map 6 of the discussion paper: *Human Settlement - Shoalhaven, Northern Area* notes the approximate area of Pacific Pastures site with "UD" which means Urban

Development Proposals. Clarification of this classification with the DoP has indicated that "UD" refers to areas experiencing pressures for development rather than areas which have been formally identified in any local or state land release program.

2.1.4 *Jervis Bay Our Heritage, Our Future*

Jervis Bay Our Heritage, Our Future was released by the DoP in 1992 as a discussion paper for a public consultation program which would enable the preparation of a plan of management for Jervis Bay. The study area extends from the coast to Turpentine Road in the west, Culburra in the north and Wreck Bay in the south. Public submissions have been considered by the DoP and a report has been prepared for the Minister for Planning. Specific reference is made to Pacific Pastures and other old subdivisions. Aspects of the discussion paper of relevance to this study are reproduced below.

i. Community Services and Public Transport

> *"The cost of servicing these villages is high. Moreover, the ability to fund additional services through contributions arising from urban expansion is unlikely, given the environmental sensitivity of much of the area. The view has been put that people who choose to live in the study area are aware of the present level of servicing. Under these circumstances, it could be argued that these people may have to accept a limited level of servicing and recognise the important link between the study area and Nowra for their requirements.*
>
> *Access to Nowra is mostly by car. There are limited public transport services available between Nowra and the villages and those services that exist are costly. Whilst there are some community facilities in the villages, the inadequacy and cost of public transportation between villages prohibits their easy access." (DoP, 1992)*

ii. Urban Development

> *"Based on the demand between 1986 and 1991, there is no shortage of residential land in the study area. Of the four most popular areas, two have a long term supply of urban land (Sanctuary Point and Currarong), one has a medium term supply (Vincentia) and one has a supply of less than ten years available (Erowal Bay).*
>
> *Should there be a future need to increase the supply of urban land in the Jervis Bay area, preliminary assessments indicate that opportunities might be available north-west of Callala Bay, north of St Georges*

Basin and limited opportunity west of Vincentia, subject to detailed environmental assessment. Erowal Bay has limited opportunity to expand its urban boundary because of the important surrounding natural areas. Rural land within the area could accommodate a further 1,300 dwellings under existing zoning provisions. This represents a possible further 2,300 residents." (DoP, 1992)

iii. Urban Development Pressures

The environmental quality of the area covered by the discussion paper and its proximity to Nowra place the area under high development pressure.

"There is considerable pressure from landowners for additional residential and rural residential development, on land which is not connected to public utilities such as a reticulated water supply, electricity and telephone, nor to the sewerage treatment system. The reasons for this pressure include a depressed rural economy and the consequent selling of farmland. It is also partly due to a perceived high demand for urban land from people seeking a holiday home, or permanent residence and a general trend towards living in rural coastal areas whilst commuting to urban centres for work." (DoP, 1992)

Pacific Pastures is identified in the discussion paper as an old subdivision which is part of a widespread problem affecting a large part of Jervis Bay with estimates that there are up to 10,500 old non urban subdivision lots in existence. *Figure 2.1* reproduces a map from the study showing the location of these estates.

"Other urban development pressures include the existence of approximately 10,500 small lots which were created and registered in the study area in the early part of this century. All are residential sized lots and are located in a rural zone and do not have dwelling entitlements. Many of the old subdivisions are located in areas unsuitable for development due to their environmental sensitivity, landform, soil properties or potential impact on water quality and the cost of servicing them." (DoP, 1992)

The conclusion to the discussion paper reinforces the difficulties associated with development in these subdivisions by stating that:

"Many old subdivision areas are located in sensitive natural areas and should not be rezoned to permit urban development. Any rezoning to permit residential uses of old subdivisions outside these important natural areas should occur only in those locations which meet all environmental and planning criteria." (DoP, 1992)

The important natural areas referred to above include habitat corridors, wetlands and the like which are identified in maps in the discussion paper. Pacific Pastures has not been identified as being within such areas.

iv. Water Quality

The water quality of Jervis Bay is an increasingly important issue. The discussion paper recommends adoption of a total catchment management approach and this includes the creeks which drain the subject site. The following quotation discusses important management principles in relation to water quality.

> *"The high level of water clarity of Jervis Bay is very susceptible to impact by sediments and nutrients which would result from extensive development of the catchment. Such impacts have already been observed in St Georges Basin where deteriorating water quality is becoming a major issue.*
>
> *The creeks flowing into the bay and adjacent buffer areas form the immediate interface between the land and the water and are a critical component for managing the bay's catchment. The management of creeks and buffer areas along the creeks should aim to ensure that activities within these areas, or within their catchments, do not have an adverse impact on the natural ecosystems of the creeks. Important waterways to be protected include Currambene, Moona Moona, Carama and Callala Creeks, as well as any significant wetlands, particularly those protected under State Environmental Planning Policy No. 14." (DoP, 1992)*

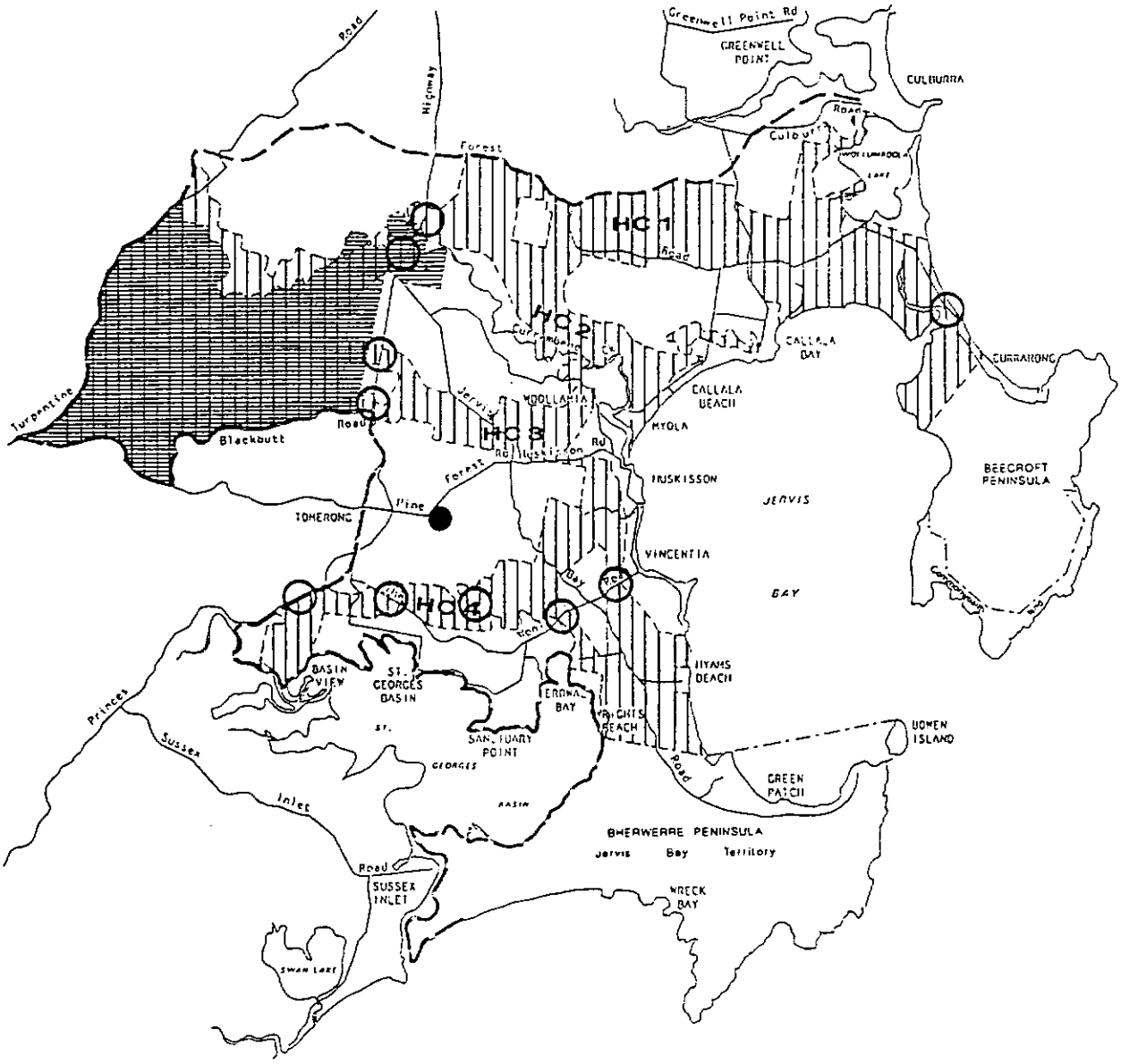
v. Flora and Fauna

An important recommendation of the discussion paper is the identification of a network of habitat corridors which is shown in *Figure 2.2*. Although the site is not included in a corridor, such corridors are to be found to the north, east and south of the site and therefore consideration needs to be given to any impacts on the corridor arising from increased urbanisation. This issue is discussed in detail in Chapter 3.

2.1.5 State Environmental Planning Policies

State Environmental Planning Policy (SEPP) No. 14 - *Coastal Wetlands* is of relevance to the study area. SEPP No 14 wetland number 325 lies two kilometres to the east of the site. The significance of the wetland in relation to the proposal is considered in Chapter 4.

As the rezoning does have potential to generate significant amounts of additional traffic on main roads, the provision of SEPP No.11 - *Traffic Generating Developments* apply. The Roads and Traffic Authority has indicated in correspondence dated 21 October, 1993 (Appendix B) that a detailed Traffic Impact Statement should be submitted to the Shoalhaven Development Committee to assist in the evaluation of the rezoning proposal. There is sufficient information in the traffic analysis in Chapter 5 and Chapter 6 to meet this requirement.



HABITAT CORRIDOR

HABITAT CORRIDOR CHOKE POINTS

*WILDLIFE CORRIDORS
(ILLAWARRA REGIONAL ENVIRONMENTAL PLAN NO.1)

HC 1 – 4 REGIONAL HABITAT CORRIDORS (REFER TEXT)

* NOW REFERRED TO AS HABITAT CORRIDORS.

Source: *DoP. 1992*

MAP PREPARED BY SHOALHAVEN CITY COUNCIL

NOTE: MAPS ARE INDICATIVE ONLY

0 4km

Figure 2.2 HABITAT CORRIDOR SYSTEM

2.1.6 *Department of Planning Circulars*

There are two DoP circulars of relevance to this study, namely:

- C1: *Preparation of Local Environmental Plans;* and
- C2: *Local Environmental Studies.*

The procedures outlined in both of these have been followed in this study.

2.1.7 *Section 117 Directions*

Section 117 of the EP&A Act enables the DoP to give general and specific directions to councils about matters to be considered in the preparation of draft LEPs. Relevant general directions are outlined below; there are no specific directions of relevance to the study area.

The provisions of Illawarra REP No. 1 supersede the first 19 general directions.

- G20 *Planning in Bushfire Prone Areas*

Bushfire issues are addressed in Chapter 3.

- G27 *Planning for Bus Services*

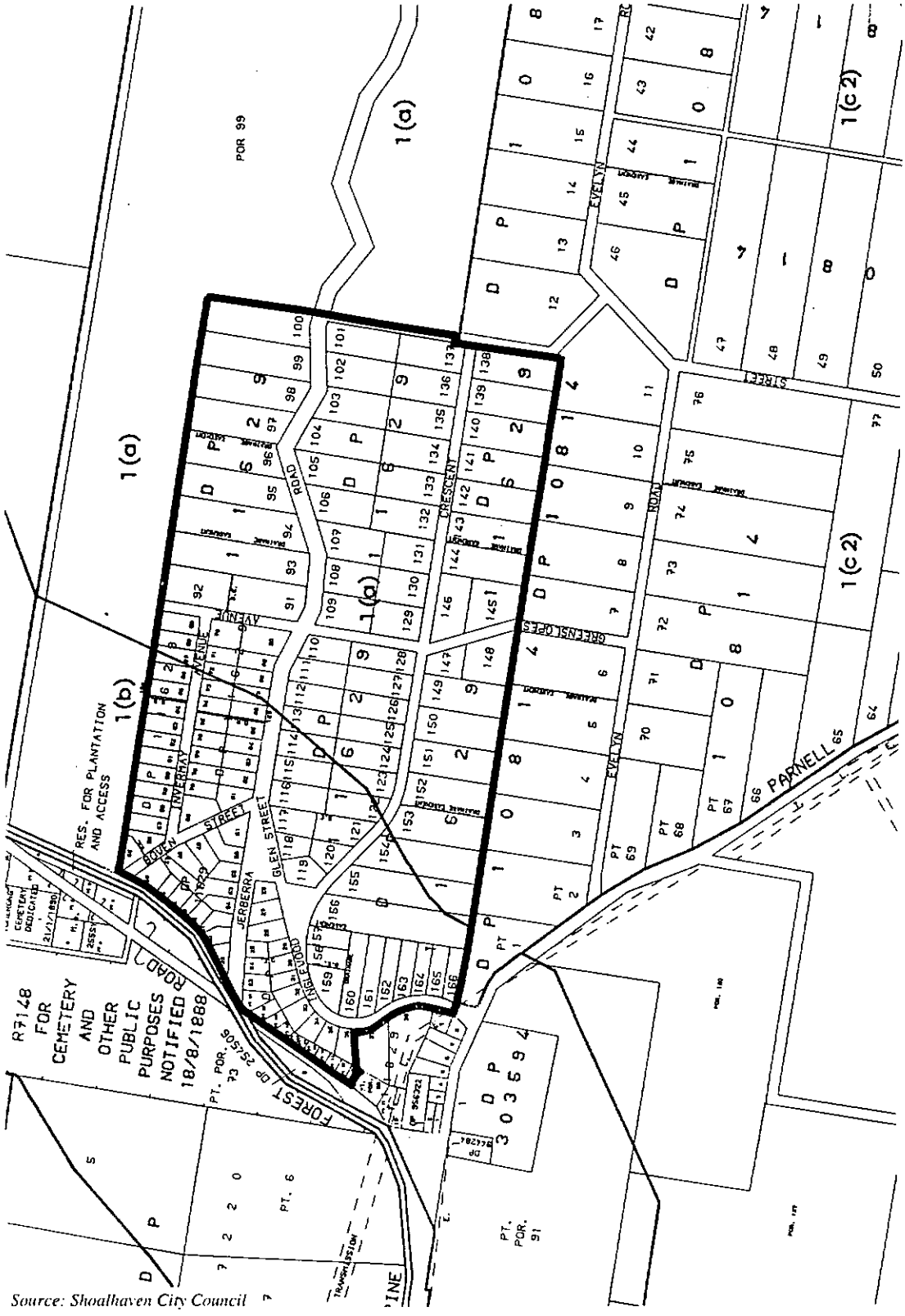
This issue is addressed in Chapter 5.

2.1.8 *South Coast Design Guidelines*

The South Coast Design Guidelines were published by the Department of Planning in 1990. Although the controls are oriented towards coastal locations and villages, many of the principles relating to bulk, scale, materials and siting would be relevant to any dwellings which would be built at Pacific Pastures. If a rezoning does occur, the guidelines could form the basis of a development control plan for the study area.

2.1.9 *Conclusions*

Regional planning studies and instruments have been primarily concerned with the preservation of prime crop and pasture land and the prevention of ad hoc subdivisions. More recent policy documents have encouraged more careful



Source: Shoalhaven City Council

Figure 2.3 CURRENT ZONING

consideration of rural residential development proposals, particularly the real costs of establishing and maintaining services for such proposals. Total catchment management is also being encouraged as a method of controlling land uses and this provides a better context for determining the suitability of on-site disposal of effluent and related nutrient levels.

2.2 LOCAL PLANNING PROVISIONS

Shoalhaven LEP 1985 is the primary local planning instrument and is supported by a local environmental study and a number of policy documents. The provisions of the LEP relating to rural planning are currently under review by Council. The draft rural plan is on public exhibition from 4 August, 1994 for three months.

2.2.1 Shoalhaven LEP 1985

Shoalhaven LEP 1985 was gazetted on 17 May 1985 and has been amended on a number of occasions. The clauses of relevance to the study area are outlined below:

i. Aims, Objectives, etc

Clause 2(2) sets out the general aims and objectives of the plan, five of which are relevant to the study area, namely:

- *(a) to provide for a variety of residential life styles;*
- *(i) to provide a safe and efficient transport network connecting land use activities inside and outside the City;*
- *(j) to encourage the provision of adequate community facilities and services;*
- *(k) to ensure the social amenity and well-being of the City; and*
- *(l) to provide the most appropriate public utility services in the most effective manner.*

ii. Zoning

The study area is zoned part *Rural 1(a)* and part *Rural 1(b)* under LEP 1985 as shown in *Figure 2.3*.

The objectives of the two zones are presented below.

ZONE NO. 1(a) (RURAL "A" ZONE")

1. *Objectives of zone*

The objectives are -

(a) to protect the agricultural potential of rural land; and

(b) to prevent the fragmentation of viable rural holdings

ZONE NO. 1(b) (RURAL "B" ZONE)

1. *Objectives of zone*

The objectives are -

(a) to protect the agriculture potential of rural land;

(b) to prevent the fragmentation of viable rural holdings; and

(c) to prevent the establishment of traffic generating development along main rural traffic arteries.

The zones basically allow low intensity agricultural uses without the consent of Council. There are a range of non-agricultural uses which are prohibited such as car repair stations, non-agricultural industries and residential flat buildings. All other developments require the consent of Council. Dwelling houses are permissible with the consent of Council subject to the compliance with minimum lot size provisions.

iii. Subdivision in Zones 1(a) and 1(b)

Concessional allotments were included in Interim Development Order No. 1 as a method of dealing with the introduction of town planning controls for the first time. The intention was to allow individuals to continue to have some subdivision rights depending on the ownership pattern of individual parcels on 28 February 1964 or whether a relative or rural workers associated with a particular parcel wished to have a separate title.

Council's discussion paper, *Rural Shoalhaven Directions for Change* and draft rural plan have indicated that the concessional lot system will be phased out by 1996. Rural subdivisions will then become totally based on environmental capacities.

iv. Dwelling Houses in Zones No. 1(a) and 1(b)

Clause 14(2)(a) restricts the construction of dwelling houses at Pacific Pastures by introducing a minimum lot size of 40 hectares.

It should be noted that this minimum lot size provision is a development standard and as such could be varied using the provisions of SEPP No. 1 - *Development*

Standards to permit dwelling houses within the study area. Having regard to the current lot sizes, significant variations would be required to meet the 40 hectare standard and as such would be well beyond the variations originally envisaged by the policy.

v. Provision of Services

Clause 31 requires specific consideration of water, sewerage and drainage services prior to the granting of consent for development.

> *31. A person shall not carry out development on any land unless and until arrangements satisfactory to the Council have been made by the applicant (and if the applicant is not the owner, the owner also) for the provision of a water supply, facilities for the removal of sewage, and for the drainage of stormwater and other surface water from the land.*

This clause is particularly relevant to the study area and is addressed in detail in Chapter 4.

vi. Roads

Clause 31A(3) is of relevance to the roads in the study area which have been poorly formed, are unsealed and from observation appear to be voluntarily maintained and are experiencing heavy erosion in parts.

> *31A(3) A person (other than a public authority) shall not carry out any work referred to in this clause without the consent of the Council, except for the maintenance or repair of an existing physically constructed road and where the consent of the owner of the land concerned has been obtained.*

The roads within the study area are not "existing physically constructed" roads and therefore any work on the roads would require the development consent of Council.

vii. Bushfire Danger

Clause 32 outlines a range of ameliorative measures which should be undertaken before granting consent for dwelling houses in areas potentially affected by bushfire. This clause reflects the intention of clause 73 of the Illawarra REP and has been addressed in this study. The clause would need to be given detailed consideration for any development application for a dwelling house.

viii. Building Lines Along Main Roads

Clause 33 introduces development standards for the 1(b) zone as follows:

> *33. A person shall not, on an allotment of land which is within Zone No. 1(b).*
>
> *(d) erect a building for any other purpose -*
>
> *(i) where the road is a major road not less than 40 metres in width - closer than 20 metres from the nearest alignment of the road; or*
>
> *(ii) where the road is a main road less than 40 metres in width - closer than 40 metres from the centre line of the road.*

These standards are aimed at reducing the visual impact of development fronting major roads, and as with the minimum lot sizes, the standard could be varied using SEPP No. 1.

2.2.2 *Rural Planning*

i. Rural Environmental Study

The *Shoalhaven Rural Environmental Study* was adopted by Council in May 1985. The study provided an overview of all rural land in the local government area. It reviewed the provisions of Interim Development Order No. 1 (1964) and was aimed at providing a basis for the rural components of Shoalhaven LEP 1985.

The study did not establish policies relating to old subdivisions. It is now fairly dated with the council now reviewing all provisions in relation to rural land.

ii. Rural Shoalhaven Directions for Change

Rural Shoalhaven Directions For Change was published by Council in March 1993 as a discussion paper for a major review of the rural zones throughout the local government area. The paper adopts the policy of phasing out the concessional lot system by 1996. The strong demand for rural residential living is recognised although Pacific Pastures has not been identified as a priority area for further investigation for future rural residential development. The discussion paper has provided a basis for a draft rural plan which is presently on public exhibition.

iii. Draft Rural Plan

In August 1994, Council placed on public exhibition the *Planning Report for Draft Shoalhaven Rural Land Environmental Plan*. This is a comprehensive review of all rural zones in the city and establishes a new rural settlement strategy. The major goals relating to rural settlement are as follows:

- *To give preference in land allocation to productive land uses which contribute in an ongoing way to the rural economy and to provide for a settlement density appropriate to those uses.*

- *To minimise conflicts between people or authorities engaged in productive or essential uses of rural land and those people who wish to enjoy a rural residential lifestyle.*

- *To ensure that land identified in any urban development strategy is not developed for purposes which would frustrate the implementation of that strategy.*

- *To match dwelling densities to the capability of the land to sustain development and to land attributes and values, but not to create new villages or semi urban areas unless this is clearly stated in the urban expansion strategy.*

- *To provide as wide a range of residential lifestyles as possible with minimal impact on the rural character, natural, heritage, landscape, forestry and agricultural values at a minimal cost to the community and with regard to safety.*

The report emphasises that the new approach to rural settlement in the plan will be based primarily on the natural characteristics of the land and the environmental sustainability of any new development. Increased emphasis is also being given to bushfire risk with the recognition that much of the city, including the subject site, is affected by high bushfire threat. In relation to tree preservation, the plan states that "The Tree Preservation Order will continue to apply to land within 30 metres of a rural road and on the old paper subdivisions..."

The subject site is depicted in Sheet 8 of the draft plan as an area undergoing separate study. The zoning surroundings the site include:

- Rural 1(b) *Arterial Road Protection* which runs parallel to Pine Forest Road;

- Rural 1(d) (General Rural Zone) to the north; and

- Rural 1(c) *Rural Lifestyle* to the south.

2.2.3 *Planning Policies*

Shoalhaven Beyond 1990 is a consolidated outline of a range of Council policies relating to development in the Shoalhaven. The policies of relevance to the study area are outlined below. All of the policies discussed below were adopted in June 1990.

i. Policy No. 1 Main Centre Strategy

> *This strategy is based on the premise of three major urban areas located in the North, Centre and South to provide services and facilities for their own population and that of the surrounding districts. These are Nowra (to remain the principal town), Ulladulla (includes Milton) and a new urban centre based on existing settlements around Jervis Bay and St. Georges Basin.*

The intention of this policy is to ensure that the dominance of Nowra in terms of higher order goods and services is maintained and that its status as a main centre continues. The implementation of this policy requires the complementary development of a number of smaller centres including "the crossroads" (refer to Vincentia Draft LEP background document, July 1991). The implications of this strategy for Pacific Pastures would be a reduction in travel time for residents who would ordinarily have to go to Nowra for most basic goods and services. The completion of the draft LEP is dependent upon the outcome of the plan of management for Jervis Bay.

ii. Policy No. 4 - Highways and Arterial Roads

This policy has similar objectives to those formulated for the Rural 1(b) zone and advocates shared access for existing lots with direct main road frontage where feasible.

iii. Other Relevant Policies

Other policies of broad relevance include:

- Policy No. 5 - *The Built Environment - General;*
- Policy No. 8 - *Structures in Rural Areas;*
- Policy No. 9 - *Public Utilities Water & Sewerage;*

- Policy No. 17 - *Tree Preservation*; and

- Policy No. 19 - *Social Awareness*

All of the policies outlined in this section are non-statutory indicators of Council's opinions on a range of issues. Their main purpose therefore, is to ensure consistency in planning decisions. Their applicability will be primarily at the development application stage for new dwellings.

2.2.4 *Tree Preservation Order*

Clause 5(2) of Shoalhaven LEP 1985, enables tree preservation orders to be made in the LGA. Initially the order did not cover general rural land. In response to the clear felling of a number of lots in old subdivisions, and other areas, Council made an order to specifically include such areas. Deposited Plan 11629, the subject site, was included in the amendment which was gazetted 9 December 1988. An extract of the Order is shown below.

> *The Tree Preservation Order prohibits the ringbarking, cutting down, lopping, topping, removing, injuring, poisoning or wilful destruction of any tree which meets any one or more of the following standards:*
>
> 1. *is 3 metres or more in height*
> 2. *has a girth of 300mm or more at a height of 1 metre above the natural ground surface; or*
> 3. *has a branch span of 3 metres or more.*
>
> *without the written consent of Council, and any such consent may be given subject to such conditions that Council may think fit.*

This order means that any tree, as defined, cannot be removed from the study area without the approval of Council. Field observations show a number of areas of cleared land for which Council has not issued an approval for the removal of trees. The impacts of tree clearing on the study area are discussed in Chapter 3.

2.3 POLICIES RELATING TO OLD SUBDIVISIONS

There are approximately 12,000 lots in Shoalhaven local government area which were created by old subdivisions. The subdivisions date from the turn of the century through to the late 1920s and usually incorporate the *"garden suburb"* style of

subdivision layout. This was a contemporary subdivision form which was promoted at that time in reaction to grid street patterns. A restored example of this method of subdivision can be seen at Daceyville in Sydney.

Since the advent of planning controls in the Shoalhaven in 1964, residential development rights on these lots have been restricted. The few dwellings which have been legally developed have been achieved pursuant to the concessional lot clauses outline earlier.

Until the mid 1980s, many of the old subdivisions were in single ownership and used for either agricultural purposes or supported natural vegetation. However, with the selling of allotments within the old subdivisions and the associated fragmentation of ownership, the ability to develop individual allotments for residential purposes has become a difficult planning issue for the Council. Old subdivisions are a planning problem faced by many other New South Wales coastal councils.

The formation of groups of land holders seeking dwelling rights has resulted in considerable pressures on councils to release such land for residential and rural residential development. The number of allotments available in the LGA in old estates and the precedental effect of releasing individual estates has meant that it has been difficult for Council to formulate a policy on the issue other than enforcing the 40 hectare minimum lot size provisions of the LEP and the prosecution of unauthorised dwelling construction and tree felling.

As the old subdivisions are a problem of State significance, approaches have been made to the Minister for Planning by Council to investigate a solution. One such submission was made to the Minister for Local Government and Planning in 1989. This submission proposed a range of options including new legislation which would seek to contain further fragmentation of ownership in existing estates, as the following quotation shows:

> *"It is understood that there is reluctance in some quarters to consider legislation which would in effect close down old estates. Council believes that it is appropriate for the State Government to consider legislation which would allow the Registrar General to refuse to issue separate titles on individuals lots within estates which have remained in a single ownership over a specified period of time and have not been developed with roads and other services. There is already legislation which allows owners to amalgamate such estates if they chose to do so on a voluntary basis.*
>
> *It would appear therefore that reluctance to introduce such legislation is not so much a matter of law, but rather of philosophy, that is, the rights of individual ownership of land against the public interest. This is not a new conflict. Legislation which deals with planning, resumption and so on accepts that on occasion the public interest must override that of the individual. In this case legislation as suggested*

would be designed to protect many individuals who might otherwise be prospective purchasers of parcels of land which would be in effect useless to them and yet be an ongoing drain on their financial resources." (Second submission to the Minister for Local Government and Planning, undated)

Establishing a clear policy on old subdivisions is, therefore, an extremely difficult task which involves State level commitment. Correspondence from the DoP dated 1 November, 1993 (Appendix A) shows that possible mechanisms for dealing with the problem are being explored. However, at the moment no specific policies have been formulated.

"The Department recognises the problems associated with small rural subdivisions, since these were created prior to the introduction of planning controls. The Department is presently examining appropriate mechanisms to minimise the risk whereby people purchase old rural subdivisions without being fully aware of the implications and secondly, to address problems associated with subdivisions held in fragmented ownership. This assessment is being undertaken in association with relevant Government agencies, the Local Government and Shires Association and Royal Australian Planning Institute. One of the options being considered by the Working Party is land pooling ....." (DoP 1993, refer to Appendix A).

In the light of this, the investigation of the development potential for Pacific Pastures needs to occur on a purely merits basis with consideration being given to the environmental and financial implications of development and servicing rather than the larger picture of the potential cumulative impact of old subdivisions throughout the region.

2.4 CONCLUSIONS

The regional and local planning documents and instruments examined do not identify any particularly outstanding features for the study area. The study area is, however, situated amidst a regionally significant natural area which contains recommended habitat corridors and SEPP No. 14 wetlands. The relative over supply of appropriately zoned and serviced but unsubdivided land is mentioned in a number of documents as is the continuing high demand for rural residential land. The latter form of subdivision has been criticised for being expensive to service, and usually subsidised by the wider community. Concessional lot provisions have also meant that many of the rural residential subdivisions have, by necessity, been based on past ownership patterns, rather than environmental capacities. In recognition of the continued demand for rural residential lifestyles, Council's latest rural planning document has set aside areas for investigation for such subdivisions. However, Pacific Pastures is not included in these areas.

In relation to the planning challenges of old subdivisions, there has been no official policy guidance given due to the complexity of the problem and the difficult, political issues associated with development rights. An outline of the problem was submitted to the State Government in 1989 and a request made for special legislation to prevent further fragmentation. Whilst land pooling and special property trusts are an option, the Attorney General's Department has not yet endorsed such an approach. Investigations of all options will have to be completed by the Department of Planning before a state level policy emerges.

Given that no specific directions have been given for old subdivisions, the study must focus on the environmental capacity of the site for rural residential development and identify likely costs for servicing such dwellings. Although consideration will be given to the overall demand and supply for residential and rural residential lots, only limited consideration can be given to the precedental effect for old estates generally as an investigation into this extensive problem is beyond the scope of this study.

Chapter 3

BIOPHYSICAL ENVIRONMENT

This chapter examines the biophysical characteristics of the study area including soils, hydrology, flora and fauna.

3.1 PHYSICAL CHARACTERISTICS

3.1.1 Topography

The study area is characterised by undulating slopes and broad drainage depressions. The high point of the site is located on the north western boundary, while a low ridge extends in a south easterly direction across the site; elevations range between 20 to 50 metres above sea level. The topography is generally consistent with the surrounding landscape.

A low ridge running in a north easterly direction divides the site into two catchments. The slopes of each catchment have north easterly to southerly aspects. The slopes are not steep, being generally less than five per cent and do not exceed 10 percent; generally those in the southern catchment are slightly steeper than those in the northern catchment.

Slope plays an important part in effluent disposal. The EPA (1992) recommends that only slopes of up to 15 per cent are acceptable for pasture irrigation of effluent, provided runoff and erosion are controlled. Irrigation on slopes above 15 per cent is generally considered to be unacceptable.

3.1.2 Geology

The study area lies near the southern boundary of the Sydney Basin. The underlying geology is dominated by the Permian sedimentary associations of the Shoalhaven group. This association contains quartz sandstone, some siltstone, tuftaceous sandstone, basalt and is pebbly in parts. The dominating material within the study area is Nowra Sandstone (Mitchell McCotter, 1992).

3.1.3 *Soils*

i. Survey Outline

The investigations of the site's soils were aimed at determining the following for each soil type found:

- suitability of the soil for the application of treated effluent; and
- likely erosion hazards.

Soil characteristics can be critical for on-site disposal of effluent. This is because characteristics such as texture, particle size, porosity, dispersibility and degree of aggregation influence the rate of infiltration into and percolation through the soil. If the permeability of a soil is limited, the amount of effluent and the rate at which it can be applied will also be limited. However, this can be overcome to a degree by reserving larger areas of land for effluent application.

ii. Recommended Standards

The EPA (1992) recommends in its draft guidelines for treatment of wastewater that the ideal soil for effluent application is a medium grained, moderately permeable, well structured soil. It also notes that very sandy or gravelly soils, heavy clays or expanding clays may not be suitable. Well drained soils are preferred, with soil depths to be ideally between 1.5 to 1.8 metres over a site. However, it is noted that less well drained soils may be used if drainage structures are included in the design and that lesser soil depths may be acceptable for shallow-rooted pasture plants which would take up some irrigated wastewaters.

iii. Methodology

The soils of the site were documented by examining existing information which was then checked by field survey. Existing information included colour aerial photographs, 1:25,000 topography maps and published reports including Public Works (1992) Hazelton (1992) and Mitchell McCotter (1993). Using this information as a base, a field survey was planned to locate any possible differences in the soils of the site. This was achieved by ensuring that a variety of landscape elements were surveyed, with the survey sites located so that the majority of the site was examined.

Soil characteristics were described in the field at five locations as shown in *Figure 3.1.* Samples were obtained by hand augering holes to an average depth of

80 centimetres. The soils of each hole were described in accordance with the *Department of Conservation and Land Managements Soil Data System* (1992). The soils were classified into soil profile forms according to Northcote (1979) and into *Great Soil Groups*, (Charman and Murphy, 1991). The site survey combined with analysis of colour aerial photographs and 1:25,000 topographic mapping enabled mapping of the different soil types. The soil profile reports of this soil survey are included in Appendix C.

iv. Existing Information

Hazelton (1992) described the soil landscapes of the Illawarra coast from Wollongong to Nowra on the 1:100,000 Kiama map sheet. Soil landscapes are areas of land that "*have recognisable and specifiable topographies and soils, that are capable of presentation on maps, and can be described by concise statements*" (Hazelton, 1992). Although this mapping did not cover the study area, two soil landscapes, *Nowra* and *Fairy Meadow* defined by Hazelton (1992) reflected similar topographies and lithologies to the study area and were considered prior to fieldwork.

The Nowra soil landscape contained podzolics, which are soils exhibiting a marked texture contrast between the topsoil and the subsoil. Yellow podzolics similar to those in the study area occupy lower slopes and drainage lines. Limitations associated with this soil type include highly erodible subsoils, low permeability, shallow soils and low wet bearing strength; that is, the soils deform easily under pressure when wet.

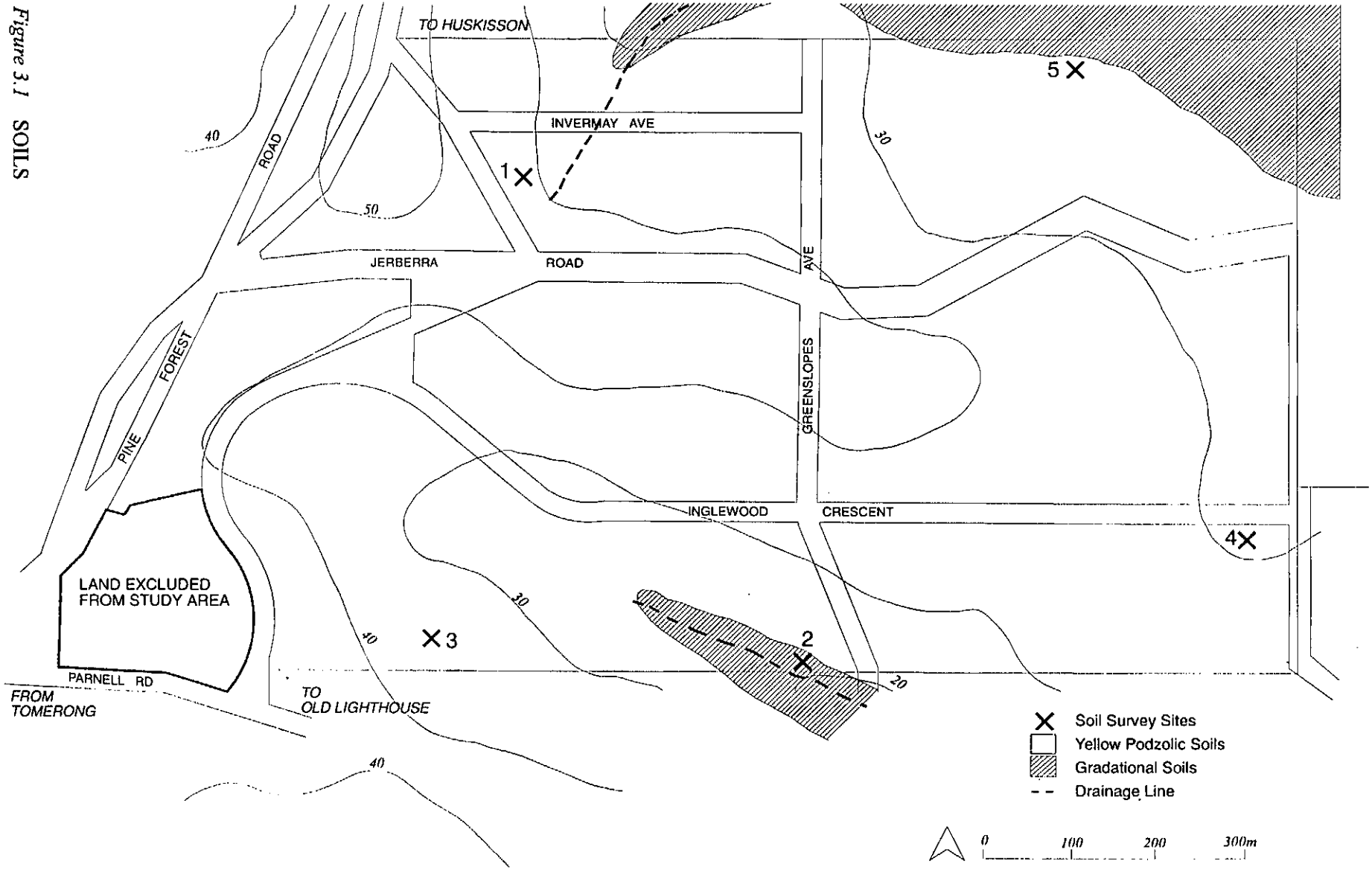
The Fairy Meadow soil landscape is characterised by gradational prairie soils and yellow podzolics similar to those in the study area. Gradational soils show a gradual increase in clay content with depth throughout the soil profile. Limitations associated with these soil types include flood hazard, low wet bearing strength, highly permeable topsoils and high water tables.

v. Survey Units

a. General Observations

During the field survey extensive gully and rill erosion of the existing roadways in the study area was noted. The soils appeared to be hardsetting in some areas where soil conditions were dry. Localised waterlogging of soils was observed in natural drainage lines and field observations of local water bodies indicated dispersable subsoils. The depth to bedrock was largely undetermined over the site although it was located at approximately one metre depth at soil survey location 1.

Figure 3.1 SOILS



Two soil types were found in the study area, yellow podzolics and gradational soils. The main difference between the two soils was the higher degree of texture contrast between the topsoil and the subsoil of the yellow podzolics.

b. Yellow Podzolics (Dy 3.11, Dy 2.11, Dy 5.11)

Podzolic soils are characterised by a distinct texture contrast between the topsoil and the subsoil. Topsoil textures varied between clayey sand and sandy loams above a sandy clay loam to clay subsoil. The topsoil was yellowish brown in colour slightly acidic and weakly pedal. The average topsoil depth was approximately 15 centimetres.

The subsoil was moderately pedal and exhibited a significant increase in clay content. Moderate root penetration was present and the profile brightened in colour becoming increasingly yellow.

The effluent disposal capacity of this soil is low to moderate. The presence of clay within the profile means the soil has the capacity to absorb nutrients from effluent. The low permeability of the soil however, is a limiting factor for effluent disposal.

The soil is likely to be highly erodible if the clay subsoil becomes exposed. This is already evident in the study area with severe erosion on roadways. The shallow topsoil and apparent dispersible subsoil are balanced by the gentle slopes on the site. The erosion hazard would be severe to moderate while the soil remains undisturbed.

This assessment of erodibility should be revised once analytical testing of the soil has been undertaken and the dispersibility indicated more accurately and incorporated in the management plan for the site.

c. Gradational Soils (Gn 2.51)

The soil materials which form the gradational soils are similar to those which comprise the yellow podzolics, however there is less texture contrast between the topsoil and subsoils.

The clay content of these soils increases with lower topographic position. The soil adjacent to the Moona Moona Creek wetland (site 5) exhibited a significantly higher clay content than the gradational soil on the southern edge of the site (site 2).

The topsoil texture of the gradational soil adjacent to Moona Moona Creek wetland was a light clay, whereas at the site's southern edge it was clayey sand. The soil colour lightens with depth from a brownish grey to a dull yellow and the clay

content gradually increases. The pHs of the gradational soils were slightly acid, similar to those of the yellow podzolics. The average topsoil depth was approximately 30 centimetres. It would not be desirable to use these soils for effluent disposal due to their location in drainage depressions, low permeability and high level water tables.

The erodibility of this unit is low to moderate due to good soil structure. The overall erosion hazard would be moderate to low in an undisturbed state.

vi. Conclusions and Recommendations

a. Effluent Disposal

Irrigation of treated effluent on some of the soils on the site could be possible, given the slopes of the site and the soils present, including drainage characteristics and apparent permeabilities. The yellow podzolic soils appear to be most suited to effluent disposal but it would be desirable for the permeability of these soils to be confirmed by conducting *Emerson aggregate tests* on representative soil samples. Other tests which would be useful include a dispersion index test, particle size analysis and a water holding capacity test. The combination of all four tests would not only provide a comprehensive indication of the erodibility of the soil, but also indicate more accurately the capability of the soil to absorb effluent.

The gradational soils located in the broad drainage depressions are not recommended for effluent disposal due to the high water table level and consequent likelihood of effluent contaminating ground water.

The depth of soil present and the water table depth would need to be confirmed for all proposed application areas prior to use. Prior to any final decisions being made about development on the site, the suitability of the soils for effluent disposal should be subject to more detailed investigations.

b. Erosion Control

Careful erosion control measures would be needed both during and after construction. The results of the effluent application rate tests would also be useful in determining more accurately the erodibility of the soil. This is particularly important for the clay subsoil, which would be an erosion hazard if exposed. Field observations of the soil suggest that the erodibility is likely to be moderate to high, but this should be confirmed through testing.

Prior to any development occurring, it would be necessary for a detailed land management plan to be produced which would document the proposed erosion and sedimentation controls, including proposals for the stabilisation of cut and fill surfaces. The schedule of development would need to be designed to limit the duration of construction activity and minimise the number of cleared areas; this would in turn reduce the generation of sediment.

Prior to disturbance, topsoil would need to be stripped to a depth of approximately 20 centimetres and stockpiled to depths of no greater than sixty centimetres. Wherever possible, existing endemic vegetation should be retained and disturbed areas revegetated as quickly as possible using respread topsoil as a growing medium. A permanent vegetation cover should be established and maintained on all surfaces that are not sealed. Disturbed areas should be hydromulched using a mixture of sterile introduced annual species such as Japanese millet, and perennial native species. Such introduced species only last one generation and enable initial ground stabilisation. Native species should be encouraged in the long term.

Catch-drains should be located to divert clean water around disturbed sites, with further erosion control measures such as filter fences and catch-drains used to prevent the movement of sediment off site into the wetland, or if not, to direct the contaminated water to an appropriate sedimentation control device.

Construction traffic should be strictly controlled to minimise erosion. Heavy vehicular traffic should be confined to sealed roads wherever possible. Temporary roadways should be designed to drain transversely and be dressed with crushed stone, aggregate or gravel. Runoff diversions should be provided along road verges to prevent the concentration of runoff.

Accelerated erosion on permanently unsealed tracks such as walking or riding trails should be prevented by the use of a number of erosion controls. The trails could be designed to be of sufficient capacity for the maximum anticipated level of usage, with no long, straight stretches at a constant grade. Tracks should be aligned across natural slopes rather than directly down, to impede the concentration of runoff. Protective cover such as gravel or wood chips should be used on level sections of trails, and stone or wooden steps used on grades steeper than 25 per cent. However, given the gently undulating nature of the site, there should be no locations where there is a grade this steep. Runoff controls should be incorporated into all trails by providing a slight crossfall on tracks, and barriers should be constructed where it is likely that walkers or riders may stray off the path and cause unchecked erosion.

3.1.4 *Agricultural Capability*

All land in the Shoalhaven local government area has been mapped into agricultural capability classes by the Department of Agriculture and these are documented in the Shoalhaven Rural Environmental Study (1985). The technique used is specified in the Rural Lands Evaluation Manual (DEP, 1981b) and classifies land into agricultural suitability classes decreasing in suitability from class 1 to 5.

Land in the study area is classified as class 5 agricultural land. Class 5 land is suited only for grazing and cannot normally support commercial agriculture. Severe or absolute constraints to production are imposed by environmental factors. The Shoalhaven Rural Environmental Study states that "*These lands, being the less agriculturally productive should generally be considered as potentially available for a wide range of uses subject to other considerations*" (Shoalhaven Council, 1985).

The Department of Agriculture's Nowra Office confirms the class 5 agricultural capability classification and does not believe agricultural value is a constraint to development of the study area. The Department's letter is included in Appendix B.

3.2 HYDROLOGY AND WATER QUALITY

3.2.1 *Hydrologic Characteristics*

The study area is situated near the western head waters of the Moona Moona Creek catchment which contains significant wetlands designated under SEPP No. 14 Coastal Wetlands. Moona Moona Creek feeds into Jervis Bay.

The study area is dissected by intermittent drainage lines which form the upper reaches of Moona Moona Creek. Most of the area is relatively flat with broad gently sloping gullies draining to the drainage lines. A north-west/south-east trending ridgeline divides the land into two sub-catchments which drain to the north and south respectively, as shown on *Figure 3.2*.

There is a natural wetland to the north of the study area to which the northern sub-catchment drains. The southern sub-catchment is drained by a broad gully which flows into a wet heath swamp downstream of the study area before merging into Moona Moona Creek.

Currently, the study area has substantial tree cover. However, there is evidence of significant tree clearing on a number of lots. Ongoing clearing would modify the hydrological characteristics of the catchment by generating increased runoff. There

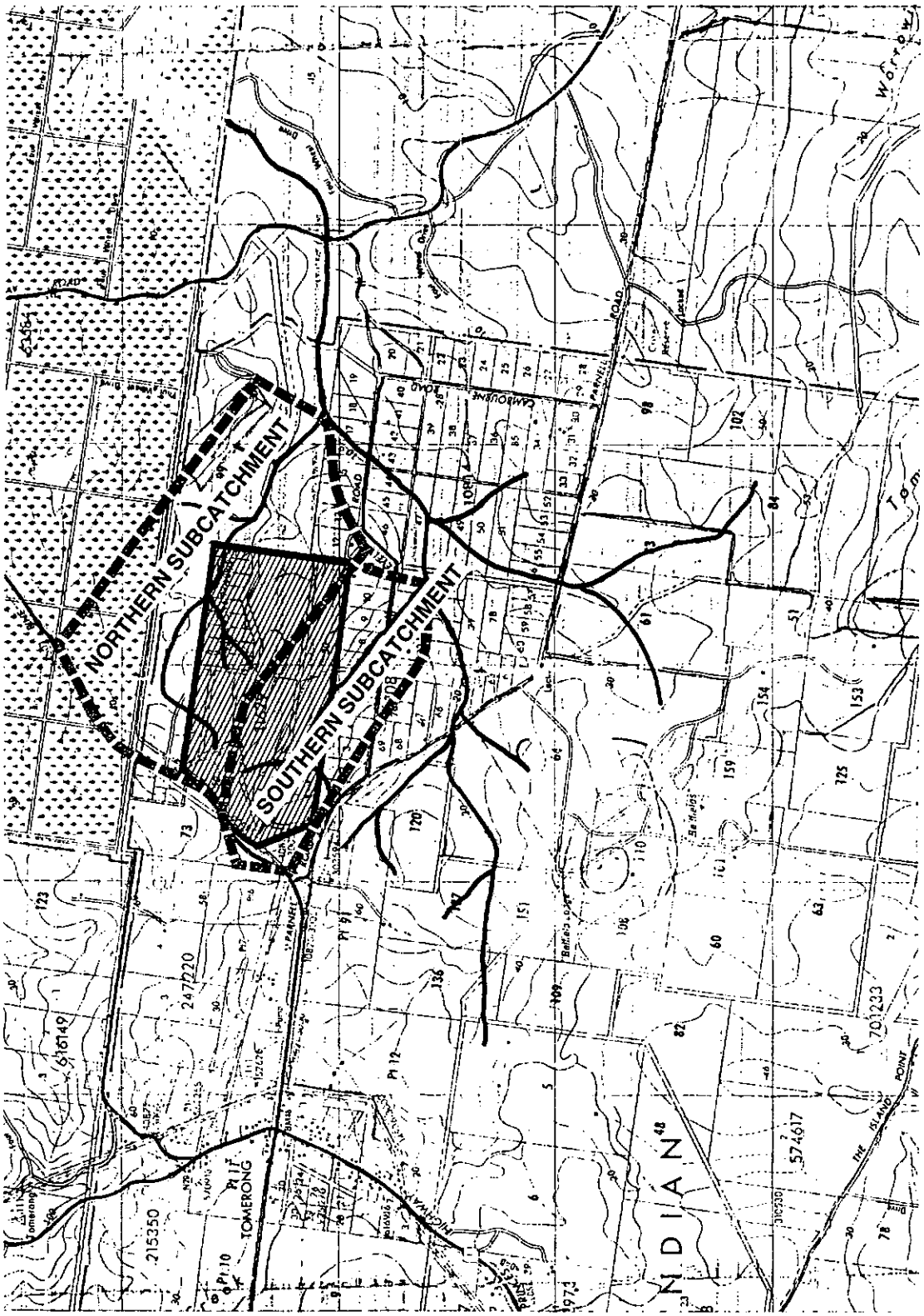


Figure 3.2 DRAINAGE CATCHMENTS

are a number of small manmade dams in the northern sub-catchment which collect surface runoff and thereby interfere with normal drainage to the northern wetland.

Generally, the catchments have a high runoff potential because of the hardsetting and relatively impervious characteristics of top soils in the area.

3.2.2 *Rainfall and Evaporation*

The study area receives high rainfall which is typical of the south-east coastal areas of New South Wales. Average annual rainfall in the Jervis Bay region is 1,127 millimetres. Typically, the wettest months are January through to March and October and November, whilst July to September have the lowest rainfalls.

The highest evaporation occurs between October and March. On an annual basis evaporation exceeds rainfall.

Rainfall and evaporation data for the Jervis Bay area from the Royal Australian Navy air station at Nowra are shown in *Table 3.1*. The rainfall distribution characteristics are illustrated in *Figure 3.3*.

Table 3.1 MONTHLY RAINFALL AND EVAPORATION DATA FOR THE JERVIS BAY/ST GEORGE BASIN REGION

Month	Mean Rainfall (mm)	Median Rainfall (mm)	Evaporation (mm)(1)
January	97	74	198
February	132	79	162
March	136	77	146
April	107	52	120
May	93	72	96
June	115	63	87
July	59	41	96
August	74	42	127
September	60	41	150
October	120	75	180
November	105	84	180
December	79	70	220

Notes *(1)* *Class A Pan Evaporation*

mm *millimetres*

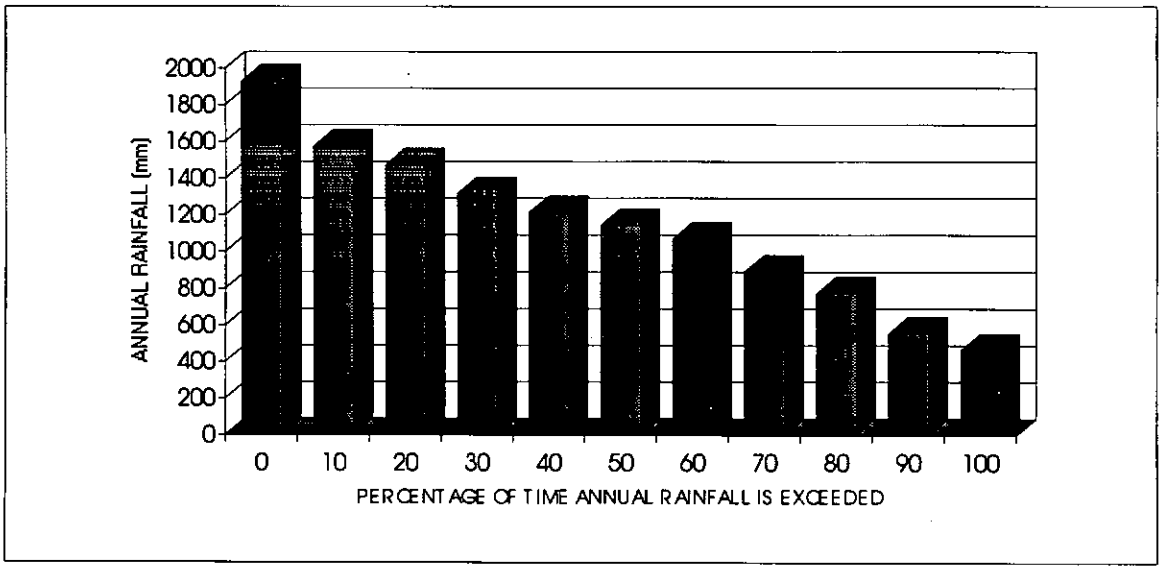


Figure 3.3 ANNUAL RAINFALL DISTRIBUTION

3.2.3 *Groundwater*

There is groundwater available within the study area and a number of allotments have access to borewater. However, bores in the area are not licensed by the Department of Water Resources and are therefore unauthorised. Data from licensed bores in the general area obtained from the Department of Water Resources indicated that ground water is available at depths of between 16 and 27 metres below the surface approximately one kilometre west of the site.

Groundwater quality data indicates that the water has low levels of salinity, dissolved solids and hardness. Levels of nitrate in the water are also quite low. Iron levels are such that they would be undesirable and would probably result in objectionable taste and odour if the water was used for potable purposes. High iron levels also cause staining of laundry. Relative levels of sodium, magnesium and calcium would cause problems with soil permeability if groundwater is used extensively for irrigation.

3.2.4 *Flooding Characteristics*

As discussed earlier, the study area is characterised by hard setting top soils with a high runoff potential. Under the existing bushland and rural catchment conditions, over 50 percent of rainfall would form runoff. Low lying areas in the vicinity of

drainage lines have highly saturated soils with very low infiltration capacities. Consequently, higher runoff rates would be generated at those sites.

The north-eastern portion of the study area, east of Lot 96, lies within a wetland and would be prone to flooding in moderate storms. Groundwater at the northern boundary of Lot 96 was observed approximately 25 millimetres below the surface which indicates negligible infiltration and a high runoff and flooding potential. These low lying areas would not be suitable for effluent disposal by irrigation.

3.2.5 *Existing Water Quality*

The study area drains to Moona Moona Creek which subsequently flows into Jervis Bay. To date there has been no extensive water quality monitoring in the head waters of the creek. The lower tidal reach of Moona Moona Creek has been the subject of previous water quality studies. *Table 3.2* presents water quality information on the tidal reach of Moona Moona Creek reported in baseline studies conducted by CSIRO (1989).

Table 3.2 WATER QUALITY IN THE TIDAL REACH OF MOONA MOONA CREEK

Parameter	Units	Concentration Range
Suspended Solids	mg/L	4.5
Ammonia	mg/L	0.0039 to 0.0059
Oxidised Nitrogen	mg/L	0.0027 to 0.0036
Total Kjeldahl Nitrogen	mg/L	0.6 to 1.31
Total Phosphorus	mg/L	0.0001 to 0.0044

Source: *CSIRO (1989)*

Notes: *mg/L* *milligrams per litre*

Table 3.2 shows that the water quality in the creek is very high with the exception of nitrogen levels as indicated by total kjeldahl nitrogen.

Desirable water quality criteria for waters draining to Moona Moona Creek may be obtained from guidelines published by the Australian and New Zealand Environment and Conservation Council (ANZECC, 1992). *Table 3.3* outlines the desirable water quality criteria for selected parameters.

Table 3.3 DESIRABLE WATER QUALITY CRITERIA OF WATERS DRAINING TO MOONA MOONA CREEK

Parameter	Freshwater Sections mg/L	Marine Sections mg/L
Dissolved Oxygen	>6	>6
Total Nitrogen	0.100 to 0.750	0.0106. to 0.100
Total Phosphorus	0.010 to 0.100	0.005.to 0.015
Bacteria		
Faecal Coliforms (organisms / 100ml)	150	150

Source: *ANZECC (1992)*

Notes: *mg/L* *milligrams per litre*
ml *millilitres*

The above criteria represent ideal levels for the maintenance of aquatic ecosystems and human contact recreational activities. Ideally total nitrogen levels not exceeding 0.5 milligrams per litre are desirable.

Moona Moona Creek has a total catchment area of about 28 square kilometres. The study area represents about 2.8 per cent of this catchment and therefore would contribute a relatively small amount of pollutants to the creek. However, if the current practices of uncontrolled removal of vegetation, widespread use of fertilisers, modification to surface hydrology through earthworks and proliferation of inadequate wastewater disposal systems were to continue, in due course, they would degrade the quality of runoff from the site. It is important that appropriate controls be put into place for any development proposed in the Moona Moona Creek catchment in order to safeguard the environmental qualities of the SEPP 14 wetlands.

3.3 ECOLOGICAL CHARACTERISTICS

3.3.1 Flora

The flora of the study area closely reflects topography and is typical of vegetation in the Jervis Bay region. Large areas of original vegetation in the region have been cleared for forestry activities, however, pockets of the original vegetation and extensive areas of regrowth remain.

A flora survey of the study area was undertaken on 9 and 10 September 1993. Its purpose was to examine, describe and map the vegetation communities on the site. The method adopted included a review of relevant literature, interpretation of 1:5000 colour aerial photographs and field investigations. It was not within the scope of this study to prepare a comprehensive species list but the main species in each community were recorded. The vegetation communities were classified on the basis of height and percentage cover (Specht, 1981) and the dominant tree species. Species names follow the Beadle *et al* (1989) communities are described in terms of their structural and floristic characteristics below.

The vegetation communities on the site include:

- woodland;
- open forest;
- wetland creekline community;
- creek headwater open forest; and
- cleared areas.

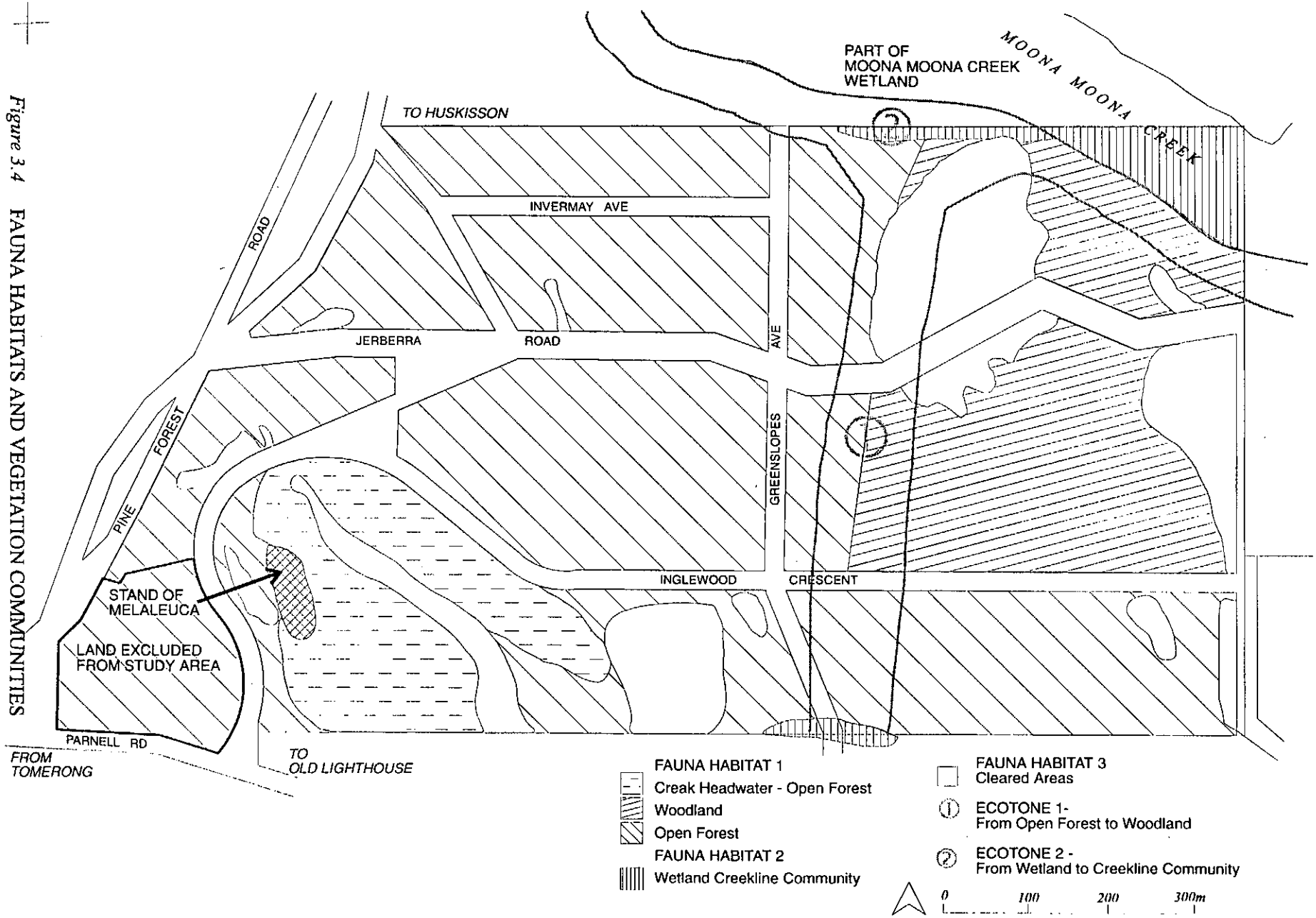
The distribution of these communities is shown in *Figure* 3.4.

i. Woodland

Structure: This is a woodland reaching 20 metres in height. The understorey ranges from well developed through sparse to cleared depending on the level of disturbance. A tall shrub layer, reaching ten metres and a small shrub layer 1.5 metres in height are present. The ground cover consists of a mixture of native and introduced grasses.

Description: Snappy Gum (*Eucalyptus racemosa*) dominates the canopy. Red Bloodwood (*E. gummifera*), Turpentine (*Syncarpia glomulifera*) and Swamp Mahogany (*E. robusta*) occur in the canopy to a lesser extent, however as slopes drop off to the south, they increase in number. The tall shrub layer where present consists of Eucalyptus seedlings, Black She-Oak (*Casuarina littoralis*) and Lemon scented tea tree (*Leptospermum flavescens*). The shrub layer was dominated by *Casuarina* seedlings and contained a range of species including *Daviesia ulicifolia, Banksia spinulosa, Epacris microphylla, Woollsia pungens,* Prickly Moses (*Acacia ulicifolia*), *Banksia Serratta, Boronia pinnata* and *Dillwynia floribunda.* The ground cover was a mixture of grasses

Figure 3.4 FAUNA HABITATS AND VEGETATION COMMUNITIES



including Blady grass (*Imperata cylindrica*), Paspalum (*Paspalum dilatum*), Kangaroo grass (*Themeda australis*), *Lomandra* sp, *Ghania* sp and *Pimelea linifolia.*

Occurrence: This community occupies the eastern end of the site (refer *Figure* 3.4).

ii. Open Forest

Structure: This is an open forest reaching 30 metres in height. The understorey contains a small tree layer reaching 12 metres and a tall shrub layer to around two metres and a small shrub layer to 0.5 metres in height which vary with the level of disturbance.

Description: Spotted Gum (*E. maculata*) dominates the canopy. Red Bloodwood *(E. gummifera)*, Turpentine (*Syncarpia glomulifera*), White Stringybark (*E. globoidea*), Swamp Mahogany (*E. robusta*) and Grey Ironbark (*E. paniculata*) also occur. The small tree layer reaches 12 metres in height and is dominated by Spotted Gum saplings, *Casuarina glauca* and a range of other eucalypt saplings also occur. The tall shrub layer is sparsely distributed and contains Geebung (*Persoonia levis*), Narrow leaved Geebung, (*Persoonia linearis*) *Banksia ericifolia* and *Banksia Spinulosa.*

The small shrub layer is dominated by *Dillwynia floribunda, Boronia pinnata* also occurs. The ground cover includes Bladey Grass (*Imperata cylindrica*), Kangaroo Grass (*Themeda australis*), *Lomandra* sp, *Ghania* sp and Braken Fern (*Pteridium esculentum*).

Occurrence: This community occupies the north western section of the site as shown on *Figure* 3.4 on moderately drained soils.

iii. Wetland Creekline Community

Structure: This is a low closed forest reaching four metres in height with eucalypt and melaleuca emergents, which range from 10 to 20 metres in height. The ground cover consists of reeds and sedges.

Description: The canopy is dominated by *Melaleuca ericifolia*, Lemon scented tea tree (*Leptospermum flavescens*), Prickly tea tree (*Leptospermum juniperinum*) also occur. The Paperbark (*Melaleuca decora*) and Swamp Mahogany (*Eucalyptus robusta*), Turpentine (*Syncarpia glomulifera*) and Snappy gum (*E. racemosa*) form emergents in this community. The shrubs *Callistemon citrinus, Petrophile pulchella* and *Dillwynia floribunda* also occur in slightly higher positions. The ground cover is a dense

mixture of sedges dominated by *Baumea juncea* and including *Lomandra* sp and *Cihania* sp, moss occurs as a ground cover in some areas.

The wetland creekline community is an upstream extension of Moona Moona Creek wetland. The downstream wetland was mapped by the DoP from large scale aerial photography and is listed in SEPP 14 as wetland number 325. Recent changes in the hydrological regime have resulted in dieback of the eucalypt emergent canopy. It is now apparent from 1:5,000 colour aerial photos and ground survey that the wetland extends upstream along Moona Moona Creek and into the site.

Occurrence: This community occupies the broad drainage line on the northern boundary of the site, as shown in *Figure 3.4*.

iv. Creek Headwater Open Forest

Structure: This is an open forest community ranging from 15 to 20 metres in height. A small tree and tall shrub layer occurs and the ground cover is a mixture of ferns and grasses. Climbers also occur in this community.

Description: The canopy is dominated by Blackbutt (*E. pilularis*), Spotted Gum and Red bloodwood occur to a lesser extent. The small tree layer consists of saplings of these species and small stands of Turpentine (*Syncarpia glomulifera*). The tall shrub layer includes Narrow leaved Geebung (*Persoonia linearis*), Black Wattle (*Callicoma serratifolia*) and *Acacia decurrens*. The climber Native Sarsaparilla (*Smilax glyciphylla*) is common in this community. The small shrub *Dillwynia floribunda* is also present. The ground cover includes *Lomandra* sp, Braken fern (*Pteridium esculentum*) and the nodding greenhood orchid (*Pterostylis nutans*).

Occurrence: This community occurs around the headwaters of a small unnamed tributary of Moona Moona Creek, in the south west of the site, as shown in *Figure 3.4*.

This community may have supported an understorey of rainforest species in the past. Recent clearing and an increase in fire frequency has resulted in the existing understorey.

v. Cleared Areas

Areas of vegetation within the study area have been cleared. In some instances entire blocks have been clear felled. Elsewhere selective logging has occurred

and/or the understorey has been removed. In all cases the cleared areas now support a closed grassland of a variety of species, mentioned previously.

3.3.2 *Fauna Habitats*

Vegetation communities were classified in relation to their provision of habitat for native fauna. Each habitat was investigated by foot traverse and assessed as to its condition and significance for native wildlife. Faunal species and important habitats were noted from field observations and other indicators recorded during the survey and from information provided by past studies including wildlife corridors in the Jervis Bay Region, (Kevin Mills and Associates, 1991).

The assessment criteria involved:

Mammals: the amount of ground cover, extent of shrub layer or tree canopy, occurrence of old trees with hollows, type of substrate (for burrowing etc). Signs of the presence of various species such as droppings, diggings, footprints, scratches on trees, nests, burrow paths and runways were sought.

Birds: structural features such as the extent and nature of understorey and ground stratum, extent of the canopy and flowering characteristics of vegetation species. Bird species were noted.

Reptiles and Amphibians: availability of cover, shelter, suitable substrate, basking sites, breeding sites (free water). Reptiles and frogs were sought in their likely sheltering places.

It is not the intention of this study to conduct a fauna survey but to assess the habitat as to its potential to support populations of native wildlife.

The vegetation communities previously described reflect differences in plant species composition. The majority of native animal species do not detect these floristic differences but choose habitat based structural characteristics; that is, the number of layers, the vegetation density and height. For many specialised groups, the ability to survive may depend upon the availability of water, a certain species of tree, or microclimate. Any activity that would alter the structure or the cover of the vegetation would also the alter the habitat characteristics and may lead to changes in the fauna.

The study area has undergone clearing by land holders, in some instances small blocks of land have been completely cleared and in other areas the canopy has been thinned by tree removal and understorey removal. Parts of the study area have also been extensively fenced. The fauna habitats on the site are:

- *open forest and woodland communities:* consisting of spotted gum, snappy gum Blackbutt and Red bloodwood. A tall and small shrub layer if present consisting of eucalypt seedlings, Casuarina seedlings and a range of small flowering shrubs. A ground cover of grasses reeds and or bracken fern;

- *creekline community* consisting of *Melaleuca ericifolia* with melaleuca and eucalypt emergents; and

- *cleared areas*: consisting of a range of grasses and sedges.

i. Habitat 1 - Open Forest

Underlying Geology: Nowra sandstone

Vegetation Communities: Open forests and woodland

Structure: Trees up to 20 metres in height with an open canopy cover. Dry understorey with a sparse cover of small trees and dense cover of small shrubs and grasses. Trees up to 30 metres on lower south facing slopes with a moderate canopy cover well developed small tree layer, tall and small shrub layer. A dense ground cover of grasses and reeds.

Habitat elements: Open tree canopy, moderate small tree, tall and small shrub layer. Dense ground cover. Some mature trees with hollows, suitable for parrots and/or gliders. Some stumps, small localised water bodies, small dams and channels.

Human Elements: Extensive fencing through entire habitat, cleared areas, active logging, alterations to natural drainage lines, introduced vegetation, obvious presence of domestic animals including dogs, cats, goats and sheep.

ii. Habitat 2 - Creekline Community

Underlying Geology: Nowra sandstone.

Vegetation Communities: Creekline community.

Structure: Dense cover of trees up to five metres in height with a sporadic cover of emergents up to 20 metres high. Understorey wet with a dense cover of sedges and reeds, well developed shrub layer in slightly elevated areas.

Location: Waterlogged sandy clays on north eastern edge of site.

Habitat Elements: Good nectar sources from flowers, *Eucalyptus robusta* (winter flowering) and *Melaleuca* spp. Dense low canopy. Extensive well developed understorey within the ecotone (gradational boundary from creekline community to the woodland community to the south). Numerous fallen logs and stumps. Freewater on ground surface, and numerous small channels. Extensive dieback of the emergent eucalypt canopy.

Human Elements: Extensive clearing of ecotone on the southern boundary for fencing. Two large dams at the southern boundary may have effected water availability to the creekline community and contributed to dieback along with nutrient enrichment. Some selective logging of Casuarina trees. Potential for exotic plant species invasion from adjacent properties.

iii. Habitat 3 - Cleared Areas

Underlying Geology: Nowra sandstone.

Vegetation Communities: Cleared areas.

Structure: Little if any canopy cover, no shrub layer, dense cover of grasses and sedges. No natural habitat components but generally surrounded by natural habitat. Ponded surface water and some small channels.

Appendix E includes three tables which provide an overview of fauna species recorded in the general area by Kevin Mills and Associates (1989). *Table E.3* is a list of Bat species which could potentially occur in the study area or region and was prepared by Strahan (1991)

Two native mammals listed in *Table E.1*; the Swamp Wallaby and the Eastern Gray Kangaroo were recorded in the study area, along with the introduced rabbit. A variety of other common mammal species are likely to occur in the study area.

A total of 12 bird species were recorded in the study area and are listed in *Table 3.4*. A range of other bird species have been recorded in the locality by Kevin Mills and Associates (1989). These are listed in Appendix E. A large number of birds listed in

Appendix E are expected to utilise habitat in the study area as part of a much wider home range.

Table 3.4 BIRD SPECIES OBSERVED ON SITE

Common Name	Species Name
Maned Duck	*Chenonetta jubata*
Yellow tailed Black Cockatoo	*Calyptorhynchus funereus*
Galah	*Cacatua roseicapilla*
Sulphur-crested Cockatoo	*Cacatua galerita*
Crimson Rosella	*Platycercus elegans*
Laughing Kookaburra	*Dacelo novaeguineae*
Richard's Pipit	*Anthus novaeseelandiae*
Eastern Whipbird	*Psophodes olivaceus*
Australian Raven	*Corvus coronoides*
Australian Magpie	*Gymnorhina tibicen*
Australian Magpie-lark	*Grallina cyanoleuca*
White Winged Chough	*Corcorax melanorhamphos*

The only reptile species confirmed on site was the Common Eastern Froglet *Crinia signifera*. Anecdotal evidence from local residents suggested the use of the site by the Red-Bellied black snake *Pseudechis prophyridcus* and the Eastern brown snake *Pseudonaja texilis*. Due to the time of year and weather conditions during the survey, habitat searches for reptiles were largely unsuccessful. A variety of other lizards, snakes and frogs are likely to utilise the area.

Species listed on Schedule 12 of the National Parks and Wildlife Act that are known or likely to occur in the study are discussed in Section 3.3.5.

3.3.3 *Assessment of Conservation Value*

In this report the conservation value of vegetation communities and fauna habitats has been determined by reference to the following criteria:

- *Representativeness* whether the vegetation communities are unique, typical or common with regard to occurrence in the Shoalhaven Region. In addition it takes into account whether or not such vegetation units and their animal habitats are presently held in reserves;

- the existence of *Rare and Restricted Species* would add to an area's conservation value. Particular classified species or species of special conservation significance to the area might be present which would warrant protection;

- the *Degree of Naturalness* is used to indicate the extent of human influence and to identify the condition of the vegetation and habitats; and

- the presence of *Special Natural Features* is used to indicate uniqueness in that unusual natural features might be present which may not be associated with a particular vegetation unit.

i. Vegetation

An assessment of the conservation values of the vegetation communities within the study area is summarised in the *Tables 3.5* and *3.6* which reference the criteria defined above.

ii. Summary of Conservation Values

Table 3.5 indicates that vegetation communities present in the study area are common in the region but inadequately held in reserves. Coastal wetlands are extensive in the region and many are identified within SEPP 14, however upstream extensions such as the wetland creekline community in the study area are rarely protected. This area has a high conservation value as it forms an extension of the SEPP 14 wetland and protects the headwaters of Moona Moona Creek. No rare or restricted flora species are expected to occur in the study area. All the vegetation communities exhibit varying degrees of disturbance of the understorey and the wetland creekline community exhibits dieback of the eucalypt emergent canopy. The conservation significance of the vegetation communities are discussed in Section 3.3.4.

Table 3.6 summarises the conservation values of fauna habitats in the study area. The table indicates all habitats are common in the region but inadequately held in reserves, except the creek headwater open forest which is now uncommon in the region. The table indicates rare and restricted species are likely to occur in the study area. The species include the Yellow Bellied Glider, and a range of bird species listed on Schedule 12 of the National Parks and Wildlife (Interim Protection) Act. Migratory bird species listed on JAMBA (Japanese Australian Migratory Bird Agreement) are also expected to utilise the study area on a season basis.

All the fauna habitats exhibit extensive disturbance of the understorey. Changes in hydrology and nutrient rich runoff have contributed to extensive dieback of the eucalypt emergent canopy. Most of the fauna habitats exhibit some special natural features which contribute to their conservation value. These features include large old trees with hollows and resting areas for migratory birds.

3.3.4 Conservation Significance

The vegetation communities and fauna habitats they form have a moderate conservation significance. The communities exhibit a relatively intact canopy cover and a sporadic distribution of 'habitat' trees, that is, old growth trees with hollows. The area may also provide habitat for rare or endangered species listed on Schedule 12 of the National Parks and Wildlife Act. However the conservation significance of these vegetation communities and fauna habitats is balanced by the large scale disturbance of understorey, extensive fencing, often six foot wire mesh severely limiting fauna movement and the obvious presence of domestic animals.

The wetland creekline community is part of an extension of designated SEPP 14 wetland number 325, known as the Moona Moona Creek wetland. This vegetation community forms an important habitat for a variety of bird species. It may be utilised on a temporary basis by many migratory bird species listed on JAMBA and CAMBA. The community protects the headwaters of Moona Moona Creek wetland which has a high conservation significance in the Jervis Bay region as stated by Broadbent (1988). As a result it holds high conservation significance.

The remaining vegetation communities and fauna habitats in the study area exhibit varying degrees of human disturbance, resulting from uncontrolled development. The communities contain a sporadic distribution of habitat trees and provide suitable habitat for a range of fauna species including species listed on Schedule 12 of the National Parks and Wildlife Act.

A system of wildlife corridors was identified by Kevin Mills and Associates (1991). These corridors have been identified as habitat corridors by the Department of Planning and Shoalhaven Council (1992). Habitat corridor 3 is located approximately 2.5 kilometres north of the study area. The existing vegetation communities in the study area combined with the remaining pine forest, Tomerong State Forest and extensive vegetation surrounding the study area provide a buffer for habitat corridor 3. The retention of vegetation surrounding these wildlife or habitat corridors increases the likelihood of fauna movement not only in an east west direction but also in a north south direction. This is especially important for migratory birds. Mills (1991) states that the size of vegetation remnants and linkages to other larger habitat areas have a direct impact on the number and diversity of

species vegetation remnants can support. The retention of fauna habitats in the study area and the maintenance of links from it to other areas of fauna habitat directly impact upon the number and diversity of fauna species the study area and habitat corridor 3 can support. As a result of these factors, the vegetation communities and fauna habitats they form have moderate conservation significance.

The vegetation communities in the study area and the fauna habitats they form are represented elsewhere in the region. The Jervis Bay National Park contains examples of the woodland, open forest, creek headwater open forest and wetland creekline community. A number of coastal wetlands designated on SEPP 14 are located around Jervis Bay including those on Moona Moona, Currambene and Bid Bid creeks. The integrity of these wetlands is under constant pressure from upstream and adjacent urban and agricultural development.

Table 3.5 VEGETATION CONSERVATION VALUES - FLORA

Vegetation Communities	Representativeness	Rare and restricted species	Degree of Naturalness	Special Natural Features
WOODLAND	common in the region, inadequately held in reserves	no such species expected	adequate condition, human disturbance evident with removal of understorey, fencing and clearing	no such features present
OPEN FOREST	common in the region, inadequately held in reserves	no such species expected	adequate condition, human disturbance evident with removal of understorey, fencing and clearing.	no such features present
WETLAND CREEKLINE COMMUNITY	common in the region, coastal communities well conserved as SEPP 14 wetlands, terrestrial systems poorly conserved	no such species expected	adequate condition, extensive dieback of emergent canopy and edge disturbance, clearing and fencing	landward extension of SEPP 14 wetland number 325
CREEK HEADWATER OPEN FOREST	common in the region, inadequately held in reserves	no such species expected	severely disturbed understorey, canopy in adequate condition disturbance evident, clearing and fencing	no such features present

Table 3.6 VEGETATION CONSERVATION VALUES - FAUNA

Fauna Habitats	Representativeness	Rare and Restricted Species	Degree of Naturalness	Special Nature Features
WOODLAND	common throughout the region, but inadequately held in reserves	The Yellow Bellied Glider listed on Schedule 12 may utilise this habitat. It may form part of Schedule 12 and/or migratory bird habitat	canopy in adequate condition but significant disturbance of understorey	large old trees with hollows suitable for birds, bats and arboreal mammals
OPEN FOREST	common throughout the region, but inadequately held in reserves	The Yellow Bellied Glider listed on Schedule 12 may utilise this habitat. It may form part of Schedule 12 and/or migratory bird habitat	canopy in adequate condition but significant disturbance of understorey	large old trees with hollows suitable for birds, bats and arboreal mammals
WETLAND CREEKLINE COMMUNITY	common in the region, coastal habitat well conserved by SEPP 14	Schedule 12 or migratory birds may visit the habitat ~~visit the habitat~~	low canopy and understorey in adequate condition extensive dieback of emergent eucalypt canopy	habitat may provide resting place for migratory birds
CREEK HEADWATER OPEN FOREST	now uncommon in the region and inadequately held in reserves	The Yellow Bellied Glider listed on Schedule 12 may utilise the habitat, along with Schedule 12 and/or migratory bird species	canopy in good condition, extensive disturbance of original understorey	no such features present

3.3.5 *Likelihood of Rare or Endangered Species*

Australian plant species which are rare or threatened are listed in Briggs and Leigh (1988). The conservation significance of plant species in New South Wales is assessed using this publication. The rating system used by the authors is provided in Appendix D. Mills (1988) describes rare rainforest plants in the Illawarra region which is also useful for assessing rare plant species in the region.

The Nowra office of the National Parks and Wildlife Service considered it possible that the rare or threatened plant *Syzygium paniculatum* could occur in the study area. This species is endangered and is rated 3EDi by Briggs and Leigh (1988). The creek headwater open forest which contained some rainforest species in the understorey was considered the likely location for this species. However, due to the disturbance of the original understorey, and its replacement by a more sclerophyllus understorey, it is unlikely that this species occurs in the study area.

Mills (1988) provides information on the known populations of *Syzygium paniculatum* in the Jervis Bay region. Small populations at Jervis Bay are found in small patches of littoral rainforest scattered around the Beecroft Peninsula on the northern side of Jervis Bay and in the Jervis Bay nature reserve on the southern side of the bay, however no species are in the vicinity of the study area.

Elsewhere in the study area, extensive disturbance and an increased fire frequency reduce the likelihood of the presence of any rare or threatened Australian plants.

Fauna species of conservation significance in New South Wales are listed on Interim Schedule 12 of the National Parks and Wildlife Act (1991). No fauna species listed on Schedule 12 were observed in the study area. However a number of bird species identified by Mills (1989) as likely to occur in the Tomerong area may utilise the site from time to time. The Yellow Bellied Glider has also been sighted at Tomerong and may utilise the study area as part of a larger home range (pers. com. NPWS Nowra). The Study Area provides suitable habitat for two bat species listed on Schedule 12. The species from Schedule 12 likely to occur in the study area are provided in *Table 3.7*.

Table 3.7 SPECIES LISTED ON INTERIM SCHEDULE 12 OF THE NATIONAL PARKS AND WILDLIFE SERVICE, LIKELY TO OCCUR IN THE STUDY AREA.

Part 1: FAUNA OF SPECIAL CONCERN

Birds		
Great Egret	(*Egretta alba*)	Could be present from time to time in the wetland creekline habitat.
White-bellied Sea-Eagle	(*Haliaeetus leucogaster*)	Probably aerial presence
White Throated Needletail	(*Hirundaptus caudacutus*)	Probably present only aerial
Fork tailed Swift	(*Apus pacificus*)	Possibly present, aerial only
Cicarda Bird	(*Coracina tenuirostris*)	May occur in forests in study area
Crested Shrike-tit	(*Falcunculus frontatus*)	May occur in forests in study area

Part 2: VULNERABLE AND RARE FAUNA

Birds	
Peregrine Falcon (*Falco peregrinus*)	May occur occasionally in study area
Mammals (excluding bats)	
Yellow Bellied Glider (*Petaurus australis*)	Study area contains habitat requirements and is within home range distance of previous sightings at Tomerong, (Muston 1990) in Kevin Mills and Associates (1991)
Bats	
Greater Broad-nosed Bat *(Nycticeius rueppellii)*	The Study Area provides suitable roosting and foraging habitat for this species.
Great Pipistrelle *(Pipistrellus tasmaniensis)*	The Study Area provides suitable roosting and foraging habitat for this species.

A large number of trees were searched in the study area for the characteristic mark made by Yellow Bellied Gliders on food trees, but none were observed. Not every tree in the study area was searched and the presence of potential food trees, Spotted gum and Red Bloodwood means the possible presence of the species cannot be ignored. This is balanced by the lack of the preferred food tree, Grey gum, (*Eucalyptus punctata*) in vegetation communities in the study area.

It is likely that rare or endangered fauna species occur in the study area from time to time, this is balanced by the high level of human disturbance. A full fauna survey including spotlighting and trapping and ultrasonic detection of echolation calls and bat traps may identify other species not identified in this report.

In consultation with the Nowra District National Parks and Wildlife office and in view of the likelihood of endangered fauna species occurring in the area, the following Seven Point Test of significance was applied to the study area.

The following factors are established by Section 4A of the EP&A Act to enable determination as to whether there is likely to be a significant effect on the environment of endangered fauna:

(a) *the extent of modification or removal of habitat, in relation to the same habitat type in the locality;*
(b) *the sensitivity of the species of fauna to removal or modification of its habitat;*
(c) *the time required to regenerate critical habitat, namely, the whole or any part of the habitat which is essential for the survival of that species of fauna;*
(d) *the effect on the ability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities;*
(e) *any proposal to ameliorate the impact;*
(f) *whether the land is currently being assessed for wilderness by the Director of National Parks and Wildlife under the Wilderness Act 1987; and*
(g) *any adverse effect on the survival of that species of protected fauna or of populations of that fauna.*

The proposed residential development of the study area is considered likely to result in a significant effect on the environment of endangered fauna, known or likely to occur in the study area. As a result a Fauna Impact Statement will be needed to assess the impact of the proposed development on fauna species listed as rare, threatened or endangered on Schedule 12 of the Endangered Fauna (Interim Protection) Act, 1991.

3.3.6 Further Investigations

On the basis of information and investigations presented in this chapter, it is apparent that further detailed investigations are required prior to any further development of the study area.

In Section 3.1.3 Soils, a number of recommendations for further investigations were made, including:

- Laboratory tests of soils, recommended tests are Emmerson aggregate test, dispersion index test, particle size analysis and water holding capacity. These tests would provide a comprehensive indication of soil erodibility and indicate accurately the capability of the soil to absorb effluent; and

- Preparation of a detailed land management plan prior to development. This should include detailed erosion and sediment control plans and a revegetation plan for disturbed areas.

Section 3.3.4 Conservation Significance, highlights the significant ecological features of the study area. In view of this, a number of recommendations for management proposals are appropriate as follows:

- The remaining vegetation in the study area and the entire wetland creekline community to the north of the site should be preserved.

- Proposals for the removal of trees should be inspected by a qualified ecologist to ensure valuable habitat trees are not removed.

- To prevent the felling of occupied roost trees of rare and endangered bats, it is recommended that clearing of all hollow bearing trees be undertaken in the warmer months of the year when bats are not in torpor and at night when bats are likely to be absent from roost trees, due to foraging activity.

- The location of drains and dams in the study area should be carefully considered to ensure the survival of existing trees and guard against extensive dieback which has already occurred to the north of the site.

- The extent and type of fencing in the study area should be reconsidered. The existing fencing severely restricts fauna movement and hence detracts from the habitat value of the site.

- The issue of domestic pets should be addressed and safeguards against pets preying on native fauna implemented. Strict control of domestic pet dumping is required to avoid contribution to the already widespread problem of feral animals in the Shoalhaven region.

- The establishment of gardens in the area should be sympathetic to the surrounding environment. The use of exotic species which are known weeds in the region should be controlled particularly on the northern edge of the

site. Plantings in this area may escape into the Moona Moona creek wetland system and have potential to severely degrade that entire wetland system and its value as fauna habitat.

3.3.7 Potential Bushfire Risk

Details of Council's bushfire hazard planning and hazard mapping methodology are outlined in the Shoalhaven Rural Environmental Study (1985). Council considered state fire zones, vegetation, slope and aspect and adjoining bushland in their bushfire hazard assessment. The Shoalhaven region has been classified into areas of low, moderate, considerable, high and extreme bushfire hazard. The study area has been classified as having a moderate to considerable bushfire hazard. The draft rural LEP study (Shoalhaven City 1994) identifies a large proportion of the LGA, including the subject site, as having high bushfire danger.

Council's fire history records indicate that wildfires occurred to the north and west of the site in the late 1940s, all through the 1950s to 1957 and the early 1960s to 1965. Wildfires also occurred around the site in the north and east from 1980 to 1983. Council carried out ground and aerial hazard reduction burning in 1984, 1986 and 1987. The records indicate the study area has not been directly engulfed by any of the recorded fires. However discussions with residents and field survey revealed evidence of past hot ground based fire on the site. Residents communicated that approximately 10 years ago, a hot fire which started in the adjacent Tomerong State Pine Forest engulfed the site. This was supported by evidence of fire on existing tree trunks in the study area.

This information enables the broad classification of the bushfire hazard of the site from a planning perspective. In consideration of all the available information, the bushfire hazard for the site ranges from moderate to extreme. Considerable bushfire management measures would be required as a pre-requisite to any development. These would also have to be a proportional increase in the fire fighting capacity of the Tomerong bushfire brigade.

Chapter 4

SOCIAL ENVIRONMENT

This chapter considers aboriginal archaeology, early development history, visual quality and possible development impacts as well as potential socio-economic characteristics and demand generated for community facilities.

4.1 HERITAGE

4.1.1 Aboriginal Participation

The study area falls within the boundaries of the Jerrinja Local Aboriginal Land Council based at Orient Point on the Beecroft Peninsula. The Co-ordinator of the Land Council, Ms Rhonda Connelly, participated in the survey of the study area.

4.1.2 Archaeological Background

The south coast of New South Wales has been the subject of extensive archaeological research over the last twenty years, much of it concentrated along the coastline and estuaries. This includes excavations of Aboriginal sites, mainly shell middens and rock shelters, and detailed systematic regional surveys.

Archaeological research in the broader Jervis Bay region has included studies carried out on a commercial contract basis and more detailed studies conducted within an academic research framework. Research has determined that Aboriginal occupation of the area extends back at least 3,000 years (Collier 1975; Lampert 1971; Paton & MacFarlane 1989). However this association may well be much longer as Pleistocene sites may yet be located.

Hundreds of archaeological sites have been located in the general vicinity of Jervis Bay/St Georges Basin. There are over 130 sites recorded on Beecroft Peninsula (Cane 1988) and over 60 sites recorded on Bherwerre Peninsula (Sullivan 1977). Most of the recorded sites in the region are the result of Aboriginal exploitation of the marine and near shore environments.

Some surveys and investigations in the Jervis Bay hinterland (Cane 1987, 1988; Lance 1987; Land and Fuller 1988; Navin 1989) indicated low site densities within the hinterland area. However, more recent surveys (Navin 1991a, 1993a & b) clearly indicate that site densities in areas away from tidal influence are probably higher than once predicted.

Few surveys and investigations have been conducted in the hinterland area around Tomerong/St Georges Basin (Koettig 1989, Silcox 1990, 1991 and Navin 1991b). Navin noted that the majority of sites recorded in the Tomerong area were located in open valleys either near stream lines or on low spurs adjacent to water courses (1990).

To date sixteen sites are listed on the NSW NPWS Register of Aboriginal Sites as occurring with a 10km^2 area surrounding the present study area. These comprise 12 open camp sites, two axe grinding groove sites and two middens.

No sites have been previously recorded as occurring within the study area.

4.1.3 Site Location Criteria

Extensive archaeological research throughout the south coast region has established a set of generalised criteria for predicting the location of Aboriginal sites within the landforms represented in coastal and immediate hinterland areas (Lampert 1971; Lampert and Sanders 1973; Hughes *et al* 1973; Sullivan 1976, 1983; Byrne 1982; Cane 1987; Navin 1991b).

Byrne (1982) suggested that ridgelines provided access routes through the rugged hinterland. Flat areas and saddles were more favoured as site locations for longer term or repeated visits than slope of more than 15 degrees. Closer to the coastline, where topographic slopes become more gradual, some drainage lines may have afforded easier access routes, and sites frequently occur on well drained, elevated locations adjacent to wetlands and alluvial flats.

The hinterland areas of Jervis Bay/St Georges Basin still remain relatively unsurveyed and the distribution of archaeological sites in these areas is still not fully understood. However, Navin (1991a, 1993b) identified a consistent local site distribution pattern with isolated finds and open artefact scatters occurring on the south facing slopes of ridgelines adjacent to wetlands or major creek corridors.

4.1.4 *Investigation Methodology*

i. Review of Existing Documentation

A range of documentation was used in assessing the state of archaeological knowledge for the Jervis Bay/St Georges Basin area. This material was reviewed prior to the field survey in order to determine if known sites were located in the vicinity of the study area and to place the study area within an archaeological and resource management context. Sources (Aboriginal) included information contained in the N.S.W. National Parks and Wildlife Service Register of Sites, associated files and archaeological survey reports. Sources (historical) included published monographs, parish maps, 1st edition topographic maps and subdivision plans.

ii. Field Survey and Sampling Strategy

A comprehensive survey of the study area was conducted on foot by three people: Ms Kerry Navin and Ms Jan Klaver (archaeologists) and Ms Rhonda Connelly (Jerrinja LALC). The survey was conducted during bright sunny conditions.

The survey was conducted both systematically, with personnel spaced 3 to 5 metres apart and walking transects along all existing roads, tracks and creeklines, and using less structured traverses allowing individual and opportunistic inspection of specific features such as mature trees, creeklines, ridgecrests and discrete areas of visibility.

Comprehensive inspection was carried out of areas in the vicinity of the two un-numbered lots in the western part of the study area.

iii. Visibility

Field survey and its effectiveness is necessarily related to surface visibility, which is a measure of the bare ground visible to the archaeologist during the survey. The predominant factor affecting surface visibility is the degree of vegetation and ground litter. However, secondary deposition of eroded material can also impact visibility.

Ground surface visibility varied over the study area. Visibility was generally around 30 to 40 per cent, except on roads and tracks and in clearings where visibility was 80 to 100 per cent.

iv. Results

The results of the field survey are that:

- No Aboriginal sites or relics were located within the study area; and
- No European heritage sites or relics were located within the study area.

A very sparse scatter of fragment of porcelain and (old) black and green glass were associated with gravels in a denuded area at the north western corner of the study area (adjacent to the road). No other cultural material was associated with the scatter.

4.1.5 Survey Evaluation and Discussions

The ground coverage achieved within this survey combined with the degree of surface visibility across all landscape units within the study area allows a high degree of confidence that the results of the survey reflect the actual archaeological sensitivity of the study area, rather than a reflection of survey bias or limited visibility.

The paucity of Aboriginal sites in the Pacific Pastures study area is attributable to a number of factors. The area is located in a hinterland context which is relatively close to areas which contained major exploitable resources such as coastal bay beaches and rocky headlands, creek flats and estuarine areas. These areas were almost certainly preferred to the relatively more marginal areas contained with the study area.

The creeks draining the study area are intermittent and do not provide a reliable source of fresh water. Sandstone exposures were not noted within the study area. Few mature native trees remain in the study area thus reducing the potential for scarred trees to survive in the area.

Based on the results of the field inspection and the information provided by a local resident, the potential for significant historic relics to remain in the study area is low.

4.1.6 Historical Background

Reference to Jervis Bay and the surrounding region dates to the period of earliest European exploration along the south-east coast of Australia. James Cook, in his

1770 voyage of discovery named Cape St George and noted the entrance of what appeared to be a bay (Jervis (1936).

In August 1791 Lieutenant Bowen, a naval agent, ran his convict transport ship the *Atlantic* into a bay 'between Van Dieman's land and Port Jackson...to which, in honour of Sir John Jervis, knight of the bath, Mr. Bowen gave the name Port Jervis'. Later that year the convict transport ship *Matilda,* captained by Matthew Weatherhead, visited Jervis Bay. Weatherhead drew a rough chart of the bay, which was subsequently redrafted by Alexander Dalrymple (Jervis 1936).

The first permanent European settlement in the Shoalhaven area was established in 1822 by Alexander Berry at Coolangatta, northeast of Nowra. In the 1820s the Government commenced issuing land grants in the vicinity of Jervis Bay. Permanent European settlement in the Jervis Bay area began in 1828.

By the end of the 1830s the completion of the 'Wool Road' from the Southern Tablelands, across the coastal ranges to Huskisson, provided an alternative to the overland route for the transport of wool to Port Jackson. This boosted the amount of local shipping trade and by the 1840s commercial shipping was frequent in the bay.

In May 1841 allotments in the proposed Jervis Town development, situated around the northern shore of Jervis Bay were advertised for sale in *The Australian* and the *Sydney Herald* and had been sold by the end of July.

Central Jervis Town, nearby on the northern shore was next auctioned, as reported in the *Sydney Herald* on 5 October 1841. Three other small townships were also envisaged for Jervis Bay. However the five towns never grew and by 1848 Townsend noted that there were only two houses occupied. Although fifty years later another land boom was organised, 'the auctioned towns all returned to nature'. (Bayley 1975).

In the Tomerong area significant land selection dates from the 1840 to the 1850s. The land within the study area comprises portions 87 and 88, Parish of Wandrawandian. The land was alienated in the name of Thomas Ganderton, who was an original trustee of the local Tomerong Church (Antill, 1982). The Church was erected on the Barham Estate (the southern section of Tomerong) in 1877.

Portions 87 and 88 were subdivided in 1922 to form the Jerberra Estate (DP11629) comprising 166 lots. The Jerberra subdivision was one of several subdivisions in the Jervis Bay area which anticipated development of the bay and its hinterlands as a Federal territory port.

4.1.7 Conclusions

Having regard to:

- Legal requirements under the terms of the National Parks and Wildlife Act (as amended) which states that it is illegal to deface, damage or destroy a relic or Aboriginal place in New South Wales without first obtaining the written consent of the Director of the National Parks and Wildlife Service;
- Legal requirements under the terms of the NSW Heritage Act, 1977;
- Background research into the extant archaeological and historical record for the Jervis Bay/St Georges Basin area;
- An assessment of the study area based on the results of the investigation documented in this report; and
- Consideration of the views of the Jerrinja Local Aboriginal Land Council.

It is recommended that;

1. There are no heritage constraints to the proposed development of the Pacific Pastures study area.
2. Further archaeological/heritage survey or investigation is not required within the study area.
3. Three copies of this report should be forwarded to the Cultural Resource Officer for consideration by the NSW NPWS;
4. A copy of this report should be forwarded to the Jerrinja Local Aboriginal Land Council.

4.2 VISUAL ASSESSMENT

4.2.1 Methodology

The methodology involved in the visual landscape assessment of the site and the proposal entailed:

- general assessment of the wider area within which the site is located in order to appreciate its visual context in the broader landscape;

- an analysis of the character of the site through description and mapping;
- an assessment of the visibility of the site; and
- an assessment of these factors in order to establish the visual quality of the study area.

A site survey was undertaken on the 9 September, 1993. Its purpose was to examine, describe and map the site's visual character, as well as testing assumptions about visibility drawn from a topographic analysis of the area. The flora survey which forms part of this study has also been extensively referred to and interpretation of 1:5000 colour aerial photographs has also been used.

4.2.2 Landscape Character

The study area lies between the Princes Highway and the coast in an area characterised by undulating slopes and broad drainage depressions. The major features of the locality are identified in *Figure 4.1.* The immediate surrounds are generally forested with some areas cleared for pasture land to the west. Almost immediately to the north of the site is an area of pine forestry.

The elevation of the immediately surrounding area varies between 10 and 60 metres above sea level. The most significant topographic feature of the broader landscape is the forested ridge on the western side of the Princes Highway which at some points is 200 metres above sea level.

Roads within the locality generally pass through indigenous woodland and forest and long views are most limited by the combination of gentle topography and vegetation, except in areas of localised clearing.

Within the site the topography is consistent with the surrounding area. The site is divided in two by a low ridge running south-east with a high point on the site's north-western boundary. The undulation of the slopes is very shallow (generally less than five per cent), with site elevation varying only from 20 to 50 metres above sea level.

The gentle nature of the site's topography means that the vegetation is of greatest significance in determining the visual character. The site's flora is described in Chapter 3 and this information has been used extensively in the process of visual analysis.

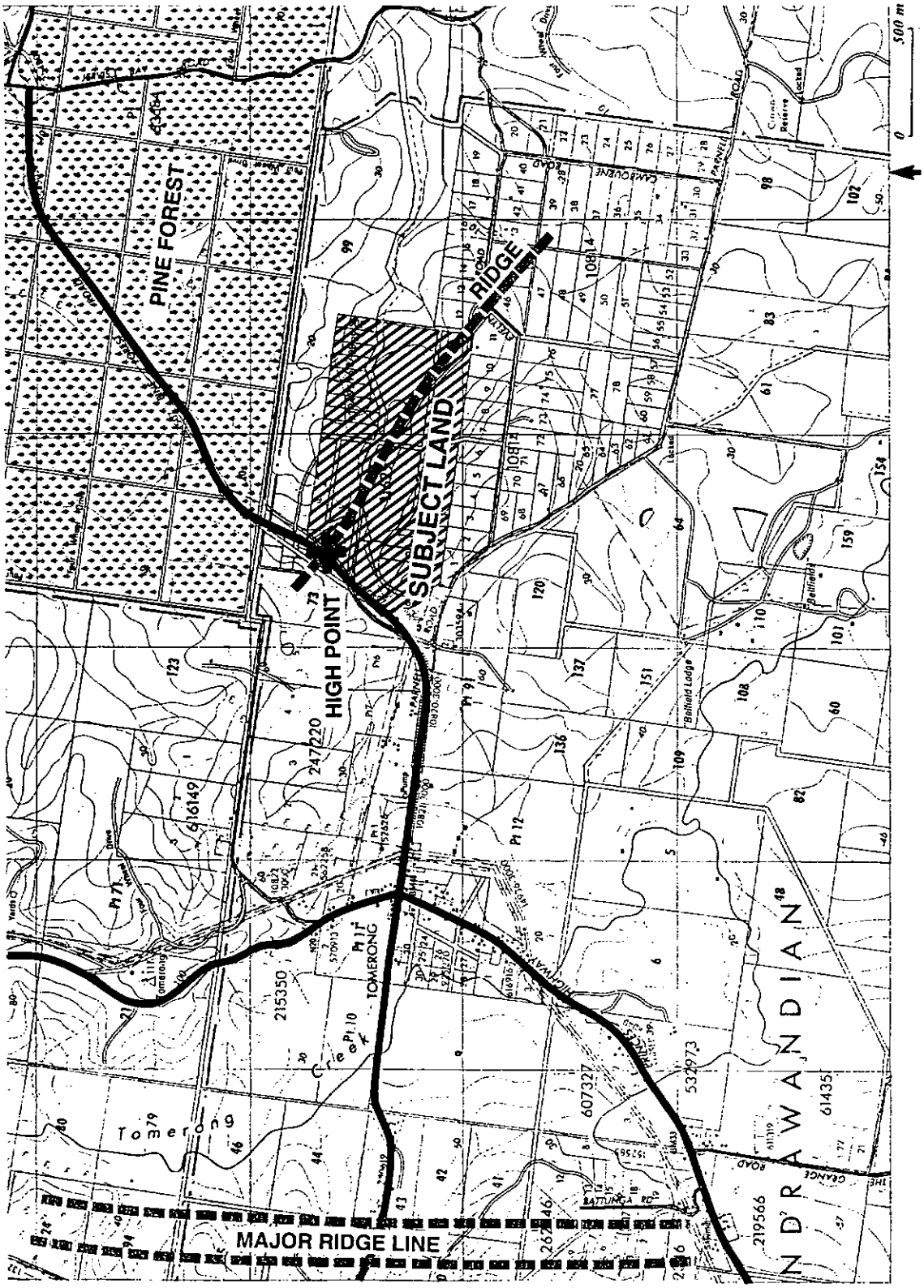


Figure 4.1 **MAJOR FEATURES OF THE SURROUNDING AREA**

The site's natural vegetation closely reflects its topography. The majority of the site is covered by two communities divided by a north/south boundary to the east of Greenslopes Avenue, open forest to the west and woodland to the east. Other vegetation communities are a creek headwater open forest in the south-western part of the site and a creekline community which occurs in the northern boundary.

Visually, there are variations between these different communities in colour, texture and form. For example, the open forest community is the tallest and its canopy is dominated by the spotted gum (*Eucalyptus maculata*) which has a characteristic patterned trunk. The extra height of the canopy changes the spatial experience on driving or walking through the forest. The tall, straight, coloured trunks emphasise its vertically and give it a characteristic feeling.

The dominant elements of the open forest are the tree trunks, the pinkish grey of the spotted gums (*E. maculata*) and the darker greyish brown trunks of the other canopy species (*E. gummifera, E. Globoidea* and *E. paniculata*). The colour of the trunks is thrown into relief by the darker greens of the foliage. The small shrubs and grasses form a dense layer near the ground and are much lighter in colour and generally fine textured.

The woodland is considerably less tall, generally reaching a maximum of 20 metres in height and with a canopy dominated by the snappy gum *E. racemosa* which has a distinctive white trunk. The contrast between the light and dark tree trunks is distinctive and the taller understorey is noticeable darker green than the grassland.

These differences between the vegetation communities are, however, relatively subtle to the eye of the average observer. All the major communities contain a tree canopy of around 20 to 30 metres, dominated by eucalyptus, with understorey shrugs and grasses. Therefore for the purposes of this study, the vegetated area are shown as one character type with sub-groups to indicate the character variation related to the different communities as shown in *Figure 4.2*.

By far the most significant visual differentiation is provided by human intervention. This takes different forms; clearing of vegetation, planting of species not indigenous to the area and the introduction of built structures such as houses, sheds, shelters, railway carriages, fences, garden structures, etc.

Clearing simply removes the species of the natural vegetation communities. This can involve different degrees of disturbance ranging from removal of the shrub layer only, to the removal of both canopy and understorey layers, leaving only grassland.

Planting of species not indigenous to the area usually involves the introduction of exotic garden plants (shrubs, trees and ground covers) of highly contrasting form,

colour and structural arrangement. In some cases productive species are used such as orchard plantings. It can also involve the replacement of the indigenous grassland by areas of lawn or exotic grasses which provide a high contrast in both colour and texture.

Mapping the many variations of disturbance and exotic planting would require a much more detailed survey than is possible within the scope of this study. These areas are shown broadly in *Figure* 4.2. The areas have been classified broadly into two levels of disturbance based on whether or not the canopy has been removed

4.2.3 Visual Catchment

The lack of dramatic variation in the topography of the surrounding area in combination with its forested nature means that the site's visual catchment is fairly limited. In the immediate surrounds there are a number of small hills which reach 60 metres above sea level but the site is only visible from one of them immediately to the south-west as shown in *Figure* 4.3. From other high points in the surrounding area existing vegetation prevents any views of the site.

The only other nearby area from which it is possible to view the site is along its southern boundary where a large cleared area associated with residential development makes it possible to see into the site from lots along Evelyn Road.

Distant glimpses of the site are possible from some points along the ridge to the west of the Princes Highway in places where local topographic variation and clearing to combine to allow views out. There are few roads through this area and little development so that the number of people viewing the site from this area are very limited. The wooded character of the undulating plane surrounding the site is, however, very strong and any major areas of clearing would have a significant impact on this.

The other area from which the site is highly visible is the frontage along Pine Forest Road. The tall forest character is currently very strong along this section of the road and the impact of change to this through clearing would be very significant to the experience of anyone travelling along it.

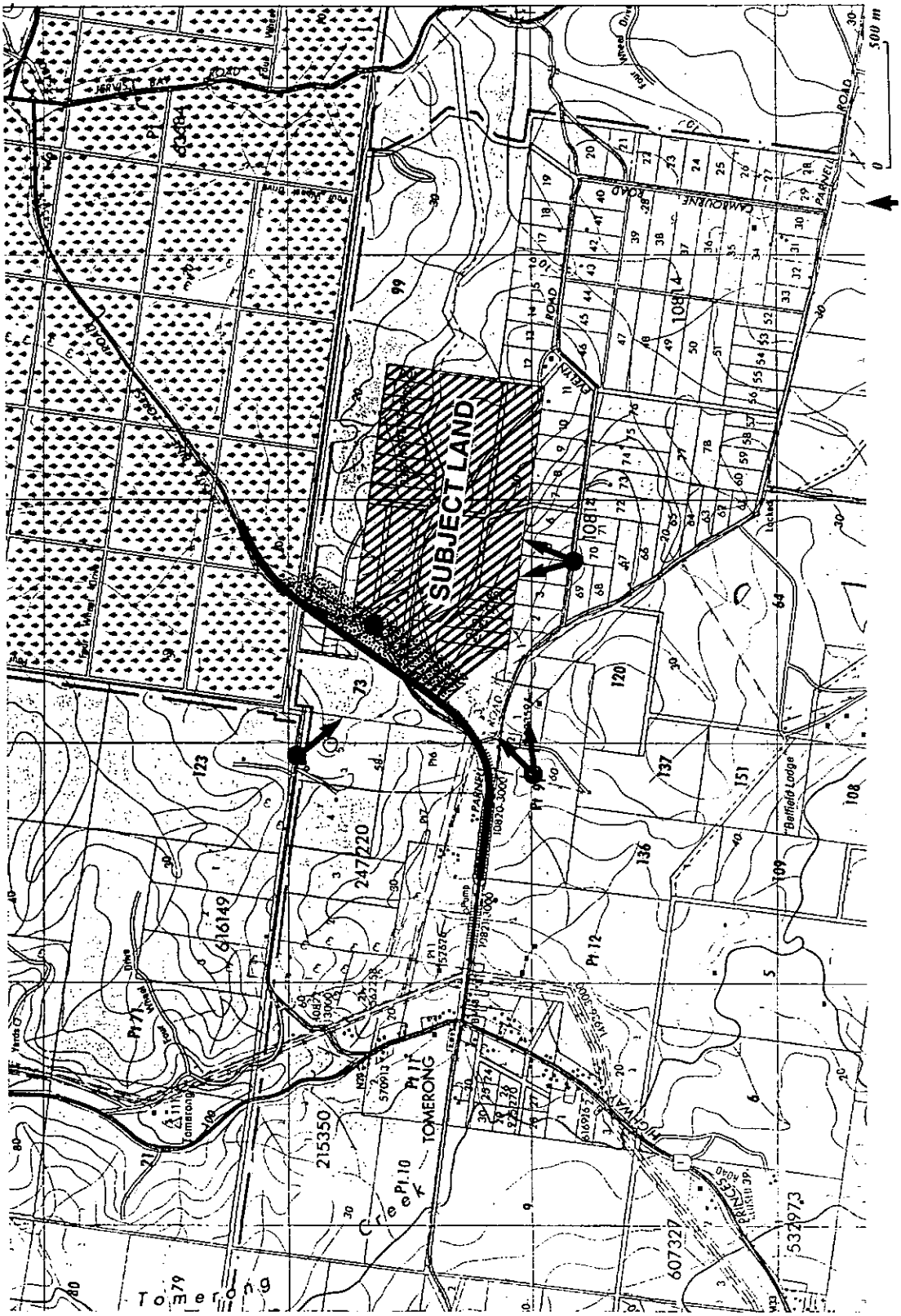


Figure 4.3 **VISUAL CATCHMENT**

4.2.4 *Visual Quality*

The existing character of the site is largely that of natural bushland. Community attitudes generally rate areas more highly, the more 'natural' they are perceived as being. For many people it is the 'natural' or 'bushland' quality of areas such as this which make it desirable as a place to settle, holiday or recreate in. The act of developing these areas to accommodate human settlement is generally done in such a way which fundamentally changes their character as can be seen from the development which has already taken place on the site.

Where the natural vegetation communities remain largely intact, the visual quality remains reasonably high because of its consistency and the attractiveness of the canopy species. Of highest quality are the areas of healthy open forest because of its relative rarity. There are, however, no outstanding features, dramatic topography or areas of very high sensitivity.

The impact of clearing and residential development has, however, been extremely significant. The site's visual quality is generally lowered by the intrusion of suburban type residential development with its small scale structures and associated planting and contrasting colours.

Based on assumptions made about community attitudes, it is desirable to conserve and enhance the 'natural' character of the area and so these areas would rate as having the highest visual quality. This would mean that visual quality would be directly correlated with levels of disturbance as shown in *Figure 4.4*.

4.2.5 *Visual Effects of the Proposal*

A very good indication of potential impacts of residential development within the study area can be gained by looking at the existing development on the site. Key issues identified by this analysis include:

- impacts in areas of highest visibility ie: Pine Forest Road;
- preservation of viable vegetation communities; and
- preservation of canopy.

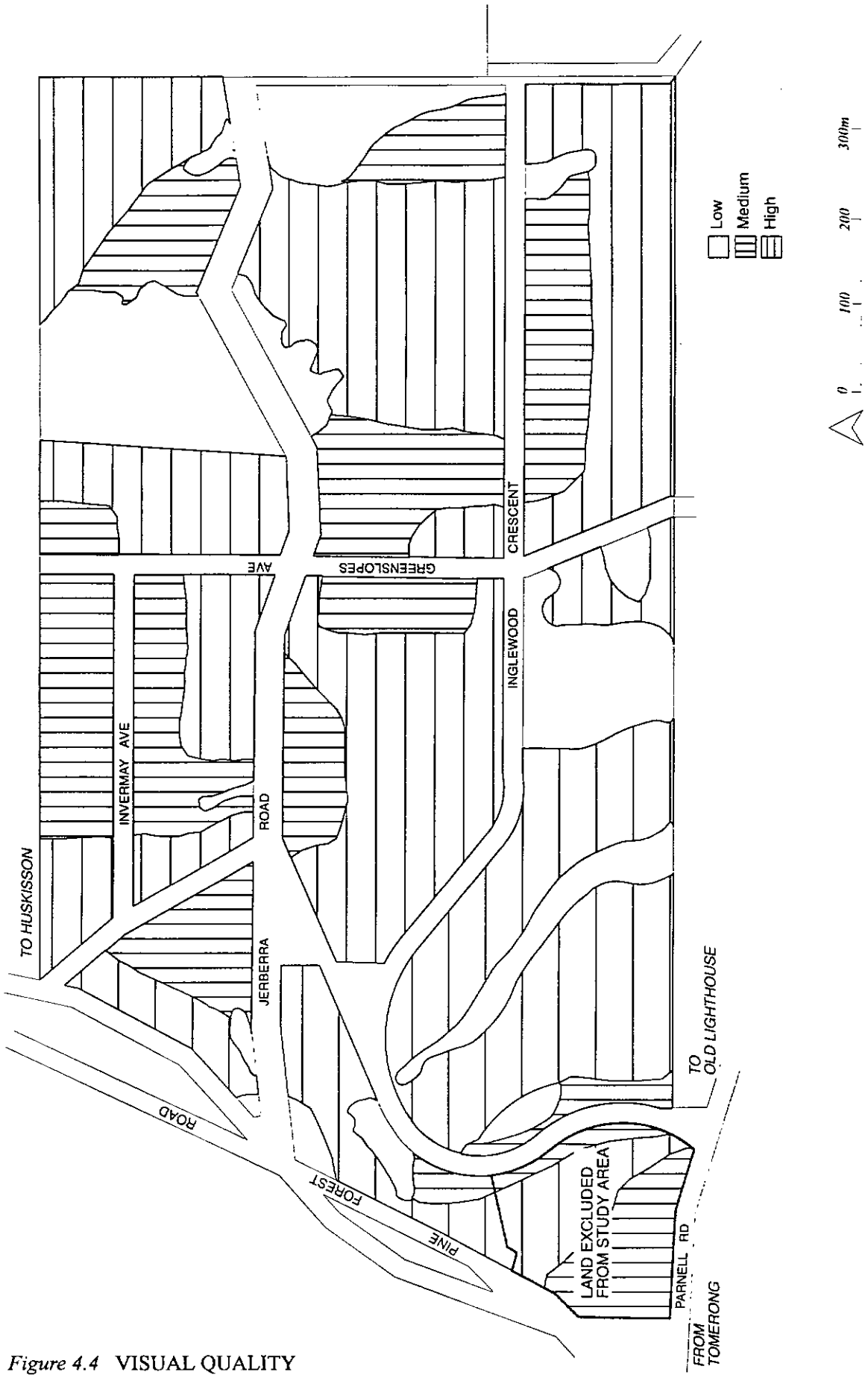


Figure 4.4 VISUAL QUALITY

4.2.6 *Visual Impact Reduction Principles*

If the 'natural' character of the study area is what is perceived as being most desirable for any future site development, then the aims of development controls are to conceal development and to minimise its visual impact. To achieve this, the following principles need to be implemented and issues considered.

- preservation of vegetation;
- canopy retention;
- planting and indigenous species;
- codes for structures:
  - form and scale of building
  - architectural character of all structures
  - materials
  - colour
- enforcibility;
- reasonableness and desirability;
- rural residential zonings generally
  - highest impact visually and environmentally
  - least productive; and
- importance of regional environmental and planning context.

4.3 SOCIAL INFRASTRUCTURE

4.3.1 *Residential Demands*

The Shoalhaven LGA is one of the most rapidly growing areas in New South Wales. In 1991, there were 68,236 persons residing in the LGA. The annual growth rate since 1986 has been 4.0 per cent which is more than three times the State average. Consequently, the Shoalhaven is facing considerable development pressure, particularly around Jervis Bay. The Department of Planning predicts that these human settlement pressures will continue and will probably increase as a result of increasing growth rates as well as increased mobility which allows people to live in rural coastal areas and commute to large urban centres for work. Other factors

include increased leisure time, a desire for a rural lifestyle and a perceived shortage of affordable housing in some of the existing urban areas (DoP, 1993).

There are 35 villages and towns located along the coast in the LGA. The level of demand for urban residential land varies between these towns. Highest demands are for the larger centres of Nowra, Bomaderry and Ulladulla and the villages of Mollymook Beach, Burrill Lake, Dolphin Point, Callala Bay, Culburra, Orient Point, Shoalhaven Heads, Sussex Inlet, Sanctuary Point and Vincentia (DoP, 1993).

Demands for a variety of rural residential lifestyles in the Shoalhaven are also strong with an average of 200 rural lots demanded each year. Shoalhaven Council (1993a) defines "rural residential living" as lifestyles which require a rural setting but do not necessarily rely on land for productive purposes. Rural demands are expected to increase in line with increases in the supply of lots and falling land prices (Shoalhaven Council, 1993a).

The Department of Planning has also recognised that there is considerable pressure from landowners for additional urban and rural residential development on land which is not connected to reticulated water supply, electricity, telephone or sewerage treatment system (DoP, 1993).

Council has received a number of re-zoning applications for major urban developments at Vincentia, Sussex Inlet, along the southern side of St Georges Basin, Dolphin Point and Bawley Point, several major rural residential developments and numerous small lot subdivisions of rural land near Jervis Bay.

Based on the level of demand for serviced lots from 1986 to 1991, Shoalhaven Council and Department of Planning have predicted that there be no immediate shortage of residential land in the Shoalhaven LGA. As many as 20 coastal towns and villages have a long term supply in excess of 20 years available, including the most popular areas identified above. Council has estimated that there is potential for a further 16,562 lots to be developed in the LGA for residential purposes as shown in *Table 4.1*. This equates to 27,762 potential dwellings and a population of 108,471 persons (Shoalhaven Council, 1993b).

The study area falls within "Area 3" as identified in the City of Shoalhaven Section 94 Contributions study. Area 3 includes Huskisson, Vincentia, Basin View, Erowal Bay, Sanctuary Point, St Georges Basin, Hymans Beach and Tomerong and has 1,913 potential lots available for development.

Table 4.1 PERMANENT POPULATION AND RESIDENTIAL DEVELOPMENT POTENTIAL

Shoalhaven Catchment Area	Existing Lots	Undeveloped Residential Area (ha)	Potential Lots	Potential Dwellings	Potential Population	Population Capacity
Area 1	16,767	749.64	6,857	9,886	37,364	71,347
Area 2	5,055	383.6	3,154	4,117	15,397	20,678
Area 3	**10,253**	**224.18**	**1,913**	**4,720**	**20,279**	**31,833**
Area 4	2,905	125.7	1,203	1,701	7,037	10,163
Area 5	12,789	371.58	3,435	7,338	28,394	42,351
TOTAL	47,769	1,854.7	16,562	27,762	108,471	176,372

Source: Shoalhaven Council (1993b)

The villages of Huskisson, Old Erowal Bay, Basin View, St Georges Basin and Sanctuary Point and have supply in excess of 20 years available. Vincentia has medium term supply available. Erowal Bay and Hyams Beach have less than 10 years supply of urban land available due to their close proximity to significant natural areas. Rural land within the Jervis Bay area could accommodate on estimated 1,300 dwellings under the present zonings. Nowra, the main regional service centre in the Shoalhaven, has an estimated 50 year supply of urban land available (DoP, 1993; Shoalhaven Council, 1993).

Findings of *Jervis Bay Our Heritage Our Future* (DoP, 1992) have identified areas immediately west of Vincentia, north west of Callala Bay and north of St Georges Basin in the vicinity of Wool Road as possible areas for future limited urban expansion. The study stated that further limited rural development may be appropriate where it can meet high environmental standards. Council's report *Rural Shoalhaven Direction For Change* strongly recommended that: "maintenance and economic use of productive resources and conservation of the environment take priority over further rural residential development".

4.3.2 Population Profile

Demographic statistics for the Shoalhaven LGA were analysed to help determine a possible population profile for the study area if development occurred. Averages for the Shoalhaven have been assumed for the basic potential population profile as the demographic characteristics of existing land holders are not known and it is quite possible that land will be bought and sold if dwelling rights are granted. This means

that existing Shoalhaven averages are the closest indicators of likely future population available.

The age structure of the Shoalhaven population has a heavy concentration in the older age groups, with 27.7 per cent of persons aged over 55 years compared to 20.6 per cent for NSW. Retirees are attracted to the Shoalhaven for lifestyle and environmental amenity reasons. At the other end of the age spectrum, the 0 to 14 year age groups represent 23.6 per cent of the population. This is slightly higher than the State average of 22.1 per cent. The relatively low cost of land attracts young families to the area. Reflecting the elderly age structure, there are a number of married couple households in the area, (42.3 per cent). About 45 per cent of households comprise two parent families and there are quite a significant number of single parent families, (11.6 per cent).

A large proportion of the population falls within the lower income brackets. Nearly 50 per cent of individuals earn an annual income of less than $12,000 per annum. This can be attributed to many residents receiving pensions. A small proportion of the population have tertiary qualifications. Nearly 68 per cent left school at or before the age of 16 and possess no formal qualifications. At the 1991 census there were 25,547 occupied dwellings in the LGA with an average occupancy rate of 2.67. Reflecting the seasonal nature of some of the settlements, 6.3 per cent of private dwellings were unoccupied on census night.

Assuming an occupancy rate of 2.67 persons per household and a maximum development capacity of 153 lots, the development could have a population in order of 409 persons.

Given the distance of the study area from the ocean and proximity to Nowra, the study area may attract less retirees and more people who prefer a rural residential lifestyle but are willing to commute daily to work.

4.3.3 Demand for Community and Recreation Facilities

The development of residential and rural residential land creates demand for the provision of social infrastructure. The future population will require access to educational establishments, childrens services, health and support services, recreation and leisure facilities, retail facilities and transport.

According to planning standards for social infrastructure, the population will not be large enough to warrant the provision of any community facilities solely for the study area. The population will, however add to current demand for community facilities in the area particularly for the aged (for example, home care, meals on

wheels, community nurse and transport), childrens services (pre-school, occasional care and long day care) and a multi-purpose community centre. It is expected that the population will draw on services from Huskisson, Vincentia and Nowra and impact on their costs.

The new population will also add to the current demand for active recreation facilities. Council's Section 94 Contributions Plan was identified the following of facilities needs in Area 3:

- Football (all codes) 1
- Cricket 2
- Basketball 1
- Netball 4
- Hockey 1

Council has adopted the standards of 1:210 for football and 1:430 for netball. This means that the area would generate demand for additional facilities for both football and netball if the development was approved.

Council' Section 94 study adopts the standard of 12 square metres per head of population for passive recreation open space. Assuming a maximum population of 409 persons, a total of 4,908 square metres would be required.

There are limited community and recreation facilities available in the locality. Tomerong is the closest centre to the study area. It is a rural village providing basic services to residents including a service station, post office, primary school, church and community hall. The catchment area of the school includes the study area. The school currently has 111 students enrolled and 4 teachers. The school has plans to expand in the near future to have five teachers and an extra classroom.

Day-to-day convenience and personal needs would be met by centres at Huskisson, Vincentia, Sanctuary Point and St Georges Basin. The types of retail stores in each centre are listed in *Table 4.2*. Limited public transport in the area makes travel between these centres difficult as such these is a heavy reliance on private vehicles.

Table 4.2 EXISTING RETAIL SERVICES

Type	Huskisson	Vincentia	Sanctuary Point	St Georges Basin
Supermarket	1	1	1	-
Take away	3	-	3	1
Butcher	1	1	1	1
Chemist	1	1	1	-
Liquor	1	1	1	-
Hardware	1	2	-	2
Newsagent	1	1	1	-
Other	18	20	15	8
Total	27	27	23	13

Source: Shoalhaven Council (1991)

Residents travel to Nowra for higher order needs and comparison goods shopping. They will continue to do so until Vincentia is developed further and this will depend on the outcome and implementation of the plan of Management for Jervis Bay. In the proposed Vincentia Structure Plan, Council has identified land along the Wool Road east of its intersection with Jervis Bay Road for development of a large commercial/retail complex incorporating community and recreation facilities.

Council's forward works program for recreation and community facilities as outlined in its Section 94 Contributions Plan include:

- the provision of tennis, football, basketball and netball facilities in Area 3 at a contribution per lot/dwelling of $1,590;
- a district community centre/library at Vincentia, cost per lot/dwelling $264;
- a recreational and cultural centre at Vincentia, cost per lot/dwelling $12;
- a home and community care centre at Huskisson, cost per lot/dwelling $110;
- a home and community care centre at St Georges Basin, cost per lot/dwelling $59; and
- given an occupancy rate of 2.67, an average current residential land value of $36 per square metre for Tomerong and 12 square metre standard of provision per head of population, the cost of providing open space would be $1,153 per lot.

The population of the estate would be required to contribute to the development costs of these facilities as they are within their catchment areas. Total Section 94 contributions for community and recreation facilities each lot/dwelling is estimated to be $3,188.

Chapter 5

URBAN INFRASTRUCTURE

This chapter examines road and traffic issues as well as the need and standards of urban infrastructure such as water, sewerage and drainage.

5.1 ROADS, ACCESS AND TRAFFIC

5.1.1 Local Road Network

The road network in the vicinity of the study area is illustrated on *Figure 5.1*. The site has a significant frontage to Pine Forest Road (Main Road 267) of approximately 250 metres commencing 1.35 kilometres east of the Princes Highway at Tomerong.

The primary access route to the study area for future residential traffic is Pine Forest Road leading to the Princes Highway at Tomerong. Pine Forest Road is part of a network of sealed two lane rural roads which link residential settlements around the eastern shore of Jervis Bay and northern shore of St Georges Basin, to the Princes Highway.

The eastern continuation of Pine Forest Road between Huskisson and Jervis Bay Road (Main Road 312) is known as Huskisson Road. It is approximately four kilometres in length and is the major access route for traffic to and from Huskisson from both the north and south.

Pine Forest Road connects Jervis Bay Road and the Princes Highway at Tomerong and is about five kilometres in length. It carries primarily through traffic to and from Huskisson to the south. It is more lightly trafficked than the Huskisson Road and until relatively recently had a 1.3 kilometre unsealed section which included part of the frontage of the study area.

The last 1.3 kilometre section of Pine Forest Road was realigned and reconstructed in 1988 to a high standard rural highway alignment with a relatively wide carriageway of 6.7 metre seal width, edge lining and some sealed shoulders. The other sections of Pine Forest Road are of older type construction, with 6.0 metre seal width without

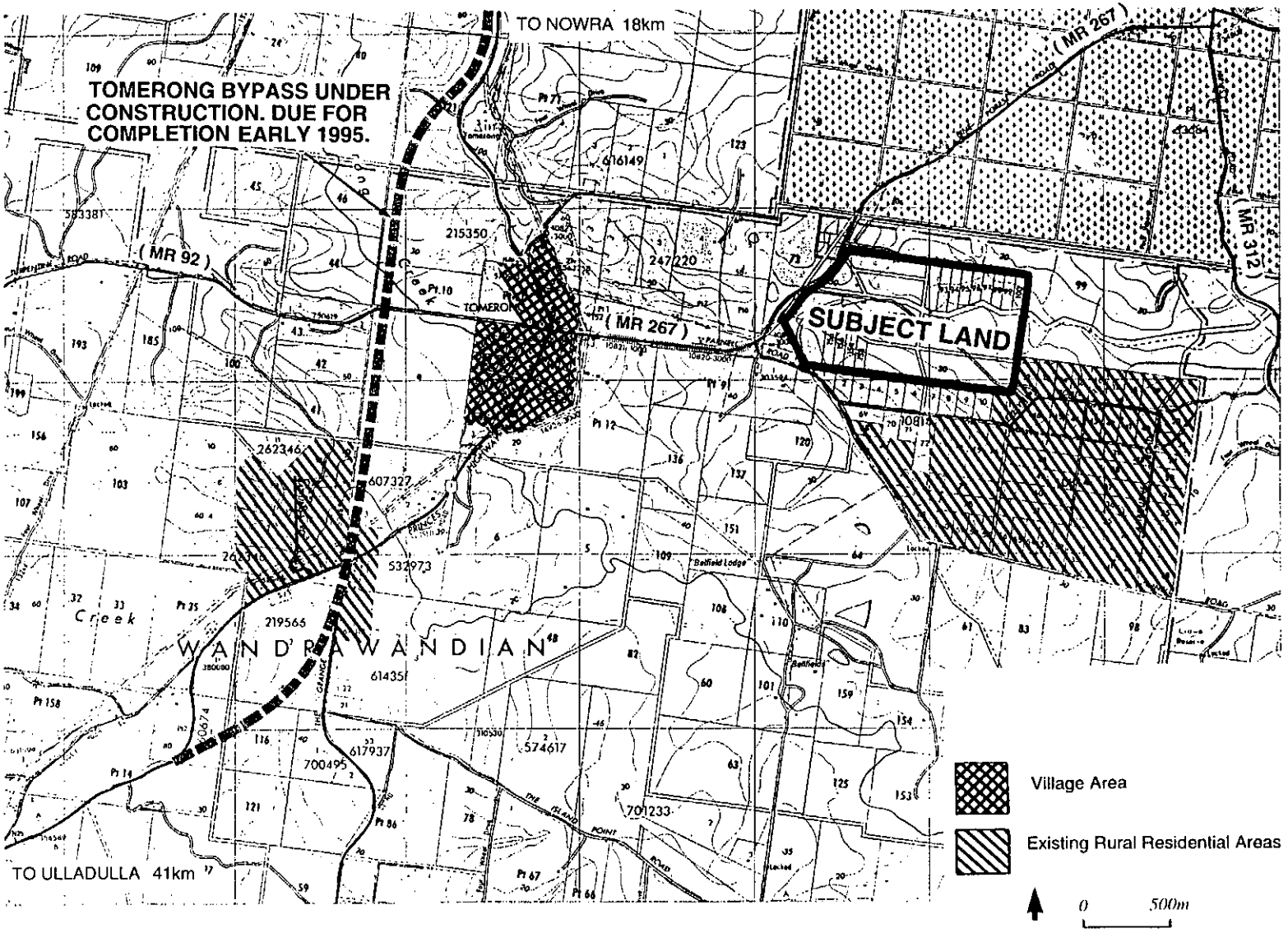


Figure 5.1 LOCAL ROAD NETWORK

edge lining, and shoulders which are in need of maintenance at several locations namely where surface erosion is evident.

Pine Forest Road currently has only one significant local road intersection, at Parnell Road, at the western end of the subject land, about 1.25 kilometres from the Princes Highway at Tomerong. Parnell Road is a relatively minor local road which serves a rural residential subdivision of 78 lots of average five acres of which 32 are currently developed. Parnell Road does not carry large volumes of through traffic but does add significant additional local traffic to Pine Forest Road between the study area and the Princes Highway.

5.1.2 *Existing Traffic Volumes*

Existing daily traffic volumes for the local road network, namely Pine Forest Road and the intersecting roads at either end are summarised in *Table 5.1.*

Daily traffic volume data is available from RTA (1990) surveys for most of these roads for the years 1986 and 1990. Where 1990 daily traffic volumes are not available, these have been estimated from the average growth in daily traffic volumes at other comparable locations during the period 1986 to 1990.

Growth in daily traffic was relatively high on all roads during the period 1986 to 1990. The average growth rate at three locations on the Princes Highway was 5.8 per cent per annum linear growth during the four years from 1986 to 1990. At three locations on Jervis Bay Road and Huskisson Road east of the Princes Highway, the average growth rate was even higher, 9.8 per cent per annum, during the corresponding period.

The relatively high traffic growth rates during the years 1986 to 1990 are probably not applicable for the longer term. More moderate overall traffic growth occurred during the period 1982 to 1990 which corresponded to the following average traffic growth rates of 3.9 per cent per annum linear from 1990 on the Princes Highway and 3.7 per cent per annum linear from 1990 at other locations.

These more moderate traffic growth rates have been used to estimate traffic growth between 1990 and the current year (1993) for the local road network shown on *Table 5.1.*

The daily traffic volume for Pine Forest Road at the study area's frontage was estimated from weekday morning and afternoon peak hour counts in September, 1993. The daily traffic volume for Parnell Road has been estimated from comparison of the daily traffic volumes to either side of the intersection on Pine Forest Road.

The Parnell Road traffic is distributed 85 per cent towards Tomerong and the Princes Highway and 15 per cent towards Huskisson.

Table 5.1 DAILY TRAFFIC VOLUMES ON SURROUNDING ROADS

Location	AADT Year 1986	AADT Year 1990	AADT Year 1993
MR 267 Pine Forest Road (East of Tomerong)	489	(680)	(760)
MR 267 Pine Forest Road (At Subject Land Frontage)	-	-	540 survey
Parnell Road (East of MR 267 Pine Forest Road)	-	-	(310)
MR 267 Huskisson Road (East of Jervis Bay Road)	2073	2693	(2990)
MR 312 Jervis Bay Road (East of Princes Highway)	4356	5947	(6610)
Jervis Bay Road (South of MR 267 Pine Forest Road)	1965	3051	(3390)
Princes Highway, (North of Tomerong)	6024	7333	(8190)
Princes Highway, (South of Tomerong)	6262	(7620)	(8510)
MR 92 Turpentine Road (West of Tomerong	157	(220)	(240)

Source: *RTA (1990).*

Note: *Figures in ( ) are calculated estimates based on prevailing locality traffic growth rates or survey (1993) at subject land frontage.*

5.1.3 Site Access

The current subdivision plan for the site indicates that the major internal site distribution road is Jerberra Road, which has its intersection with Pine Forest Road close to the mid point of the site frontage.

The majority of future traffic would enter and depart from the study area via Jerberra Road. The possible alternative access route via Inglewood Crescent and Parnell Road to Pine Forest Road has not been constructed and would only be used by a small and barely significant proportion of the subdivision traffic.

The site frontage to Pine Forest Road has recently been extensively modified by the re-alignment and reconstruction in 1988. To the south of Jerberra Road, thirteen of the original lots have had land resumed for the road realignment. The residues of most of these lots are effectively sterilised with the current subdivision layout for two reasons, namely:

- the lot sizes are now too small;
- the RTA would not permit frontage access as advised in correspondence dated 21 October, 1993 (Appendix B).

To the north of Jerberra Road, a number of lots now have frontages to the former road reserve of Pine Forest Road. A future subdivision access road would be required within the former road reserve to provide access to a minimum of four lots if developed individually.

The existing site internal roads have been graded but are unsealed. These roads have been observed to be subject to surface erosion particularly on the steep sections. Consequently sealing and sub surface drainage would generally be required for these roads if the area were to be formally developed as a residential subdivision.

5.1.4 Traffic Generation and Distribution

The future traffic generation and distribution has been estimated for an "ultimate development" scenario whereby the subject land is fully developed as a residential subdivision with a range of lot sizes subject to a maximum limit of 153 lots.

There have been a number of dwellings erected on lots at various locations around the subject land but few are currently considered to be occupied on a regular basis. The additional traffic generated by the development would therefore be the appropriate amount of residential traffic generation for 153 lots.

Recent traffic generation surveys of rural subdivisions indicate daily traffic generation rates of eight to 10 trips per day per occupied lot. Any future subdivision would include substantial proportions of weekend occupiers, holiday homes and retirees. Consequently, on an average annual basis the daily traffic generation is more likely to be equal to the standard Roads and Traffic Authority (RTA) rural residential rate of 6.7 trips per lot.

It is estimated that the additional residential development would generate an average daily total of 1,030 vehicle trips on the external road network. This traffic would be distributed to a range of local and regional destinations. Consideration of

the relative size of these destinations and distance from the subdivision indicates that the overall traffic distribution to/from the subdivision would be the following:

- 15 per cent east from the site to Huskisson/Vincentia; and

- 85 per cent west from the site distributed between:
  35 per cent Nowra/Bomaderry;
  30 per cent St Georges Basin; and
  20 per cent Tomerong local.

5.1.5 *Improvements for Increased Traffic Capacity*

Assessment of improvements required to the local road system as a result of future residential development of the subdivision has been considered in the context of additional local background traffic growth over a 20 year period from other residential development in the Jervis Bay and St Georges Basin areas.

The estimation of future traffic volumes on the major links of the locality road network is summarised in *Table 5.2*. The future residential traffic would require improvements or contribute to a requirement for improvements at a number of locations on the local road network.

i. Site Access Intersection

The future site traffic based on a total development scenario would generate a need for an Austroads Type B right turn lane at the main site access intersection of Jerberra Road with Pine Forest Road. This improvement would logically be required to be funded 100% by the site land holders.

ii. Pine Forest Road, Subject Site to Parnell Road

This section of Pine Forest Road has recently been reconstructed to a high standard and no further improvements would be required as a result of the anticipated traffic.

iii. Pine Forest Road and Parnell Road Intersection

The future study area traffic and locality background traffic growth would together generate a future requirement for an Austroads Type B right hand turning lane at this intersection. A contribution of 39 per cent towards the cost of these works

would be consistent with the proportion of future Pacific Pastures subdivision traffic in relation to future total traffic at the intersection.

iv. Pine Forest Road, Parnell Road to Tomerong

This 1.25 kilometre section of Pine Forest Road is older than the section at the study area frontage and is of a lower standard with an existing seal width of approximately 6 to 6.5 metres, no sealed shoulders and no edge markings. The future traffic volume would increase from 760 AADT currently to 2140 AADT in the longer term as a result of the combination of Pacific Pastures traffic and local background traffic growth.

This would cause a marginal reduction in the level of service for vehicular traffic from "A" currently to "B" in the future. However, the future traffic volume (2,140 AADT) would remain well below the ultimate capacity threshold for a two lane rural road (16,300 AADT). Widening would not be required for traffic capacity purposes.

Nevertheless the future provision of sealed shoulders and edge lining on this section of Pine Forest Road would be desirable to maintain a reasonable level of safety for pedestrians and cyclists. The location of the study area is such that future residents and their children may regularly walk or cycle between the site and the village of Tomerong.

v. Jervis Bay Road Intersections

The two intersections on Jervis Bay Road at Pine Forest Road and Huskisson Road, some 2.5 kilometres north-east of the site, are currently in an unimproved condition with no auxiliary right turn lanes on Jervis Bay Road.

The current daily traffic volumes on these roads are such that auxiliary right turn lanes, (Austroads Type B) at Pine Forest Road and (Type C) at Huskisson Road, are required at the current time. The future proportions of Pacific Pastures subdivision traffic, in relation to existing traffic and local background traffic growth at these intersections, are relatively low, in the order of one or two percent, as shown in *Table 5.2*. The future Pacific Pastures subdivision traffic would not contribute significantly to the need for intersection improvements at these two intersections.

vi. Princes Highway Intersection at Tomerong

The future opening of the Tomerong Bypass (completion expected in early 1995) would remove the great majority of existing highway traffic from the village of Tomerong. Intersection improvements such as Austroads Type C right turning lanes

are currently warranted for existing traffic volumes at the four way intersection at Tomerong. However, these improvements are unlikely to be implemented now because of the expected opening of the bypass in the short term future.

In the longer term future, towards the end of a 20 year growth period, an additional turning lane would again be required on the current highway alignment at Tomerong for northbound traffic turning into Pine Forest Road, even after removal of the highway through traffic to the bypass. The future connection between the Pacific Pastures subdivision traffic and this intersection improvement would be relatively tenuous and difficult to establish at the current time.

Table 5.2 FUTURE TRAFFIC VOLUME ESTIMATES

Location	Existing Year 1993 Background Traffic AADT	20 Year Background Traffic Growth AADT	Future Pacific Pastures Traffic AADT	Future Total Traffic AADT
Jerberra Road (Site access)	80	-	1,030	1,110
MR 267 Pine Forest Road				
(East of subject site)	480	320	150	950
(Subject site to Parnell Road)	540	360	880	1,780
(Parnell Road to Tomerong)	760	500	880	2,140
Parnell Road	340	220	-	560
Jervis Bay Road				
(MR 312 East of Princes Highway)	6,610	4,360	-	10,970
(South of MR 267 Pine Forest Road)	3,390	2,240	100	5,730
MR 267 Huskisson Road	2,990	1,970	50	5,010
Princes Highway				
(North of Tomerong Village)	670*	440	360	1,470
(South of Tomerong Village)	990*	650	520	2,160
Turpentine Road	120*	80	-	200

* *Note: Princes Highway and Turpentine Road traffic is the effective residual traffic after allowing for changes due to the Tomerong Bypass which would remove approximately 90 per cent of existing highway traffic and divert some of the Turpentine Road traffic to the north and south.*

5.1.6 *Internal Site Road Improvements*

A number of internal site road improvements would be required for full residential development of the study area. These improvements are illustrated on *Figure 5.2* and involve the following work:

- The internal site road network would be required to be constructed with a combination of six metre, eight metre and 11 metre width sealed roads in accordance with Council's subdivision road design requirements as outlined in *Table 5.3*. Where roads in the study area serve the smaller lots typical of urban development, the normal residential subdivision guidelines would apply. Where roads serve the larger lots the low density residential subdivision guidelines would apply.

  The combination of six metre, eight metre and 11 metre road widths required for the subdivision are indicated on *Figure 5.2*. The choice between layback kerbs or sealed shoulders for these roads would be based on local drainage requirements.

- The main loop road through the subdivision would be required to be constructed with a suitable heavy duty pavement in recognition that this loop road would be used as a bus route, as shown in *Figure 5.2*, for school buses and an occasional "town" bus service.

- The former alignment of Pine Forest Road to the north of Jerberra Road would be required to be closed at Jerberra Road to reduce intersection conflicts in the vicinity of the main site access intersection. Part of this former alignment should become a landscaped road closure. However, a short section of the northern end would be required to be retained as a cul de sac to provide access to lots 42 to 45 inclusive.

- A realignment of Inglewood Crescent and Glen Street would be required to simplify the road junction at this location. The remaining sections of the road reserve could be utilised as landscaped road closures or could be consolidated into adjoining land holdings.

- Additional minor realignments of Bowen Street at Jerberra Road and Invermay Avenue at Bowen Street would be required to eliminate difficult turning angles for traffic at these junctions.

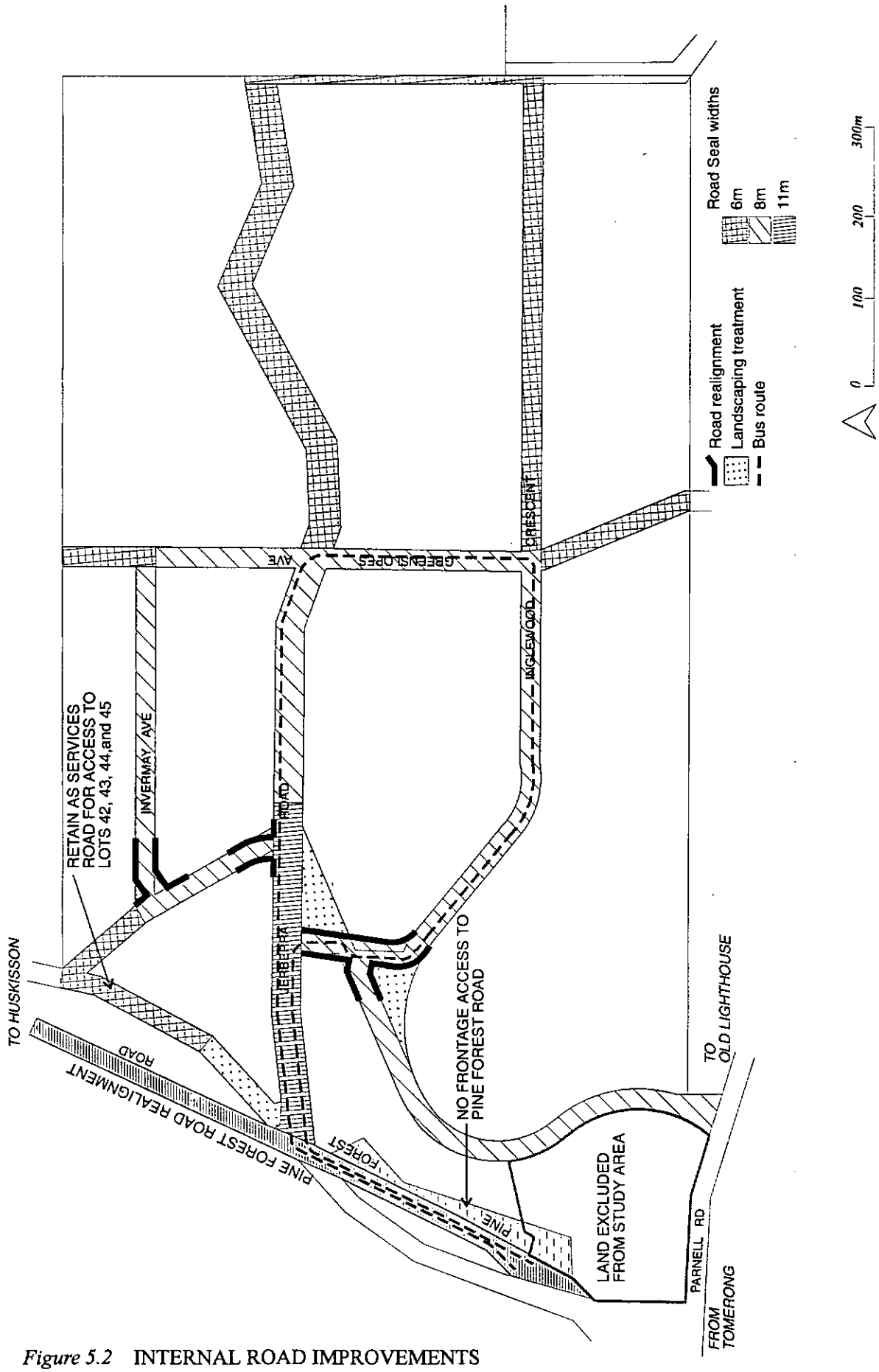


Figure 5.2 INTERNAL ROAD IMPROVEMENTS

Table 5.3 SHOALHAVEN CITY COUNCIL
SUBDIVISION ROAD DESIGN REQUIREMENTS

		Reserve Width	Seal Width	Maximum No. of dwellings	Maximum AADT
Normal Residential Subdivisions					
Cul de sac	(short)	16m	6m	15	150
	(long)	16m	7m	25	250
Local access roads		17-18m	8m	100	1,000
Minor collector		20m	11m	200	2,000
Major collector		21m	12m	300	3,000
Distributor		22m	13m	500	5,000
Low Density Residential Subdivisions					
Cul de sac		20m	5m +0.5 sealed shoulders		
Local access road		20m	6m +0.5 sealed shoulders		
Collector road		22m	8m +1.0 sealed shoulders		
Local distributor road		24m	10m +1.5 sealed shoulders		
Rural Residential Subdivision					
1 ha and 2 ha lots		20m	4-6m sealed		

5.2 PUBLIC TRANSPORT

5.2.1 Existing Services

Existing bus services to the Tomerong area are provided by Nowra Coaches. These consist primarily of school bus services including a service to Tomerong primary school which currently travel via Parnell Road.

A secondary school services accommodates Tomerong and its outlying residential areas and travel to Nowra where there are both government and Catholic high schools. School travel patterns in the area are likely to change however as a result of the recent opening of a new high school at Vincentia that would potentially also serve the study area.

There is currently one bus service daily to Nowra at 10.00 am on weekdays that travels around a loop from Tomerong to Parnell Road, St Georges Basin and Basin View.

There are currently numerous other private bus services available from Tomerong on the Princes Highway to Nowra. There may however be a reduction in the number of

services passing through Tomerong in the future after the opening of the Tomerong Bypass in early 1995.

5.2.2 *Future Requirements*

The future population concentration resulting from full development of 153 lots would generally justify the diversion of existing bus services into the study area and a suitable loop road through the estate would be required as a bus route as illustrated on *Figure 5.2*.

The loop road would be used by school bus services as the site is over 1.6 kilometres from the Tomerong Primary School and primary age school children would be entitled to bus passes.

Discussions with Nowra Coaches indicate that the future population increase from 153 additional lots would justify the diversion of the existing Nowra Coaches local bus service from Parnell Road into the estate and a possible increase in the frequency of this service.

5.3 WATER SUPPLY

5.3.1 *Existing System*

The study area lies within the broad area serviced by the Northern Shoalhaven Water Supply Scheme. There is no reticulated water supply within the study area. Existing dwellings rely on rainwater tanks to supply potable water.

The nearest water supply main terminates at Tomerong along Pine Forest Road. It consists of a 100 millimetre diameter pipeline which extends some 630 metres along Pine Forest Road east of Tomerong.

In order to provide reticulated water for the proposed development it would be necessary to augment the water supply system servicing Tomerong.

5.3.2 *Water Demands*

It is necessary to assess water demands of the study area to determine the extent of augmentation needed if 153 lots were to be developed. Two types of water demands need to be catered for by a water supply system namely: peak daily water demands

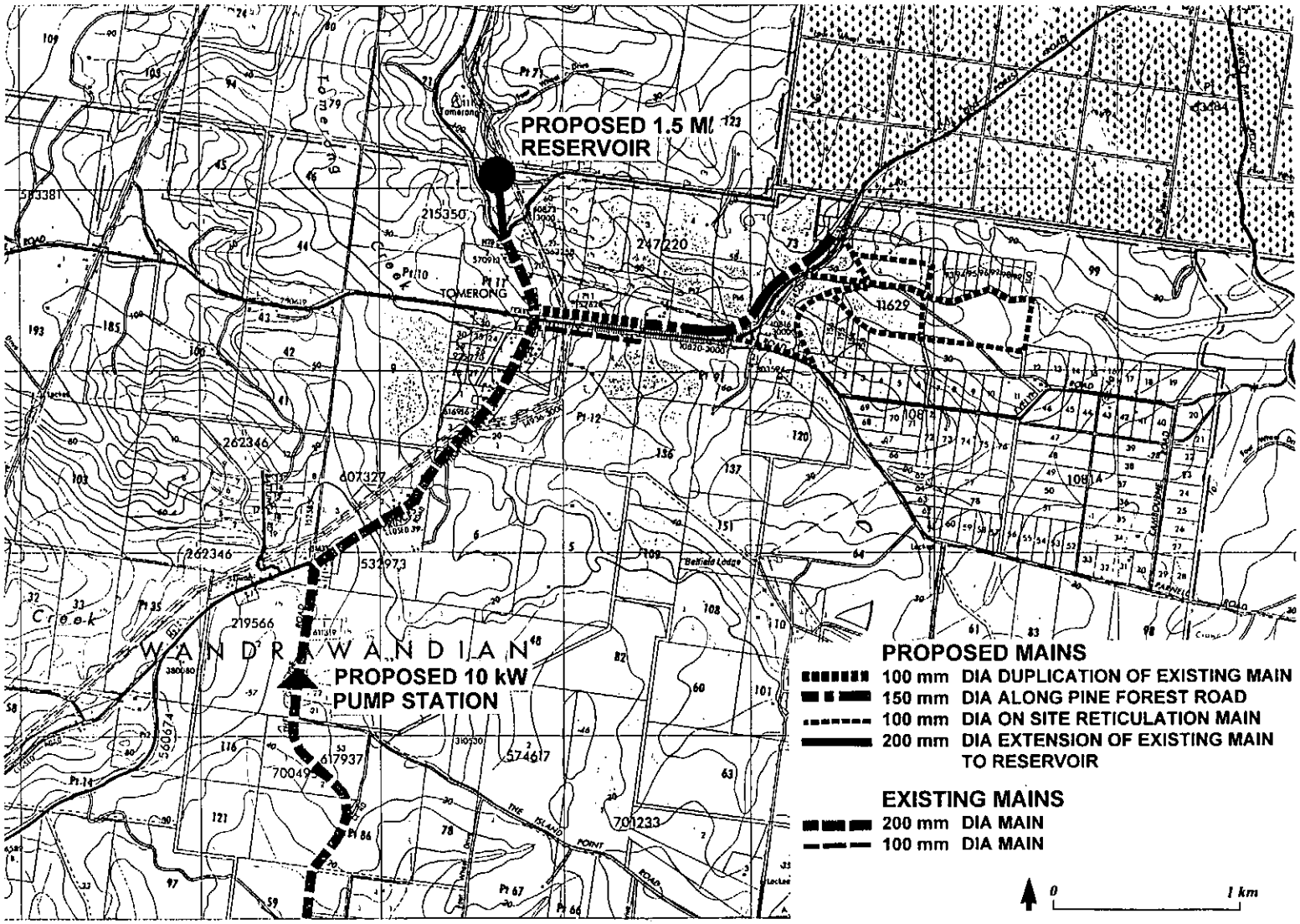


Figure 5.3 WATER SUPPLY AUGMENTATION

and peak instantaneous water demands. The requirements for these demands are discussed below.

i. Peak Daily Water Demands

Water storage reservoirs are designed to hold the equivalent of one days peak water demand. For the Northern Shoalhaven Water Supply Scheme peak daily water demands of four kilolitres per tenement have been adopted previously (Sinclair Knight, 1983). Therefore, the peak daily demand from 153 tenements would be approximately 612 kilolitres. This amount of storage would have to be provided by a storage reservoir.

ii. Peak Instantaneous Water Demand

The reticulation system (pipe systems which carry water from the storage reservoir to individual dwellings) would be designed to cope with peak instantaneous water demands. This demand is based on a demand of 0.15 litres per second per tenement (Sinclair Knight, 1983). Peak instantaneous demand from the 153 lots being proposed would be around 23 litres per second.

5.3.3 *Augmentation Requirements*

In order to satisfy the water demands discussed above, the existing system would need to be augmented. On the basis of previous assessments undertaken by Council the following infrastructure would be needed:

- a booster pumping station in the existing main supplying Tomerong to deliver water to a storage reservoir;
- a new 1.5 megalitre storage reservoir, 700 metres north of Tomerong to supply Tomerong and the proposed development; and
- reticulation mains from the reservoir to the study area.

Figure 5.3 shows the augmentation works needed to service the study area. Council indicated a cost of around $3,100 per dwelling in 1986 to provide reticulated water supply to the study area. After allowing for increases in labour, material and plant costs the revised current estimate per lot would be around $4,900 per dwelling assuming 153 lots are developed in the study area. If the number is reduced the costs per dwelling would increase proportionately.

5.4 SEWAGE TREATMENT AND DISPOSAL

The location of the study area within the Moona Moona Creek Catchment will require careful management of domestic wastewater to prevent pollution in the longer term. Changes to the existing land use of Jerberra Estate to permit dwelling houses and concentration of a permanent resident population will require an effective strategy for managing sewage wastes.

The New South Wales Health Department generally requires reticulated sewerage services for:

- areas serviced with reticulated water supply and having lots of less than one hectare;
- areas within 400 metres of a watercourse or likely to contaminate an aquifer; and
- areas within two kilometres of a reticulated sewerage system.

As the study area is not currently served by reticulated water and is not within two kilometres of a reticulated sewerage system, the possibility of on-site disposal of wastewater needs to be investigated.

5.4.1 Design Wastewater Flows and Characteristics

The New South Wales Health Department adopts guidelines set out in Australian Standard *AS1547 - Disposal of Effluent and Sullage from Domestic Premises* where on-site disposal is contemplated.

Assumptions adopted by the standard for designing on-site disposal systems are:

- a minimum number of five persons per dwelling; and
- a wastewater flow rate of 180 litres per day per person.

Therefore, each dwelling can be expected to generate an average wastewater flow of around 900 litres per day.

Typical characteristics of wastewaters from mainly domestic sources are shown in *Table 5.4.*

Table 5.4 TYPICAL WASTEWATER CHARACTERISTICS AND LOADS PER DWELLING

Constituent	Concentration (1) mg/L	Daily load per dwelling - g	Annual load per dwelling - kg
Degradable Organic Matter	280	252	92
Suspended Solids	295	266	92
Total Phosphorus	12	11	34
Total Nitrogen	55	50	18

(1) Source: Camp Scott Furphy (1990)

Notes: *mg/L* *milligrams per litre*
g *grams*
kg *kilograms*

Changes to the existing land use of the study area to permit dwelling houses and concentration of a permanent resident population will require an effective strategy for managing sewage wastes. Any proposal for sewage treatment and disposal will need to ensure that no degradation of soils and downstream waters occurs.

5.4.2 Existing Regional System

The study area is not presently served by any reticulated sewerage system. Existing dwellings rely on individual on-site sewage disposal facilities such as septic tanks, infiltration trenches and pit latrines all of which are considered to be inadequate.

Currently, the Council and the NSW Public Works Department are investigating strategies for long term management of sewage effluent in the Jervis Bay /St Georges Basin region. At present, the region is served by two treatment plants. Huskisson sewage treatment plant serves the areas of Vincentia and Huskisson and settlements around St Georges Basin are served by the recently commissioned St Georges Basin treatment plant, as shown on *Figure 5.4*. Treated effluent from both these plants is currently discharged into Jervis Bay from Plantation Point at Vincentia. This is an interim arrangement only and a regional effluent management options report is currently on public exhibition before a final effluent management scheme is selected by Council.

There are some areas around Jervis Bay and St Georges Basin which are not currently sewered, including Callala Bay, Callala Beach and Myola. To safeguard

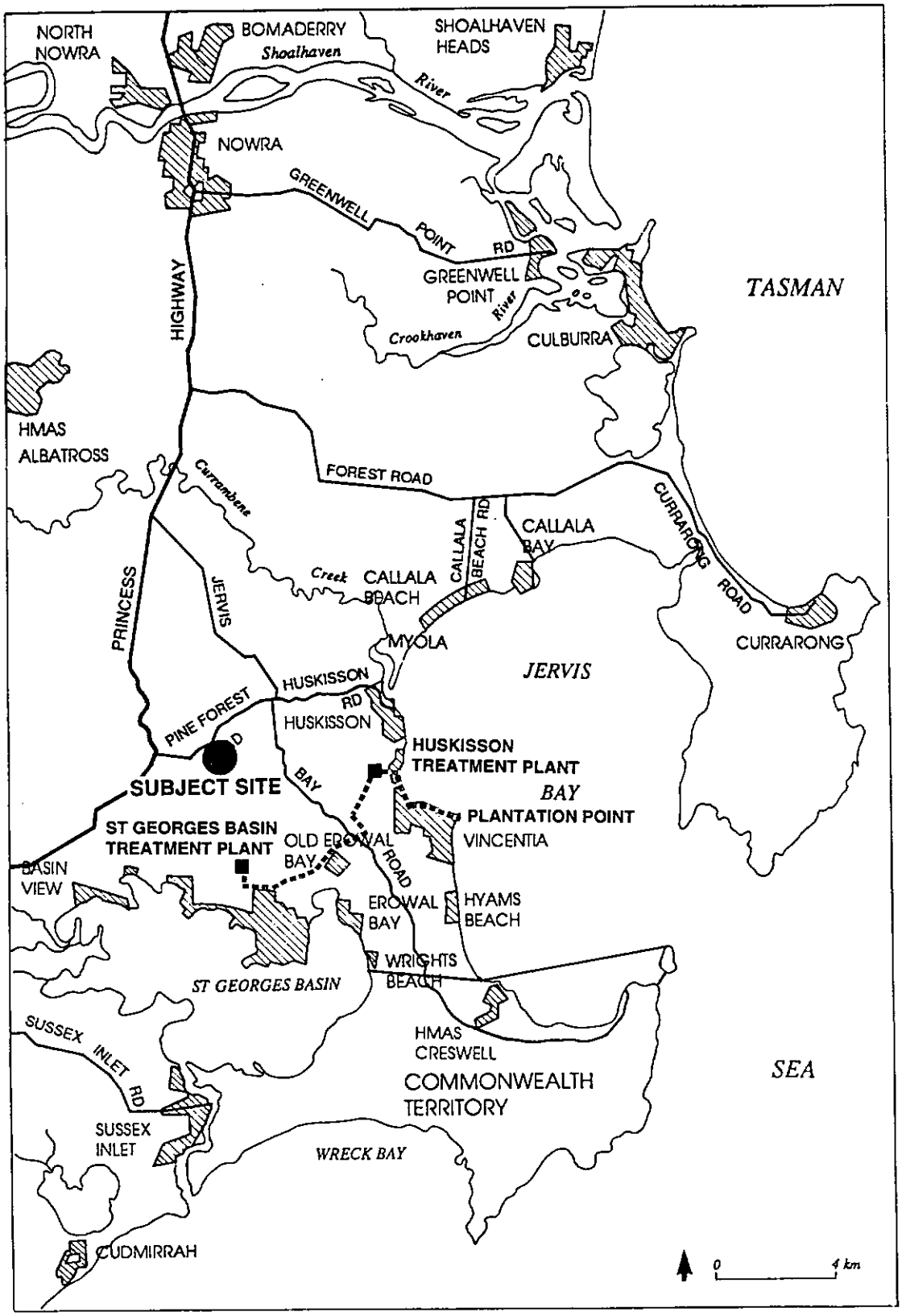


Figure 5.4 EXISTING REGIONAL SEWERAGE DISPOSAL SYSTEMS

the marine environment, septic tanks in these areas are gradually being replaced by reticulated sewerage.

The regional effluent management scheme will cater for areas fringing Jervis Bay and the northern side of St Georges Basin. These areas include:

- St Georges Basin, Sanctuary Point, Erowal Bay, Old Erowal Bay, Wrights Beach, Bream Beach and Basin View;
- Huskisson, Vincentia and Hyams Beach;
- Myola, Callala Bay and Callala Beach; and
- peripheral areas which may be developed as the Jervis Bay region of Shoalhaven City expands over the next four decades.

The Huskisson treatment plant currently has a capacity to handle wastewater from 8,000 people. Augmentation of the plant is proposed to increase its capacity to 20,000 persons. This capacity is expected to be fully utilised by the year 2030 from existing zoned urban land. However, if it is decided to treat wastewater from the Callala and Myola areas at Huskisson, the plant will reach its capacity sooner, by the year 2008. An important outcome of present planning will be a decision on how Callala and Myola should best be accommodated.

The St Georges Basin treatment plant has a capacity to serve 16,000 persons at present. The plant will be progressively augmented to cater for an ultimate population of around 41,000 by the year 2030.

Existing zoned urban areas in the Jervis Bay/St Georges Basin region are expected to be fully developed by the year 2011 when peak a summer population equivalent of 48,900 persons would need to be serviced (Mitchell McCotter, 1993).

The regional effluent management scheme aims to service the existing zoned urban areas identified above. It is not intended to incorporate additional areas which are not currently zoned urban areas. Inclusion of additional areas into the scheme will be at the expense of foregoing full development of existing zoned urban areas.

5.4.3 Treatment System Options

Existing on-site wastewater disposal systems used on a number of lots with dwellings are not environmentally acceptable because of their potential to pollute soils and downstream waters in the longer term.

The sensitive nature and environmental attributes of the downstream Moona Moona Creek wetlands and Jervis Bay require carefully planned management of wastewater discharges.

There are three practical options available for wastewater management:

- individual on-site sewage disposal systems for each proposed dwelling;
- a collective package treatment plant for all dwellings within the estate; and
- connection to the reticulated sewerage system at Huskisson or St Georges Basin.

Each of the above options is discussed below.

i. Individual On-Site Disposal Systems

Such systems would involve each individual household having its own treatment facility for household wastewater. Such systems include:

- septic tanks;
- package treatment plants; and
- dry composting toilets.

With septic tank facilities wastewater is discharged from the home directly into the tank where it is retained for a day or more. During this time, the larger solids settle to the bottom forming sludge and greases and oils rise to the top forming a floating scum layer.

From the tank treated wastewater is discharged to a dedicated land area for absorption by the soil. Effluent produced from septic tanks is not of high quality. Further treatment needs to be provided to the effluent. This is normally done by disposing effluent from the tank to a soil absorption area. An absorption area generally comprises a series of one metre deep trenches containing a perforated pipe overlying a gravel bed. Septic tank effluent is distributed over the gravel bed by the pipe and eventually percolates through the soil. A properly operating soil absorption area can remove significant amounts of organic contaminants, phosphates, pathogenic bacteria and viruses. However, failures in septic tank systems are common.

Problems which arise include:

- excessive numbers of potentially pathogenic organisms;
- increased nitrogen and phosphorus inputs to ground and surface waters;
- hydraulic failures when soil surrounding an absorption system cannot receive effluent as fast as it is generated;
- inadequate maintenance resulting in sludge carry over in the effluent; and
- inadequate soil due to the lack of coarse textures and poor drainage characteristics.

Clay loam soils found on the site would not be effective in allowing substantial percolation and could cause the above mentioned problems. For this reason septic tank systems are not recommended.

Proprietary wastewater treatment systems are another form of individual on-site disposal for treating domestic sewage. There are a number of companies manufacturing aerated wastewater treatment systems which satisfactorily comply with the health department's standards. These systems are capable of producing tertiary treated effluent which includes nutrient removal and disinfection. Treated effluent is usually spray irrigated on a disposal area. For safety reasons, most authorities require that a fixed area of land be set aside for irrigation. Irrigation should not take place in vegetable gardens or recreational areas.

Accumulated sludge would have to be periodically pumped out and disposed of at the closest sewage treatment plant. The systems are susceptible to mechanical malfunctions which may result in irrigation of unsatisfactory effluent. Periodic maintenance of the systems is needed to ensure satisfactory performance and effective disinfection. If the systems are not in use for prolonged periods of time, for example during vacations, then the treatment process is adversely affected and the systems require a start up period of a few weeks. During start up periods there may be malodorous emissions from the plant.

Propriety wastewater treatment plants are a feasible option provided sufficient irrigation area is available for each dwelling. The use of individual proprietary plants would need to be approved by Council. Individual households would require a regular certifiable maintenance agreement which would need to be monitored by Council. If approved, Council should assume responsibility for ensuring regular maintenance. Maintenance could be undertaken by Council or alternatively

contracted out. All costs associated with administration and maintenance should be fully recovered through the imposition of a special indexed levy on the area. It is recommended that such systems be maintained every six months

Use of dry composting toilets are another option for wastewater disposal from individual dwellings. These treatment facilities are available from a number of manufacturers. The system relies on micro-organisms to break down organic wastes into material which is suitable for composting. Liquid wastes are evaporated from the systems using warm air provided by a heater and fan. The broken down solid wastes need to be disposed of in accordance with the Health Department's requirements.

In winter months there may be problems associated with evaporation of liquid wastes due to lower temperatures and evaporation rates. Grey water from the bath, shower, laundry and kitchen and hand basins generally need to be treated separately. Maintenance of composting toilets is labour intensive involving periodic mixing of the compost using a hand rake.

The use of dry composting toilets is not desirable because of potential problems with evaporation of liquid wastes in winter months and the need for a separate treatment facility to handle grey water.

Of the individual on-site disposal options the proprietary wastewater treatment plants are preferred. Assuming a total of 153 dwellings the cost of installing these units would be around $6,500 per dwelling. A minimum irrigation area of around 470 square metres per dwelling would be needed to dispose of the effluent in a satisfactory manner. The systems would have to be periodically maintained to ensure satisfactory performance.

ii. Collective Package Treatment Plant

An alternative to individual on-site wastewater disposal is a package sewage treatment plant which would service all dwellings in the estate. Package treatment plants are capable of providing good quality tertiary treated effluent which can be irrigated onto open space areas. It is not considered likely that direct effluent discharge into the upland waters of Moona Moona Creek would be environmentally acceptable. A package sewage treatment plant will requires approval and licensing from the EPA.

The cost of constructing such a plant, reticulation and an effluent storage pond would be approximately $700,000. This means a cost of $4,600 per lot assuming a

maximum of 153 dwellings are permitted. In addition an area of 14 hectares would have to be set aside for effluent irrigation.

Whilst this is a feasible option Council would most likely be responsible for operating and maintaining such a facility and ensuring satisfactory environmental compliance as it would not be feasible for individual land holders to co-ordinate such a facility.

iii. Connecting to Reticulated Sewerage

The most feasible option for connecting to reticulated sewerage would involve discharging to a sewer which would run east along Evelyn Road and then south along Jervis Bay Road before connecting into the existing sewer from the St. George Basis plant to Huskisson treatment plant. Such a route would follow existing road easements and would involve the least land acquisition costs. Any potential impacts on Moona Moona Creek due to construction activities would be negligible. The proposal would involve the use of a package sewage pumping station, rising main and gravity sewers. This scheme would cost around $1.05 million. Assuming that 153 lots are developed then the cost per dwelling would be approximately $6,900. This cost does not include any land acquisition and provision for easements or costs associated with the proposed augmentation of the Huskisson sewage treatment plant.

5.4.4 Impacts of Feasible Options

Three feasible wastewater treatment and disposal options have been indicated, namely:

- individual on-site proprietary wastewater treatment plants;
- a collective package sewage treatment plant; and
- connection to reticulated sewerage.

The first two options involve disposal of treated effluent by irrigation onto designated areas. Irrigation of effluent in the longer term can lead to nutrient accumulation in the soil if not managed properly. Nutrients such as nitrogen and phosphorus retained in the soil and vegetation are potential sources of soluble nitrates and phosphates and could lead to contamination of surface and ground waters. Harvesting of vegetation is required to achieve effective nutrient removal.

According to the New South Wales Department of Agriculture, harvesting by mowing of grasses such as kikuyu turf would yield around 15 tonnes per hectare per year. This is equivalent to a dry weight of three tonnes per hectare assuming that the grass is made up of 80 per cent moisture. If this dry weight has about 20 per cent nitrogen and two per cent phosphorus, then harvesting the grass is capable of removing 600 kilograms per hectare of nitrogen and 60 kilograms per hectare of phosphorus. These quantities are considerably greater than the total amount of nutrients that would be contributed by irrigating treated effluent.

During winter months, from May to August, some effluent could be expected to escape in runoff if individual on-site treatment systems are used. However, the effluent would be significantly diluted by runoff and contain relatively small concentration of nutrients. For a licensed package sewage treatment plant, the possibility of effluent escaping in runoff would be reduced because a 14 megalitre wet weather effluent storage dam would have to be provided to cater for average winter conditions.

If on site disposal is adopted, it is recommended that surface runoff from all effluent irrigation areas be directed to the artificial wetlands proposed for stormwater quality improvement. This would facilitate further reductions in nutrients leaving the site. The use of artificial wetlands is discussed later.

Furthermore, the EPA has indicated that irrigation of effluent must not be carried out within 50 metres of any water course.

Connecting the area to existing reticulated sewerage would have the least impact on Moona Moona Creek. If this option is adopted, the sewage would receive a very high level of treatment at Huskisson sewage treatment plant. At present the plant discharges effluent into Jervis Bay from Plantation Point at Vincentia. However, in the longer term the management of effluent will depend on the regional scheme adopted by Council. Incorporation into the regional reticulated sewerage system while offering the best environmental safeguards will be the most costly option.

5.5 STORMWATER DRAINAGE AND POLLUTION CONTROL

There is no formal drainage system in the study area at present. Council has indicated that a formal drainage system involving roads with kerb and guttering and sub surface drainage pipes would be required. The present standard adopted for such drainage systems is that they should be capable of safely conveying runoff from a one in five year storm.

The impacts of urban development on the volume and characteristics of runoff are reasonably well understood. These impacts include:

- a higher proportion of rainfall runs off and this results in greater volumes of water reaching drains and watercourses;
- flow travel times are reduced because of the lower resistance to flow over surfaces such as concrete and bitumen which are smoother than natural vegetated surfaces;
- the incidence of flash floods may increase because floods take less time to reach peak flow rates;
- sediment generation can be increased;
- the faster flows aggravate watercourse erosion by scouring and eroding the bed and banks of natural channels; and
- the increased volumes can transport pollutants such as oils and heavy metals from roads into receiving waters.

Ideally, drainage schemes should be designed to limit flows from the proposed development area to the levels that exist at present and confine flooding to allow safe landuse. However, due to the rural residential nature of the proposed development it is not considered necessary to mitigate increases in runoff.

5.5.1 Water Quality

The principal water quality issues related to stormwater are concerned with the potential export of a range of contaminants in runoff discharged to Moona Moona Creek.

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);
- microrganisms;
- toxic organics (such as pesticides);
- toxic trace metals;
- oils and surfactants; and
- litter.

A summary of target water quality parameters for stormwater run off is presented in *Table 5.5.*

Table 5.5 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)*

Development of the catchment should consist of a three part strategy for protecting Moona Moona Creek from the potential impacts of development. The three main components of the strategy are:

- source control to minimise the amount of material washed off construction zones by on-site activities;
- using gross pollutant traps for removing sediments and litter; and
- using artificial wetlands to retain runoff water to allow particulate matter to settle, nutrients to be taken up and purification mechanisms to operate on other potential contaminants.

The first component in the strategy involves the implementation of a soil water management plan to minimise the quantity of sediment that is washed off bare zones. This strategy is particularly important during the construction phase of the development which considering the fragmented ownership and location could be a significant period.

The second aspect of the strategy is the provision of gross pollutant traps in the drainage system to catch litter and coarse sediment before it enters the artificial wetlands. These structures would be located just upstream of the artificial wetlands.

The third part of the strategy is the use of artificial wetlands upstream of the natural drainage lines. Wetlands would be designed to contain runoff for sufficient time to allow various treatment processes to take place before water flows to Moona Moona Creek. By intercepting stormwater in the pond, the macrophytes (larger aquatic plants) will be promoted rather than the nuisance micro-species (algae or phytoplanktori) thereby reducing the levels of nutrients discharged to Moona Moona Creek and minimising downstream water quality problems.

5.5.2 Soil and Water Management Plan

A soil and water management plan should be prepared to control erosion and sedimentation from two sources, namely:

- any major drainage works; and
- land being developed for housing, roads, services etc.

The following sequence of catchment development should be deployed to adequately control construction stage sediment export:

- delineation of buffer areas and drainage areas;
- location of topsoil stockpiles;
- construction of diversion works necessary to prevent runoff from entering into construction zones;
- construction of temporary erosion and sediment control measures;
- site clearing;
- construction of stormwater drainage facilities;
- land shaping;
- construction of roads and installation of services;

- building construction;
- land rehabilitation and landscaping; and
- maintenance works.

The above activities in conjunction with the following measures, would control export of sediments during the construction phase.

i. Temporary Sediment Control Ponds

These should be used to collect sediment laden runoff from disturbed areas and allow sediment to settle prior to discharging water downstream. Sediment control ponds should be used as a final control before discharge of waters off-site and would be complemented by a host of upstream controls as detailed below. Artificial wetlands sites could be used temporarily for this purpose before being upgraded to their intended use.

ii. Diversion Barriers

These should be located upstream of the works site to divert clean runoff around the construction area.

iii. Rumble Racks

These should be placed at the entrance to a works site to shake any loose material free from construction vehicles.

iv. Level Spreaders

These should be situated at the end of diversion barriers to spread the flow such that it forms a sheet and proceeds downstream at non-erosive velocities.

v. Perimeter Banks and Straw Bale Barriers

These should be used to intercept and direct runoff to the sediment control pond.

vi. Sediment Traps

These should be used to strain out coarse sediments from runoff from small localised catchments generally less than 0.5 hectares. They should collect sediment before it enters the natural channels in the area. Sediment traps include silt fences, hay bales, drop inlet structures, gabions and sand bags filled with gravel or stone etc. Sediment traps should be put in place after construction of the drainage system and prior to any clearing of building sites.

vii. Topsoil Removal and Stockpiling

This should be carried out so that topsoil could be reused at a later stage of the development. The topsoil stock pile should be located in areas which are self draining and clear of earth works. Straw bale barriers or filter fences should be placed upslope to divert runoff around them, and a grass or mulch cover should be established on stockpiles to prevent erosion if the stockpiles are to remain for more than one month.

viii. Rehabilitation of Exposed Surfaces

This should be done as soon as possible after completion of the items of construction work.

ix. Maintenance of Temporary Sediment Controls

These sediment controls should be regularly monitored especially after each significant rainfall event. Damage to control structures should be repaired and clogged straw bales, silt fences and gravel filled sacks should be replaced.

x. Removal of Temporary Sediment Controls

This should be done when all construction is completed and all exposed areas have been stabilised.

5.5.3 Gross Pollutant Traps

Gross pollutant traps (GPTs) are an integral part of the stormwater management strategy. The structures should be installed in the piped drainage system to

intercept trash, debris and coarse sediments and to protect the artificial wetlands from being overloaded with gross pollutants. Typically GPTs comprise a concrete-lined sediment trap with a downstream trash rack designed to intercept trash borne by flows.

The general design guidelines for GPTs should be an annual retention of 70 per cent of grain sizes larger than 0.04 millimetres (Phillips, 1992). It has been reported by the former State Pollution Control Commission (SPCC, 1989) that sediment fractions coarser than 0.04mm, deposit readily in the upstream ends of ponds, adversely impacting on macrophyte systems whilst finer fractions appear to disperse throughout the beds of ponds. Accordingly, the 0.04 millimetres sized particle retention would be an appropriate control guideline for GPTs for the development proposal.

5.5.4 *Artificial Wetlands*

Artificial urban wetlands would be the main component of the strategy to protect Moona Moona Creek from potential impacts of development. These systems would be a "low technology", energy efficient approach to protecting Moona Moona Creek. A variety of self purification mechanisms in artificial wetlands which operate to improve water quality were reported by Cullen (1992) including:

- deposition of larger particles;
- physical filtering by larger aquatic plants (macrophytes);
- flocculation and sedimentation;
- absorption of organic particles;
- gas diffusion (ammonia, nitrogen, methane and hydrogen sulphide);
- nutrient and metal uptake by plants;
- disinfection by sunlight;
- decomposition and grazing of organic matter; and
- complexing of metals in sediments.

Other ancillary benefits of the ponds include improved aesthetics, contribution to wildlife habitats, particularly for birds and a water supply for open space.

The artificial urban wetland concept involves three main zones where different processes operate to reduce pollutants (Cullen, 1992); they are as follows:

- an inlet zone in which larger particles, including litter, tree branches and coarser sediment are removed. GPTs normally form part of the inlet zone;

- a macrophyte zone in which large quantities of aquatic plans are encouraged to grow and they, in association with microbial mats, filter fine particulates and directly take up various contaminants such as nutrients, heavy metals and organic chemicals. They are also capable of trapping oil. In shallow zones where water flows over sediment, pollutants such as phosphorus and metals will be taken up on sediment surfaces and partially immobilised; and

- an open water zone which is a deeper area where fine particles flocculate and settle to the bed and where sunlight disinfects bacteria. There will be decomposition and grazing of organic matter in this zone. Periodic algal growth can be expected in this zone and this will also trap dissolved nutrients and allow them to enter the food chain or settle to the pond bed.

It is anticipated that two artificial wetlands would be required; one for the northern sub-catchment and one for the southern sub-catchment. Using guidelines set out by the Department of Housing it is estimated that each sub-catchment will have a 12 megalitre wetland with an area of about 0.8 hectares. *Figure 5.5* shows a conceptual location for the wetlands. Runoff from any effluent irrigation areas should be directed to the artificial wetlands.

5.5.5 *Stormwater Drainage and Pollution Control Costs*

The cost of constructing stormwater drainage to cater for a once in five year storm is estimated at $720,000. In addition, the pollution control costs associated with construction of gross pollutant traps and artificial wetlands is about $280,000. Therefore, the total cost of providing stormwater drainage and pollution control infrastructure is $1.0 million which translates to around $6,500 per lot assuming a total of 153 lots are developed.

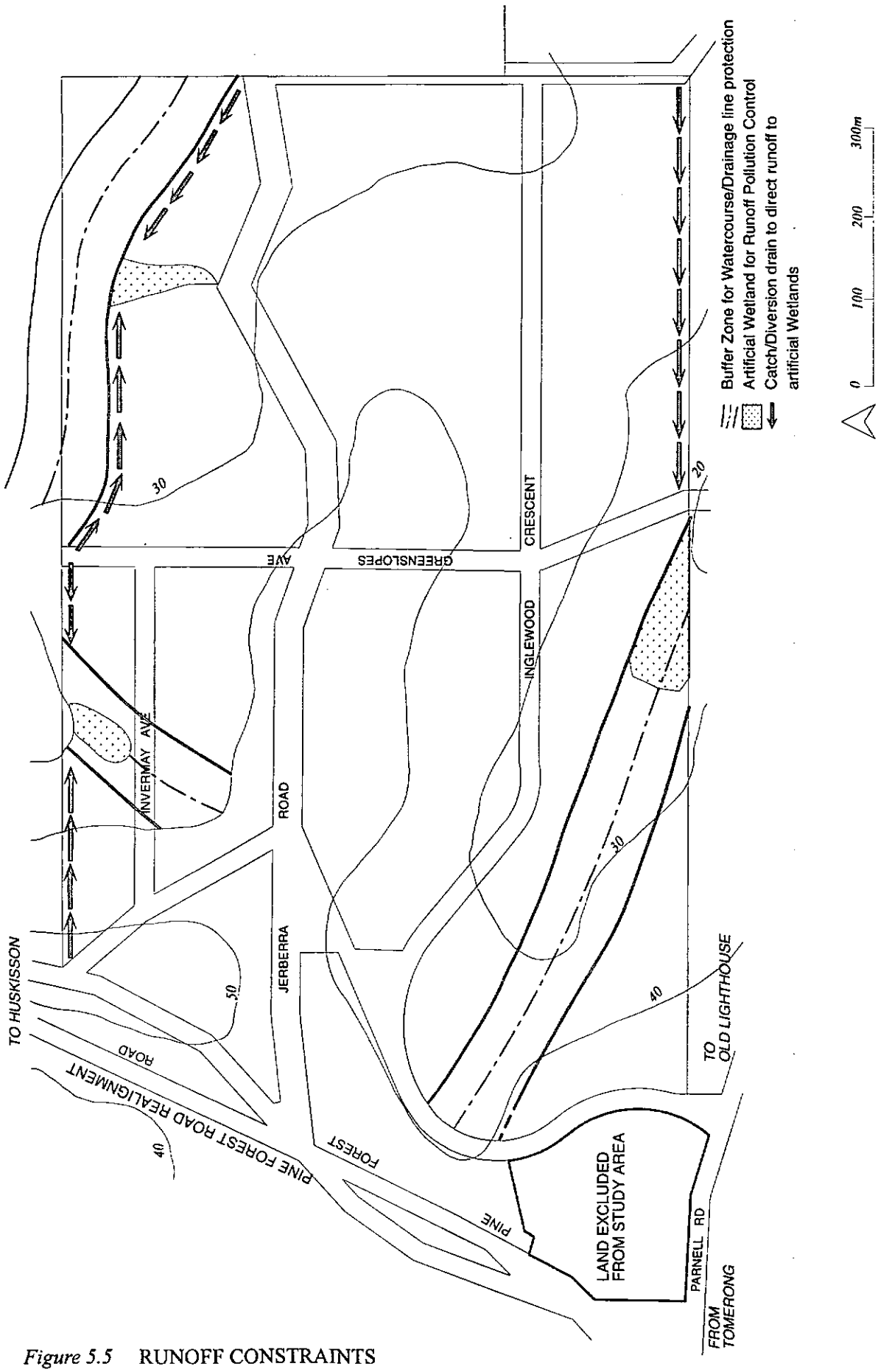


Figure 5.5 RUNOFF CONSTRAINTS

5.6 OTHER INFRASTRUCTURE

5.6.1 Electricity

Illawarra Electricity is the relevant authority for supplying power to any development in the area. At present there is no electricity available in the study area. In order to supply power to the area electricity would have to be drawn from the existing 11 kilovolt overhead lines along Pine Forest Road. Illawarra Electricity has developed a concept plan for extending power supply to the study area. *Figure 5.6* illustrates the proposed power reticulation system to service the area. Tall trees within ten metres of the high voltage lines and three metres of low voltage lines will need to be either pruned or removed to reduce fire hazards.

The cost to supply reticulated power has been estimated at $4,140 per lot.

5.6.2 Natural Gas

There are no proposals by the Australian Gas Light Company to supply the area with gas.

5.6.3 Telecommunications

Telecommunication services for the area would be provided by Telecom. Minor telecommunication cables which exist along Pine Forest Road could be used to service residences within the study area. Augmentation of Telecom external plant and exchange equipment will be necessary and would be programmed and funded by Telecom. Reticulation within the study area would either be the responsibility of developers or Telecom could install reticulation provided adequate easements are made available. Currently, Telecom's policy is to provide and fund services where practicable and returns on infrastructure investment are obtained through utilisation of the service.

5.6.4 Waste Disposal

It has been estimated that the amount of domestic waste generated per person in the Shoalhaven area is 0.9 kilograms per day. In the longer term it may be assumed that each dwelling in the study area will be inhabited by three to four persons which means between 3.1 and 4.2 tonnes of waste would be generated each week. This quantity of waste would have to be picked up and disposed of by Council on a weekly basis.

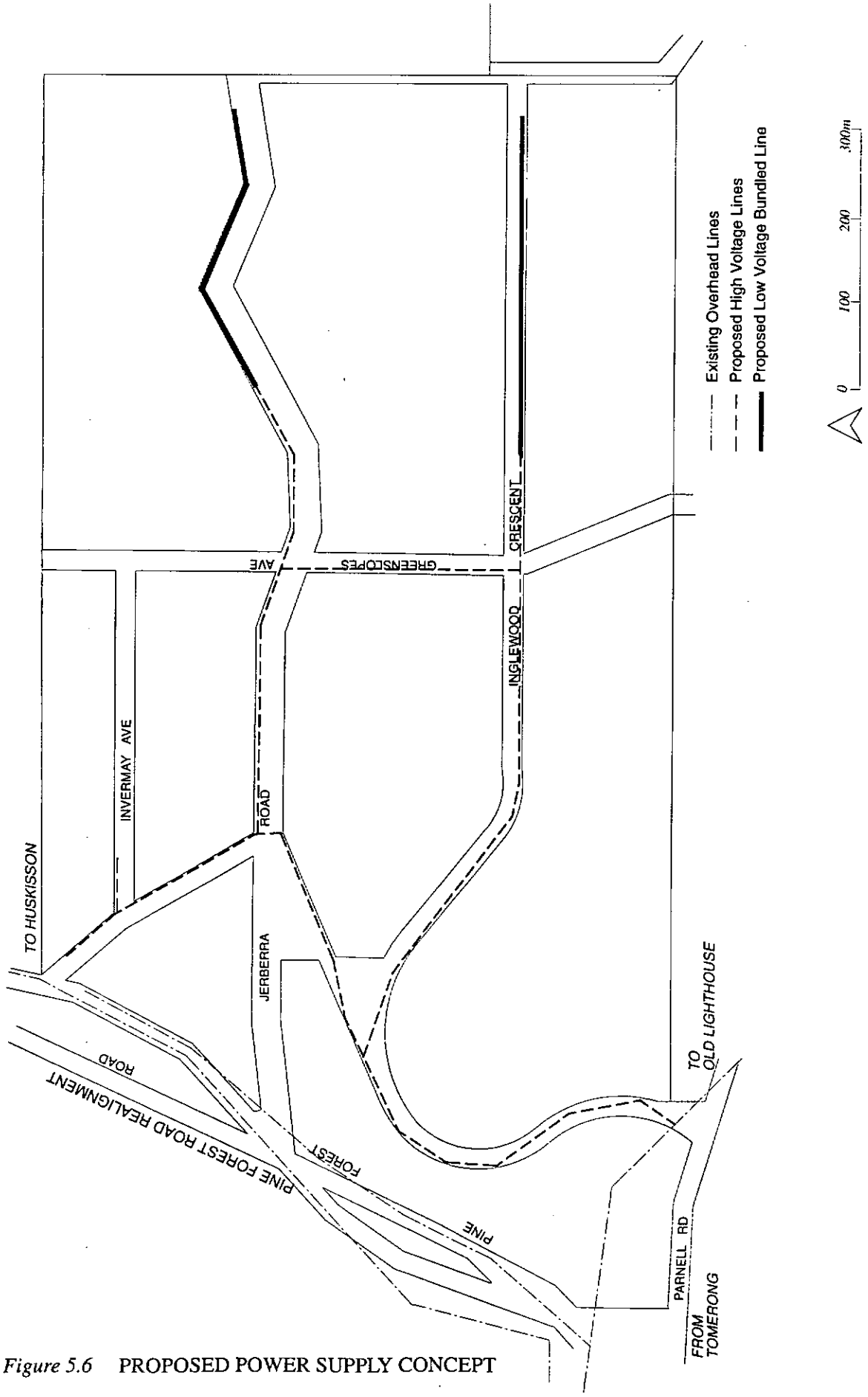


Figure 5.6 PROPOSED POWER SUPPLY CONCEPT

Currently, domestic wastes in the surrounding area are collected by a Council contractor and transported directly to the West Nowra Waste Depot. Wastes may also be transported to a smaller tip at Huskisson, however, this tip is only estimated to have another four years capacity. West Nowra Waste Depot is expected to reach capacity by 1996 and expansion of facility into adjoining crown land is being investigated. Therefore waste disposal from the proposed development can be accommodated by the existing and proposed Council facilities. The cost for domestic waste disposal is estimated to be $87 per tonne (Mitchell McCotter, 1992). This cost is expected to rise as existing landfills approach their capacity. To dispose of wastes from the proposed development would cost Council in the order of $360 per week (based on 1991 costs).

Chapter 6

OPPORTUNITIES AND CONSTRAINTS

This chapter discusses opportunities and constraints for development of the site. The costs associated with developing the site and the provision of infrastructure are also described.

6.1 BACKGROUND

Figure 6.1 is a cadastral map which overlays an opportunities and constraints map in *Figure 6.2*. The opportunities and constraints map illustrates the implications of the various environmental characteristics identified in earlier chapters. The compilation of such a map is by necessity a balancing exercise as it involves assessing elements of the environment and determining which areas may be able to sustain development without adverse impacts upon the site, adjoining lands and downstream areas.

6.1.1 Objectives

The opportunities and constraints map for the site has been based on the following objectives:

- to minimise impacts on fauna habitats;
- to preserve a variety of vegetation species by ensuring representative examples of all significant vegetation communities are maintained;
- to create vegetation linkages within the site to assist the movement of fauna;
- to minimise impacts on water quality through the creation of buffer zones around key drainage lines;
- to minimise impacts on SEPP No. 14 wetlands;
- to minimise risks of development in areas with a high bushfire hazard;

- to preserve the visual amenity of the Pine Forest and Parnell Road corridors; and

- to allocate adequate area on-site for pollution control and sewage treatment.

The opportunity areas marked on *Figure 6.2* are those which might be suitable locations for dwellings. In compiling the map, consideration was given to the existing land ownership pattern to determine whether dwelling rights could be distributed equitably amongst owners. Unfortunately, land ownership does not occur in a pattern which can be related to the environmental opportunities and constraints on the site.

The existing road pattern and subdivision layout should not be altered because this would cause further environmental disturbance. Such disturbance would result from the need to clear trees for new roads and the need to remediate existing roads. The ultimate result would be a much higher level of clearing than is desirable.

6.1.2 Key Constraints

This section briefly explains how each of the key constraints and opportunities was identified and incorporated into *Figure 6.2*.

i. High Visual Quality

Pine Forest Road and Parnell Road provide primary viewing points of the site. Pine Forest Road in particular is an important tourist link which needs to be protected. The cross hatching shown in *Figure 6.2* demarcates the minimum amount of vegetation needed to protect the visual catchment of both these roads. The protection area depends upon a layering of vegetation to provide an effective visual screen. Any removal or thinning of the vegetation would diminish the effectiveness of this screen.

ii. Representative Vegetation

The three main vegetation communities which require protection are:

- creek headwater vegetation;
- woodland; and
- open forest.

Maintaining representative communities on the site is important from both a vegetation and fauna habitat perspective.

Maintenance of vegetation samples throughout the site will help to conserve local and regional species stocks. The hatching in *Figure 6.2* shows the most healthy examples of the vegetation communities. Areas which are excluded are those which have been cleared or could be removed if other areas on the site are preserved. The preservation areas overlap with the visual protection areas.

iii. Bushfire Hazard

Bushfire hazards are moderate to extreme. The site has high fuel loads and past history of bushfires. In general, clearing for bushfire protection would be incompatible with the preservation of vegetation although limited bushfire protection clearing could occur in the opportunity areas. It should be noted that the bushfire constraint is not only limited to the site but extends into the surrounding areas.

iv. Runoff Protection

The proximity of SEPP No. 14 wetlands and the presence of wetland communities on the site creates a need for the effective management of surface runoff. The three main methods suggested to achieve this are:

- establishment of water course buffer zones;
- provision of artificial wetlands for runoff pollution control; and
- construction of catch drains to direct runoff to artificial wetlands.

Each of these methods are space consuming and are incompatible with the existing subdivision pattern. The amount of land required for each of these elements is illustrated in *Figure 6.2*. Due to higher moisture levels, the artificial wetland is an area of slightly lower bushfire risk.

v. Opportunity Areas

The opportunity areas are those which have low conservation value and physical potential to support some development. The boundaries of the opportunity areas are broadly comparable to existing lot shapes although natural characteristics have been given a higher weighting in defining their areas. Broad comparability to existing lot shapes will assist lot consolidation. The shapes are also reflective of the need to preserve vegetation corridors through the site.

The potential number of dwellings shown in *Figure 6.2* is based on a reticulated water and sewerage system being made available and is reflective of the background cadastral pattern. In other words, one dwelling per existing lot within the designated opportunity areas.

6.1.3 Residential Development Potential

The availability of an acceptable method of sewage disposal to service any development is an essential determinant of whether development is practical or not. On-site methods of disposal for development at normal residential densities have been investigated and found to be inadequate because of the likelihood that unacceptable nutrient levels would occur in adjoining water courses and wetlands.

The Department of Planning and the NSW Environment Protection Authority have both indicated that they are not prepared to support a rezoning which involves on-site sewage disposal. Although use of this method is not supported by these authorities, a limited number of rural residential dwellings with well managed sewage treatment units could be acceptable and this option has been explored in the next section.

i. Reticulated Sewerage System

Connection to Shoalhaven Council's reticulated sewerage system is considered to be the most effective option as it means all sewage would be removed from the catchment area of the SEPP No. 14 wetlands and treated in a high level treatment plant. Whilst this method has most support from the Department of Planning and Environment Protection Authority, it would be very expensive. The availability of a reticulated sewerage system linked to Council's treatment plant would enable 47 dwellings to be developed.

ii. Package Sewerage System

Localised reticulation linked to a package treatment system is a further alternative although this method would require a four hectare irrigation area if 47 dwellings were to be served. In addition, a wet weather effluent storage dam of 4.8 megalitres capacity would be required to cater for wet periods when effluent could not be irrigated. The effluent irrigation area would also need to be situated on land with development potential so that it would not affect environmentally sensitive areas of the site. A potentially suitable area has been identified between Jerberra Road and Inglewood Crescent as shown in *Figure 6.2*. It would mean the loss of four potential dwelling sites from the area capable of supporting development. The use of a package treatment system would therefore enable 43 dwellings to be developed.

6.1.4 Rural Residential Development Potential

Two distinguishing characteristics of rural residential development are that dwellings may have on-site effluent disposal systems and on-site water collection methods. It is this type of development which is contemplated by the proposed Rural 1(c) *Rural Lifestyle* zone in the draft Rural LEP. The detailed controls and objectives for each 1(c) zone are contained in Schedule 12 of the draft LEP. Minimum lot sizes vary between one and two hectares.

The main limiting factor with this type of development is the amount of land required for irrigation disposal of treated effluent. In Section 5.4.3 a range of on-site disposal methods were reviewed. The main conclusion drawn was that due to soil characteristics and the close proximity of wetlands, only one method of on-site disposal method should be explored. This method is a proprietary wastewater treatment plant. Such systems produce tertiary treated effluent which can be spray irrigated onto dedicated areas of at least 470 square metres. Accumulated sludge needs to be periodically removed from the treatment plants and this would normally be undertaken by an authorised contractor. There are a number of companies manufacturing these systems with each unit costing around $6,500 to $7,000.

Given the environmental sensitivity of the area and the need to ensure consistency with the Rural 1(c) zone objectives, a minimum lot size of approximately one hectare would be required. *Figure 6.3* shows where the rural residential dwellings could potentially be located. A rural residential approach could yield 26 dwellings with an average lot size of just under one hectare.

In relation to on-site collection of water, there are a range of tank types available. The minimum acceptable size would probably be 13,500 litres. Depending on dwelling roof sizes, annual rainfall and number of users, it is quite possible that

water collected on-site would need to be supplemented by supplies from Shoalhaven Water. There are a number of local tank manufacturers. Averages prices for 13,500 litre tanks are given below:

- metal $1,300;
- fibreglass $1,600; and
- concrete $2,000.

If the siting of dwellings, the location of sewage irrigation areas and vegetation clearance are carefully controlled, a rural residential option could be possible.

6.2 COMPARISON MATRIX

Table 6.1 provides a comparison of the five approaches considered for the study area.

Table 6.1 COMPARISON MATRIX

Option	Effluent Disposal Method	Flora and Fauna Impacts	SEPP 14 Wetland Impacts	Visual Impacts	Bushfire Risk
153 dwellings	reticulated	very high	high	high	moderate
47 dwellings	reticulated	acceptable	controllable	low	high
43 dwellings	package	acceptable	controllable	low	high
26 dwellings	on-site	acceptable	controllable	low	high
0 dwellings	none	dependent on zoning	low	low	high

Table 6.1 COMPARISON MATRIX (Cont)

Option	Infrastructure Requirements		
	Water Supply	Drainage	Roads
153 dwellings	reticulated	full system	full system
47 dwellings	reticulated	partial system	partial system
43 dwellings	reticulated	partial system	partial system
26 dwellings	on-site	partial system	partial system
0 dwellings	none	none	none

A brief explanation of each option is given below.

6.2.1 Description of Options

i. 153 Dwellings

This option assumes full development of the study area. It would entail full suburban standard infrastructure including reticulated sewerage and water as well as a full road and drainage system. The impacts on flora and fauna would be very high. Although controllable to some extent, the impacts on the SEPP No. 14 wetlands would also be high. In addition, full development would have very significant visual impacts. Bushfire risk would be slightly moderated by clearing vegetation but it would still be a constraint.

ii. 47 Dwellings

The 47 dwelling option reflects the opportunities and constraints analysis and hence would result in acceptable impacts on flora and fauna, the wetlands and visual character. Control of runoff quality would depend upon the availability of reticulated sewerage. There would be reticulated water and only a partial drainage and road system would be required. Bushfire risk would be high.

iii. 43 Dwellings

The 43 dwelling option is similar to the 47 dwelling option described above. The main difference is that effluent would be treated in a package system. As will be further discussed, this option is cheaper than reticulated sewerage and this is why it can be considered separately. Development of 43 lots in the opportunity area, would have the following effects:

- acceptable flora and fauna impacts;
- controllable SEPP No. 14 wetland impacts; and
- low visual impacts.

Bushfire risk would remain high. This option would require the same standard of drainage and roads as the 47 dwelling option.

iv. 26 Dwellings

The 26 dwelling option (also described as the rural residential option) entails on-site effluent disposal and water collection. Dwellings would be built in the opportunity area and this would result in:

- acceptable flora and fauna impacts;
- controllable SEPP 14 wetland impacts; and
- low visual impacts.

Bushfire risks would be high and rural residential standard drainage and roads would be required.

v. No Development

This option is included in the matrix as the implications of no development need to be fully considered. It is possible that no development within the opportunity areas could occur because:

- the costs of necessary infrastructure make development non viable; and/or
- the administrative and legal processes associated with land pooling are unable to result in equitable solutions for all land owners.

The implications of the no development option on the environment are dependent on the zonings which emerge. This aspect is discussed further in Chapter 7.

6.2.2 *Available Options*

Of the five options considered in *Table 6.1*, only one option will not be considered further. This option is 153 dwellings. The environmental impacts relating to flora and fauna, SEPP 14 wetlands and visual impacts are too high to be able to be supported. Therefore, the remainder of Chapter 6 and Chapter 7 only consider the implications and options for development in the opportunity areas and no development.

Figure 6.2 OPPORTUNITIES AND CONSTRAINTS

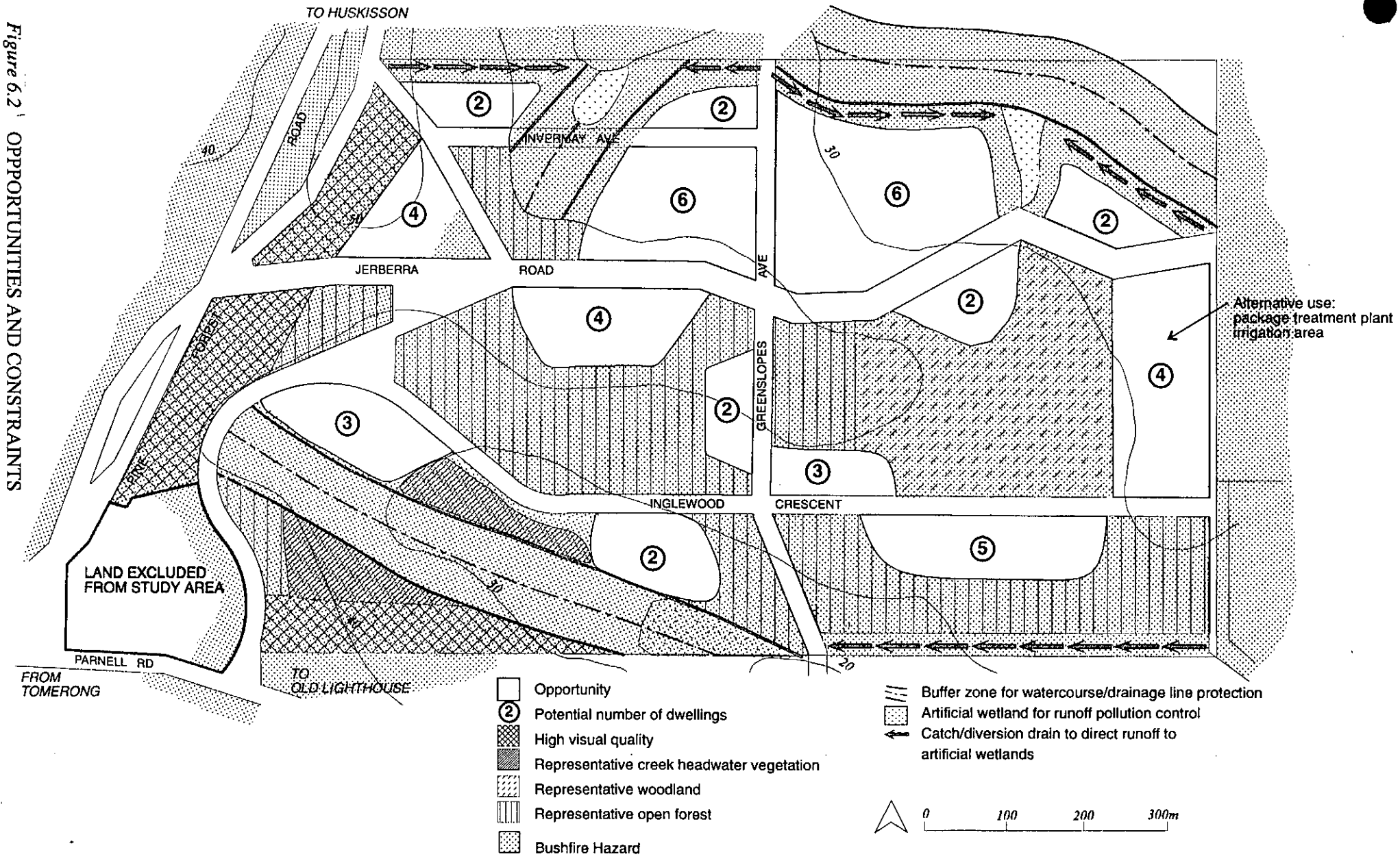
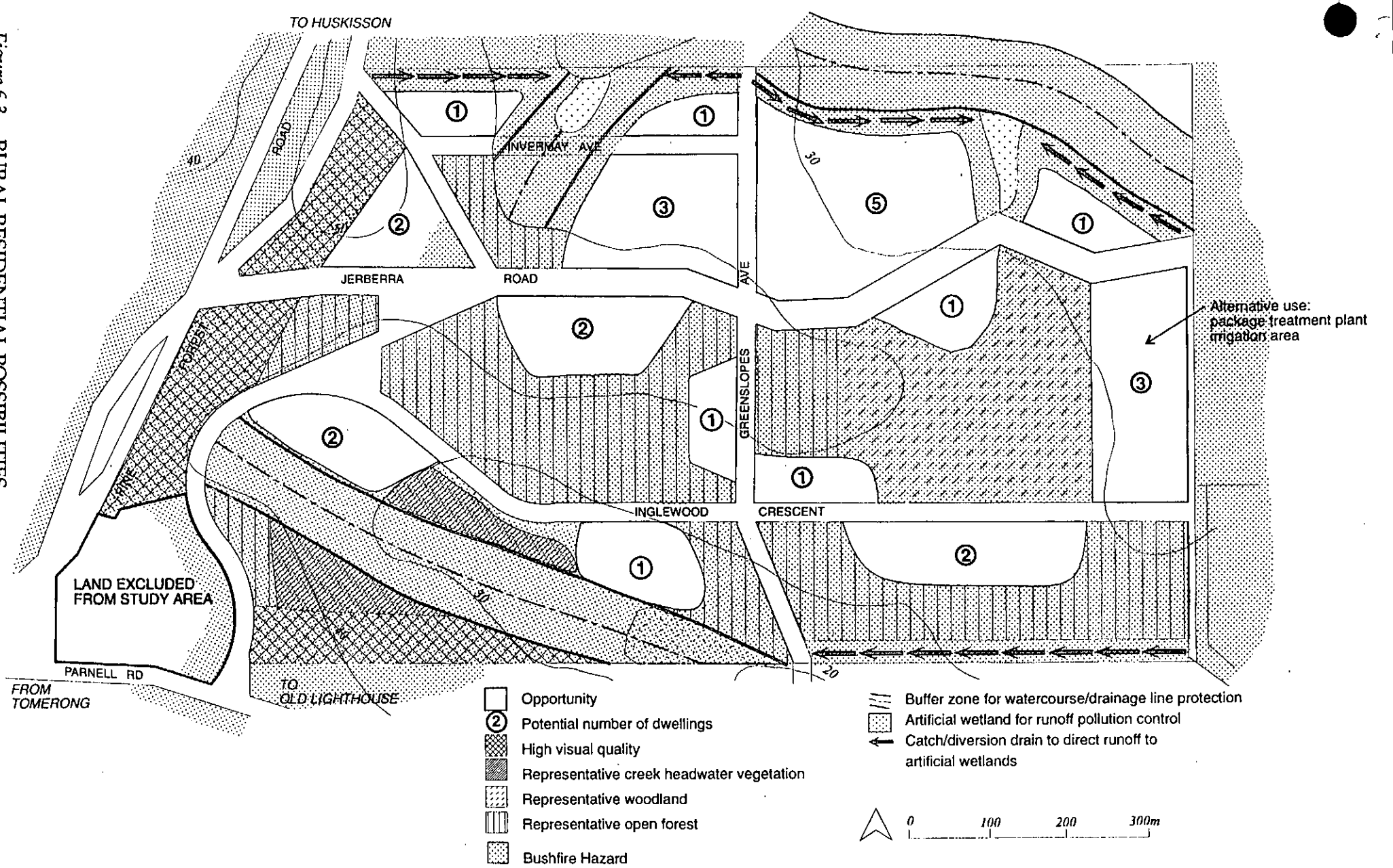


Figure 6.3 RURAL RESIDENTIAL POSSIBILITIES



6.3 COSTS OF DEVELOPMENT

This section considers the infrastructure costs associated with the three development approaches within the opportunity areas.

6.3.1 Roads

For all three development options, a typical low density residential road network would be required using the standards in the Shoalhaven Subdivision Code. Sections of the internal road network not directly serving lots could remain unsealed. A total of 950 metres of local access road (6 metre pavement plus 0.5 metre sealed shoulders) and 2,220 metres of cul-de-sac road (5 metre pavement plus 0.5 metre sealed shoulders) would be required, at a total cost of $599,100.

Construction of an Austroads Type B intersection at Pine Forest Road and other external road works that were necessary for the full 153 lot development strategy would not be required.

The per dwelling cost for each option would be as follows:

- 47 dwellings: $12,750
- 43 dwellings: $13,930
- 26 dwellings: $23,000

The per dwelling cost of roads for the rural residential option at $23,000 is very high. The roadworks are necessary due to the extreme erosion already existing on some parts of the site due to poorly formed roads. Traffic generated by 26 rural residential dwellings in a relatively isolated area would achieve a threshold which warrants suitable road formation.

6.3.2 Sewerage

i. Reticulated System

Compared to the 153 lot development considered in Chapter 5, there would not be a significant reduction in the total cost of connecting a 47 dwelling development to the reticulated sewerage system. Most of the costs are associated with extending the sewer mains which would be only marginally shorter in length for the smaller scale

of development. The cost to connect to reticulated sewerage would be $910,000 which is around $19,400 per lot.

ii. Package Treatment System

For 43 dwellings the total cost of providing the plant and associated local reticulation would be around $360,000 which equates to $8,400 per dwelling.

iii. On-Site Disposal

The cost of individual on-site disposal systems would remain constant at $7,000 per lot.

6.3.3 *Drainage*

The three remaining development options would be considerably smaller than the full scale development considered in Chapter 5, meaning that it would not be necessary to have a piped stormwater drainage system. Rather a system of shallow grassed swales running parallel to the roads would be acceptable. This system would be integrated with the road construction and the costs are incorporated into the road formation costs. However, there would be a cost of $127,500 associated with the establishment artificial wetlands to intercept stormwater runoff.

The per dwelling cost implications of this are as follows:

- 47 dwellings: $2,700
- 43 dwellings: $2,900
- 26 dwellings: $4,900

6.3.4 *Water Supply*

i. Residential Options

A reticulated water supply system would require a new 100 millimetre main be constructed from Tomerong to the site and some augmentation of the reservoir at Tomerong. The estimated costs of these works, including reticulation within the site, is $558,500. The per dwelling costs would be as follows:

- 47 dwellings: $11,900
- 43 dwellings: $13,000

ii. Rural Residential Option

The rural residential option would involve on-site water collection. Installing a 13,500 litre tank for each dwelling would cost around $1,600 which is considerably less than reticulated water. Such a tank capacity may not be adequate for large families or high water usage activities such as car washing, horse care and gardening. It would also provide less reliable security in a bush fire fighting situation.

6.3.5 *Other Infrastructure*

i. Electricity

The cost per lot for electricity would be constant at $4,140.

ii. Telecommunications

Telecom has stated that infrastructure costs would be recovered through service usage, meaning there would be no up-front costs for land owners.

6.3.6 *Community and Recreation Facilities*

The Section 94 costs described in Chapter 4 are on a per dwelling basis and therefore could be constant at $3,188 per dwelling.

6.4 TOTAL INFRASTRUCTURE COSTS

The total costs of infrastructure for the various types of development are given in *Table 6.2.*

Table 6.2 TOTAL DEVELOPMENT COSTS

Cost Element	Option		
	47 dwellings	43 dwellings	26 dwellings
Roads	$12,750	$13,930	$23,000
Sewage Disposal	$19,400(1)	$8,400(2)	$7,000(3)
Drainage	$2,700	$2,900	$4,900
Water	$11,900	$13,000	$1,600
Other Infrastructure	$4,140	$4,140	$4,140
SUB TOTAL*	$50,890	$42,370	$40,640
Community & Recreational Facilities (Section 94)	$3,188	$3,188	$3,188
TOTAL	$54,078	$45,558	$43,828

* *Sub total excludes Section 94 Contributions.*

(1) Reticulated System

(2) Package System

(3) On-site disposal

It should be noted that these are capital costs. On-going maintenance costs would also apply and they could be significant for some items, such as the package sewerage system, road maintenance and waste disposal.

Chapter 7

CONCLUSIONS

This chapter presents the main findings of the study and outlines a strategy for future action.

7.1 INTRODUCTION

In Chapter 6 the opportunities and constraints for residential development within the site were described. The evaluation found that full development of the site (153 lot option) would not be environmentally acceptable. This left three options for development and a no development option. The cost implications of the development options were then examined.

Having reached this point, it is now appropriate to review the main findings of the study which provide a basis for the zoning options which are discussed at the end of this chapter.

7.2 MAIN FINDINGS

7.2.1 Planning Policy

To date, local planning controls have sought to restrict residential development through the imposition of a 40 hectare minimum lot size for the development of dwellings in the Rural 1(a) and 1(b) zones. Other than the opportunity to create concessional lots, residential development has, in effect, been prohibited over the site since the introduction of planning controls in 1964.

Regional planning instruments have not identified any elements of regional significance for the site although SEPP No. 14 wetlands do occur in the locality. Regional policy documents prepared by the Department of Planning have highlighted the expense of servicing rural residential developments. The relatively high supply of existing serviceable but unsubdivided land within the Shoalhaven LGA has also been noted by the Department.

Source: Shoalhaven City Council

Figure 7.1 DEVELOPMENT ZONINGS

1(c) RURAL (*Rural lifestyle*)

7(a) ENVIRONMENT PROTECTION (*Ecology*)

7(d1) ENVIRONMENT PROTECTION (*Scenic*)

In terms of old subdivisions, the lack of a formal policy framework for dealing with such developments within the LGA and statewide is a recognised difficulty. The precedental effect of enabling residential development in such estates is a factor for consideration. Although many of the old subdivisions within Shoalhaven LGA remain in single ownership, no legislation exists to prevent the selling of small, legally valid existing lots with no dwelling development rights. Therefore, in terms of planning policy very little guidance is available on old subdivisions.

7.2.2 Traffic Impacts

The traffic impacts associated with the development would be manageable but the necessary road works would be costly. The existing roads are unauthorised, poorly constructed and not currently maintained by Council. The roads have eroded significantly in parts and this is causing environmental degradation. Development of any part of the site for residential or rural purposes would require a main sealed access road and stabilisation of other unsealed roads.

7.2.3 Visual Impacts

Visual analysis of the site has shown that there are parts with high visual quality and that this quality is closely related to existing vegetation. Loss of visual amenity would therefore be a function of clearing. The two most visually sensitive parts of the site are those which can be seen from Pine Forest Road and Parnell Road and these have been identified as unsuitable for development in the opportunities and constraints map.

7.2.4 Social Environment

Assuming an occupancy rate of 2.67 persons per household, the various forms of development in the opportunity areas could yield the following populations:

- 47 dwellings: 125 people
- 43 dwellings: 114 people
- 26 dwellings: 70 people

Development under any option would, therefore, create a demand for community services and open space. These would not be able to be satisfied in-situ and would

draw upon services in Nowra and to a lesser extent St Georges Basin. In the longer term, some community needs could be provided by facilities proposed for Vincentia.

Only a small proportion of the costs associated with meeting these demands for community facilities could be recovered by Section 94 contributions. Other ongoing costs, such as wages for community facility employees, would have to be met by other sources such as Council's rate revenue. The state government would also have to bear costs such as health care, police, education costs and subsidised public transport.

7.2.5 *Agricultural Land Capability*

The investigations presented in Chapter 3 have shown that the agricultural land capability of the site is low and therefore agriculture is not a highly ranked alternative use.

7.2.6 *Bio-Physical Characteristics*

In Chapter 3 the vegetation communities and fauna habitats on the site were described and assessed in terms of conservation significance. The conclusion was that the habitats could support rare or endangered species and that a Fauna Impact Statement would be required before any development in the habitat areas would be allowed to proceed. It was also noted that unauthorised clearing had significantly degraded parts of the site and that unauthorised dams appeared to be causing vegetation dieback on-site and downstream.

The bushfire hazard for the area has been assessed as moderate to extreme and this poses an important limitation on development. Clearing for bushfire protection would have to occur within and around the identified opportunity areas.

7.2.7 *Financial Implications*

The per dwelling development costs outlined in *Table 6.2* can be translated into the following capital costs for development:

- 47 dwelling option; $2,541,700
- 43 dwelling option; $1,959,000
- 26 dwelling option; $1,139,500

It should be noted that these estimates do not include ongoing maintenance costs.

Each option involves significant capital costs. In terms of the wider community, equity considerations suggest that the costs associated with the development should be totally financed by those developing dwellings. For Council to bear such costs on behalf of individuals would be inequitable as it would require major borrowing, meaning that all residents of the LGA would carry the attendant risks and subsidise the interest on loan repayments.

Credit limitations on Council also mean that such borrowing would have to occur at the expense of other scheduled capital works. Borrowing would also entail further risks for Council as it is quite possible that the site would never be developed to its full identified potential and this would leave Council with a partially recovered debt.

If, however, Council is willing to borrow on behalf of land owners, a local loan rate could be an appropriate method of recovering costs over time.

7.2.8 Land Economics

A major factor for consideration with any of the development options is land economics. Local real estate agents have advised that the average cost of a serviced residential lots equivalent to that proposed is around $30,000 to $40,000. When this compared to the cost of servicing Pacific Pastures ($45,000 to $54,000 per dwelling) it is apparent that there is a risk of over capitalising. In other words, the cost of infrastructure investment may not be recovered through subsequent re-sale. This risk will need to be carefully considered by the Pacific Pastures Progress Association before the decision to proceed with any development is made.

The risk is slightly lower with the rural residential option as locally available lots of this type are usually worth around $80,000 to $100,000. These lots are however, slightly larger than the rural residential lots outlined in the rural residential option.

7.3 ZONING OPTIONS

There are a number of zoning options available to accommodate the development methods examined in Chapter 6. This section examines zoning options using the zone names and associated development controls outlined in the *Planning Report for Draft Shoalhaven Rural Local Environmental Plan.*

The zoning options fall into two broad categories:

- Opportunity Area Zonings; and
- No Development Zonings.

It is envisaged that the no development zonings would only emerge if it was decided by the Pacific Pastures Progress Association that the land economics and land pooling aspects of the proposal were such that development of the opportunity areas was considered not feasible.

7.3.1 Opportunity Area Zonings

i. Zoning and Development Control

Figure 7.1 illustrates the recommended zonings for development of the opportunity areas. These zonings are:

- Opportunity Areas: Rural 1(c) *Rural Lifestyle;*
- High Visual Quality Areas: Environment Protection 7(d1) *Scenic;*
- Remaining Areas: Environment Protection 7(a) *Ecology.*

Detailed aims and objectives relating to the opportunity areas as well as specific development controls would be included in Schedule 12 of the LEP.

ii. Implementation

In order to implement these zonings, it is likely that Pacific Pastures Progress Association would need to form a system of land pooling so that those land owners who are not able to develop dwellings can receive compensation from those land owners who can. This would mean that land ownership would be reduced to a much smaller number of people.

If an appropriate tenure system can be devised, the next task becomes establishing how necessary infrastructure will be paid for. This may involve Council financing infrastructure and recovering costs through a local loan rate. If Council does not wish to undertake this level of borrowing, the alternative would be for owners to provide up-front infrastructure financing.

Figure 7.2 MAINTAINING EXISTING ZONINGS

7.3.2 *No Development Zonings*

If development of the opportunity areas proves to be too difficult, or financially not viable then a new set of zonings will need to be devised which do not permit dwelling development anywhere on the site. Two possible approaches to this task are described below.

i. Maintaining Existing Zonings

One method of ensuring no development would be by maintaining the existing zonings. This approach is illustrated in *Figure 7.2.*

In this instance the two zonings would be:

- Rural 1(b) *Arterial Road Protection;* and
- Rural 1(d).

The 1(b) zone boundary would be set 400 metres from Parnell Road to maintain consistency with 1(b) zones throughout the local government area. The zone is basically an agricultural zone with the intent of ensuring "safe and smooth traffic flow" along arterial roads.

The proposed 1(d) Rural zone in the draft Rural Plan is a broad rural zone which will have a similar affect as the existing Rural 1(a) zone. The main negative aspect of maintaining the existing system of zonings is that they are not specifically concerned with environmental protection. Agriculture is therefore permissible without development consent. Despite this, a tree preservation order will continue to remain over the site.

ii. An Alternative Approach

Given the environmental sensitivity of the site and recognising the unauthorised developments which has already occurred, a preferred set of zonings are illustrated in *Figure 7.3.* These zonings are:

- Environment Protection 7(d1) *Scenic;* and
- Environment Protection 7(a) *Ecology.*

The 7(d1) zone would cover the areas of high visual quality (as identified in *Figure 6.2*) and the remainder of the site would be zoned 7(a). "Agricultural Pursuits" and

Source: Shoalhaven City Council

Figure 7.3 ENVIRONMENTAL PROTECTION ZONES

7(a) ENVIRONMENT PROTECTION (*Ecology*)

7(d1) ENVIRONMENT PROTECTION (*Scenic*)

"Agriculture" are both permitted with consent in these zones. This means there would be more scope for development control. Although the site has low agricultural capability it would still be possible to permit limited agricultural activities in the opportunity areas.

7.4 RECOMMENDATIONS

It is recommended that the results of this study be explained to representatives of the Pacific Pastures Progress Association. Following this, the study should be placed on public exhibition for three months.

Comments should be sought and considered from the community and government authorities.

Following the public exhibition, the Pacific Pastures Progress Association should be given three months to determine if land pooling (or a similar method of consolidation) is possible. There would also need to be a clear demonstration that at least some of the capital cost funding is available from development proponents before rezoning is contemplated.

Following this, a rezoning of some type will need to occur. If development of the opportunity areas is economically viable, then the zonings illustrated in *Figure 7.1* should be adopted. If this is not possible then the zonings illustrated in *Figure 7.3* should be adopted.

Rezoning will need to occur for the following reasons:

- once the draft rural LEP is adopted, the new set of zoning controls will require the existing controls on the site to be updated;

- zoning opportunity areas for development (*Figure 7.1*) or environmental protection (*Figure 7.3*) will give at least some finality and certainty for an ongoing problem.

Land pooling of the type needed to achieve development within the opportunity areas will be extremely complex from a legal perspective. Such an approach also appears to be unprecidented in NSW. If the process does prove to be too difficult to achieve, it would be much fairer for Council to zone for environmental protection as soon as possible. This may mean that in the longer term that Council could end up owning some of the lots through defaulting rate payments. This situation has occured in other old subdivisions in Shoalhaven local government area and other LGAs such as Penrith and Blacktown.

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The Australian Museum Complete Book of Australian Mammals. Angus and Robertson Pty Ltd, Sydney.

State Pollution Control Commission (1989)
Pollution Control Manual for Urban Stormwater

Sullivan, M.E. (1977)
Aboriginal Sites of Bherwerre Peninsula. Conservation Memorandum No. 5 Conservation and Agriculture Branch, Dept. of the Capital Territory.

APPENDICES

Appendix A

CORRESPONDENCE FROM DEPARTMENT OF PLANNING

New South Wales Government

Department of Planning

ILLAWARRA & MACARTHUR REGIONAL OFFICE

Ms. Clare Brown
Senior Planner
Mitchell McCotter
P.O. Box 943
CROWS NEST NSW 2065

State Office Block
84 Crown Street
Wollongong, 2500
P.O.Box 61
Wollongong East, 2520

Telephone :(042) 268111 Ext:

Fax No. :(042) 268127

Contact :

Our Reference : W93/4

Your Reference :

1 November, 1993

Dear Ms Brown

Pacific Pastures Local Environmental Study

I refer to your letter of 29 September, 1993, seeking clarification of the Department's views with respect to issues concerning the abovementioned matter.

1. Precedent Effect

The Department intends to assess any proposed rezoning of small rural subdivisions on a merit basis. This will have regard to the physical capability and suitability of the land to sustain the proposed change in land use, without causing significant environmental degradation nor cost to the community. Accordingly, the Department will not be giving special consideration in order to facilitate rezoning proposals affecting small rural subdivisions, in view of the vast number of allotments in NSW, of which many are located in inappropriate locations for urban development.

2. Small Rural Subdivisions

The Department recognises the problems associated with small rural subdivisions, since these were created prior to the introduction of planning controls. The Department is presently examining appropriate mechanisms to minimise the risk whereby people purchase old rural subdivisions without being fully aware of the implications and secondly, to address problems associated with subdivisions held in fragmented ownership. This assessment is being undertaken in association with relevant Government agencies, the Local Government and Shires Association and Royal Australian Planning Institute. One of the options being considered by the Working Party is land pooling and I have attached information on this matter for your information.

3. Effluent Disposal

The Department would not support any rezoning for urban purposes on the subject land, which was reliant on on-site methods of sewage disposal. This is because of the site's proximity to a SEPP No. 14 wetland, and the environmental sensitivity of the area generally. Moreover, this issue would need to be addressed within the context of a sewage effluent solution to the entire area, which is currently under investigation by the Council and Public Works Department.

I trust this clarifies the position for you. Should you have any further queries, please contact Fay Steward on (042) 268120.

Yours faithfully

K. Sullivan
Regional Manager (Illawarra/Macarthur)

Appendix B

CORRESPONDENCE FROM STATUTORY AUTHORITIES

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

The General Manager
Mitchell McCotter & Associates
P.O.Box 943
CROWS NEST NSW 2065

Our reference: F0836

Your reference: 93152L5 CAROLYN HOWARD

6th October 1993

Dear Sir

Pacific Pastures Local Environment Study Jervis Bay

I refer to your letter of 8th September. There are two specific areas in particular I would like to see addressed in the Study. They are both relevant given the largely forested nature of the land.

There needs to be a detailed study of the aboriginal archaeological potential of the site. I enclose herewith a list of consulting archaeologists who would undertake a study to determine possible sites of relics which may either require Consent to Destroy or special protection in the event of the land being developed. Often a subdivision can be designed around such sites avoiding future conflict. In this context contact should also be made with the local Aboriginal Lands Council.

There needs to be an assessment of the likely impact on endangered fauna as required by the Endangered Fauna (Interim Protection) Act 1991. A report should be prepared by a suitably qualified person applying the Seven Point Test of Significance. Attached is a leaflet which explains the Act. It may well be that the area has important values to endangered fauna thereby warranting a full Fauna Impact Statement. Again I include a list of possible consultants for your convenience.

Nowra District
Housing Commission
Building
24 Berry Street
Nowra
PO Box 707
Nowra 2541
Phone: (044) 23 9822
Fax: (044) 23 3122

In respect of specific matters you have targetted I offer the following comments:

* Moona Moona Creek wetland is indeed vulnerable to any development in the catchment. I would recommend appropriate permanent stormwater retention basins together with adequate buffer zones will need to be provided. A model for these works might be the proposed Long Bow Point subdivision near Culburra.

* In respect of the Jervis Bay study I suspect your task will be largely unaffected as it appears to lie well outside the identified wildlife corridors. The corridor may or may not be relevant to the Seven Point Test of Significance.

Yours faithfully

Geoff Spencer
District Manager
for the DIRECTOR GENERAL

RECEIVED 1 0 OCT 1993

93152

Central West
South East and
Illawarra Region

NSW Agriculture

161 Kite Street
Locked Bag 1
ORANGE NSW 2800

Telephone (063) 91 3590
Facsimile (063) 91 3599

M/s Carolyn Howard
Environmental Scientist
Mitchell McCotter
PO Box 943
CROWS NEST NSW 2065

Your Ref: 93152L5
Our Ref: AJD/WO'K 4E2/4

12 October 1993

Dear M/s Howard,

Re: Pacific Pastures Local Environmental Study, Jervis Bay

NSW Agriculture has inspected the site of the Pacific Pastures Local Environmental Study.

The land is entirely Class 5 and has no agricultural potential.

There are no agricultural issues involved with or adjacent to the study area.

NSW Agriculture has no concern over the study.

Yours faithfully,

D J McDonald
REGIONAL DIRECTOR
NSW AGRICULTURE

f:\data\wp\common\john\pacific.les

Roads and Traffic Authority NSW

Wollongong Zone - Southern Region

71-77 Kembla Street, Wollongong
PO Box 477 Wollongong East 2520

To	**Carolyn Howard**
Office	Mitchell McCotter
Phone	02 906 1666
Fax	02 906 5375

From	Ken Collis	**File**	404.5314
Phone	042 202445	**Date**	21-Oct-93
Fax	042 273705	**Pages**	2

Dear Ms Howard

Pacific Pastures Local Environment Study, Jervis Bay

I refer to your letter of 8 September 1993 concerning the above Local Environmental Study, and also to discussions with Mr Brah and Mr Brooker. As previously discussed, the Authority would be concerned to ensure that the following issues are addressed within the Local Environmental Study:

- access to MR 267 from the proposed development should be restricted to a single safe point of ingress/egress;
- the access is designed and constructed to an appropriate standard acceptable to the RTA;
- impacts of increased traffic from the development on both the traffic capacity and maintenance of MR 267 are recognised and quantified;
- impacts on the safe operation of the present junctions of MR 267 with other major junctions are identified, including any impact resulting from provision of the Tomerong Deviation; and
- an assessment of the justification and appropriateness of s.94 contributions under the EPA Act for intersection upgrading and/or accelerated costs of road maintenance.

It should also be noted that this proposal would require to be submitted to the

Shoalhaven Development Committee under the provisions of SEPP 11, together with a detailed Traffic Impact Statement.

The delay in responding to your letter is regretted.

Yours faithfully

KM Collis
Zone Planner 21/10/93

New South Wales Government

Water Resources

The Manager
Mitchell McCotter & Associates Pty Ltd
PO Box 943
CROWS NEST NSW 2065

Telex: 121188
Facsimile: (02) 895 7281
Telephone: (02) 895 6211
Ext: 7441
Contact Name: John Ross
Our Reference: 0083001
Your Ref.: 93152L3

23·9·93

Attention: Mr Nav Brah/Ms Carolyn Howard

Dear Sir/Madam,

Re: LES - Pacific Pastures, Jervis Bay

Thank you for your letter of 8 September 1993 seeking this Department's comments and requirements for the above LES.

This Department has no special comment or advice on the subject proposal. However, in the conduct of the project it is recommended that you make full use of the documents sent to you with the Department's letter of 14 October 1992 (copy attached) together with "The Importance of the Riparian Zone in Water Resource Management - A Literature Review", sent on 9 August 1993, under your reference 93151L3. All appropriate matters discussed in these guideline documents should be addressed in the above study.

Again, the Department would appreciate being sent draft copies of the subject documentation for review and endorsement.

Yours sincerely,

John A. Ross
for J.F. Clarke,
Regional Director
Sydney-South Coast.

attach.

New South Wales Government

Water Resources

The Manager
Mitchell McCotter & Associates Pty Ltd
PO Box 943
CROWS NEST NSW 2065

Telex: 121188
Facsimile: (02) 895 7281
Telephone: (02) 895 6211
Ext: 7441
Contact Name: John Ross
Our Reference: 0064528
Your Ref.: 9209815

14·10·92

Attention: Jan Parsons.

Dear Sir/Madam,

Re: EIS Requirements for Proposed Improvements, Lake Illawarra Entrance.

Thank you for your letter of 28 September 1992, seeking this Department's comments and requirements for the above EIS.

Enclosed for your information and retention are the following Departmental documents:

a) "Amendments to the NSW Rivers and Foreshores Improvement Act";

b) "The 7-Step Method of controlling Bank Erosion and Sediment Build-up"; and

c) a revised "General Requirements for Environmental Impact Statements". (This is essentially a checklist of water resources matters to be addressed in the assessment of environmental impacts).

The Department would appreciate being sent a draft copy of the subject statement for review. It would be worth noting that if multiple copies of the draft document can be made available (even on a loan basis) this helps significantly to expedite the review process.

I trust the above and enclosed information will prove useful.

Yours sincerely,

John A. Ross
for J.F. Clarke, Manager
Sydney-South Coast Region.

Encl.

RECEIVED 1 8 NOV 1993

EPA

Environment
Protection
Authority
New South Wales

NSW Government Offices
84 Crown Street
Wollongong
NSW 2500
PO Box 513
Wollongong
East
NSW 2520

Telephone .042. 26 8100
Facsimile .042. 27 2348

The Manager
Mitchell McCOTTER
P O Box 943
Crows Nest
NSW 2065
Attention: Mr N S Brah

Our Reference: 281,485A/1 RAC:DT

Your Reference:

Contact: R Cumming (042) 268100

Dear Sir

DRAFT LOCAL ENVIRONMENT STUDY - PACIFIC PASTURES

Thank you for your letter of 7 September 1993 concerning the above matter. The EPA is concerned over the potential for the development to cause adverse impact on wetlands and water quality. We regard the setting as environmentally sensitive. It is important that these matters are carefully and scientifically assessed in the study so that planning decisions are based on an accurate understanding of the potential impacts. We would appreciate being given the opportunity to review the findings of the study, and advise Council further before any decision is taken. The following matters provide a general guide for matters to be considered in the study.

WATER QUALITY

- The impact of the proposal on catchment water quality. This includes adverse changes to both the quantity and quality of stormwater run-off arising from permissible developments, during the construction phase and afterwards. It should be noted one hectare of exposed development site can lose hundreds of tonnes of sediment in a year. Additionally, increased stormwater run-off flows arising from reduced infiltration rates in urbanising areas can cause stream channel enlargement-sediment exports of 70,000 m3/km of stream length have been measured. This material, along with soil nutrients which promote algal blooms, can severely degrade downstream water resources. The

pollutant export quantities, flows and technical and economic feasibility of satisfactorily controlling such pollution should be investigated and detailed in a scientific way;

- The suitability of the locality with regard to the need to confine urbanisation to geographic areas in which effective stormwater run-off water quality control practices can be incorporated in a cost-effective way;

- The sensitivity of the receiving waters, especially to sedimentation and nutrient enrichment;

- Urban capability including soil erodibility/dispersibility (which relates directly to the feasibility of water quality control measures;

- The ability of Council to maintain any **permanent** stormwater pollution control facilities (eg flow retention basins, gross pollutant traps, water quality control ponds) which may be necessary to control the long term environmental impacts of permissible developments;

- Any adverse environmental impact as a consequence of permissible developments which may involve channelisation, flow change, physical interference with or alteration of the bank, bankside vegetation, or bed of any perennial stream or wetland.

- Potential impact on any wetland, having regard for the legal protection afforded these natural resources under Section 16 of the Clean Waters Act, 1970, as well as SEPP 14. The impact on the wetland ecosystem should include a consideration of the effect of loss of isolation, and increased pressure from human activity (disturbance from recreational vehicles, water access, mooring construction, domestic animals, noise). The scientific basis for any buffer strip widths or other management strategy should be detailed;

ACCUMULATIVE IMPACTS

- The accumulative impacts of land use changes over time in the same water catchment, and the threat this poses to the sustainable use of natural resources. Urban land-use for example generally contributes substantially greater pollutant loads than most rural-land uses, and due to the limitations of control technology [and poor compliance levels], it **may not be possible to maintain existing water quality** as such rural land in the catchment is converted to urban - even though individual developments are subject to stormwater pollution control measures.

  Where the receiving waters are especially sensitive (such as poorly flushed coastal lagoons, and lakes - which act as sediment 'sinks') - the catchment capability for sustainable development needs to be

determined, and an integrated catchment management strategy implemented to prevent gradual degradation of the resource. It should be noted that the sustainable use of water resources is a NSW government policy objective.

WASTE DISPOSAL

- Availability of town sewerage, (on-site disposal by either septic or aerated systems is not generally favoured excepting in low-density rural situations without reticulated water supply, as they almost inevitably lead to contamination of surface water run-off with nutrients during wet weather). Where an existing town sewer is to be used, the capacity of the system to convey, treat, and dispose of the additional load should be documented;

- The ability of Council to monitor and control the effectiveness of any domestic on-site sewage disposal systems, after installation, and the implications of this for potential contamination of stormwater run-off;

- Where town sewerage is available, control of sewer surcharges in the event of pump station failure where sensitive waters are involved;

- The potential accumulative water quality impact of a proliferation of package sewage treatment systems in the catchment, (with major developments involving a common, non-municipal sewer);

- Garbage generation and disposal, with respect to Council's waste strategy;

- Trade waste generation and disposal, if appropriate;

LAND USE CONFLICTS

- Identification and assessment of any potential land-use conflict. This may include the environmental impact of any air, water or noise pollution likely to be arising from the development on any nearby sensitive land-use, as well as the potential impact of existing land-uses (eg heavy industry, intensive agricultural operations, and transport corridors) on the proposed development. The need for 'buffer zones' should be identified where appropriate.

AIR POLLUTION

The potential for degraded air quality as a consequence of urban concentrations and transport corridors in regions subject to atmospheric inversions or other unfavourable geographic factors.

EXISTING POLLUTION

- Consideration of the alternatives available (including legal redress) to correct existing environmental problems where it is argued that a rezoning should proceed on the basis that the existing environment is already polluted or degraded.

Please direct any further enquiries to the above officer.

Yours faithfully

JOHN M AVEYARD
Regional Manager - South Coast
for Director-General

16/11/93

(N:\RC\RICKS.LES)

Telecom AUSTRALIA

Telephone 222772-773 Area Code 042
Facsimile 262599 042
Reference HK/1/882
Your Reference:- Job 93/52

WOLLONGONG AREA OFFICE
90 Crown Street
Wollongong NSW 2500

Postal Address:
P.O. Box 811
Wollongong East NSW 2520

26th November, 1993

Mitchell Mc Cotter
P.O. Box 943
Crows Nest NSW 2065

Attention:- Mr Nav Brah

Re: Jarberra Estate - Pacific Pastures Pine Forest Road Tomerong.

Dear Sir,

In reply to your letter of 23rd November 1993 regarding Telecommunications facilities to the above sub division, the following comments are proffered as a general guideline.
1/ Minor cables exist along Pine Forest Road and provide services to various residents within the area.
2/ Augmentation of main Telecom external plant and exchange equipment will be necessary to provide services to the proposed sub division and will be programmed and funded by Telecom to coincide with Telephone applications within the proposed sub division.
3/ Sub division Telecommunications pit and pipe reticulation will be installed by either the Sub Divider or by Joint Use in conjunction with electricity excavations. Funding for this construction will be in accordance with the conditions relating to "External Cabling of Estates", "Property Development" and "Fee for Service" at the current period of subdivision construction. Cost responsibilities should be negotiated with the Telecom Estimating Section, 38 Berry Street Nowra, Telephone (044) 239 524 and at an appropriate "lead time" to the commencement of the subdivision development.

Should you wish to discuss these matter further, please do not hesitate to liaise with this section at the above contact points.

Yours faithfully,

Bob Toohey
for Network Development Manager
South Coast Section.

NSW FISHERIES

Ms C Howard
Mitchell McCotter & Associates Pty Ltd
PO Box 943
Crows Nest NSW 2065

Our ref: HS 93/044
Your ref: 93152L5

13 September 1993

Dear Ms Howard,

Re: PACIFIC PASTURES LOCAL ENVIRONMENTAL STUDY - JERVIS BAY

I refer to your letter of 8 September 1993, in which you requested details of any matters NSW Fisheries consider should be addressed in the preparation of a Local Environmental Study for Pacific Pastures.

NSW Fisheries is concerned with the protection of fishing values in Moona Moona Creek and Jervis Bay and with the protection of fish habitats that support those values.

The major fisheries issues associated with the proposed development are;

1. Sewage disposal.
2. Site runoff both during construction and ongoing.
3. The protection of wetlands and the maintenance of buffer zones adjacent to wetlands and waterways.

Details on the matters that should be addressed in the Local Environmental Study and the draft Local Environmental Plan can be found in the NSW Fisheries Estuarine Management Guidelines (sections 1, 2, 3.6, 3.8, 3.9, 3.10 and 4.1). Any proposed stormwater pollution control ponds must not be placed on existing water courses.

I hope these comments are helpful and I look forward to receiving a copy of the study and draft plan when they are available.

Yours sincerely

P. Dalmazzo
for P. Crew
Director of Fisheries

NOWRA
Suite 102, 24 Berry Street — PO Box 456 Nowra NSW 2541
Telephone: (044) 23 2200 • **Facsimile:** (044) 23 2007

Appendix C

SOIL PROFILE REPORTS

PACIFIC PASTURES SOIL SURVEY Profile No. 1

MAP REFERENCES:
1:100 000 sheet no:9027 JERVIS BAY Scale of Mapping:1:25 000
AMG Eastings:281700 AMG Zone:56
AMG Northings:6118425
SURVEY DETAILS:
Described by: Mitchell McCotter Assoc Date:09/09/93
Site Location:CREST OFF INVERMAY AVENUE
Photo taken: No of layers described: 4
Methods of exposure:auger
SOIL and MAP CODES:
Great Soil Group:YP, Yellow podzolic soil
Factual Key:Dy5.11
TOPOGRAPHY:
Slope:3%, estimated Aspect:SE
Elevation (m):40
LANDFORM:
Site Process:transportational Site Morphology:crest
Landform Pattern:plain Landform Element:hillslope
VEGETATION:
Crown Sep. Ratio:isolated(› 20:1)
Vegetation Community:dry sclerophyll forest Upper Stratum Height:12 - ‹ 20 m
SITE CONDITION:
Ground Cover:70% Expected Dry Condition:hardsetting
Current Condition:firm
Site Disturbance:limited clearing
LITHOLOGY:
Rock Outcrop:nil
Substrate Material:solum parent mat. Substrate Strength:moderately strong
Weathering & Alter:slightly weathered rock
Upper Solum PM:silstone/mudstone
LAND USE:
Site:urban
General Area:timber/scrub/unused
HYDROLOGY:
Run Off:low Run On:low
Permeability:slowly permeable Profile Drainage:poorly drained
Free Water Presence:none
EROSION:
minor, partly stabilised sheet
EROSION HAZARD: slight
SALINITY: no salting evident

LAYER: 1 () Depth (m): .00 to .20
COLOUR: moist:10YR 5/2 (greyish yellow brown) value/chroma:2a
TEXTURE: sandy loam
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:weak pedality
dominant peds:‹ 2 mm, crumb
fabric:rough-faced peds
SOIL FAUNA ACTIVITY:
degree:low (‹ 10%)
COARSE FRAGMENTS:
type:as rock outcrop amount:very few(‹ 2%)
distribution:dispersed orientation:reoriented
weathering:non-weathered
shape:sub-rounded platy
size:gravel(6-20 mm)

type:charcoal amount:few(2-10 %)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:angular platy
size:fine gravel(2-6 mm), gravel(6-20 mm)

ROOTS:
very fine (<1 mm):many(25-100/10x10cm) fine (1-2 mm):common(10-25/10x10cm)
medium (2-5 mm):few(1-2/10x10 cm) coarse (>5 mm):none

CHEMICAL TESTS:
pH:6.0

SAMPLE(S) TAKEN: disturbed

BOUNDARY:
distinctiveness:abrupt (5-20 mm)

LAYER: 2 () Depth (m): .20 to .38
COLOUR: moist:10YR 5/3 (dull yellowish brown) value/chroma:2b
TEXTURE: sandy clay

CONSISTENCE:
soil water status:moderately moist

STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds

COARSE FRAGMENTS:
type:charcoal amount:few(2-10 %)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:angular platy
size:fine gravel(2-6 mm), gravel(6-20 mm)

ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):none coarse (>5 mm):none

CHEMICAL TESTS:
pH:6.0

SAMPLE(S) TAKEN: disturbed

BOUNDARY:
distinctiveness:clear (20-50 mm)

LAYER: 3 () Depth (m): .38 to .80
COLOUR: moist:10YR 5/6 (yellowish brown) value/chroma:4
TEXTURE: light clay

CONSISTENCE:
soil water status:moderately moist

STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds

COARSE FRAGMENTS:
type:charcoal amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:strongly weathered
shape:angular platy
size:fine gravel(2-6 mm)

ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):none coarse (>5 mm):none

CHEMICAL TESTS:
pH:5.0

SAMPLE(S) TAKEN: disturbed

BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 4 ()
Depth (m): .80 to 1.10
COLOUR: moist:7.5YR 6/6 (orange)
value/chroma:4
MOTTLES: Dominant:
type:weathered
munsell colour: 7.5YR 7/1 (light brownish grey)
colour:grey
contrast:distinct
abundance:10% - 20%
TEXTURE: light-medium clay
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds
COARSE FRAGMENTS:
type:as parent material
amount:very few(< 2%)
distribution:dispersed
orientation:reoriented
weathering:weakly weathered
shape:sub-angular platy
size:gravel(6-20 mm)
ROOTS:
very fine (<1 mm):none
fine (1-2 mm):none
medium (2-5 mm):none
coarse (>5 mm):none
CHEMICAL TESTS:
pH:5.0
SAMPLE(S) TAKEN: disturbed

PACIFIC PASTURES SOIL SURVEY Profile No. 2

MAP REFERENCES:
1:100 000 sheet no:9027 JERVIS BAY Scale of Mapping:1:25 000
AMG Eastings:282575 AMG Zone:56
AMG Northings:6117125
SURVEY DETAILS:
Described by: Mitchell McCotter Assoc Date:10/09/93
Site Location:CREEKLINE STH END GREENSLOPES AVE
Photo taken: No of layers described: 3
Methods of exposure:auger
SOIL and MAP CODES:
Great Soil Group:PS, Prairie soil
Factual Key:Gn4.51
TOPOGRAPHY:
Slope:1%, estimated Aspect:S
Elevation (m):10
LANDFORM:
Site Process:alluvial Site Morphology:open depression
Landform Pattern:alluvial plain Landform Element:drainage depression
VEGETATION:
Crown Sep. Ratio:isolated(> 20:1)
Vegetation Community:dry sclerophyll forest Upper Stratum Height:12 - < 20 m
SITE CONDITION:
Ground Cover:95% Expected Dry Condition:hardsetting
Current Condition:firm
Site Disturbance:limited clearing
LITHOLOGY:
Rock Outcrop:nil
Upper Solum PM:silstone/mudstone
LAND USE:
Site:other
General Area:timber/scrub/unused
HYDROLOGY:
Run Off:low Run On:moderate
Permeability:highly permeable Profile Drainage:imperfectly drained
Free Water Presence:none
EROSION:
none
EROSION HAZARD: high
SALINITY: no salting evident
FIELD NOTES:
Rural residential area/site.
Open depression creekline waterlogged.

LAYER: -1 () Depth (m): -.02 to -.01

LAYER: 1 () Depth (m): .00 to .15
COLOUR: moist:10YR 4/1 (brownish gray) value/chroma:2a
TEXTURE: light clayey fine sand
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:weak pedality
dominant peds:2-5 mm, crumb
fabric:rough-faced peds
SOIL FAUNA ACTIVITY:
degree:none
COARSE FRAGMENTS:
type:charcoal amount:few(2-10 %)
distribution:dispersed orientation:reoriented
weathering:strongly weathered

shape:angular platy
size:gravel(6-20 mm)
ROOTS:
very fine (<1 mm):many(25-100/10x10cm) fine (1-2 mm):common(10-25/10x10cm)
medium (2-5 mm):common(2-5/10x10cm) coarse (>5 mm):few(1-2/10x10 cm)
ERODIBILITY: high
CHEMICAL TESTS:
pH:5.5
SAMPLE(S) TAKEN: disturbed
BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 2 () Depth (m): .15 to .44
COLOUR: moist:10YR 6/1 (brownish gray) value/chroma:2a
TEXTURE: fine sandy loam
CONSISTENCE:
soil water status:moist
STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds
COARSE FRAGMENTS:
type:as parent material amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:sub-angular tabular
size:gravel(6-20 mm)
type:charcoal amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:strongly weathered
shape:angular platy
size:fine gravel(2-6 mm)
ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):few(1-2/10x10 cm) coarse (>5 mm):few(1-2/10x10 cm)
ERODIBILITY: high
CHEMICAL TESTS:
pH:6.0
SAMPLE(S) TAKEN: disturbed
FIELD NOTES:
Coarse fragment probably an alluvial deposit. Smell of hydrogen sulfide at base.
BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 3 () Depth (m): .44 to .85
COLOUR: moist:2.5Y 6/4 (dull yellow) value/chroma:2b
TEXTURE: light clay loam,fine sandy
CONSISTENCE:
soil water status:wet
STRUCTURE:
grade:moderate pedality
dominant peds:5-10 mm, polyhedral
fabric:rough-faced peds
ROOTS:
very fine (<1 mm):few(1-10/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):none coarse (>5 mm):none
ERODIBILITY: high
CHEMICAL TESTS:
pH:5.5

SAMPLE(S) TAKEN: disturbed
FIELD NOTES:

Groundwater at base.

PACIFIC PASTURES SOIL SURVEY Profile No. 3

MAP REFERENCES:
1:100 000 sheet no:9027 JERVIS BAY Scale of Mapping:1:25 000
AMG Eastings:281450 AMG Zone:56
AMG Northings:6118150
SURVEY DETAILS:
Described by: Mitchell McCotter Assoc Date:10/09/93
Site Location:MIDSLOPE ON STH BOUNDARY OF SITE
Photo taken: No of layers described: 3
Methods of exposure:auger
SOIL and MAP CODES:
Great Soil Group:YP, Yellow podzolic soil
Factual Key:Dy2.11
TOPOGRAPHY:
Slope:3%, estimated Aspect:NE
Elevation (m):35
LANDFORM:
Site Process:transportational Site Morphology:mid-slope
Landform Pattern:plain Landform Element:hillslope
VEGETATION:
Crown Sep. Ratio:sparse(0.25:1- 20:1)
Vegetation Community:dry sclerophyll forest Upper Stratum Height:12 - < 20 m
SITE CONDITION:
Ground Cover:90% Expected Dry Condition:hardsetting
Current Condition:firm
Site Disturbance:limited clearing
LITHOLOGY:
LAND USE:
Site:other
General Area:other
HYDROLOGY:
Run Off:moderate Run On:moderate
Permeability:moderately permeable Profile Drainage:well drained
Free Water Presence:none
EROSION:
none
EROSION HAZARD: moderate
SALINITY: no salting evident
FIELD NOTES:
Sandstone observed on surface.

LAYER: -1 () Depth (m): -.01 to .00

LAYER: 1 () Depth (m): .00 to .10
COLOUR: moist:2.5Y 5/3 (yellowish brown) value/chroma:2b
TEXTURE: clayey fine sand
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:weak pedality
dominant peds:2-5 mm, crumb
fabric:rough-faced peds
SOIL FAUNA ACTIVITY:
degree:low (< 10%)
type:ant channelling
COARSE FRAGMENTS:
type:charcoal amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:strongly weathered
shape:angular platy
size:fine gravel(2-6 mm)

ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):few(1-2/10x10 cm) coarse (>5 mm):few(1-2/10x10 cm)
CHEMICAL TESTS:
pH:6.0
SAMPLE(S) TAKEN: disturbed
FIELD NOTES:
Soil material only slightly moist.
BOUNDARY:
distinctiveness:abrupt (5-20 mm)

LAYER: 2 () Depth (m): .10 to .44
COLOUR: moist:10YR 5/4 (dull yellowish brown) value/chroma:2b
TEXTURE: fine sandy clay loam
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:weak pedality
dominant peds:2-5 mm, crumb
fabric:rough-faced peds
COARSE FRAGMENTS:
type:charcoal amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:strongly weathered
shape:angular platy
size:fine gravel(2-6 mm)
ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):few(1-2/10x10 cm) coarse (>5 mm):few(1-2/10x10 cm)
CHEMICAL TESTS:
pH:6.0
SAMPLE(S) TAKEN: disturbed
FIELD NOTES:
Lack of coarse fragments.
BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 3 () Depth (m): .44 to .85
COLOUR: moist:10YR 5/8 (yellowish brown) value/chroma:4
TEXTURE: clay
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds
COARSE FRAGMENTS:
type:not evident
ROOTS:
very fine (<1 mm):few(1-10/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):none coarse (>5 mm):none
CHEMICAL TESTS:
pH:5.5
SAMPLE(S) TAKEN: disturbed
FIELD NOTES:
Lack of coarse fragments.

PACIFIC PASTURES SOIL SURVEY Profile No. 4

MAP REFERENCES:
1:100 000 sheet no:9027 JERVIS BAY Scale of Mapping:1:25 000
AMG Eastings:282550 AMG Zone:56
AMG Northings:6118025
SURVEY DETAILS:
Described by: Mitchell McCotter Assoc Date:10/09/93
Site Location:MIDSLOPE EAST END OF INGLEWOOD CRES
Photo taken:both site & profile No of layers described: 3
Methods of exposure:auger
SOIL and MAP CODES:
Great Soil Group:YP, Yellow podzolic soil
Factual Key:Dy3.11
TOPOGRAPHY:
Slope:2%, estimated Aspect:N
Elevation (m):45
LANDFORM:
Site Process:transportational Site Morphology:mid-slope
Landform Pattern:plain Landform Element:hillslope
VEGETATION:
Crown Sep. Ratio:sparse(0.25:1- 20:1)
Upper Stratum Height:12 - < 20 m
SITE CONDITION:
Ground Cover:100% Expected Dry Condition:hardsetting
Current Condition:firm
Site Disturbance:limited clearing
LITHOLOGY:
Upper Solum PM:silstone/mudstone
LAND USE:
Site:other
General Area:other
HYDROLOGY:
Run Off:moderate Run On:low
Free Water Presence:none
EROSION:
none
EROSION HAZARD: moderate
FIELD NOTES:
Rural residential.

LAYER: -1 () Depth (m): -.01 to .00

LAYER: 1 () Depth (m): .00 to .10
COLOUR: moist:10YR 5/1 (brownish gray) value/chroma:2a
TEXTURE: clayey fine sand
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:weak pedality
dominant peds:2-5 mm, crumb
fabric:rough-faced peds
SOIL FAUNA ACTIVITY:
degree:low (< 10%)
type:ant channelling
COARSE FRAGMENTS:
type:charcoal amount:few(2-10 %)
distribution:dispersed orientation:reoriented
weathering:strongly weathered
shape:angular platy
size:fine gravel(2-6 mm), gravel(6-20 mm)
ROOTS:

very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):common(10-25/10x10cm)
medium (2-5 mm):common(2-5/10x10cm) coarse (>5 mm):none
CHEMICAL TESTS:
pH:6.0
SAMPLE(S) TAKEN: disturbed
BOUNDARY:
distinctiveness:clear (20-50 mm)

LAYER: 2 () Depth (m): .10 to .80
COLOUR: moist:2.5Y 5/4 (yellowish brown) value/chroma:2b
TEXTURE: light fine sandy clay loam
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds
COARSE FRAGMENTS:
type:quartz amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:sub-rounded
size:gravel(6-20 mm)
type:charcoal amount:few(2-10 %)
distribution:dispersed orientation:reoriented
weathering:strongly weathered
shape:angular platy
size:fine gravel(2-6 mm), gravel(6-20 mm)
ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):few(1-2/10x10 cm) coarse (>5 mm):few(1-2/10x10 cm)
CHEMICAL TESTS:
pH:6.0
SAMPLE(S) TAKEN: disturbed
BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 3 () Depth (m): .80 to .90
COLOUR: moist:10YR 5/8 (yellowish brown) value/chroma:4
MOTTLES: Dominant: type:weathered
munsell colour: 5YR 5/8 (bright reddish brown) colour:red
contrast:distinct abundance:10% - 20%
TEXTURE: clay loam,sandy
CONSISTENCE:
soil water status:moderately moist
STRUCTURE:
grade:moderate pedality
dominant peds:2-5 mm, polyhedral
fabric:rough-faced peds
COARSE FRAGMENTS:
type:not identified amount:common(10-20%)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:rounded tabular, sub-rounded
size:gravel(6-20 mm), coarse gravel(20-60 mm)
type:quartz amount:few(2-10 %)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:sub-rounded
size:gravel(6-20 mm)
ROOTS:

very fine (<1 mm):few(1-10/10x10cm) fine (1-2 mm):few(1-10/10x10cm)
medium (2-5 mm):none coarse (>5 mm):none

CHEMICAL TESTS:
pH:5.0

SAMPLE(S) TAKEN: disturbed

PACIFIC PASTURES SOIL SURVEY Profile No. 5 Page 1

MAP REFERENCES:
1:100 000 sheet no:9027 JERVIS BAY Scale of Mapping:1:25 000
AMG Eastings:282300 AMG Zone:56
AMG Northings:6118600
SURVEY DETAILS:
Described by: Mitchell McCotter Assoc Date:10/09/93
Site Location:LOWER SLOPE DRAINAGE DEPRESSION
Photo taken:both site & profile No of layers described: 3
Methods of exposure:auger
SOIL and MAP CODES:
Great Soil Group:PS, Prairie soil
Factual Key:Gn4.51
TOPOGRAPHY:
Slope:3%, estimated Aspect:N
Elevation (m):15
LANDFORM:
Site Process:depositional Site Morphology:open depression
Landform Pattern:plain Landform Element:drainage depression
VEGETATION:
Crown Sep. Ratio:absent
Vegetation Community:swamp complex Upper Stratum Height:1 - < 3m
SITE CONDITION:
Ground Cover:70% Expected Dry Condition:hardsetting
Current Condition:firm
Site Disturbance:extensive clearing
LITHOLOGY:
Upper Solum PM:sandstone-lithic
Substrate:sedimentary
LAND USE:
Site:other
General Area:other
HYDROLOGY:
Run Off:low Run On:moderate
Permeability:very slowly permeable Profile Drainage:very poorly drained
Free Water Presence:above soil surface Free Water Depth(m): 0.01
EROSION:
none
EROSION HAZARD: high
SALINITY: no salting evident
FIELD NOTES:
Rural residential drainage depression.
Some free water on surface near
headwater of Moona Moona Ck wetland.

LAYER: 1 () Depth (m): .00 to .44
COLOUR: moist:2.5Y 5/2 (dark greyish yellow) value/chroma:2a
TEXTURE: fibric light clay
CONSISTENCE:
soil water status:wet
STRUCTURE:
grade:moderate pedality
dominant peds:50-100 mm, polyhedral
fabric:rough-faced peds
SOIL FAUNA ACTIVITY:
degree:low (< 10%)
type:earthworm casts, ant channelling
COARSE FRAGMENTS:
type:charcoal amount:common(10-20%)
distribution:dispersed orientation:reoriented
weathering:weakly weathered

shape:angular tabular, angular platy
size:fine gravel(2-6 mm), gravel(6-20 mm)
ROOTS:
very fine (<1 mm):many(25-100/10x10cm) fine (1-2 mm):many(25-100/10x10cm)
medium (2-5 mm):none coarse (>5 mm):none
ERODIBILITY: low
CHEMICAL TESTS:
pH:6.5
SAMPLE(S) TAKEN: disturbed
FIELD NOTES:
Watertable at 5cm below surface.
BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 2 () Depth (m): .44 to .50
COLOUR: moist:2.5Y 5/3 (yellowish brown) value/chroma:2b
TEXTURE: light-medium clay
CONSISTENCE:
soil water status:wet
STRUCTURE:
grade:moderate pedality
dominant peds:50-100 mm, polyhedral
fabric:rough-faced peds
COARSE FRAGMENTS:
type:charcoal amount:very few(< 2%)
distribution:dispersed orientation:reoriented
weathering:weakly weathered
shape:angular tabular, angular platy
size:fine gravel(2-6 mm)
ROOTS:
very fine (<1 mm):common(10-25/10x10cm) fine (1-2 mm):none
medium (2-5 mm):none coarse (>5 mm):none
ERODIBILITY: low
CHEMICAL TESTS:
pH:5.5
SAMPLE(S) TAKEN: disturbed
BOUNDARY:
distinctiveness:gradual (50-100 mm)

LAYER: 3 () Depth (m): .50 to .64
MOTTLES: Dominant: type:weathered
munsell colour: 5YR 5/8 (bright reddish brown) colour:red
contrast:distinct abundance:2% - 10%
TEXTURE: medium clay
CONSISTENCE:
soil water status:wet
STRUCTURE:
grade:moderate pedality
dominant peds:50-100 mm, polyhedral
fabric:rough-faced peds
CHEMICAL TESTS:
pH:5.5
SAMPLE(S) TAKEN: disturbed

Appendix D

BRIGGS AND LEIGH CLASSIFICATION SYSTEM

Summary of Rare or Threatened Plant Classification System for Australian Plants, after Briggs & Leigh (1988).

'1' Species known only from the type collection.

'2' Species with a very restricted distribution in Australia and with a maximum geographic range of less than 100 kilometres.

'3' Species with a range over 100 kilometres in Australia but occurring only in small populations which are mainly restricted to highly specific habitats.

'X' Species presumed extinct. These have either not been found in recent years despite thorough searching, or have not been collected for at least 50 years.

'E' Endangered species in serious risk of disappearing from the wild state if present land use and other causal factors continue to operate.

'V' Vulnerable species not presently endangered but at risk over the longer period through continued depletion, or which largely occur on sites likely to experience changes in land use which threaten the survival of the species in the wild.

'R' Species which are rare in Australia but which are not currently considered to be endangered or vulnerable.

'K' Poorly known species that are suspected, but not definitely known, to belong to any of the above categories.

'C' Species known to be represented within a national park or other proclaimed reserve. The species may or may not be considered to be adequately conserved within the reserve(s).

'a' Indicates that the species is known to be adequately conserved.

'i' Indicates that the species is known to be inadequately conserved.

'-' Indiactes that its reservation status is unknown.

Appendix E

SPECIES LISTS

APPENDIX E SPECIES LISTS

Table E.1 LIST OF MAMMAL SPECIES FOR THE STUDY AREA
(Nomenclature Follows Strahan, 1991)

Common Name	Species Name	Occurrence
Short-beaked Echidna	*Tachyglossus aculeatus*	A common, widespread species which may be present in the study area
Brown Antechinus	*Antechinus stuartii*	A common, widespread species which is probably present in the study area
Long-nosed Bandicoot	*Perameles nasuta*	A moderately common species which may be present in the study area
Common Ringtail Possum	*Pseudocheirus peregrinus*	A common widespread species probably present. Recorded near Tomerong.
Sugar Glider	*Petaurus breviceps*	A common and widespread species which is probably present in the study area.
Common Brushtail Possum	*Trichosurus vulpecula*	A common, widespread species which is probably present. Recorded at Sussex Inlet.
Red-necked Wallaby	*Macropus rufogriseus*	Recorded at other locations in the district; may be present in the study area from time to time.
Eastern Grey Kangaroo	*Macropus giganteus*	Recorded at the study area.
Swamp Wallaby	*Wallabia bicolor*	Recorded at the study area. Recorded near Tomerong.
Bush Rat	*Rattus fuscipes*	A common and widespread species which is probably present in the study area.
Black Rat	*Rattus rattus**	A common and widespread exotic species which is probably present in the study area.
House Mouse	*Mus musculus**	A common and widespread exotic species which is probably present in the study area.
Rabbit	*Oryctolagus cuniculus**	Recorded in the study area.
Fox	*Vulpes vulpes**	A common and widespread exotic species probably present in the study area.
Feral Cat	*Felis catus**	A common and widespread exotic species which is probably present in the study area.

* *introduced species*

Source: Mills and Associates (1989)

Table E.2 LIST OF BIRD SPECIES FOR THE 10o GRID BLOCK 35o5'S 150o35'E, (Recorded By Kevin Mills And Associates, 1989)

Common Name	Species Name
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Eastern Yellow Robin	*Eopsaltria australis*
Jacky Winter	*Microeca leucophaea*
Golden Whistler	*Pachycephala pectoralis*
Rufous Whistler	*Pachycephala rufiventris*
Grey Shrike-thrush	*Colluricincla harmonica*
Black-faced Monarch	*Monarcha melanopsis*
Leaden Flycatcher	*Myiagra inquieta*
Rufous Fantail	*Rhipidura rufifrons*
Grey Fantail	*Rhipidura filiginosa*
Willie Wagtail	*Rhipidura leucophrys*
Superb Fairy-wren	*Malurus cyaneus*
Variegated Fairy-wren	*Malurus lamberti*
Southern Emu-wren	*Stipiturus malachurus*
Origma	*Origma solitaria*
White-browed Scrub wren	*Sericornis frontalis*
Brown gerygone	*Gerygone mouki*
Brown Thornbill	*Acanthiza pusilla*
Buff-rumped Thornbill	*Acanthiza reguloides*
Yellow Thornbill	*Acanthiza nana*
Striated Thornbill	*Acanthiza lineata*
White-throated Treecreeper	*Climacteris leucophaea*
Red Wattlebird	*Anthochaera car unculata*
Little Wattlebird	*Anthochaera chyrsoptera*
Noisy Friarbird	*Philemon corniculatus*
Lewin's Honeyeater	*Meliphaga lewinii*
Yellow-faced Honeyeater	*Lichenostomus chrysops*
White-eared Honeyeater	*Lichenostomus leucotis*
White-naped Honeyeater	*Melithreptus lunatus*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Tawny-crowned Honeyeater	*Phylidonyris melanops*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Mistletoebird	*Dicaeum hirundinaceum*
Spotted Pardalote	*Pardalotus punctatus*
Silvereye	*Zosterops lateralis*
House Sparrow*	*Passer domesticus*
Red-browed Firetail	*Emblema temporalis*
Common Starling*	*Sturnus vulgaris*
Common Mynah*	*Acridotheres tristis*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Grey Butcherbird	*Cracticus torquatus*
Pied Currawong	*Strepera graculina*

Table E.2 LIST OF BIRD SPECIES FOR THE 10o GRID BLOCK 35o5'S 150o35'E, (Recorded By Kevin Mills And Associates, 1989) (Continued)

Common Name	Species Name
Gang-gang Cockatoo	*Callocephalon fimbriatum*
Rainbow Lorikeet	*Trichoglossus haematodus*
Australian King-Parrot	*Alisterus scapularis*
Eastern Rosella	*Platycercus eximius*
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*
Southern Boobook	*Ninox novaeseelandiae*
White-throated Needletail	*Hirundapus caudacutus*
Sacred Kingfisher	*Halcyon sancta*
Dollarbird	*Eurystomus orientalis*
Welcome Swallow	*Hirundo neoxena*
Whistling Kite	*Haliastur sphenurus*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Wedge-tailed Eagle	*Aquila audax*
Purple Swamphen	*Porphyrio porphyrio*
Masked Lapwing	*Vanellus miles*
Eastern Curlew	*Numenius madagascariensis*
Silver Gull	*Larus novaehollandiae*
Crested Tern	*Sterna bergii*
Topknot Pigeon	*Lopholaimus antarcticus*
Spotted Turtle-Dove*	*Streptopelia chinensis*
Emerald Dove	*Chalcophaps indica*
Brush Bronzewing	*Phaps elegans*

* *Introduced species.*

Source: Mills and Associates, 1989.

Table E.3 BAT SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Common Name	Species Name	Habitat Requirements
Yellow-bellied Sheathtail Bat	*Taphozous flaviventris*	❑ roosts in tree hollows found in abandoned nests of Sugar Glider ❑ Forages above the canopy of the Eucalypt forest
White Striped Mastriff-Bat	*Tadarida australis*	❑ roosts in tree hollows ❑ occupies a diverse range of habitats ❑ forages above the tree canopy for insects
Gould's Long-eared Bat	*Nyctophilus gouldi*	❑ roosts in tree hollows ❑ occupies range of habitats ❑ forages on flying insects ❑ winter torpor
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	❑ wide ranging and abundant ❑ adapted to presence of humans ❑ roosts in a variety of habitats ❑ forages for insects near the ground ❑ winter day time torpor
Gould's Wattled Bat	*Chalinolobus gouldii*	❑ roosts in a variety of habitats ❑ forages for insects
Chocolate Wattled Bat	*Chalinolobus morio*	❑ roosts in tree hollows ❑ winter torpor ❑ forages for insects
*Greater Broad nosed Bat	*Nycticeius rueppellii*	❑ roosts in tree hollows ❑ forages for beetles, insects small vertebrates
Little Broad nosed Bat	*Nycticeius greyii*	❑ roosts in tree hollows and disused buildings ❑ usual habitat open woodlands and plains ❑ waterholes and creeks foraging areas
*Great Pipistrelle	*Pipistrellus tasmaniensis*	❑ roosts in tree hollows ❑ forages on moths beetles and ants ❑ possible winter torpor
Little Forest Eptesicus	*Eptesicus vulturnus*	❑ roosts in tree hollows known to share roosts with possums and birds ❑ occupies a range of habitats from sclerophyll forest to desert ❑ forages for insects ❑ sinter torpor

Source: Strahan, 1991