EIS 1041

AB019751

Lismore to Mullumbimby 132kV transmission line : environmental impact statement

EIS 1041

NSW DEPT PRIMARY INDUSTRIES
AB019751

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Lismore to Mullumbimby 132kV Transmission Line

Environmental Impact Statement

DEPARTMENT OF
RAL RESOURCES
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PacificGrid

October 1994

Prepared by
SINCLAIR KNIGHT MERZ

Clause 59 Certificate

PacificGrid

LISMORE TO MULLUMBIMBY
132 kV TRANSMISSION LINE

ENVIRONMENTAL IMPACT STATEMENT
prepared under the
ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979

This is to certify that this Environmental Impact Statement has been prepared in accordance with Clause 57 and 58 of the Environmental Planning and Assessment Regulation of 1980.

M. Jamieson

Signature
Margot Jamieson
Sinclair Knight Merz

23.9.94.

Date

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Summary

Summary

Project Overview

The population of the Lismore, Ballina and Byron areas has nearly doubled to 100 000 since 1976. It is predicted to almost double again in the next 25 years.

Despite on-going substantial demand management programs by Northern Rivers Electricity (NRE), the community's demand for electricity is expected to continue to increase with the projected population growth. Without augmentation of the electricity supply system, power shortages and interruptions to supply will occur in this region.

Pacific Power needs to augment the supply of electricity to its customers in the Far North Coast of NSW. To do this, it proposes to construct a new transmission line between Lismore and Mullumbimby on the Far North Coast of NSW.

The development involves the replacement of the existing single circuit 66 kV (66 000 volts) line with a new double circuit pole line. Both circuits will initially operate at 66 kV. As electricity demand further increases, one circuit will be operated at 132 kV. This is expected to occur in 2001.

In response to this need, PacificGrid commissioned Sinclair Knight Merz to prepare an Environmental Impact Statement (EIS) for the proposed transmission line project. This document represents the culmination of a number of previous studies including a Route Options Study prepared in 1993 as well as detailed environmental investigations undertaken in preparing the EIS.

The community has been closely involved with the proposal from the early stages of the preparation of the Route Options Paper (ROP) and have been consulted throughout the EIS process. Community concerns have been considered in the selection of the preferred route option (the proposed Reconstruction Option) and in the preparation of the EIS.

The results of these studies are documented in the EIS and are summarised below.

Objectives of the Proposed Development

The principal objectives of the proposed development are to:

- ensure that a reliable and quality supply of electricity is maintained to the people in the Lismore, Ballina and Byron areas
- take into account community attitudes and expectations with respect to the preservation of the environment

- comply with legislative requirements covering environmental protection and management by employing environmentally responsible construction and maintenance techniques.

Description of the Proposed Works

The route of the proposed line generally follows the existing 66 kV transmission line route and no major vegetation removal is anticipated.

The proposed line will consist of single and two pole structures, with a typical height of 25 metres and with 6 conductors and 2 earth wires. The cost of construction is estimated at $4.5 million.

The proposed works include:

- construction of access tracks (where existing tracks are inadequate)
- vegetation control within the easement
- installation of pole structures
- stringing of conductors and earthwires
- dismantling of the existing line, and
- rehabilitation works.

The construction workforce, which will consist of approximately 25-30 contractor personnel and six PacificGrid personnel will be housed in the local area.

Once the transmission line is completed and comes into operation, maintenance patrols will make regular inspections of the line and the easement. The maintenance program will incorporate both ground and air patrols.

Environmental Impacts of the Proposed Transmission Line

The principal environmental issues have been identified through community consultation combined with a series of specialist studies undertaken within the study area.

The impacts on the environment associated with the proposed transmission line are summarised below.

- **Land Use**

The effects of the proposed transmission line on the existing land use will generally be low, since the existing line already impacts on the area, and the proposed line follows this alignment along the majority of the route. Where deviations from the existing route are proposed, no significant changes in landuse on the new route will occur. Grazing and horticultural activities will be able to continue in accordance with

PacificGrid easement guidelines. Specific land management matters for each property affected will be addressed in discussions between landholders and PacificGrid.

- **Flora**

The existing line is located in an area which supports a high diversity of plant species and one of the highest concentrations of rare or threatened plant species in Australia. The majority of these are associated with rainforests. Active regeneration of rainforest stands has been undertaken in the area. Due to the disturbed nature of the vegetation underneath the existing line, the proposed line is unlikely to result in additional significant impact. The main impacts of the proposed line on flora are those associated with vegetation control in the easement and on access tracks. The impacts of the proposed line on the flora of the area will be minimised by careful siting of poles and access tracks, helicopter stringing of conductors and sympathetic vegetation control. Where vegetation removal is required for the proposed line, supplementary planting programs will be investigated with property owners and appropriate authorities.

- **Fauna**

Fauna currently inhabiting the vicinity of the existing line has the potential to be affected by the construction of the line if significant amounts of habitat are removed. The fauna along the route of the transmission line is rich and varied, and during the fauna surveys seven species of vulnerable and rare fauna were recorded. With the recommended mitigation measures, it is not anticipated that any species affected by the proposed line will become non-viable. Further, the measures adopted will ensure that there is no adverse effect on the survival of any protected or endangered fauna.

- **Aboriginal Archaeology and European Heritage**

From the work undertaken to date, no sites of Aboriginal archaeological or European heritage significance are likely to be affected by the proposed construction.

- **Noise**

During construction and maintenance, localised and short-term noise associated with vehicles, machinery and helicopter stringing will occur. Minor blasting for foundations may also be required at some locations. Generally, the recommended EPA construction noise criteria will be met. However, in instances where residences are located close to the construction activities, the criteria may be exceeded for short periods.

☐ **Air Quality**

During construction, minimal dust and vehicle emissions will be generated by the construction activities. Such emissions will not have a significant impact on the environment. Once operational, the transmission line will have no measurable impact on the area's air quality.

☐ **Visual**

The visual impacts of the proposed line will be of a similar nature to the impacts associated with the existing line. Increased visual impacts associated with the line will occur due to the installation of taller structures and eight rather than three wires. A reduction in the visual impacts will result from a decrease in the number of structures and improved design features including painting of structures and using conductors of dull finish.

☐ **Electric and Magnetic Field Effects**

Electric and magnetic fields fall off rapidly with increasing distance from transmission line conductors. The field levels of the proposed line will be low and similar to those of the existing line.

☐ **Social Impacts**

The social impacts of the proposed line will be mainly beneficial. The line will ensure a more reliable electricity supply to the region, to provide for the growing population. To minimise any impact to property owners, PacificGrid will liaise with all property owners affected by the proposed line to discuss construction and on-going maintenance. Compensation will be paid for easement rights which will be acquired. Any damage will be made good or, alternatively, payment will be made to the owner. Design and construction safeguards will ensure that impacts on residential amenity are minimised along the length of the proposed line. While some limitations will be placed on activities within the easement, residential amenity will not be substantially impaired.

Conclusion

The proposed replacement of the existing 66 kV Lismore to Mullumbimby transmission line with a new double circuit line provides the best solution to meet growing electricity needs of the community. Its implementation would have beneficial implications to future growth and development in the area. The environmental impacts of the proposed line are similar to those of the existing line. The impacts will be mitigated through consultation with affected landholders and by measures adopted and suitable environmental management during construction and maintenance of the line.

1

Introduction

1. Introduction

This Section provides background information on the proponent, an outline of the proposed development and its regional setting. The environmetnal approval process and consultation program are also described.

1.1 Project Outline

The demand for electricity in the Lismore, Byron and Ballina areas is growing as the population in the region increases. To meet this growing demand, PacificGrid proposes to construct a double circuit transmission line which will replace the existing 66 kV transmission line between Lismore and Mullumbimby. Initially both circuits will operate at 66 kV. As electricity demand increases, one circuit will be operated at 132 kV. This stage is expected to occur in 2001.

The existing transmission line runs from the Lismore 132/66 kV Substation, located approximately 3 km west of Lismore, to a point in the vicinity of the Mullumbimby Power Station at Lavertys Gap, some 5 km southwest of Mullumbimby.

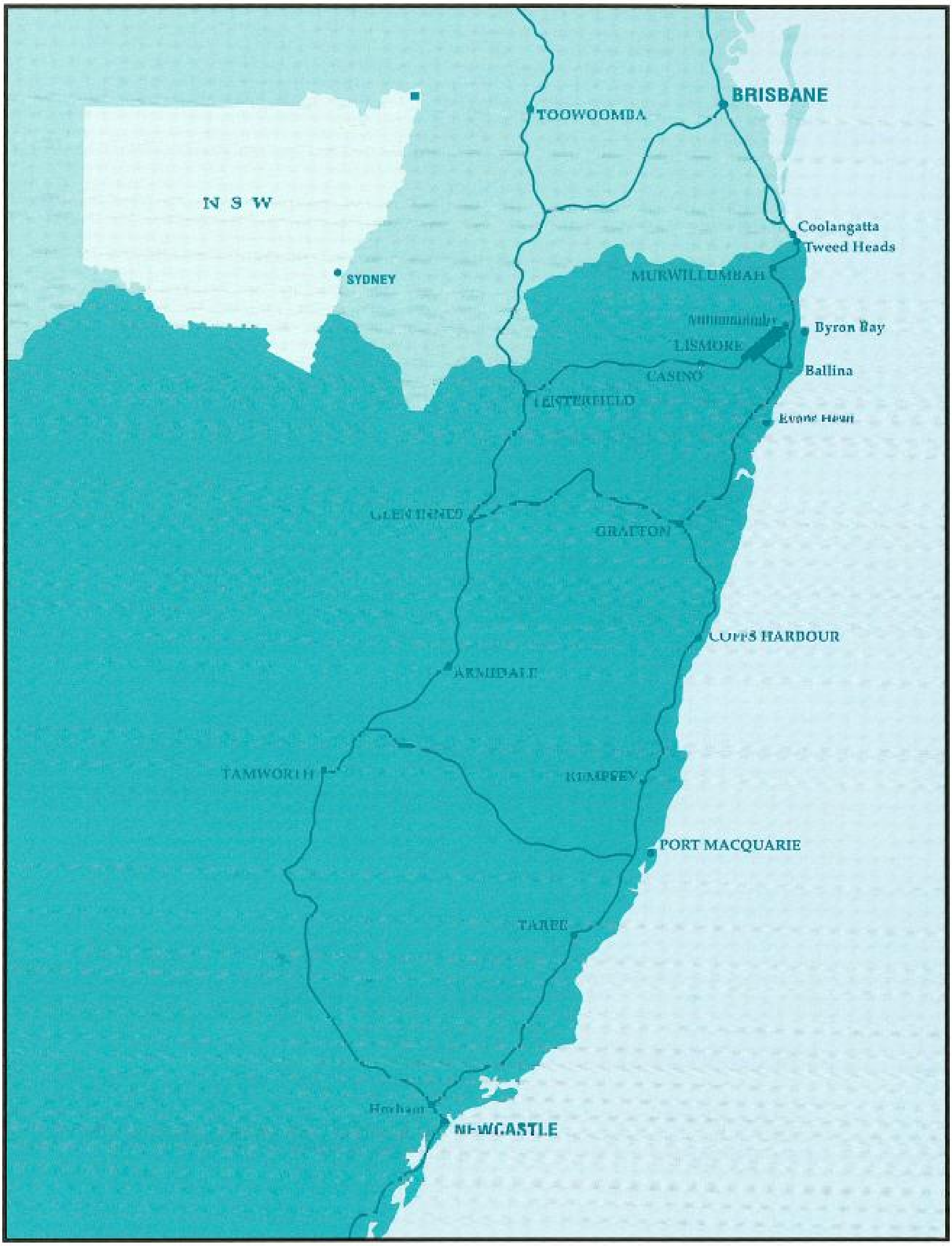
The proposed transmission line will be approximately 37 km long and will generally follow the route of the existing 66 kV line. A nominal route alignment within a bandwidth has been identified and is described in Section 4. The bandwidth represents the extent of deviations from the nominal centre line that may be incorporated in the detailed siting of the line to take into account local factors such as buildings, vegetation, property boundaries and issues emerging from negotiations with property owners.

The proposed line will be constructed using mostly single pole structures, with some two pole structures. The construction cost is estimated at $4.5 million.

1.2 Regional Setting

The area between Lismore and Mullumbimby is located on the northern portion of the Lismore plateau (see **Figure 1.1**). This plateau is a moderately to highly dissected plateau of basaltic material derived from lava flows from the original Mount Warning volcano. With a moderate climate and good volcanic soils, the area contains highly productive and valuable agricultural land.

The transmission line corridor is located south of the steep and elevated terrain of the Nightcap Range and Whian Whian State Forest; areas of a high conservation significance. The coastal escarpment, which forms the edge of the plateau, is located to the east of the corridor and joins the coastal plain. The largest centre in the district is Lismore, located at the



Legend

Study Area

N

0 100km

Figure 1.1
REGIONAL LOCATION

southwestern extremity of the transmission line corridor, with a population of 27 500. Other towns and localities near the transmission line include Booerie, Tullera, Modanville, Dunoon, Repentance Creek and Goonengerry.

While the land was originally covered by the "Big Scrub" rainforest, much of the area was extensively cleared in the late 19th century and is now used for grazing, cropping, various horticultural pursuits and residential dwellings. Small patches of forest remain scattered throughout the landscape, typically on sites which were too steep for traditional agricultural practices or on sites which were reserved for historical reasons.

1.3 The Proponent

The proponent of the proposed 132 kV transmission line from Lismore to Mullumbimby is PacificGrid Pty Ltd.

As from 1 July 1994, Pacific Power's electricity transmission network has been vested in PacificGrid Pty Ltd. PacificGrid Pty Ltd is a wholly-owned subsidiary of Pacific Power. Responsibility for operating, maintaining and developing the network, for acquiring easements necessary for transmission lines, and for constructing new lines now rests with PacificGrid Pty Ltd.

1.4 Project Objectives

The principal objectives of the proposed development are to:

- ensure that a reliable and quality supply of electricity is maintained to the people in the Lismore, Ballina and Byron areas

- take into account community attitudes and expectations with respect to the preservation of the environment

- comply with legislative requirements covering environmental protection and management by employing environmentally responsible construction and maintenance techniques.

1.5 History of Project

In the mid 1980's, annual growth in electricity demand in the area was approximately 7% compared with a State average of 3%. This rate was expected to continue and it was considered that the existing electricity distribution system servicing the area would need strengthening by early 1991.

The Electricity Commission of NSW proposed the construction of a Lismore to Mullumbimby 132 kV transmission line, which was the subject of an EIS exhibited in 1987.

The economic downturn, coupled with successful demand management initiatives and 66 kV development activities by Northern Rivers Electricity (NRE), resulted in the peak demand growth projected in the EIS not occurring as quickly as forecast. As a result, construction of the proposed transmission line was deferred.

While the growth in demand has remained much higher than the State average, it has been possible to continue to supply electricity to the area, albeit with a lower level of reliability than is considered desirable. With continuing population growth, the quality and reliability of electricity supply will deteriorate to unacceptable levels after 1997. A new transmission line is required to ensure a reliable supply of the electricity to the region.

Since the preparation of the 1987 EIS, a number of changes to environmental assessment procedures, local planning issues and land use have taken place. In 1992, the *Guidelines for the Development of Electricity Systems - Community and Environmental Considerations* were introduced.

In view of these changes and the time that had passed since 1987, PacificGrid has prepared a new EIS, preceded by a community consultation program to assist in the development and evaluation of possible route corridors for the transmission line.

1.5.1 Route Options Paper

On 17 May, 1993 it was announced that a new EIS would be prepared. Studies and community consultation were then undertaken to identify possible route options for the proposed transmission line. The study area for the Route Options Paper (ROP) is shown in **Figure 1.2**. A more detailed discussion of the routes identified by the ROP is given in Section 3 and **Appendix E** of this EIS.

1.5.2 Selection of Preferred Corridor

Following public exhibition of the ROP in November and December 1993 and consideration of the submissions received, the reconstruction of the existing transmission line was chosen as the preferred route option. The alternatives considered and the reasons for the choice of the preferred route are discussed in Section 3.

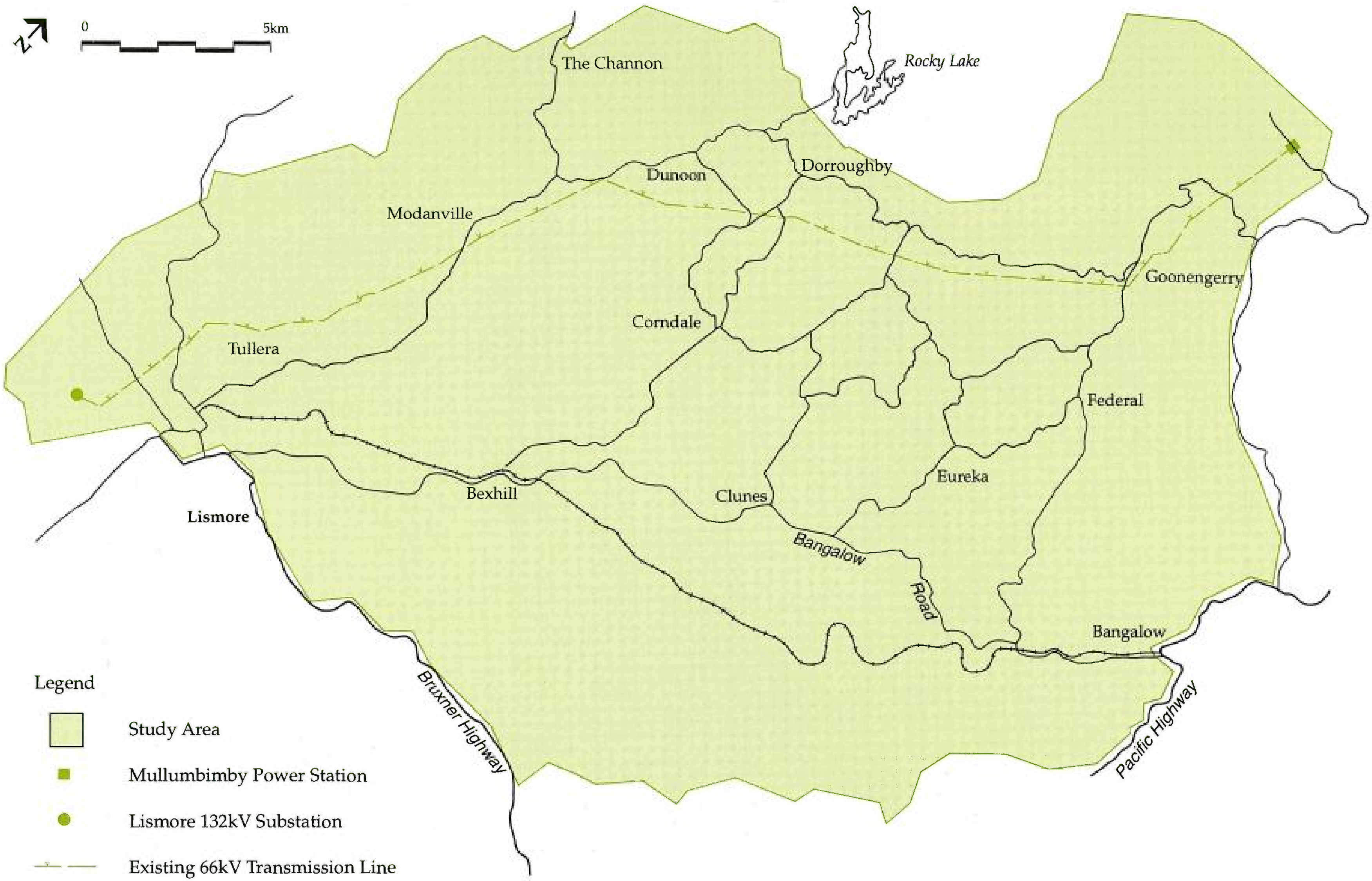


Figure 1.2
ROUTE OPTIONS STUDY AREA

1.6 The Environmental Impact Statement and Statutory Requirements

This EIS assesses the environmental impacts associated with the proposed 132 kV transmission line from Lismore to Mullumbimby, and recommends measures to reduce the social and environmental impacts of the proposal. The purpose of this EIS is to provide a clear understanding of the environmental impacts of the proposed transmission line.

State Environmental Planning Policy No.4 allows for developments by certain public utilities, including electricity transmission lines, to be carried out under Part 5 of the Environmental Planning and Assessment (EP&A) Act, 1979. Under Part 5 of the EP&A Act, consent of local government is not required. PacificGrid is responsible for the examination of the environmental impact and is the Determining Authority.

Under Part 5 of the EP&A Act, 1979, PacificGrid is required to prepare an EIS for activities which are likely to significantly impact on the environment (Section 112). The EP&A Act requires that the EIS be prepared in accordance with Clause 57 and 58 of the Environmental Planning and Assessment Regulation, 1980, as amended. The form and content of this EIS meet these requirements.

The issues to be addressed and the Sections of this document in which they are found are shown in **Table 1.1**.

In accordance with the EP&A Act, the Director of the Department of Planning was consulted regarding the form and content of the EIS and the "Director's Requirements" are provided in **Appendix A** of this document.

The legislation requires the EIS to be placed on public exhibition. During the exhibition period, submissions are invited from authorities and members of the community. These will be considered by PacificGrid and will also be forwarded to the Department of Planning in accordance with requirements of the EP&A Act. Following consideration of the submissions, PacificGrid will examine and consider the EIS and all matters raised in submissions, together with any subsequent information received, prior to making a final decision with respect to the project. The final decision and responses to issues raised during the exhibition period will be incorporated into a detailed assessment report, known as a "Determining Authority's Report".

Table 1.1 - Matters to be addressed in the EIS

	Matter to be addressed, as specified in Clause 57 of the Environmental Planning and Assessment Regulation	EIS Section
a.	A full description of the proposed activity	4
b.	A statement of the objectives of the proposed activity	1
c.	A full description of the existing environment likely to be affected by the proposed activity if carried out	5, 6, 7
d.	Identification and analysis of the likely environment interactions between the proposed activity and the environment	5, 6, 7, 8, 9
e.	Analysis of the likely environmental impacts or consequences of carrying out the proposed activity (including implications for use and conversion of energy)	5, 6, 7, 8, 9
f.	justification of the proposed activity in terms of environmental, economic and social considerations	2
g.	Measures to be taken in conjunction with the proposed activity to protect the environment and an assessment of the likely effectiveness of those measures	5, 6, 7, 8, 9
g1.	Detail of energy requirements of the proposed development and measures to be taken to conserve energy	4
h.	Any feasible alternatives to the carrying out of the proposed activity and the reasons for choosing the latter	2
i.	Consequences of not carrying out the proposed activity	2

1.7 Community Consultation

1.7.1 Consultation During the Route Selection Process

During the corridor selection process and the preparation of the ROP, a range of public agencies, individuals and community groups were consulted regarding their views on the proposed development. A description of the agency and community consultation process in this stage of the project is given in Section 3 and **Appendix E** contains a summary of the responses from the public agencies.

1.7.2 Consultation During EIS Preparation

During the preparation of the EIS, consultation with public agencies and the community directly affected by the proposed route bandwidth continued. During the initial phases of the EIS process, the Information Centre in the Strand Arcade at Lismore remained open.

The "toll free" number set up during the preparation of the ROP remained and PacificGrid personnel were available for consultation.

Various studies were carried out along the route on individual properties. In addition, concerns and issues about with the impact of the transmission line were discussed with landholders along the line.

Discussions with numerous individuals were held by both PacificGrid and Sinclair Knight Merz. In addition, meetings were organised with groups of affected residents along the line. Meetings with the following groups occurred during the course of the EIS:

□ Goonengerry residents	July 1994
□ Tullera residents	July 1994
□ Modanville School Community	August 1994
□ Booerie Creek residents	August 1994
□ Lavertys Gap residents	August 1994

A summary of the responses from public agencies consulted during the EIS preparation is contained in **Appendix B**.

1.8 Fauna Impact Statement

In accordance with the National Parks and Wildlife Service Act 1991, PacificGrid has prepared a Fauna Impact Statement (FIS) for the proposed line. The Act requires the FIS to be placed on public exhibition. Members of the community and authorities will be invited to make submissions. The National Parks and Wildlife Service (NPWS) will consider these submissions in reaching its decision on the FIS.

2

Project Justification and Alternatives

2. Project Justification and Alternatives

This section provides details of the need for the project and the alternatives considered to address the need.

The Far North Coast region offers a diverse range of enjoyable, productive and creative lifestyles within a complex and rich natural environment and is the fastest growing area of the state. As a result of rapid population growth, it is now necessary to augment the electricity network in the Lismore/Byron areas.

The System Development Discussion Paper (SDDP), issued in May 1993, provided extensive detail on the planning and justification for the proposed development. In addition to network development options, alternatives involving demand management (DM), local generation and local renewable energy sources were considered. It was concluded that the construction of a new 132 kV transmission line from Lismore to Mullumbimby will overcome existing deficiencies in the local electricity supply system and provide for future needs in the medium and long term, ensuring that local customers have an electricity supply equal to that of the rest of the state. DM programs will be continued and some utilisation of small-scale renewable energy is also assumed.

Following extensive community consultation with regard to the SDDP and route options, the proposed project, based on the reconstruction of an existing line, was formulated to meet the long term electricity needs of the area in an environmentally sensitive manner.

2.1 Electricity Supply Planning

2.1.1 Essentials of Electricity Supply

Electricity supply authorities aim to provide a safe, reliable and sufficient electricity supply of suitable quality in the most cost-effective manner. Safety is achieved by appropriate design and compliance with Statutory Regulations including structural and electrical safety aspects. The latter include the maintenance of safe electrical clearances over ground and other services as discussed in Section 4. A supply is reliable when the risk of interruptions to supply is low. The supply is sufficient when there is sufficient generation capacity to meet the needs of all customers and when the grid can supply the customers' demands at all times without overloading any of the transmission lines or substation equipment. Grid equipment ratings are discussed in **Appendix C** of this document. A supply of suitable quality has the correct voltage, low levels of harmonics (interference) and small voltage fluctuations with changing loads. Reliability and quality of supply were discussed in the SDDP (**Appendix B**).

Three basic problems can cause an electrical network to become deficient:

- Every transmission line has a heating limit which restricts the amount of electricity (power) it can carry. Above this limit, under hot, calm weather conditions, the conductors heat up to an excessive temperature, which could lead to damage of the conductor, and they may sag below the minimum safe clearance to ground.

- If transmission lines are required to carry too much power over a long distance, the voltage level at the remote end may fall below the acceptable minimum. If unacceptably low voltage levels are sustained, the customer's electrical equipment or appliances may function poorly or not at all, and could burn out or suffer other damage.

- All substations have a power supply limit. If this limit is exceeded equipment failures may occur due to overheating. This would result in widespread and prolonged loss of electricity supply.

The onset of any of these conditions requires restrictions on electricity use or interruptions to supply at times of high community need. More details are provided in **Appendix C**.

2.1.2 The Planning Process

Regular liaison is maintained between PacificGrid and Northern Rivers Electricity (NRE) in order to better understand the needs of electricity customers and to examine proposals for the development of the network. This liaison or joint planning activity is formalised through an annual meeting of the Joint Planning Committee (JPC). This process is strongly supported by the management of both organisations and has initiated most of the major programs and projects for the network.

The joint planning process develops and investigates the many alternatives for electricity supply. It aims to develop options which are acceptable with regard to technical, environmental and economic considerations and which optimise the nett benefits to the community as a whole. Bulk supply forecasting and economic analysis of alternative developments are discussed in **Appendix C** of this EIS.

Forecasts of future electricity needs are updated annually, resulting in regular reviews of any future works. PacificGrid and NRE will defer (or advance) construction of new works where necessary, or re-evaluate projects to meet the community's needs.

Both NRE and PacificGrid are committed to the advancement of DM programs and a subcommittee of the JPC (the DM Working Group) has the role of supporting existing initiatives and developing others. Practical programs are being conducted by NRE. PacificGrid supports the program development, assists with promotional material and with the evaluation of programs, and provides expert technical advice in specific areas.

PacificGrid and NRE have jointly assessed the future electricity supply needs of the local communities in the Far North Coast region. This has resulted in a load forecast for the Lismore/Ballina/Byron Area and a careful analysis of the deficiencies of the existing supply system.

Two separate and basic deficiencies have been identified:

- an inadequate 66 kV network, unable to meet the needs of the growing number of customers, and

- a 132 kV supply adequate only until the early 2000s.

To minimise the number of new lines and the resulting environmental impact, and overall cost in the long term, the reinforcement of NRE's network has been incorporated into the plans for strengthening the 132 kV network.

2.1.3 Increasing Electricity Demands

The demand for electricity in the area supplied by Lismore 132/66 kV Substation has steadily increased, generally in line with population growth in this part of the Far North Coast region.

In recent years, the Byron, Ballina and Lismore local government areas (LGA's) have experienced a rapid growth in population (from 55,400 in 1976 to nearly 98,000 in 1993), mainly due to migration from other areas of New South Wales and other states. This migration has accounted for more than 80% of the coastal population growth. (Population figures have been obtained from the Australian Bureau of Statistics (ABS) and the Department of Planning).

The population of the Far North Coast is expected to almost double in the next 25 years, according to the North Coast Population and Development Monitor. Estimates by the Department of Planning indicate that the growth rate for the next ten years will be about 2.5% per year.

The average demand per customer in the area is commendably low, at just over 1 kW per customer. This is less than 70% of the present State average. Various active DM measures and tariff incentives have already been employed by Northern Rivers Electricity (NRE) to reduce demand growth and these will be further pursued in the future.

As part of the DM program, the ability of the electricity network to meet customer needs has been extended through the use of off-peak energy and energy conservation measures. Local consumers and NRE have actively and extensively shifted electricity consumption to off-peak periods, particularly water heating. More details of DM programs are given in Section 2.6.

The growth in the community's demand for electricity is expected to continue to rise with the projected population growth, although the rate of increase could slow down, compared with current patterns. Present projections indicate a need to supply an additional 3 000 kW of peak demand each year.

The growth in the demand for electricity requires additions to the transmission network to maintain a safe, sufficient and reliable supply of suitable quality at all times.

2.2 The Existing Network and its Deficiencies

2.2.1 The Existing Network

As shown in **Figure 2.1**, the main electricity grid in New South Wales currently extends to Lismore 330/132 kV Substation which is connected to Hunter Valley power stations by high voltage, high capacity transmission lines via Tamworth and Armidale. Lismore 330/132 kV Substation was completed in December, 1992 and is located between Casino and Lismore. Lismore 132/66 kV Substation, near Lismore itself, is then supplied via three 132 kV transmission lines from Lismore 330/132 kV Substation.

At Lismore 132/66 kV Substation, PacificGrid provides supply to NRE which distributes electricity to the Casino, Lismore, Richmond River, Kyogle, Ballina and Byron LGA's via a 66 000 volt (66 kV) sub-transmission network. Lismore 132/66 kV Substation and the associated NRE network service a resident population in excess of 120 000.

Electricity is supplied from Lismore over a network of 66 kV lines which form a " ring " system as shown in **Figure 2.2**. However, sections of existing NRE 66 kV sub-transmission lines that supply Ballina, Dunoon and Ewingsdale Zone Substations are old and of limited electric current carrying capacity. These lines need to be upgraded or relieved by the construction of new lines to share the load.

To reduce the risk of electricity restrictions or interruptions in the affected areas, NRE has carried out network reinforcement works so that supply can be provided to local areas over alternative routes when a line has to be taken out of service. These works complement the proposed 132 kV development and reduce the overall cost of providing electricity to the community.

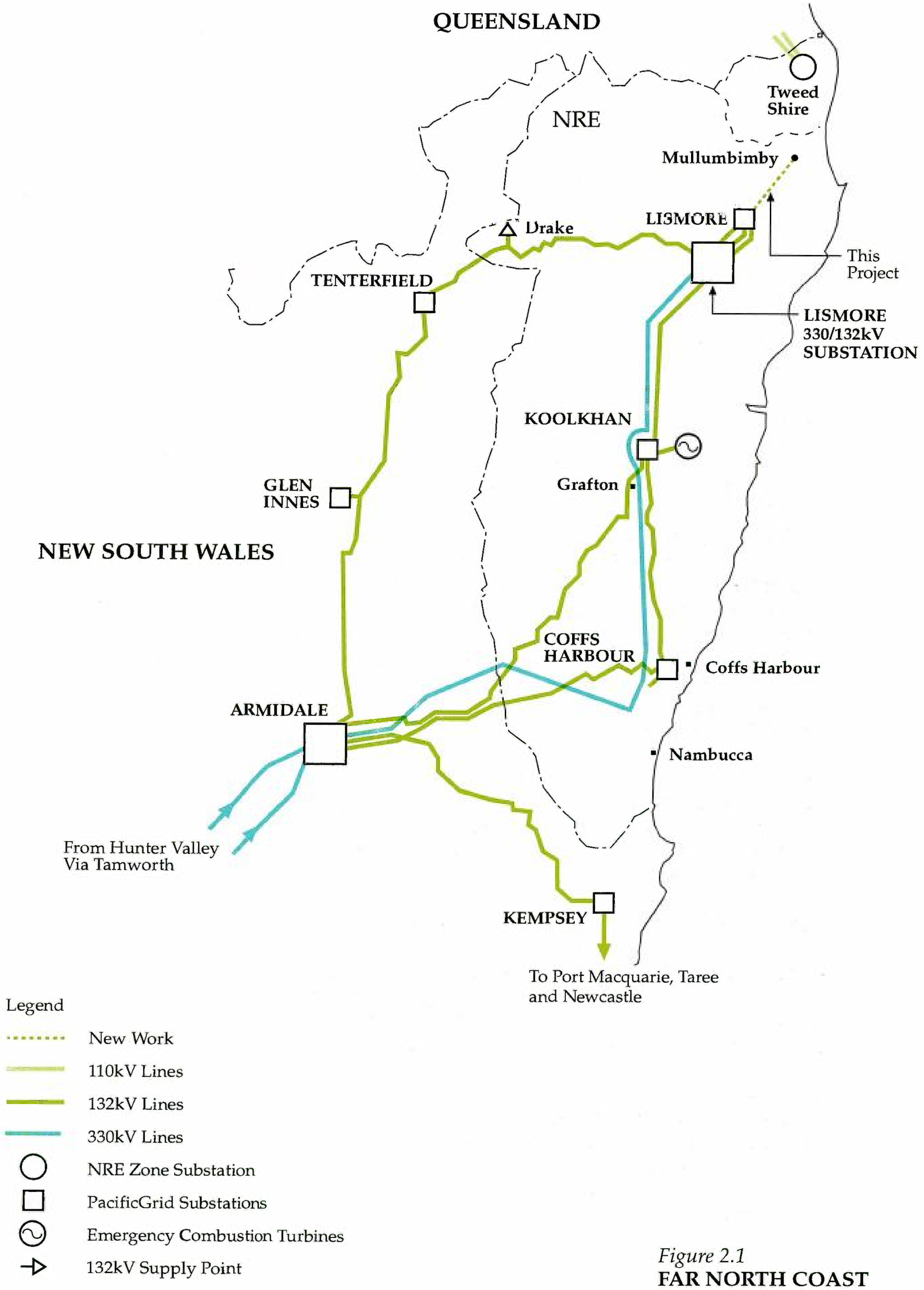


Figure 2.1
FAR NORTH COAST TRANSMISSION SYSTEM

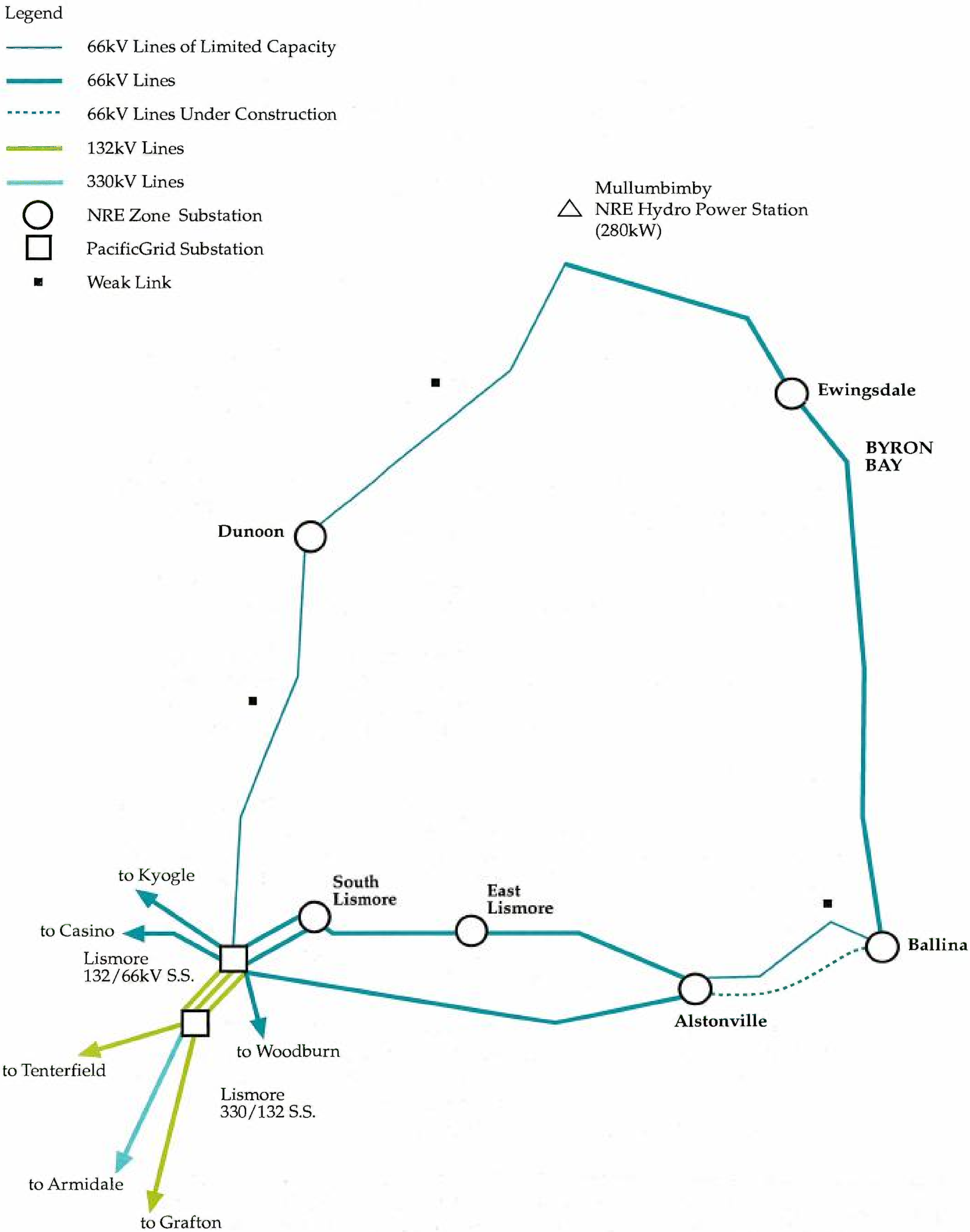


Figure 2.2
NORTHERN RIVERS ELECTRICITY 66kV SUBTRANSMISSION SYSTEM

NRE has also implemented extensive DM programs that have reduced the severity of the network problems, though not eliminating them.

Transmission works carried out by NRE to strengthen sectors of the ring network in recent years include:

- the establishment in 1991 of Dunoon 66/11 kV Zone Substation, required to service growing electricity use in Dunoon and surrounding areas, and

- the completion of a 66 kV line between Ballina and Ewingsdale, to provide greater security and reliability of electricity supply to thousands of customers. This will also cater for future development.

The most recent NRE development project which will reinforce the ring is a new 66 kV line between Alstonville and Ballina, which are still linked by a low capacity line of low reliability. Looking ahead after the completion of this link, it is considered appropriate to plan on the basis of:

- continued significant population growth as predicted by relevant agencies, although possibly at lower rates than in recent years, and

- continuing success obtained from current and new DM, energy conservation and appliance efficiency initiatives, enabling demand growth to be limited to the growth in population or less, despite an expanding use of electrical appliances by many customers.

2.2.2 Deficiencies

While PacificGrid has improved the supply by extending the NSW 330 kV main grid into the Lismore area, the electricity supply to the Ballina and Byron LGA's and to rural areas between Lismore and the coast remains below the standard enjoyed by the rest of the region and the state.

The area's continuing development and population growth mean that parts of the 66 kV ring are now carrying more electricity than they were designed to deliver and the situation will get worse as growth continues.

There are already hot summer days when there is a risk that the existing 66 kV network (with all lines and equipment in service) will not be able to meet the expected maximum demand. That is, the conductors of some older lines are too small and are not designed to carry the required current at or near times of high electricity use.

This condition in summer could cause the weaker lines in the ring (Lismore - Dunoon - Lavertys Gap and Alstonville - Ballina) to become overloaded and customers would have to be disconnected from the electricity supply network.

The existing 66 kV lines in the ring cannot supply electricity under all system and load conditions at the correct voltage for motors and appliances to work safely. If the ring is broken at times of high demand, there will not be enough voltage at the end that is remote from the 132 kV supply point at Lismore. For this reason, supply to groups of customers may have to be switched off when a line, in a distant part of the network, fails and remains out of service. This would be necessary to prevent damage to customers' equipment and to avert the possibility of conductors sagging below the statutory clearance.

Blackouts from this cause are most likely to affect customers receiving electricity supply via the weaker links in the ring; that is, in the Ballina and Dunoon areas and those supplied from Ewingsdale (Byron Bay, Mullumbimby and Federal/Rosebank).

Because of the deficiencies of the existing ring network there is a substantial and increasing risk of supply interruptions becoming necessary at times of high electricity needs. These interruptions would be required to avoid low voltage levels at the customer end and/or line overloading.

There are now only limited times during the year when each of the lines can be taken out of service for maintenance without interrupting electricity supplies to some local areas. This means that NRE has considerable difficulty in scheduling essential maintenance and repairs, leading to increased costs and some increased risk of interruption to supply.

2.3 Short, Medium and Long Term Solutions

A short term solution to the supply problems of the area would be the strengthening of NRE's existing Lismore - Dunoon - Ewingsdale 66 kV transmission line up to Lavertys Gap. A reinforced 66 kV ring network would then be formed between the Lismore, Ballina and Mullumbimby areas.

With the expected high growth in population and associated electricity demand this reinforced 66 kV ring network would only be able to supply the Ballina, Byron Bay, Dunoon and Mullumbimby areas for a few more years until voltage limitations would again be reached. Additional 66 kV lines or a 132 kV line would then be required. These new lines would require routes, would have a significant environmental impact and would add significant cost to the local community, as NRE has to recover the cost of its projects via the tariffs paid by all its customers.

System strengthening at 66 kV would not relieve the increasing demand for electricity placed on the Lismore 132/66 kV Substation by the Richmond River, Casino, Kyogle, Lismore, Ballina and Byron consumers.

For the medium term, Lismore 132/66 kV Substation would need to be reconstructed in the late 1990s or early 2000s to increase its capacity and supply all these areas. If no further system strengthening were carried out to relieve the situation, supply interruptions would need to be shared around all areas supplied from Lismore Substation at times of highest community needs, to avoid damage to equipment.

If supply to Dunoon were reinforced at 66 kV and Lismore 132/66 kV Substation were to be expanded, then the longer term actions to strengthen supplies to Ballina and Byron Bay would be based on additional new 66 kV lines from Lismore. This would result in a further increase in the number of NRE's 66 kV lines coming out of the Lismore 132/66 kV Substation. (In general, a 132 kV network element can substitute for two or more 66 kV elements because of the much smaller capacity of a 66 kV network). The environmental and economic consequences of these successive developments, which flow from addressing short term needs as they arise, are considered to be unacceptable. A longer term strategic approach is needed.

The planning process of PacificGrid considers the long term developments in a region and produces broad solutions. The details and timing of augmentations ultimately depend on the customer's pattern of use of electricity, DM programs, new generation and community needs.

Longer term planning for the Lismore area starts with the recognition that the next critical level of electricity demand for the Lismore, Ballina and Byron LGA's is determined by the capacity of PacificGrid's Lismore 132/66 kV Substation.

When the demand for electricity in the area approaches the limits of the transformers at Lismore 132/66 kV substation, a new 132 kV development becomes essential. This would avert restrictions or blackouts which would progressively begin to occur at times of peak demand, around the areas of Richmond River, Casino, Lismore, Kyogle, Ballina and Byron Bay that are supplied from Lismore. Present load forecasts and planning studies indicate that this level of electricity demand will be reached, and consequently the 132 kV stage of development will be required, in 2001. Any deferment of 132 kV augmentation would depend on greater than anticipated take-up of energy conservation and demand reduction initiatives by customers in the Lismore area.

To relieve the Lismore 132/66 kV Substation load and to provide adequate bulk supply to the area, it is preferable to establish a new 132/66 kV substation in an area of growing load rather than expand Lismore to supply remote loads over several transmission lines. The new substation could be located near Mullumbimby or near Ballina. Technical studies, economic studies and environmental considerations suggested that the optimum development would be to locate the new 132 kV substation near Mullumbimby and previous 66 kV developments have been planned to suit such a development.

Further economic study of alternatives shows that the most cost-effective solution is to construct a 132 kV line from Lismore to Mullumbimby but to operate it initially at 66 kV and to defer the 132 kV substation and 132 kV operation of the transmission line until the latest practicable date. This staged development achieves all the benefits of the short term solution but also makes cost-effective provision for the long term.

Ultimately, continuing growth in the area may require a second 132 kV circuit to provide reliability of supply.

2.4 The Proposed Scheme And Alternatives

A range of possible options for development of the electricity supply network in the area have been identified and investigated. They are compared on the basis of:

- effectively meeting customers' needs, present and future;
- minimising the number and length of new transmission lines;
- achieving compatibility with the overall long term strategy for the region; and
- being environmentally responsible and cost effective.

Options involving local generation of various kinds and a range of renewable energy options have also been considered, as well as the no-build option. These are discussed in later sections.

2.4.1 Preferred Option

The optimum solution from an electricity supply planning viewpoint is to construct a new 132 kV transmission line on a new route from Lismore 132/66 kV Substation to the Mullumbimby area near to the power station located at Lavertys Gap. The line would initially be operated at 66 kV. At a later date Mullumbimby 132 kV Substation would be established at Lavertys Gap and the new transmission line would be reconnected for operation at its design voltage of 132 kV. This would meet the community's growing electricity needs within the planning period. Use of a new route would mean that the work would cause no risk of interruptions of supply during construction. It is a cost-effective solution and would prevent a proliferation of 66 kV lines.

Following community consultation concerning the route alternatives, the proposal being evaluated in this Environmental Impact Statement is to construct a new double circuit transmission line from Lismore 132/66 kV

Substation to the Mullumbimby area broadly following the route of the existing Lismore - Dunoon - Mullumbimby 66 kV transmission line and to dismantle the existing line.

From a planning viewpoint, the double circuit reconstruction solution is similar to establishing the new circuit on a new route, except that the existing 66 kV line is concurrently reconstructed. It is a more expensive option than building a single circuit on a new route and it involves additional risk of supply interruptions during the reconstruction work. However the proposal meets the forecast electricity needs of the area and averts the additional environmental impacts associated with the establishment of a new line on a new route. It also allows some impacts of the existing line to be removed by adjustments to the route which have been developed in consultation with the local community.

It is planned to initially operate the new double circuit transmission line at 66 kV and to connect it to the existing 66 kV line from Lavertys Gap to Ewingsdale. Mullumbimby 132/66 kV Substation will be established at Lavertys Gap at a future date when required and one circuit of the new transmission line will be reconnected for operation at its design voltage of 132 kV. This will provide a long term solution without a proliferation of lines. The expenditure for the proposed Mullumbimby Substation will be deferred until absolutely required for maintaining adequate quality of supply.

After the completion of the construction of the transmission line, as described in this EIS, the network will be adequate to meet the community's long term electricity needs.

2.4.2 Alternative Transmission Line Options

Alternative transmission augmentation options to meet the needs of the community are shown and compared in **Figure 2.3**. For all options, the conductors on the new line would have a higher current carrying capacity and be more efficient than the existing lines. Less energy will be lost in the form of radiated heat (electrical losses) from the line. Reduced electrical losses means reduced emission of carbon dioxide at coal fired power stations generating the electricity.

- Option 1: Reconstruction of the Lismore to Lavertys Gap Line as a Double Circuit Line

  This is the proposed development discussed above. It involves the reconstruction of the existing Lismore - Dunoon - Lavertys Gap transmission line as a new double circuit line on 132 kV structures. The new line will be operated initially at 66 kV as a higher capacity replacement for the existing line. Operation of one circuit at 132 kV will occur in Stage 2, in the early 2000s, when Mullumbimby

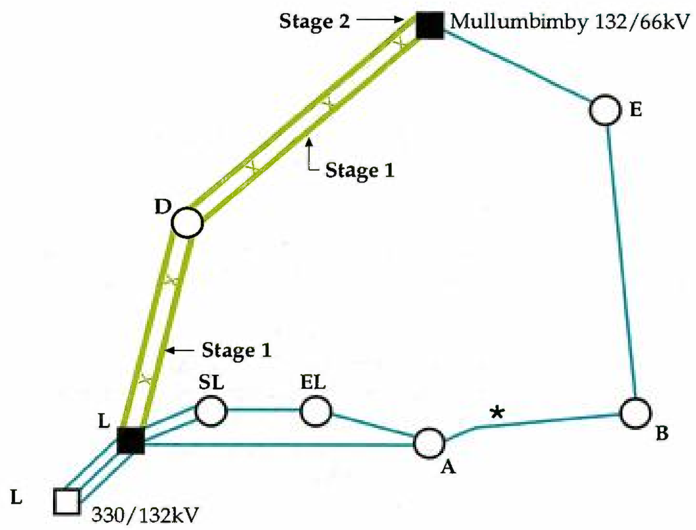
Legend

- New Work
- New Double Circuit
- Existing
- Existing Double Circuit
- * Energy Transport Limited Capacity
- 66/11kV Zone Substation
- 132/66kV Substation
- 330/132kV Substation
- 110/33kV Substation

Key to Substation Names

A	Alstonville	SL	South Lismore
B	Ballina	EL	East Lismore
D	Dunoon	L	Lismore
E	Ewingsdale	M	Mullumbimby

Option 1
Reconstruct line from Lismore to Mullumbimby as double circuit



Stage 1

Reconstruct existing Lismore to Mullumbimby line as double circuit operating at 66kV.

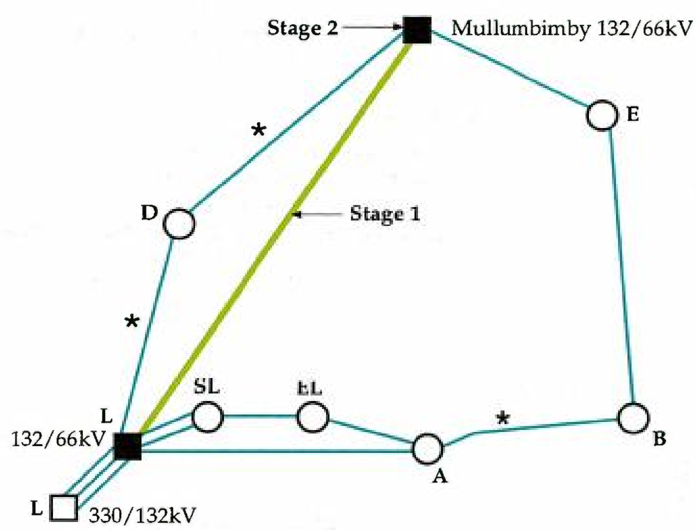
Stage 2

Construct Mullumbimby 132/66kV Substation and operate one circuit of the line at 132kV (bypassing Dunoon).

Option 1 Notes

- Existing route
- Few additional impacts
- Risk of interruptions during construction

Option 2
Construct a new line from Lismore to Mullumbimby



Stage 1

Construct new Lismore - Mullumbimby line on a new route, at 66kV operation.

Stage 2

Construct Mullumbimby 132/66kV Substation and operate line at 132kV.

Comparison to Option 1

- Greater environmental impact (new route)
- Lower cost

Figure 2.3a
ALTERNATIVE SUPPLY ARRANGEMENTS

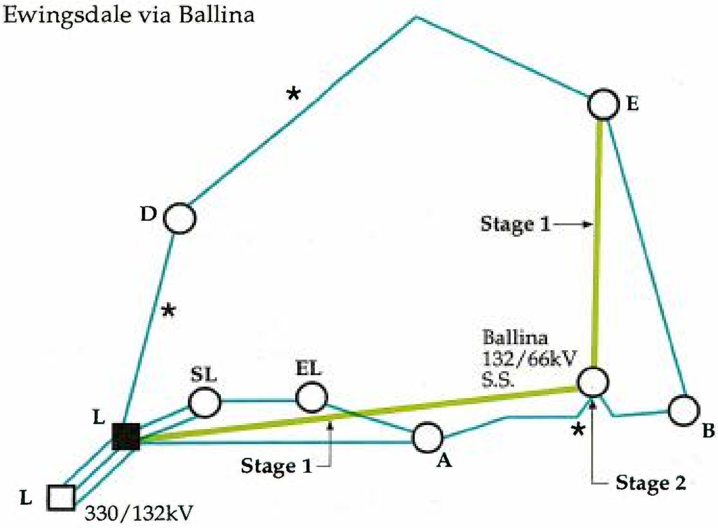
Legend

- New Work
- New Double Circuit
- Existing
- Existing Double Circuit
- * Energy Transport Limited Capacity
- 66/11kV Zone Substation
- 132/66kV Substation
- 330/132kV Substation
- 110/33kV Substation

Key to Substation Names

A	Alstonville	SL	South Lismore
B	Ballina	EL	East Lismore
D	Dunoon	L	Lismore
E	Ewingsdale	M	Mullumbimby

Option 3
Construct new lines to Ewingsdale via Ballina



Stage 1

Construct Lismore to Ewingsdale via Ballina, operating at 66kV.

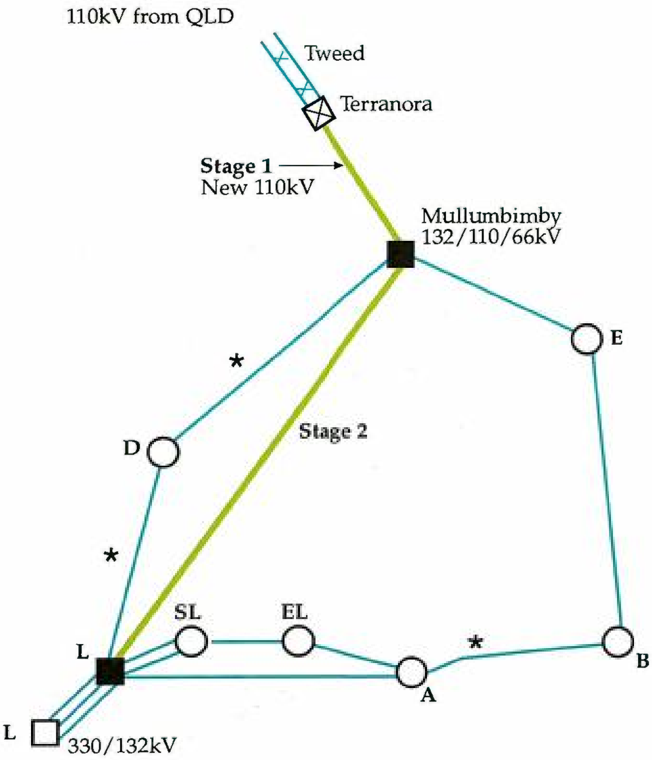
Stage 2

Construct Ballina 132/66kV Substation and operate Lismore - Ballina line at 132kV.

Comparison to Option 1

- Longer transmission line(s)
- More significant environmental impact
- Significant increase in cost
- Needs further augmentation under some scenarios

Option 4
Supply from Queensland



Stage 1

Construct Mullumbimby 132/110/66kV Substation and a line from Terranora to Mullumbimby.

Stage 2

Construct Lismore - Mullumbimby line at 132kV.

Comparison to Option 1

- Longer transmission lines
- Higher environmental impact
- Significant increase in cost (use of three different voltage levels). Supply from Queensland has limited capacity. Hence additional line from Lismore required.

Figure 2.3b
ALTERNATIVE SUPPLY ARRANGEMENTS

132/66 kV Substation will be established at Lavertys Gap. Two supplies to Dunoon at 66 kV will be maintained.

An alternative reconstruction option for this route is to reconstruct the line as a single circuit 66 kV line (Option 1(a)), or as a single circuit 132 kV line initially operated at 66 kV (Option 1(b)). The 66 kV single circuit reconstruction is a lower cost option which would be implemented by Northern Rivers Electricity, but it does not solve existing and growing inadequacies of the 66 kV supply to Dunoon, in particular the problem of low voltage when the Lismore to Dunoon section is taken out of service. It would also require the construction of a 132 kV line on a new route by the early 2000s. It then becomes an inferior re-staging of Option 2 below. If the line were reconstructed as a 132 kV single circuit line from the outset, new 132 kV substations would be required at both Lavertys Gap and Dunoon. This becomes an unwarranted expansion and restaging of Option 2(a) below.

- Option 2: New Line from Lismore to Lavertys Gap on a New Route

The construction of a new single circuit line for future 132 kV operation is also discussed in Section 2.4.1. This option involves constructing a new transmission line from Lismore 132/66 kV substation to Lavertys Gap on a new route. The line would be insulated for 132 kV operation but would initially be operated at 66 kV as part of the 66 kV ring network. Operation at 132 kV would occur in Stage 2, in about the early 2000s, when Mullumbimby 132/66 kV Substation would be established at Lavertys Gap.

An alternative (Option 2(a)) involves establishing Mullumbimby 132/66 kV Substation near Lavertys Gap in the first stage with the new line operated at 132 kV from the outset. This option provides additional savings in transmission losses but involves larger early capital expenditure and overall is economically inferior to Option 2.

- Option 3: New 132 kV Line from Lismore to Ballina with extension to Ewingsdale

This option involves constructing a new transmission line from Lismore 132/66 kV Substation to Ballina by constructing a new line to Alstonville and reconstructing the existing low capacity 66 kV line from Alstonville to Ballina. As with options 1 and 2, the new line would initially be operated at 66 kV as an integral part of NRE's system, but it would be constructed for future operation at 132 kV. In addition a second line would need to be constructed from Ballina to Ewingsdale to meet the load growth in the Byron LGA and to support the voltage at Dunoon during outages of the Lismore to Dunoon line.

In Stage 2 a 132/66 kV substation would be established at Ballina in the early 2000s, and the new line from Lismore to Ballina operated at 132 kV. A further stage (not included in cost comparisons) would involve the construction of a second 132 kV line from Lismore to Ballina.

- Option 4: Supply from Queensland

  The Tweed Shire is currently supplied from the Queensland power network via a double circuit 110 kV transmission line that terminates at Terranora. This option involves constructing a 132 kV or 110 kV transmission line from Terranora to a new Mullumbimby 110/132/66 kV Substation at Lavertys Gap. The length of this line would be about 60 km. Because of the limited capacity of the supply from Queensland, a 132 kV transmission line would soon need to be constructed from Lismore to Lavertys Gap. A variation of this development would be to install 110/132 kV transformers at Terranora in the second stage.

2.5 No-Build Option

One option is not to undertake any further development of the transmission network in the area. This option could be combined with intensified demand management activity as discussed in Section 2.6 below, however the "Do Nothing" option discussed here assumes load growth commensurate with continuation of the existing demand management programs.

If no transmission line reinforcement works proceed, then local electricity restrictions would develop and become increasingly difficult to manage in the Alstonville, Ballina, Ewingsdale, Dunoon and Byron Bay areas. With the existing network, blackouts could occur during a colder than average winter or for average summer temperatures even when all lines are in service.

The probability of blackouts affecting larger areas for longer periods increases each year as more electricity is used by the growing population. With growth, restrictions would be shared at times of highest needs by all customers supplied from Lismore Substation (more than 120 000 people). The "Do-Nothing" option would limit future connections and growth in the area.

The "Do-Nothing" Option compared to the proposed scheme increases the electrical losses in the network that services the area covered by this study. The energy savings that would otherwise be achieved are valued at over $250 000 a year after the completion of the project. These losses in the "Do-Nothing" Option mean that more energy needs to be generated and transmitted from the power stations through the grid. The losses are equivalent to approximately 4 000 additional tonnes of carbon dioxide being discharged each year in the late 1990's and growing each year.

2.6 Demand Management

Demand Management (DM) strategies seek to influence patterns of electricity consumption through assisting customers to alter the ways in which they use electricity. Most DM programs aim at altering the time at which electricity is used (loadshifting), or reducing the quantity of electricity required to achieve the same level of output, service or amenity (energy efficiency). Both PacificGrid and Northern Rivers Electricity are committed to DM strategies and significant savings have already been achieved through deferred network augmentations. NRE is a recognised world leader with its DM initiatives and pilot studies.

One of NRE's corporate objectives is to keep growth in electricity demand to at least one percentage point below the rate of population growth. This objective requires a commitment to the continuation of active DM programs.

This commitment to DM is also demonstrated by the establishment of a DM sub-committee of the Joint Planning Committee. PacificGrid and NRE staff members meet on a regular basis and several joint DM programs have been developed. Pacific Power, in association with the NSW Office of Energy has commissioned a consultancy study to provide Pacific Power, the NSW Office of Energy and Northern Rivers Electricity with a comprehensive report which examines opportunities for demand management within the NRE supply area. The study will also justify and recommend appropriate corporate goals for NRE which arise from the identified opportunities for demand management. The opportunities selected for study will be capable of significantly relieving existing and future constraints on the transmission and distribution systems in the supply area over the next ten years. The report will be capable of being used as a demonstration of the feasibility of demand management implementation to other bodies in the electricity supply industry by dissemination of those findings which are not commercially sensitive to NRE or Pacific Power.

The NRE Load Management System which now controls more than 334 000 kW of connected load (NRE, 1993). The NRE network peak last winter of 267 000 kW occurred with this 334 000 kW load switched off. The fact that NRE continuously controls loads of this magnitude (and growing) means that large capital investments have been deferred.

Examples of innovative off-peak loads controlled in this way are irrigation, aquaculture aerators and pumping for swimming pools, town water and sewerage. Time-of-use interruptible tariffs have been introduced to give certain classes of customers discounts on electricity purchases in return for allowing NRE to disconnect the load for short periods at times of network peak or emergencies.

A number of prototype installations of ice cells on farms have been established, with some funding from Pacific Power. These replace conventional refrigeration equipment to cool milk on dairy farms. Ice is made during the night using off-peak electricity tariffs and used during the day. Advantages for the farmers are reduced electricity costs and for NRE reduced electricity use during peak periods.

Pacific Power has also assisted NRE with the development of programs to promote load cycling and interruption of air conditioning and pumping loads.

Other NRE Demand Management initiatives include a program of energy audits for major customers and "energy efficient" projects such as the display homes in Grafton and Coffs Harbour.

Given the substantial success of past DM efforts, and the size of the existing controlled load, there is now much less room for further relief of the supply system by load shifting. The DM program is increasingly emphasising energy efficiency measures. The success of DM in further deferring transmission grid augmentations depends on the willingness of the community to modify its patterns of use of electricity and to invest in energy efficient appliances, buildings and industrial plant.

The overall effect of DM has been and will continue to be to reduce the rate of growth of electricity consumption in New South Wales. However, growth in demand will still occur, particularly in areas experiencing high population growth like the Far North Coast of New South Wales. The impact of DM initiatives has been taken into account in preparing forecasts of future electricity requirements. DM is an essential part of planning the augmentation of the network rather than being an alternative to development, and it has helped in the significant deferral of the proposed augmentation works.

2.7 Local Generation Options

An alternative to transmitted supply is local generation in the immediate vicinity of the load. State and regional generation schemes still require transmission lines to supply the local loads. In this section the potential of a range of local generation possibilities, including conventional and developmental technologies, is considered. Renewable energy options are considered in Section 2.8.

2.7.1 Coal or Diesel/Gas Combustion Plant

The cost of construction of new small-scale coal-fired power stations is high, as the usual economies of scale are lost. The stations would have to be of relatively small scale to be compatible with existing network connections. In addition, a lack of suitable local coal, diesel or gas resources would mean large transport costs.

Combustion turbines have relatively low capital cost compared with coal-fired steam turbo-generators, and could be strategically located near to loads. The turbines are either gas or diesel-fired. Their efficiency is poor at less than full output, however appropriate sizes are available. Gas or combustion turbines would need to be installed close to a zone substation or switching station of the network to enable the turbines to be connected to the supply network.

Fuel costs for diesel-fired units are extremely high, leading to an operating cost in the order of 20 - 25 c/kWh compared with 5 - 6 c/kWh for normal grid power. Consequently, the turbines are best suited as a means to cover temporary emergencies rather than for the continuous generation of electricity. Such turbines are used at other locations by Pacific Power as support for the transmission network.

Gas-fired generation would be substantially cheaper to operate where there is a supply of gas available from local wells or a sufficiently large existing gas pipeline. However, there are no suitable natural gas supplies close to the Mullumbimby or Ballina areas which would provide the cheaper fuel costs necessary to make gas-fired combustion a cost-effective option.

There would also be significant environmental impact, as well as site costs, because the use of combustion turbines causes air and noise pollution, and the transportation and storage of fuel are also involved. Stringent containment measures would be required to avoid the release of contaminants into waterways in the event of a leak or spill.

2.7.2 Hydro-Electric Plant

Pacific Power has extensive experience in the planning and operation of hydro-electric power stations of all sizes since its formation in 1950. It owns and operates stations with a total capacity of 335 000 kW and shares the resources of the Snowy Mountains Hydro-Electric Scheme of 3 630 000 kW with Victoria and the ACT.

NRE owns and operates conventional hydro-electric power stations. One is at Lavertys Gap near Mullumbimby with a capacity of 280 kW, and the other at Nymboida, on a tributary of the Clarence River, with a capacity of 4 400 kW. Expansion of the hydro-electric station at Lavertys Gap would require major hydro infrastructure, including new dams, at a very large capital cost and with significant environmental impacts.

Similarly, the development of a new hydro-electric scheme in the area would incur high capital costs and environmental impact associated with water storage, power stations and network connections. The overall costs would be far greater than the preferred transmission works option.

An area in the Wilsons River valley near Lismore has been considered, however, there is little potential for further hydro power generation that could cater for the growing demand for electricity in the Ballina or Mullumbimby areas. Hydro generation near Lismore itself would not avert the need for a new transmission line to strengthen the 66 kV ring supplied from Lismore.

2.7.3 Geothermal Energy

There are no known locations in the study area where geothermal energy can be used for the production of electricity (Pacific Power, 1993). Therefore, this form of electricity generation is not a feasible option.

2.7.4 Nuclear Energy

New South Wales Government Legislation, in particular, a policy statement dated 20 May 1986 by the Minister for Energy, the Hon. P. Cox, states that the generation of electricity using nuclear fission reactors is not an alternative to be considered by Pacific Power. Technology for fusion reactors is not yet viable (ECNSW, 1991).

2.7.5 Small-Scale Private Generation

Under the National Grid protocol access to the grid is open to any small private generation schemes which may be viable due to local factors. Northern Rivers Electricity actively encourages co-generation, particularly in the sugar industry where 10 MW of generation is already seasonally available, and in the timber industry. Private generation is also encouraged, whether connected to the grid or a replacement to grid supply. More than 12 MVA of private generation plant has been identified. However such small-scale private generation does not appear capable of developing rapidly enough to meet the general load growth. This is presumably the result of the highly competitive nature of grid electricity.

2.8 Renewable Energy Options

PacificGrid is actively researching renewable sources of energy as outlined in **Appendix D** and a range of renewable energy options has been considered for meeting the electricity needs of the local community.

The expected population growth in the area requires additional energy sources with a capacity of about 3 000 kW to be installed each year. More capacity would be required if new commercial or industrial developments were to be established.

As with DM, network development could be avoided only if alternative energy sources could meet all of the expected growth, and could remove some of the existing electricity use that is creating the present-day deficiencies.

Some private consumers, co-operatives and institutions already produce some or all of their electricity for their own use from wood-burning, solar energy, wind energy and other sources.

Some of the renewable energy sources may not be feasible on a smaller scale, but may prove to be viable on a larger scale. However large scale installations will tend to become cost-effective first at the most suitable sites, and some may never be effective at less suitable sites. Large-scale utilisation of renewable energy sources would require transmission or sub-transmission lines or cables to connect them to the distribution network or to the 132 kV bulk transmission network so that the electricity produced can be transmitted to places where it is needed.

While some renewable energy systems are expected to remain uneconomic within the planning horizon or to be limited to suitable remote sites where connection to transmitted supply is expensive, one or two of the renewable energy systems may become practical for medium-scale plants in the next 20 years and may become established as distributed generation closer to consumers. The strategic development of the ring network by NRE provides a flexible way of connecting new future energy sources into the area.

A number of possible renewable electricity generation options are briefly summarised below. Further information is provided in **Appendix D**.

2.8.1 Ocean, Wave and Tidal Energy

Pacific Power has for many years reviewed the development of technologies to harness wave and tidal energy with a view to its use in isolated coastal locations. However, the small mean difference between tidal level and lack of vigorous wave action along the New South Wales coast is not suitable for reliable generation from existing tidal or wave energy devices. The topography of the coastline is not congenial to the large scale efficient and cost-effective harnessing of wave or tidal energy with currently available technology.

Similarly, the differences in temperature between different depths of water off the NSW coast are not marked enough to make Ocean Thermal Gradient technology viable. A very large scale plant would be required and connections to the power network are likely to present major problems. Costs would be excessive. For these reasons, ocean energy is not considered to be a viable option (Pacific Power, 1993).

2.8.2 Fuel Cells

Pacific Power continuously reviews developments occurring in fuel cell technology and is a member of an Australian consortium that is carrying out a $30 million research project to develop this technology to the commercial stage. Currently, the technology and production facilities do not exist for ready application of fuel cells of any significant scale, in the available time or at reasonable cost.

It is anticipated that in the future, when cells are able to be mass produced, they will be used extensively on the power network.

2.8.3 Biomass

Pacific Power has been involved with two land-fill gas projects which use biomass to produce electricity. Many parts of NSW would be suitable for such schemes, but they have generally not proceeded to date because the cost is higher than the cost of transmitted supply.

Some supplies of biomass would be seasonal and therefore not sufficiently reliable to be considered as a factor in planning the supply system. In particular sugar cane waste (bagasse) is seasonally available at plants within the NRE area. The biomass generation is mainly used within the industry but some portion could be exported back to the supply network. The sugar mills alone can meet a seasonal demand of 10 MW.

The biomass resource in northern New South Wales has not been fully quantified to determine availability, seasonality and economics of supply. Some broad-based national and state-wide studies are currently taking place. These studies are not considered likely to produce alternatives which would avert the need to construct the proposed transmission line.

Pacific Power has been involved in initial discussions with potential partners on a $500 000 proposal to construct a 100 kW demonstration plant near Bourke to generate electricity using crop residue as feed-stock in an entrained flow gasifier. It is possible that the prototype plant may lead to scaling up to a 1-5 MW plant.

Pacific Power has also conducted pre-feasibility studies into combustion of scrap tyres and municipal wastes for electricity production at selected sites within NSW. Local environmental issues were recognised as being of major concern (Pacific Power, 1993).

2.8.4 Solar Farm

Pacific Power is actively involved with other power utilities in Australia in testing the Australian National University's (ANU) 400 m^2 Big Dish solar collector.

The establishment of a Solar Farm would involve:

- large space requirements, with clearing of areas of vegetation.

- a much greater overall capital cost investment compared to transmission works options.
- lack of output when most needed in clouded, cold conditions unless large scale storage or backup schemes such as that provided by natural gas are incorporated
- the need to build network connections as solar energy could not meet the area's needs alone.

The cost of electricity from any solar thermal plant is very strongly influenced by the site conditions, existing infrastructure, and size of plant. Proximity to natural gas is important for operational reliability during low or non-sunlight periods.

Pacific Power has also been instrumental in carrying out a feasibility study into a 4 MW solar thermal electricity plant for Tennant Creek, Northern Territory. Electricity produced from such a plant is expected to cost in the order of 18 c/kWh ($1993) and could be a viable option for remote inland sites with little cloud cover. A solar farm is not a viable alternative option to the proposed development.

2.8.5 Wind Farm

The largest single wind generator in NSW currently is Pacific Power's 150 kW Windmaster at Malabar near Sydney, and its output is supplied into the local distribution network.

In Esperance, Western Australia, 6 x 60 kW turbines have been operating for some time.

A large number of wind power generators with energy storage schemes would be required on the Far North Coast area as an alternative to upgrading the transmission network capacity to the area. They would require power line connections to supply their power to the network and would occupy much space at exposed and visually prominent sites.

While reducing the consumption of fossil fuel elsewhere, wind power generation would have significant local environmental, visual and noise impact disadvantages and would be very costly. At the present time, wind energy is not a viable option in this region as the wind resource in the study area is not suitable for installation of a wind farm of the required scale.

2.8.6 Small-Scale Renewable Energy

Renewable energy sources considered to be suitable for stand-alone applications are outlined below.

- Solar photovoltaic -

  This technology is fairly well established with research effort now going into increasing the energy conversion efficiency and reducing production costs. Pacific Power has already contributed $1.2 million over the past four years to fund the "Centre for Photovoltaic Devices and Systems" at the University of NSW.

  Weather data has revealed that inland areas have generally higher sunshine (insolation) levels and that the North Coast has prolonged periods of cloud cover. This indicates that the study area would not be congenial to photovoltaic generation, without expensive energy storage and conversion equipment or other electricity supply as back-up.

- Solar Thermal Energy -

  The technology of small-scale conversion from solar to heat energy is well advanced, particularly for specific applications such as solar water heating, heating and cooling of buildings and some low temperature industrial applications.

  The conversion of solar energy to electrical energy is also technically practicable. Pacific Power is part of a national consortium that is investigating potential sites to assess the potential of this type of technology. Four of the sites are in NSW. However such conversion is only possible during the daytime and under fine conditions, and the Far North Coast of NSW has a maximum electricity demand on a Winter night. Therefore, solar thermal energy also cannot alleviate the existing problem unless an electricity storage scheme is incorporated. This could take the form of a battery supply, for example. To provide such stand-alone systems with reasonable back-up supplies for every customer in the study area would incur costs of about $30 000 - $40 000 per household. In the local area, there are about 1 000 new customers connected to NRE's network each year which results in a prohibitively high cost of about $30 million per year.

  Solar energy is well suited to the supply of low to medium temperature heat without conversion to electricity. Such installations can replace electricity supply for appropriate heating applications. Pacific Power continues to monitor data from a house in Hurstville, Sydney, that has been retro-fitted with solar thermal heating technology in a project with the University of Sydney. Trough-type solar collectors have been installed to provide hot water, space heating, clothes drying and an experimental solar cooker. Economic viability against other forms of heating is still being assessed as data becomes available (ECNSW, 1991).

There are applications of small-scale power supplies in remote areas and Telecom is a major user (Pacific Power, 1992). Pacific Power also has a number of solar-powered radio transceivers in some areas of New South Wales. Sparsely populated, hot areas could benefit from this potential local electricity source to back-up the network.

- Wind -

  Since the generation of electricity by wind is susceptible to weather conditions, an alternative supply or energy storage scheme would be required to cover periods when wind generation is not practicable.

  Wind generated energy in a good wind site currently costs about 6-8 c/kWh, which is significantly more expensive than that produced in coal fired power stations. It is less expensive than solar, wave and nuclear energy and has the potential, with current research efforts, to become economically viable in selected areas. So far, Pacific Power's wind program has concentrated on identifying suitable locations for wind generation. The Far North Coast is not one of the prospective sites.

Despite the limitations of cost and site suitability which affect the economy of widespread adoption of small-scale renewable generation, individual energy consumers will increasingly find opportunities to apply renewable energy technologies.

Further development in the utilisation of a number of renewable energy sources is proceeding well, however none can provide the quality and security of supply that the majority of consumers expect from their electricity system at a competitive cost in this region at this time. Grid connection provides the best balance of environmental impact, cost effectiveness and quality of supply for most consumers.

With ongoing research and development renewable technologies will become more viable. This process is welcomed by PacificGrid and is factored into the planning process which allows flexibility of timing in staged developments such as are being followed in the Far North Coast region.

2.9 Technical Comparison of Proposed Scheme and Alternatives

A comparison of alternatives to the proposed scheme is presented in **Table 2.1** and is discussed below.

The proposed scheme draws electricity from the NSW grid which has a strong and reliable transmission network bringing low cost electricity from the efficient Hunter Valley power stations to Lismore. The environmental impacts and greater costs of local generation from fossil fuels are avoided.

The proposed development adds no air pollution to the local environment and will reduce existing losses in the 66 kV sub-transmission network. It overcomes existing deficiencies of the sub-transmission network by completing a strong 66 kV ring and makes provision for future growth by the establishment of a new 132 kV supply point at Mullumbimby. The proposed scheme takes into account the effects of DM and the expected further development and application of renewable energy technologies.

On their own, DM programs and small-scale solar and wind conversion plants installed by private consumers are not technically adequate options, to meet the electricity needs of the increasing population of the area let alone remove the deficiencies of the existing electricity supply system. However energy conservation by consumers is promoted and electricity generation from local small-scale renewable energy systems is most welcome.

Pacific Power is active in the development of new energy technologies for the future. None of these is viable and ready to meet the needs of the Far North Coast at this time.

Solar farms and wind farms are in an advanced development stage. However they are not well suited to the Far North Coast area. These energy options would require power lines to connect them to the supply network and a strong 66 kV ring network which will be completed by the proposed development is well suited to connecting new local generators when and if required.

2.9.1 Comparison of Transmission Line Options

The transmission line alternatives are schematically illustrated in **Figure 2.3.**

There is a clear technical advantage in taking supply from the New South Wales state grid at Lismore rather than taking supply from Queensland via the Tweed. Electricity supply to Lismore is strong and reliable while supply from Queensland via Terranora (Option 4) would be weak and less reliable. Option 4 does have an advantage in the initial stage in that the new bulk supply point is established early, but it becomes inferior after 2001 when this would be done under the other options.

Because of the limited capacity of the 110 kV supply available from Queensland via Tweed and the high cost of increasing that capacity, it would also be necessary to construct a 132 kV line from Lismore to Mullumbimby within 10 years after completion of the initial development. This introduces a need for additional costly voltage transformation. This would best be installed in Stage 1 (at the establishment of Mullumbimby Substation) due to savings obtained if three winding transformers are used rather than installing additional transformers in Stage 2. Considering also the greater length of the line from Terranora, which increases the risk of interruptions, it is considered that the proposed development has significant technical advantages over supply from Queensland.

While all four options would improve the performance of the existing 66 kV ring network, only the proposed development combines the provision of a second 132 kV bulk supply point to the area with the completion of a strong 66 kV sub-transmission ring network. It is therefore technically superior to the other options.

Options 1 - 3 are staged developments, initially operating at 66 kV and taking supply from Lismore. In each case Stage 2 involves the establishment of a second 132 kV bulk supply point in about 2001 which will relieve the existing Lismore bulk supply point, providing for further growth in the area continuing to be supplied from Lismore. It also provides for growth in the areas supported by the new bulk supply point.

In Option 3 the new bulk supply point will be at Ballina and a new line to Ewingsdale has to be constructed for growth in the Mullumbimby/Byron Bay area including Ocean Shores and Pottsville. In Options 1 and 2 the new bulk supply point is located further north at Mullumbimby to supply these more northerly loads.

Option 3 does nothing about the weak link in the existing 66 kV ring between Lismore and Mullumbimby. The new bulk supply point would have to pick up all of the coastal load. Under the options, which place the new bulk supply point at Mullumbimby, the coastal loads are shared more equitably between Lismore and the new supply point. Option 3 also involves longer transmission lines and is more expensive than Options 1 and 2. Options 1 and 2, with the new bulk supply point at Mullumbimby, are superior to Option 3.

Option 1 is based on the reconstruction of an existing line. This has some impact on reliability during the construction period when network elements are disconnected for work. The failure of another network component at that time could result in an interruption to supply. This temporary factor, together with the greater difficulty of construction work under the constraints required to limit the risk of interruptions to supply, would favour Option 2 under which the new line is constructed on a new route.

On the other hand, Option 1 has advantages over Option 2. Option 1 involves greater savings due to reduced electrical losses in the years prior to Stage 2, due to the high capacity of the new double circuit line operating at 66 kV. The most important advantage of Option 1 occurs after the establishment of Mullumbimby 132 kV Substation, when one circuit of the new line will be operated at 132 kV. At this stage, the double circuit reconstruction option has the advantage of retaining a strong 66 kV sub-transmission ring, while the new line on a new route leaves the Lismore - Dunoon - Lavertys Gap section weak and unable to provide strong backup to the 132 kV line. Because the advantages of Option 2 over Option 1 are temporary while the advantages of Option 1 over Option 2 are long term, it is considered that Option 1 is technically the best option.

On technical grounds alone, Options 1 and 2 are considered to be superior to Options 3 and 4, and Option 1 is the preferred option.

2.1 - Technical Comparison

Option	Scope of Option		Technical & Strategic Issues
Option 1 Proposed Development	Reconstruct Lismore to Lavertys Gap 66 kV line as a 132 kV double circuit line	About 37 km Replacement pole line	Future use of line in 132 kV network Future 132 kV substation at Lavertys Gap Completes strong 66 kV ring
Option 2	New line from Lismore to Lavertys Gap	About 40 km New pole line	Future use of line in 132 kV network Future 132 kV Substation at Lavertys Gap Weaker 66 kV backup after Stage 2
Option 3	Construct Lismore to Ballina 66 kV line for 132 kV, second Ballina to Ewingsdale 66 kV line	About 60 km Replacement pole line	Future use of line in 132 kV network Future 132 kV substation at Ballina Weaker capacity to supply northerly loads
Option 4	Terranora to Lavertys Gap 110 kV line, New 132/110/66 kV Substation at Lavertys Gap	About 60 km New pole line and new substation	Substation at Lavertys Gap Weak supply not suitable for further expansion Later development : 132 kV line from Lismore Needs extra voltage transformation
No Development	Do Nothing	Does not solve the electricity supply problem of the area, Causes substantial and growing losses and leads to costs through unreliable supply.	
66 kV NRE Works	Develop the 66 kV NRE network only	New 66 kV lines to Mullumbimby, Ewingsdale Expansion of Lismore 132 kV substation	Local supply strengthened. Additional new 66 kV lines and routes from Lismore 132/66 kV S.S. to NRE's zone substations
Demand Management (DM)	Undertake DM	Contain or reduce demand for each customer.	Reduces maximum demand of each new customer. Electricity loading still increases as population grows. DM is already applied extensively and is used by NRE for all new customers. These programs reduce but do not eliminate growth of customer demand.

Table 2.1 continued - Technical Comparison

Option	Scope of Option		Technical & Strategic Issues
Energy Options	Install individual renewable energy sources	Population increases by 3 000 each year	Suitable for rural customers. Electricity shortage for new urban customers
	Coal-fired or diesel gas combustion plant	Large MW machine possible.	Requires transport of fuel into area.
	Solar farm	Demand of 3 000 kW each year	Developing technology. Large site required.
	Wind farm	Demand of 3 000 kW each year	No suitable wind resource established. Large site required.
	Hydro-electric plant	Demand of 3 000 kW each year	Large areas for new dam. No suitable site.
	Fuel cells	Demand of 3 000 kW each year	Future Technology.
	Biomass	Demand of 3 000 kW each year	No suitable resource.
	Geothermal, Ocean, Tidal, Wave & Nuclear	Demand of 3 000 kW each year	Not viable in area.

2.10 Economic Comparisons

The economic comparison is summarised in **Table 2.2**. On economic grounds alone, considering capital expense, the cost and risk of interruptions to consumers, the cost of electrical losses, and operation and maintenance costs, but not considering technical aspects and environmental impacts, Option 2, the construction of a new line from Lismore to the Mullumbimby area would be the preferred option.

Table 2.2 - Economic Comparison of Practical Options

Option		Benefits and Costs*
Option 1	Reconstruct Lismore to Lavertys Gap 66 kV line as a double circuit line	Net Present Cost (NPC) $4.1 M Savings in electrical losses
Option 2	New line from Lismore to Lavertys Gap	NPC $3.2 M Savings in electrical losses
Option 3	Construct Lismore to Ballina 66 kV line for 132 kV, second Ballina to Ewingsdale 66 kV line	NPC $5.7 M Savings in electrical losses
Option 4	Terranora to Lavertys Gap 110 kV line and new 132/110/66 kV substation at Lavertys Gap	NPC $7.0 M Savings in electrical losses
No Development	Do nothing	No construction costs : Higher cost of electrical losses, higher risk of interruptions to customers, higher maintenance costs. Cost of restricted use of electricity and blackouts.
66 kV NRE Works	Develop the 66 kV NRE network only	More lines, higher construction cost

* Net Present Cost takes into account the capital cost of the project, the operation and maintenance and energy savings over a 10 year life at present (1993) value.

2.11 Social and Environmental Comparisons

Social and environmental comparisons are presented in **Table 2.3**.

The recently published Route Options Paper outlined the possible route options for the new transmission line. These routes were developed with the assistance of the local community.

Each option was assessed for its relative environmental impact and social aspects. This assessment was a preliminary guide for the evaluation of options and these issues were further clarified in the community consultation phase.

As a result of the community consultation process, Option 1 was identified as the best option with respect to social and environmental impact. This conclusion from the route options process is supported by further studies reported in this EIS.

Table 2.3 - Social and Environmental Comparison

Option		Social and Environmental Impact
Option 1 Proposed Development	Reconstruct Lismore to Lavertys Gap 66 kV line as a double circuit line	- Increased risk of interruptions during construction work - Taller structures on existing line route - Reduction in annual energy losses equivalent to 5 800 t of CO_2 emissions while operating at 66 kV - Reduced number of line routes overall
Option 2	New line from Lismore to Lavertys Gap	- New line route - Reduction in annual energy losses equivalent to 3 900 t of CO_2 emissions while operating at 66 kV
Option 3	Construct Lismore to Ballina 66 kV line for 132 kV, second Ballina to Ewingsdale 66 kV line	- Increased risk of interruptions during construction work - Some new line route - Taller structures on existing line routes - Local impact of substation - Reduction in initial annual energy losses equivalent to 3 600 t of CO_2 emissions while operating at 66 kV
Option 4	Terranora to Lavertys Gap 110 kV line and new 132/110/66 kV substation at Lavertys Gap	- New line route - Reduction in annual energy losses equivalent to about 3 900 t of CO_2 emissions, operating at 110 kV
No Development	Do nothing	- Restricted use of electricity - Limits to development in area
66 kV NRE Works	Develop the 66 kV NRE network only	- Extra 66 kV lines on new routes

2.12 Preferred Alternative

Comparative evaluation of the alternatives shows Option 1, the reconstruction option, to be preferred on technical and environmental grounds. Option 2, the new line on a new route, is preferred on economic grounds.

Following the community submissions to the ROP, and review by Pacific Power, the preferred option for the Lismore to Mullumbimby line is to reconstruct the existing 66 kV line from Lismore to Dunoon to Lavertys Gap as a double circuit, higher capacity, transmission line. This has become the proposed development.

The new line will be operated at 66 kV until the use of electricity in the area increases to a level that requires a new Mullumbimby 132/66 kV Substation to be established at Lavertys Gap and at that time one of the circuits will be reconnected for operation at 132 kV.

3

Route Selection Identification Process and Consultation Process

3. Route Selection Identification Process and Consultation Process

This section outlines the studies and the process of community consultation undertaken during the development of possible alternative route corridors for the proposed transmission line. The Route Options Paper (ROP), outlining the route corridors developed, was released for public comment in November 1993. Following consideration of the ROP, the associated studies, and the submissions received, the route corridor identified as the "Reconstruction of Existing Line Option" was selected as the preferred route for the preparation of this EIS.

3.1 Route Development Process

An investigation into potential corridors within which a transmission line could be constructed was undertaken by Pacific Power in 1993. The purpose was to involve the community in the development of the possible route corridors at an early stage in the project, to provide the community with the opportunity to comment on the alternatives developed, and to assist Pacific Power with the selection of the preferred option.

The objectives of the route option process were to:

- identify the constraints relevant to route selection through consultation with the community, government agencies and other organisations
- undertake specific studies to supplement available information on identified constraints and opportunities
- develop potential route corridors within which a transmission line could be constructed.

The main phases in the selection of the corridor alternatives included consultation with the community and government agencies, constraint mapping, and development of possible route corridors.

3.2 Consultation During the Route Options Process

3.2.1 Community Consultation

The consultation undertaken during the development of the alternative route options is detailed in the ROP and summarised in **Appendix E**. A number of opportunities were provided for local residents to be informed about and involved in the development of possible route corridors for the line. These included:

- the establishment of an Information Centre in Lismore, open to the public during the week
- a series of workshops and displays held in the area

- provision of a "toll-free" telephone service to assist the community in contacting the project team
- a series of newsletters entitled "Connections" which were distributed to local residents during the process
- regular press releases, radio interviews and television interviews providing information about the progress of the project.

3.2.2 Public Agency Consultation

During the preparation of the ROP a range of agencies were consulted to gain their input into the selection of the preferred route.

The list of these agencies and a summary of their responses is given in **Appendix** E.

3.3 Alternative Route Options

A number of different routes were identified, using a methodology which could accommodate, as far as possible, the views of the community and the authorities in the light of constraint mapping.

The following route corridors (shown in **Figure 3.1**) were identified as possible alternatives:

- Reconstruction of the Existing 66 kV Transmission Line currently owned by Northern Rivers Electricity, incorporating a Western Variation

- Central Corridor with Northern and Southern Variations

- Railway Corridor with a link between the Railway and Central Corridors

- Southern Corridor Option.

These are discussed in greater detail in **Appendix** E.

The corridors were developed following investigation and mapping of constraints, including flora, fauna, land use, aesthetic considerations, and the proximity of existing and potential dwellings to the line. In addition, community views regarding the use of existing service corridors were taken into consideration.

3.4 Comparison of Route Corridor Options

The route selection methodology as described in **Appendix** E catered for community views and expectations and the investigations were carried out as part of the study without favouring any particular option. The methodology allowed each alternative to be developed independently

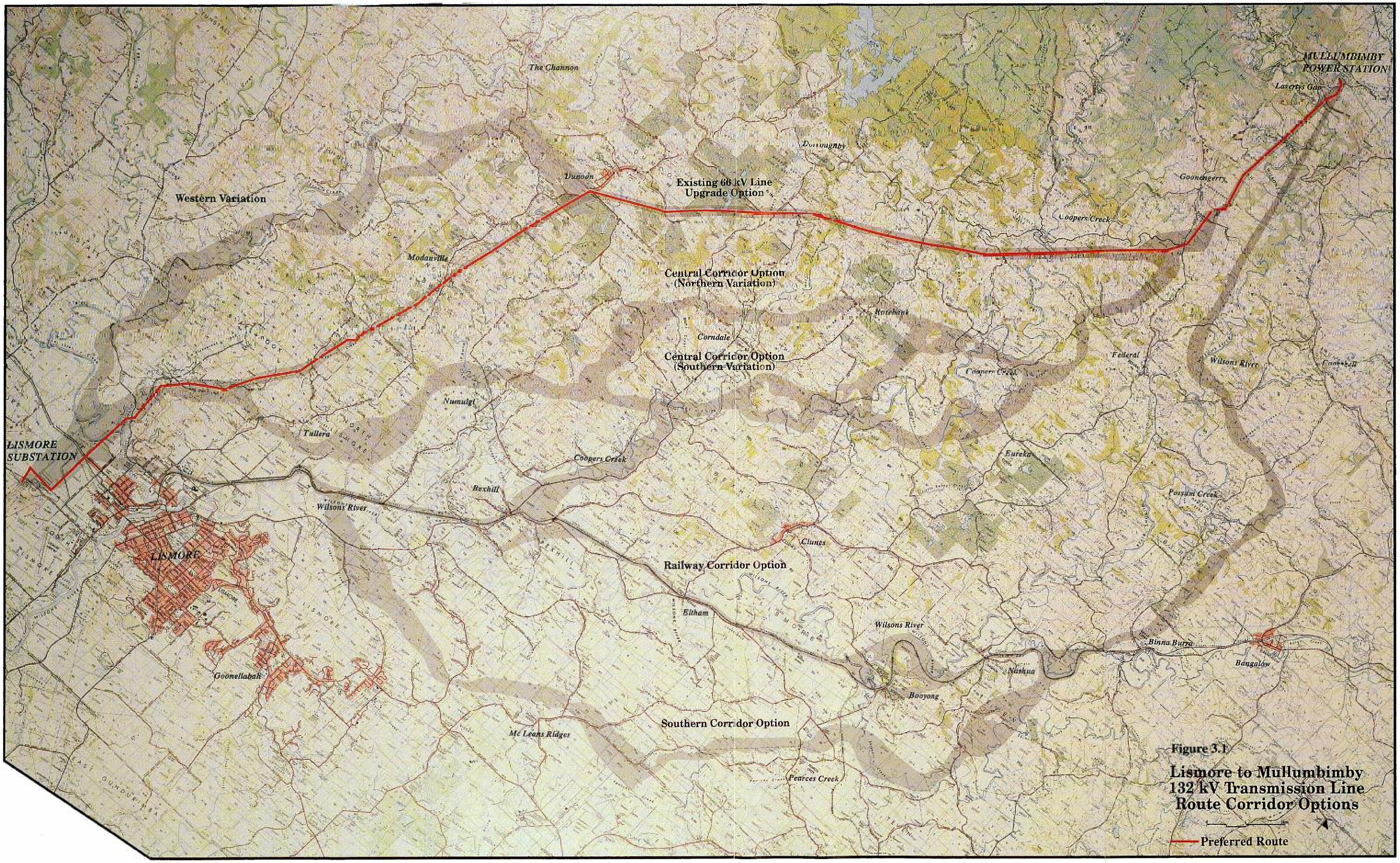


Figure 3.1
Lismore to Mullumbimby 132 kV Transmission Line Route Corridor Options

and without prejudice, and it was recognised that the environmental consequences of proceeding with each option would differ. This methodology essentially precluded a numerical approach to comparing or assessing the options.

Assessment of alternative options was based on whether the route met stated community desires (such as following existing service corridors), minimised impacts on native flora and fauna, primary producing land, and visual effects, and maximised distances from residents and met practical engineering constraints. Every effort was made to develop route corridors which satisfied all the criteria but this was not always possible.

An assessment of the alternative route and route links is provided below. Each alternative route is compared with the preferred option. A more detailed discussion and analysis of the preferred option is provided in Section 4. Impacts relating to the construction of the line which are common to all options are not considered below.

3.4.1 Reconstruction of Existing 66 kV Line - Preferred Route

Although Northern Rivers Electricity's existing line does not currently have a formally established easement, there is an existing right of way which is subject to similar restrictions and management practices as an easement.

Improving the electricity supply to the region by reconstructing the existing 66 kV line as a double circuit line will increase the level of impact. The impact would not be as great as if a separate line were constructed. The additional impacts will be in the form of increased visual impacts due to the increased view catchment resulting from taller pole structures. Minor amounts of additional vegetation removal will be required.

The existing 66 kV line passes over rainforest remnants, faunal corridors, regenerating areas and established agricultural plantations. The development involves removing the old line (comprised of one and two pole structures) and replacing it with a new double circuit line, with predominantly single pole structures. Some two pole structures will be required. This being the case, the reconstruction route will have primarily the same alignment as the existing line, and consequently the impact will not change substantially. Even if the alignment does change, there will be no incremental increase in land disturbance since the area previously disturbed will be released for other uses.

Although the route passes through large areas of prime agricultural land, the existence of large scale and widespread intensive macadamia planting beneath the existing 66 kV line indicates that it does not present a major constraint to this kind of development. A new line, replacing the existing line, will not significantly change this.

Established access arrangements are in place along the current line and it is unlikely that these will be significantly altered under the reconstruction option, although access to new structure locations will be required. Therefore, the impacts on landholders currently affected by the existing line will remain largely the same.

Due to development near the line subsequent to its original construction, the existing line passes close to a number of residences. The corridor has been widened to allow variations to accommodate land owner requirements. There are opportunities to improve the current situation in some areas.

Technical disadvantages of the Reconstruction Option are that it must be carried out in a particular two year period (by the winter of 1997) during which time the remaining network will be able to supply the electricity demand of the area while intact. Severe interruptions to supply are possible if other circuits should fail during the construction period.

The Reconstruction Option will require double circuit construction which will increase the cost of this option. It is estimated that the Reconstruction Option will cost about $1.5 million more to construct than a new single circuit line on a separate route. The additional cost will result from increased strength requirements for double circuit structures, additional conductors and increased construction costs associated with larger, heavier structures. Some savings from reduced clearing and access requirements are anticipated, but these will not be significant.

The double circuit line will have lower field strengths than a single circuit line, although the field levels of single circuit 132 kV lines are themselves low.

The Reconstruction Option has a high degree of community acceptance, with many people expressing the view both in submissions and verbally, that this is the "best option". Lismore City Council has also supported the Reconstruction Option.

It is considered that reconstructing the existing line will result in lower environmental impacts than construction of a line along an entirely new route.

Reconstruction Option - Western Variation
This variation essentially avoids impact on vegetation systems, horticultural activities and a school in the Tullera/Modanville area and reduces the impact on urban and rural residential areas between Lismore and Dunoon.

However, it does this by imposing a new transmission line on another area with similar vegetation systems and development. Unless the variation is constructed as a double circuit, the existing impact will remain and one advantage of the Reconstruction Option is substantially diminished. The opportunity to reduce the level of impact of the existing line between Lismore and Dunoon will also be lost.

The rural residential development between Lismore and Dunoon is largely ribbon development, following existing roads. As a result, the Western Variation will not result in a dramatic drop in the number of properties affected by the development.

There are no significant benefits to be gained with this option over the Reconstruction Option.

3.4.2 Central Corridor and Variations

Although the Central Corridor was developed to minimise impact on native vegetation and prime agricultural land, it requires clearing of disturbed forest and large areas with potential for reafforestation.

The Central Corridor has two variations. Although both variations sought to avoid significant vegetation systems, the northern option does so by passing through land defined as prime agricultural land by Lismore City Council.

The central corridor crosses a number of roads within the study area as well as Coopers and Numulgi Creeks. The river systems are generally wide with little potential for vegetation screening. This is particularly the case with the lower sections of Coopers Creek.

A new transmission line development will result in significant visual impacts in visually prominent areas. There are few opportunities for use of other service corridors such as road easements and existing 11 kV lines. This is largely because the Central Corridor tends to cross these without the possibility existing for paralleling.

The Northern Variation of the Central Corridor passes just to the north of Corndale and Rosebank. These areas are relatively densely populated, and although locating an easement is possible, the impact on residents would be high. Similar problems exist on the Southern Variation, although to a lesser extent.

A possible north-south link between the northern and southern central corridor variations was identified 1.5 km east of the Rosebank Road. This link crosses a large horticultural plantation. Although the link provides an opportunity to avoid potential impacts on vegetation systems around Coopers Creek to the east of Ridgewood Road, it fails to avoid impacts on the more densely populated area of Rosebank.

The Central Corridor joins the route of the existing 66 kV transmission line, just to the south of Goonengerry. From Goonengerry, the route heads in a north to northeasterly direction to Lavertys Gap approximately 6 km away.

The last 6 km of the route is highly constrained with little opportunity to avoid the reconstruction of the existing 66 kV line.

Impacts of the Central Corridor Option are greater than those associated with the Reconstruction Option.

3.4.3 Railway Corridor Option

This option uses, as far as possible, the existing railway easement but the railway is only used for less than half the length of the option. Variations are necessary to avoid villages, built up areas, and other constraints.

Given the departures from the railway easement, this option essentially becomes a stand alone option similar to the Central Corridor and the benefits of using an existing railway easement are significantly diminished.

The railway corridor essentially follows the Wilsons River floodplain. This area is highly exposed with little topographic or vegetation screening. The line has a very large view catchment extending both to the north and south of the floodplain including long range views from elevated locations.

Although the railway line is an established feature, it is considered that the transmission line along this route will increase the visual impact more than the Reconstruction Option. This is because the railway and transmission line have different structural forms and therefore are not naturally compatible. The transmission line would in fact become more dominant in the landscape than the actual railway.

At Bexhill, the Railway Corridor Option can either continue to follow the railway or can pass to the south of Bexhill to avoid the built up urban area. Either way, the line will have a high visual impact on the residential area around Bexhill.

Other significant impacts occur in the link between the railway and Lavertys Gap. This is also true for the link between the Railway Option and the Central Corridor (Southern Variation). This link runs approximately parallel to Corndale Road in the Coopers Creek floodplain, and would be highly visible from areas on either side of the floodplain.

The Railway Corridor Option will have a significantly greater impact than the Reconstruction Option.

3.4.4 Southern Corridor Option

The southern corridor was developed to minimise impacts on native vegetation and prime agricultural land. It is significantly longer than any other option under consideration and therefore will have a greater impact on land uses.

The eastern section of the route provides the only alternative option to the existing line into Lavertys Gap. All other options essentially meet at Goonengerry and form part of the reconstruction option.

This eastern alternative involves some impact on vegetation systems and has the potential to impact on future subdivisions to the east of Federal. The last 4 km into Lavertys Gap involves crossing the Wilsons River three times. The upper reaches of the Wilsons River have particular value due to riparian vegetation systems. Although the line could span the majority of these systems it is likely that some impact on these systems would occur both during construction works and future maintenance.

There are no apparent benefits in adopting the Southern Corridor Option into the substation over using the Reconstruction Option.

3.5 Route Options Paper and Submissions

The ROP, which summarises the consultation work, the studies undertaken and the alternative route corridors developed, was displayed from 23 November 1993 to 23 December 1993 and submissions were invited from the community.

Nearly 200 submissions were received in response to the ROP. Issues raised in submissions are outlined in **Appendix E**.

3.6 The Preferred Route

Following the assessment and comparison of the alternatives described in the ROP, and consideration of the submissions received, the Preferred Route chosen was the Reconstruction of the Existing 66 kV Line. It was considered that construction of a new double circuit transmission line within a corridor developed from the alignment of the existing 66 kV line between Lismore and Mullumbimby would result in a lower impact than the construction of a new line along an entirely new route.

4

Description of the Proposed Development

4. Description of the Proposed Development

This section describes the proposed development and the activities associated with the construction of the proposed transmission line. It outlines the program for the construction of the line.

4.1 Transmission Line Description

The proposed transmission line will be a double circuit pole line, approximately 37 km long. It will replace the existing 66 kV wood pole transmission line, which will be dismantled. Single pole structures will generally be used. Some two pole structures will be required.

The proposed line will run from Lismore 132/66 kV Substation, approximately 3 km west of Lismore, to Lavertys Gap adjacent to Mullumbimby Power Station in Wilsons Creek Road, approximately 5 km south west of Mullumbimby township.

While generally following the route of the existing line, the exact location of the proposed line will be negotiated with individual affected owners. Structure locations will be determined with regard to terrain constraints and property owner requirements. It is expected that the structures will be typically 280 to 300 metres apart and 25 metres high.

The transmission line will consist of poles made of steel or concrete, carrying two sets of three conductors, with two smaller earthwires at the top of the structures. One set of three conductors will replace the existing 66 kV transmission line, while the other set of three conductors will provide the new supply. The two smaller wires located at the top of each structure protect the transmission line from lightning.

The transmission line will be located within a 45 metres easement. Easement boundaries will not generally be fenced except where these boundaries correspond to property boundaries.

The proposed line will be designed to meet the requirements of the 1991 NSW Electricity (Overhead Line Safety) Regulations.

4.2 Description of Preferred Route

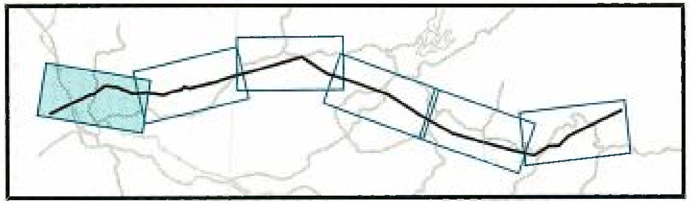
The corridor within which the transmission line will be built varies in width. The bandwidth is typically 150 metres wide but some sections are over 1 km wide where significant deviations are considered possible. The bandwidth and the nominated centreline are shown in **Figure 4.1a - 4.1f**.

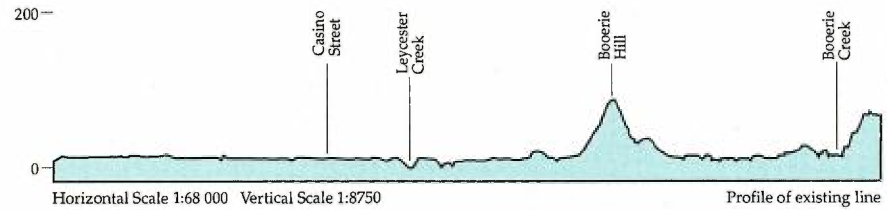
Lismore 132/66 kV Substation to Booerie Dip

In the vicinity of Lismore 132/66 kV Substation, it is proposed to locate the proposed line some 450 metres to the west of the route of the existing line. The Lismore 132/66 kV Substation is located adjacent to

Figure 4.1a
NOMINATED CORRIDOR AND ROUTE ALIGNMENT

SINCLAIR KNIGHT MERZ





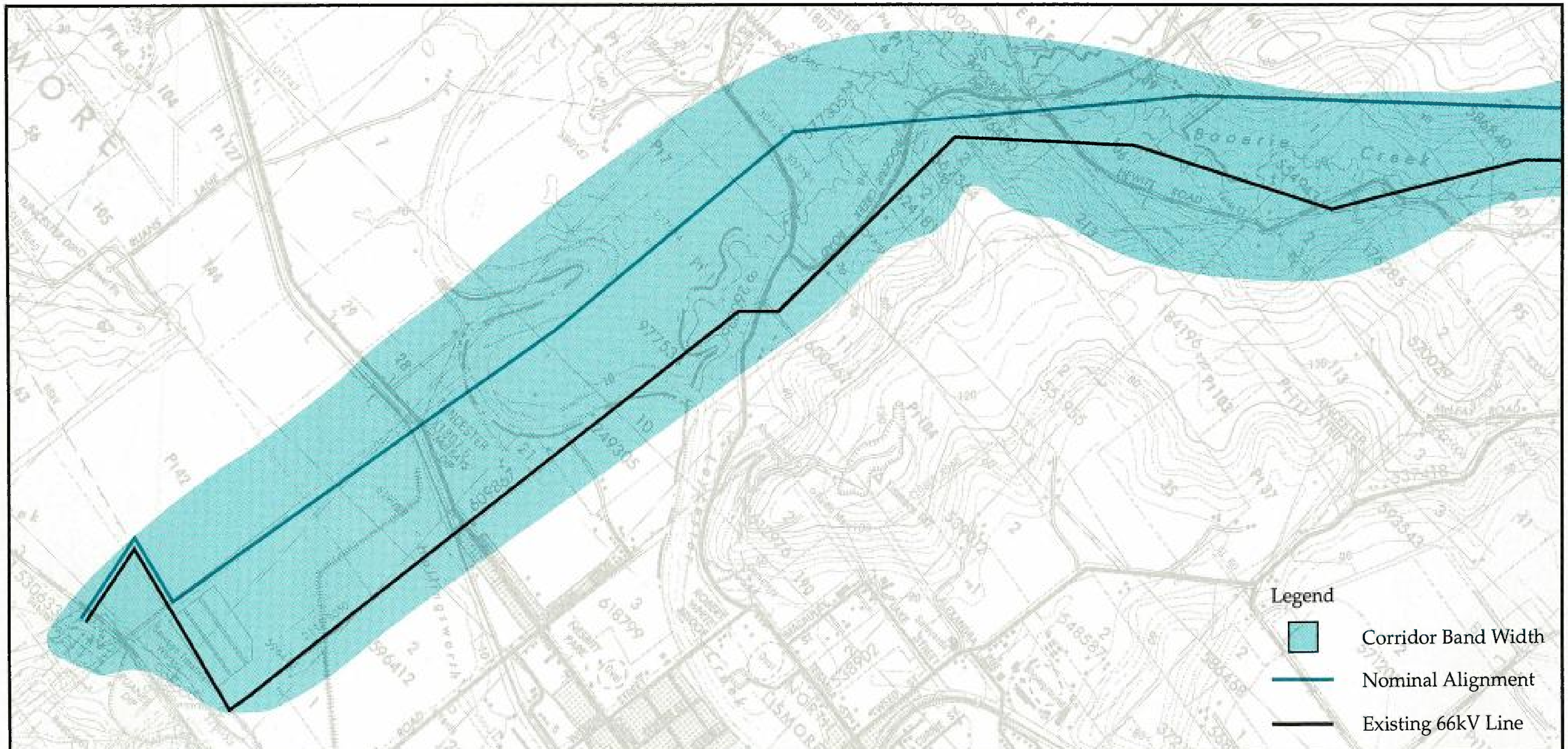


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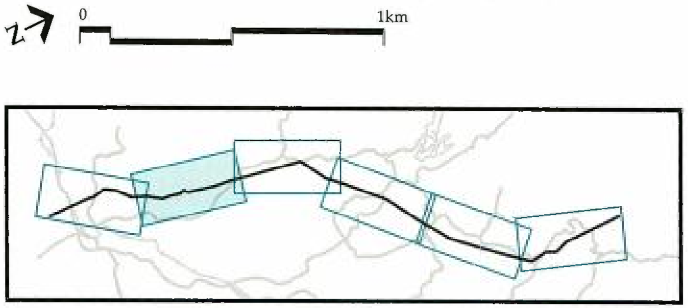
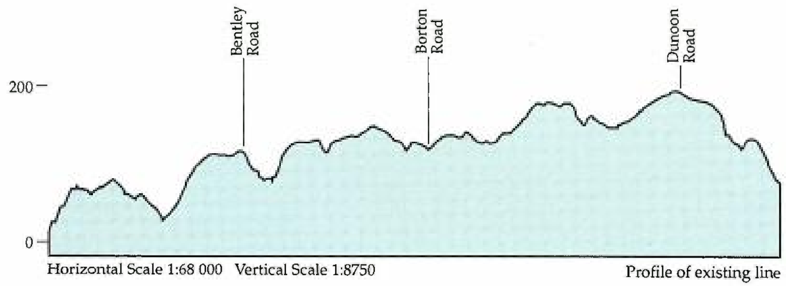
Figure 1.1b

NOMINATED CORRIDOR AND ROUTE ALIGNMENT





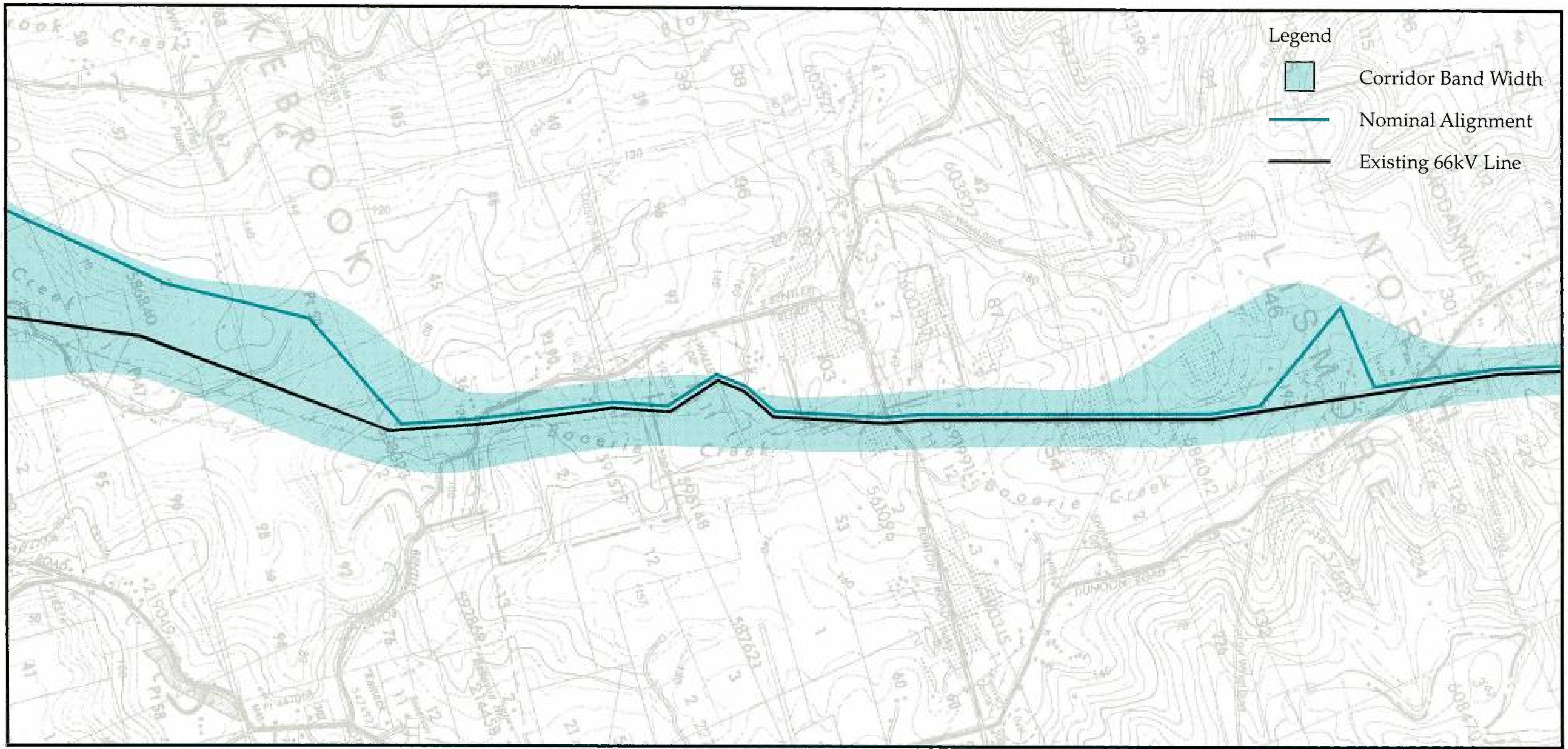


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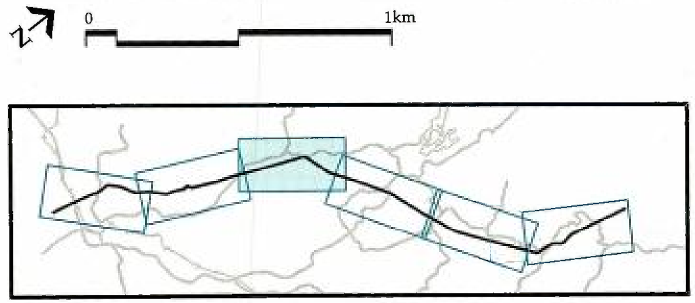
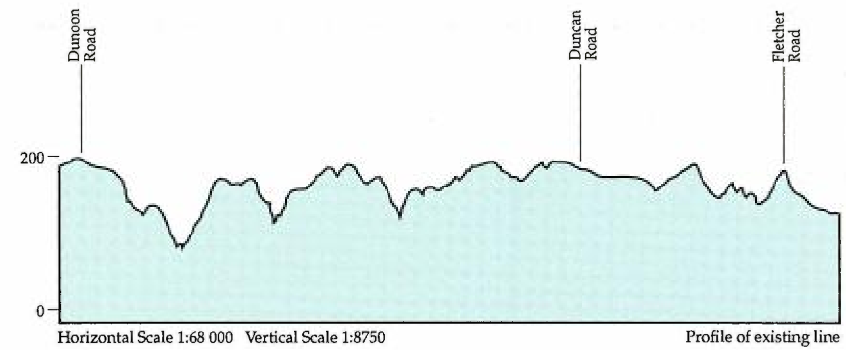
Figure 4.1c
NOMINATED CORRIDOR AND ROUTE ALIGNMENT

SINCLAIR KNIGHT MERZ





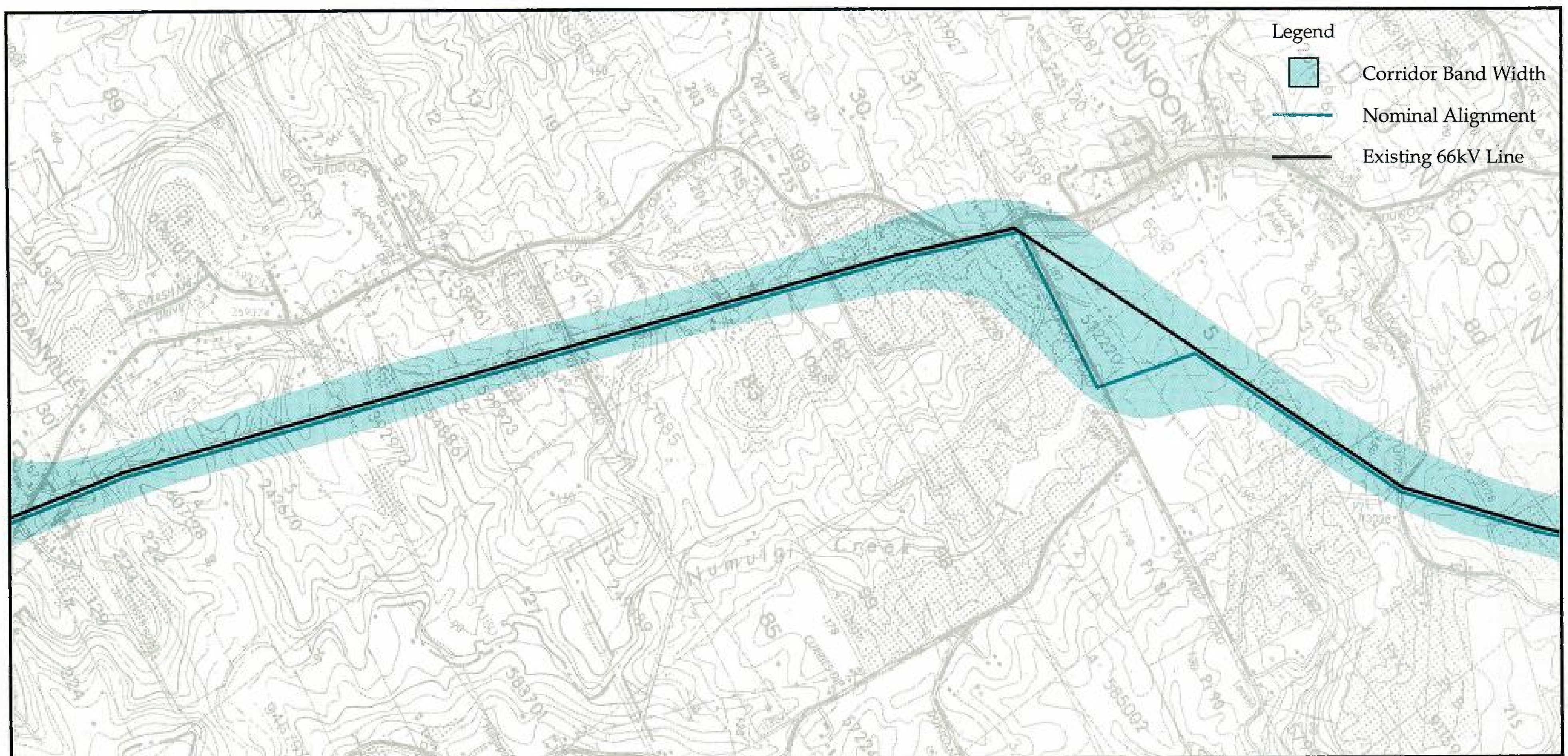


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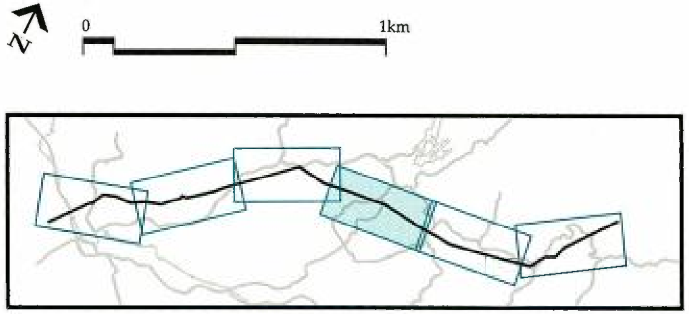
Figure 4.1a

NOMINATED CORRIDOR AND ROUTE ALIGNMENT



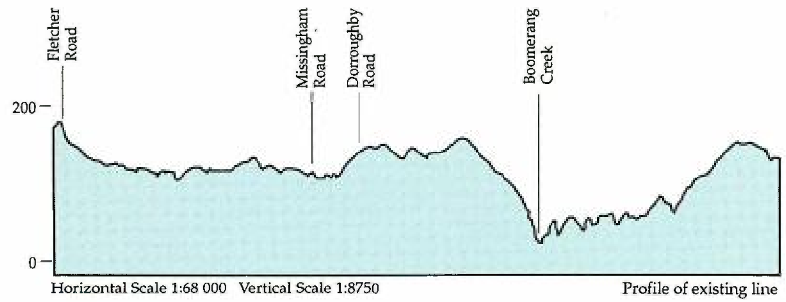


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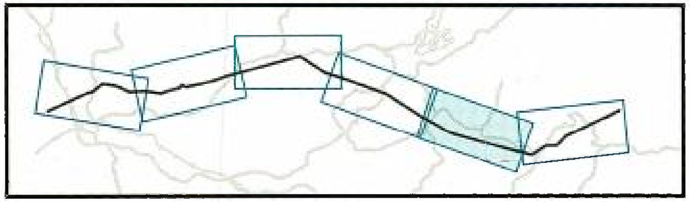
Figure 4.1e
NOMINATED CORRIDOR AND ROUTE ALIGNMENT



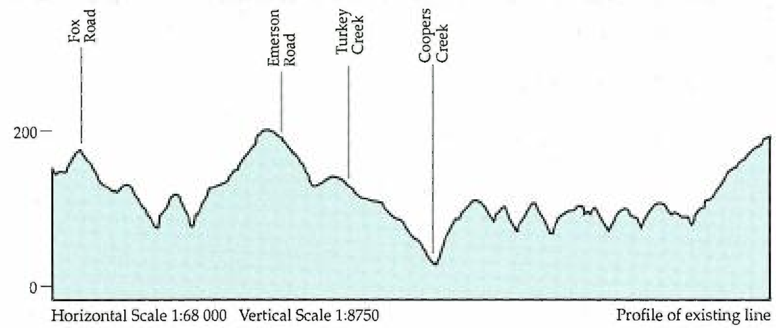


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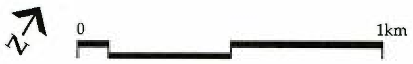
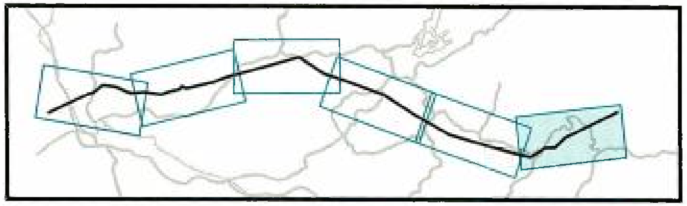
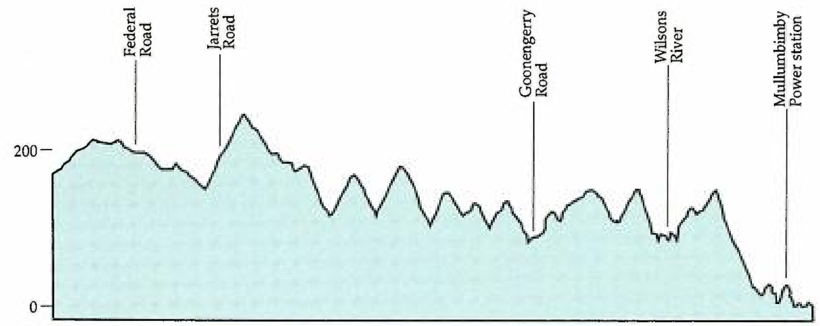
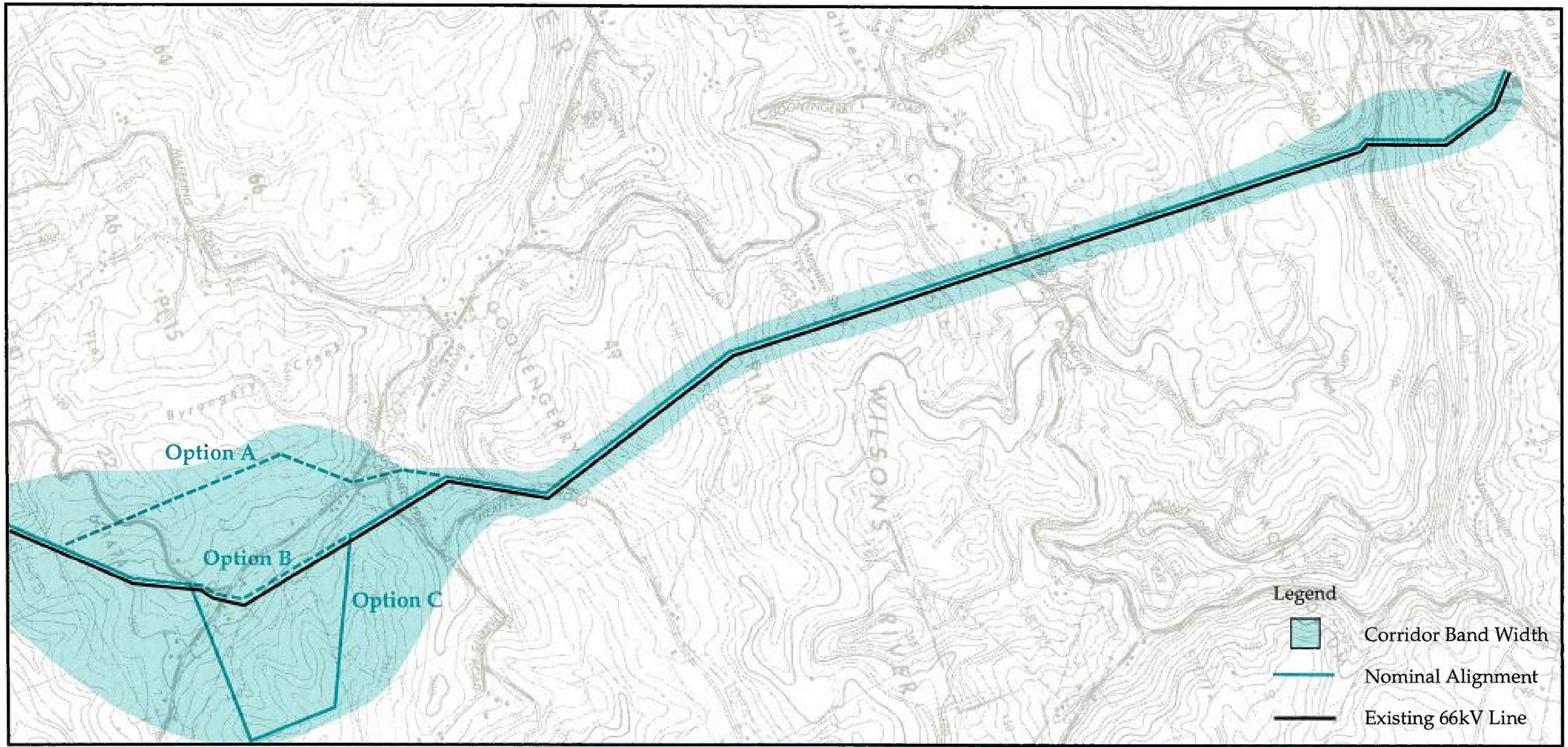
Figure 4.1f

NOMINATED CORRIDOR AND ROUTE ALIGNMENT









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the Wilsons River floodplain in South Lismore on the southern side of Three Chain Road. The existing line heads in a northerly direction across the floodplain and crosses the flood levee and the railway line near Casino Street. It passes between residential blocks and is approximately 10 metres from the nearest house (see **Plate 1**).

The existing line continues north across Leycester Creek, and Booerie Creek, and crosses Booerie Hill, adjacent to Booerie Creek Road. A number of small rural residential blocks are affected by the existing line.

The new alignment west of the existing route has been developed in consultation with property owners in the area and will decrease the impact of the line on existing houses and private land. The impacts will be transferred to flat Council and privately owned floodprone land, used for sewage treatment and grazing purposes. It will be generally less visually intrusive, being located further from settled areas and lower in the landscape than the existing line. The new route avoids crossing the area of higher elevation at Booerie Hill.

No major removal of vegetation will be required along this section of the line given the flat, open nature of the terrain.

Booerie Dip to Borton Road, Tullera

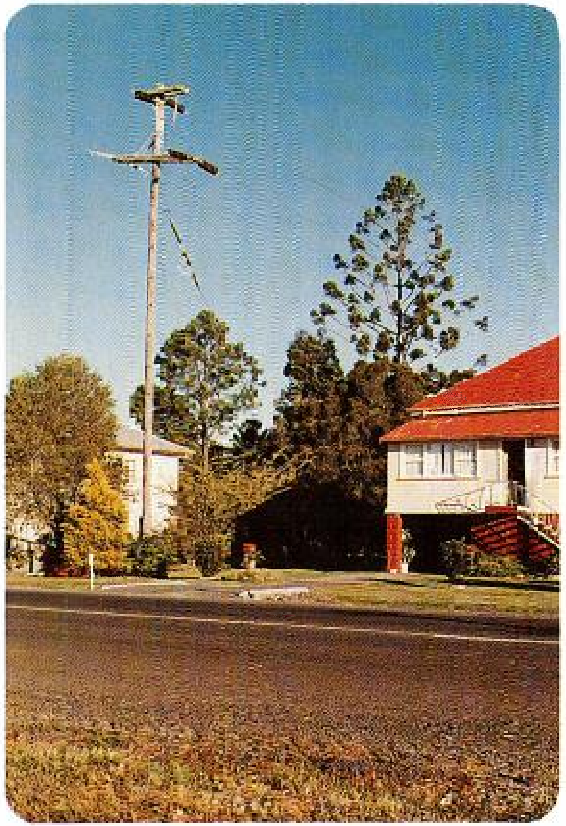
From Booerie Dip to Bentley Road, Tullera, the existing line travels in northeasterly direction, up the Booerie Creek valley, crossing the creek in places and then remaining on the northwestern side of the creek towards Bentley Road.

It is proposed to build the new line some 150-200 metres to the north of the existing route. This will move the proposed line further away from residences along Hewitt Road. From the end of Hewitt Road to Bentley Road, the proposed line follows the existing route across undulating cleared pasture land (see **Plate 1**), and banana plantations immediately to the south of Bentley Road. From Bentley Road to Borton Road the existing line crosses undulating terrain used for agricultural purposes such as grazing and banana plantations. This area is one targeted by Tullera Land Care for regeneration of native flora and fauna populations. Residential dwellings are located along the roads in the area.

No significant deviations are proposed for this area and the nominal alignment is the same as that of the existing line. The clearance over the banana plantations will be sufficient to allow existing horticultural activities to continue.

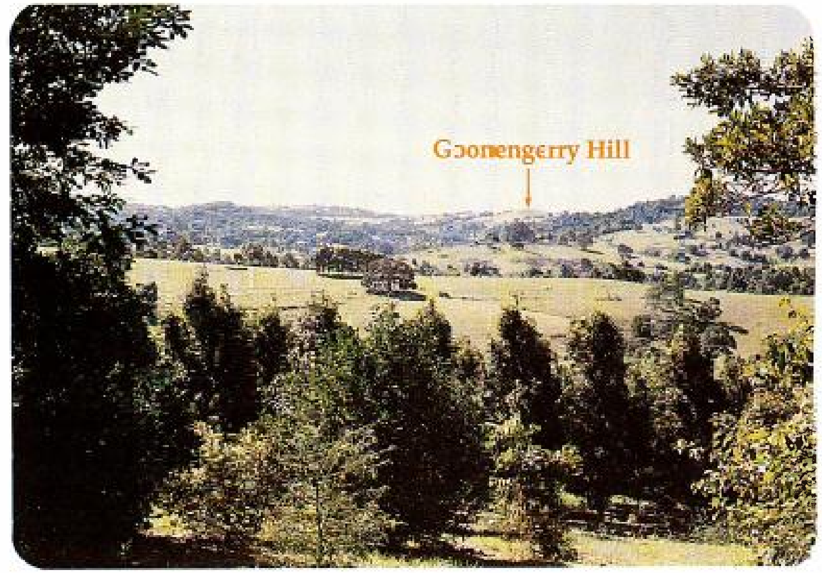
Tullera to Modanville

From Bentley Road the existing line crosses undulating land used for grazing and banana plantations. The existing line is located

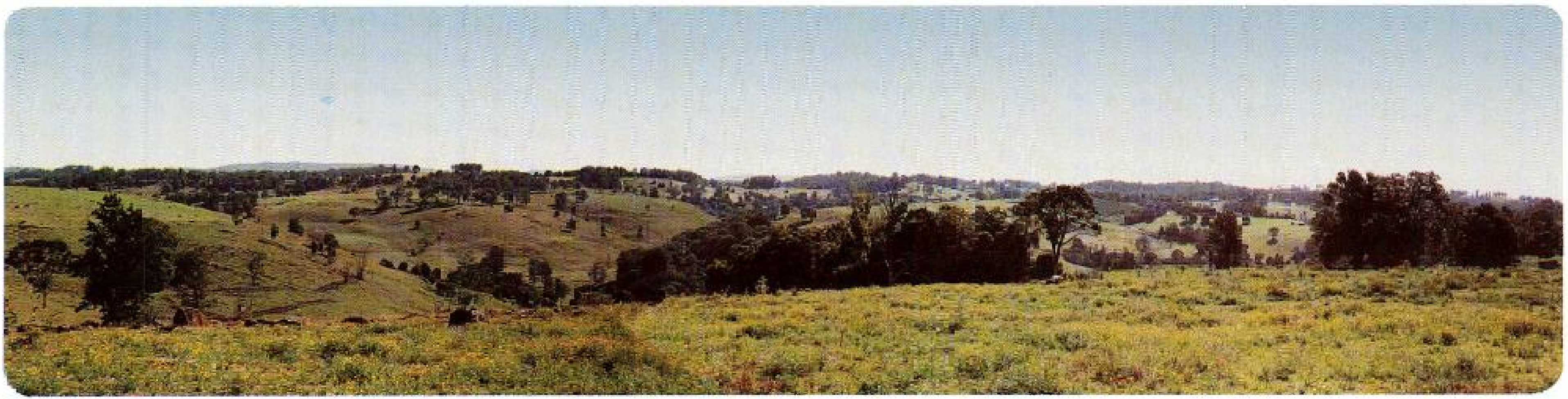


Existing 66 kV line crossing Casino Street

View to the north east from Emerson Road toward Goonengerry



View to the north from Durroon Road near the Bentley Road junction Goonengerry Hill



approximately 50 metres west of the Modanville Primary School immediately prior to crossing Dunoon Road.

A realignment is proposed in this area to reduce the perceived impact on the school. This realignment has been considered at the request of the Modanville School community and takes the line to the west of its' existing location, requiring tree and vegetation clearing on the property affected by the deviation. Tullera Land Care have been working within the school grounds, planting tree species to encourage koalas in the region.

After crossing Dunoon Road the existing line passes to the east of Modanville Village and crosses hilly grazing land containing remnant rainforest patches primarily located in the gullies, before passing through the Modanville Eastern Estate, a subdivision containing 19 residential blocks. The blocks have been designed to accommodate the existing line, and only minor realignments will be necessary.

Modanville to Fletcher Road, Dunoon

From the Modanville Estate the line travels in a north easterly direction, crossing undulating terrain used primarily for grazing and macadamia plantations. Macadamia trees are currently located underneath the 66 kV line. The proposed line follows the same alignment as the existing line to the Dunoon Substation.

The existing line is located within 150-200 metres of houses on the southern end of the Dunoon Village, and currently crosses land zoned 2(v) Village Zoning which has potential for subdivision. In addition, 2 homes are located very close to the required 45 metres easement associated with the proposed line. In order to mitigate the impact of the line in this area, the new line deviates from the existing route from the substation, following Duncan Road, within land owned and operated by Macadamia Plantations of Australia Pty Ltd. It then follows a gully north to join the existing line and traverses grazing country, moving towards Fletcher Road.

A number of dwellings are located along Fletcher Road, and the proposed line will be realigned slightly.

Fletcher Road to Dorroughby Road

From Fletcher Road to Dorroughby Road the existing 66 kV line crosses a number of macadamia plantations, and remnants of native vegetation supporting native fauna populations. It crosses Missingham Road near Missingham bridge.

The proposed line will follow the route of the existing line in this section.

No major clearing will be required for the transmission line along this section though some minor clearing may be needed to gain access to the pole structures. It is anticipated that clearing of only 1-2 trees will occur at any one place along this section of the line.

Dorroughby Road to Fox Road (Rosebank Road)

From Dorroughby Road to Fox Road (Rosebank Road) the existing line crosses hilly country, containing macadamia plantations and areas of native vegetation, particularly adjacent to Boomerang Creek. With the exception of the junctions between the transmission line and the local road network, few houses are located within the bandwidth along this section, though some houses are visually affected by the line.

The proposed line will follow the route of the existing line in this section.

Some clearing of vegetation will be required and wherever possible, this will be carried out selectively. Existing access tracks will be used as much as possible. If necessary, additional access tracks to the existing and proposed structures will be constructed.

Fox Road (Rosebank Road) Via Emerson Road to Coopers Creek

In this section of the proposed route, the existing line crosses Emerson Road and Coopers Creek, land which is primarily used for grazing and contains significant stands of native vegetation. In addition, some areas contain macadamias and some gullies under the line are planted with timber to provide wood for fencing and other such uses. Some houses are located close enough to be affected by the visual impacts of the line.

At Coopers Creek the existing line crosses a remnant of good quality rainforest vegetation.

The proposed line will follow the route of the existing line in this section.

In this area the landforms are hilly, and prone to erosion if cleared completely. Some clearing of rainforest species may be required to obtain safe clearances for the new line and if so will be carried out selectively wherever possible.

Coopers Creek to Jarrets Road, Goonengerry

From Coopers Creek, the existing 66 kV line continues in a north easterly direction, across hilly terrain, which is either cleared for grazing purposes or covered by vegetation. After the existing line reaches Federal Road it turns to the north until it joins Jarrets Road. Small areas of horticulture occur within the corridor in this section of the line, including both bananas and macadamia plantations. A tourist guest house is located on a property at Goonengerry affected by the existing line.

Until approaching Goonengerry, the proposed line will follow the existing line.

Areas of good quality rainforest vegetation occur underneath the existing line. Access tracks will be required in these areas and some disturbance of the vegetation will be necessary. Clearing will be carried out selectively.

Due to the proximity of the existing line to residential dwellings and the Anglican Church at Goonengerry and the visual prominence of the area (see **Plate 1**), a significant realignment of the new line is proposed. Three proposed realignments were developed in consultation with the community and are shown in **Figure 4.1f**.

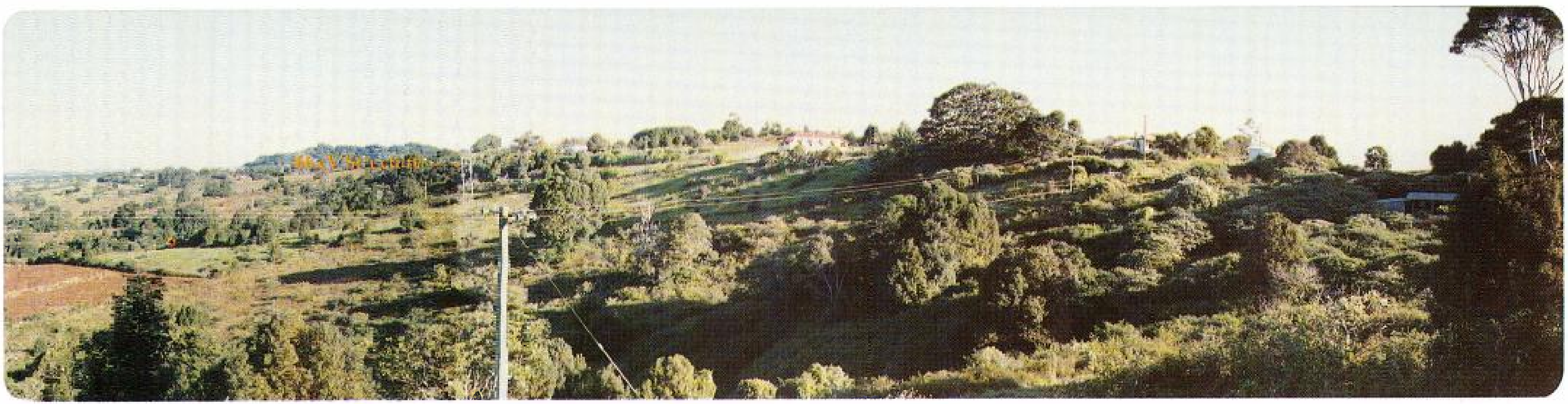
Option A (Western Option) was proposed by the "Goonengerry Quorum" owners. The line would deviate north from the existing 66 kV line and run along a road reserve some 400 metres to the west of the Church, for approximately 1.2 km. The line would then turn east and cross Federal Road in the Goonengerry Dip saddle, near Jarrets Road junction (see **Plate 2**). It then continues east, rejoining the existing alignment about 400 metres from Federal Road. This option impacts on a number of properties not currently affected by the line and would require some clearing, including the removal of rainforest supporting trees (see Section 6.2.3).

Option B involves retaining the existing alignment with modifications to reduce the visual impacts of the line and to ensure that houses are located outside the easement. This route would basically follow the current alignment across Federal Road, then continue north east for about 300 metres from the existing 66 kV route before turning northward to rejoin the existing line near Jarrets Road. Impacts associated with this option include removal of a large fig tree, and significant visual impacts on a number of properties.

Option C, the preferred alignment, crosses Federal Road about 50 metres to the south of the existing 66 kV crossing. The proposed deviation then heads almost due east for about 400 metres, across Federal Road following existing property boundaries into the valley. It then turns north west, before joining the existing line near Jarrets Road. The impacts associated with this option will be reduced on some properties and increased on others. This option has been chosen as the preferred option.

While the overall visual impact of Option C is slightly greater than Option B, the visual impact on residents will generally be reduced, as the line will be further away from houses and lower in the landscape than the existing line.

View to the north east from Emerson Road toward Goonengerry



Views of the existing 66 kV line to the southern side of Goonengerry Ridge

Plate 2

Goonengerry to Lavertys Gap
From Jarrets Road the existing line continues generally in a northerly direction towards Lavertys Gap, across cleared grazing country and sections of heavily vegetated forest (see **Plate 2**). The existing line currently impacts on this vegetation which has previously been substantially cleared for the line. This section of the line crosses hilly country, some of which is particularly steep.

In the section between Jarrets Road and Sheaffes Road, a number of residences are located too close to the existing line to allow a 45 metres easement to be taken without altering the route alignment. For this reason, minor deviations to the existing route are proposed for the new line in this area.

From Sheaffes Road, via Montecollum Dip to Wilsons River, the transmission line traverses country either cleared for grazing or under vegetation. Small areas of horticulture occur within the corridor and a few houses are located along this section of the existing line. The alignment of the new line will be the same as that of the existing line.

Areas of high quality vegetation characterise this section of the line (see **Plate 2**).

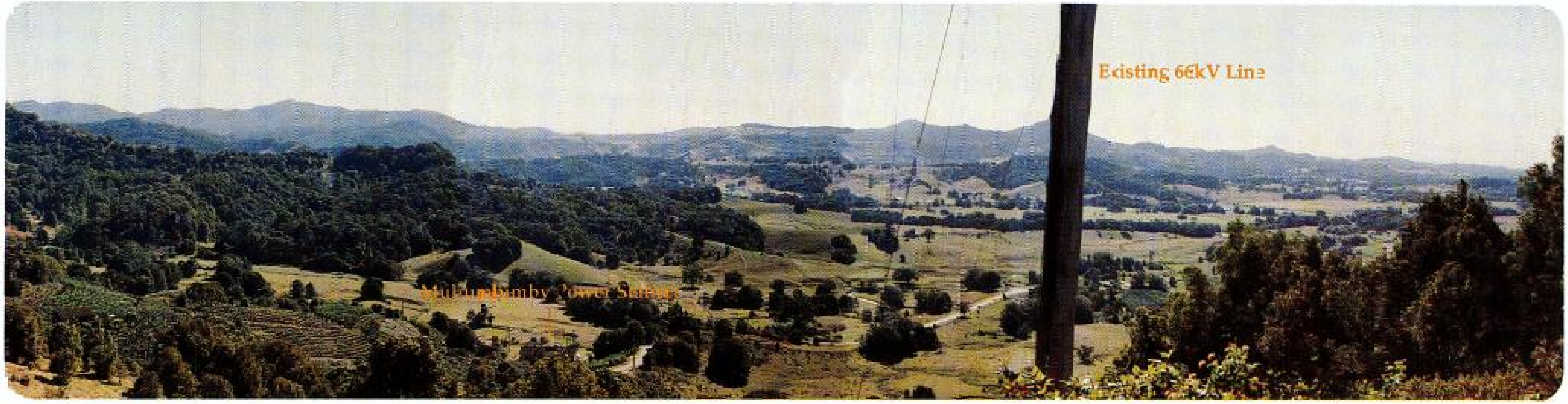
From Montecollum Road the existing line drops down the escarpment towards Mullumbimby Power Station (see **Plates 2** and **3**). The preferred alignment of this section of the new line will deviate slightly from the existing alignment, to minimise the impact of the line on the local residences. Some removal of vegetation will be required, to gain access to the pole structures, and this will be carried out selectively.

4.3 Substation Arrangements at Lismore and Mullumbimby

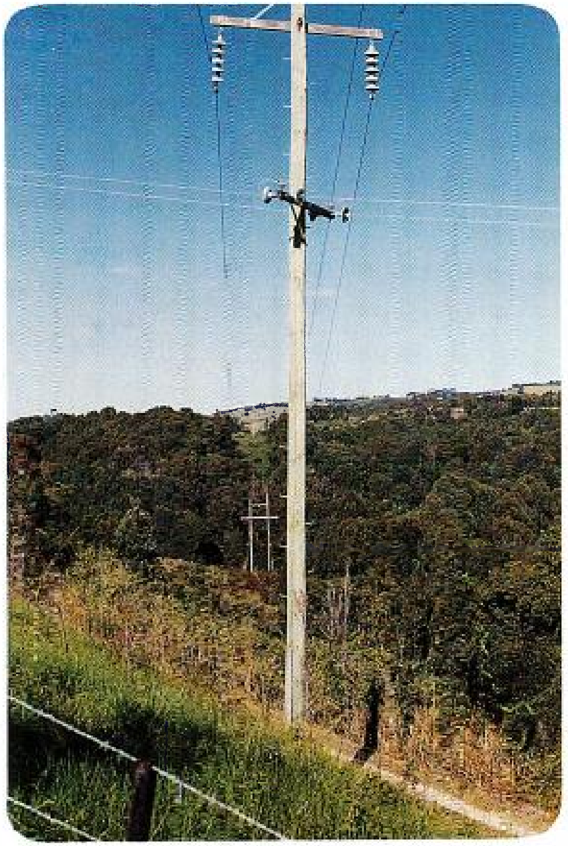
The proposed transmission line will transmit power from Lismore 132/66 kV Substation, located approximately 3 km west of Lismore on Three Chains Road.

Initially the line will operate at 66 kV and the new transmission line will terminate on the northern side of the Lismore 132/66 kV Substation. The new line will later be connected to the southern side of the Substation in a 132 kV switchbay to be constructed within the existing Substation, when it becomes necessary to operate one circuit of the new line at 132 kV.

The new line will initially connect into the existing Northern Rivers Electricity 66 kV system near Mullumbimby Power Station at Lavertys Gap, about 5 km south west of Mullumbimby. When 132 kV operation is required, a new substation will be constructed adjacent to the Power Station and the line will be connected to this Substation.



View to the north overlooking Mullumbimby Power Station



View of the existing 66 kV line looking south from Montecollum Road

Mullumbimby Power Station

Plate 3

The environmental assessment of the substation development is outside the scope of this EIS. The substation development will be the subject of a Development Application when it is required to be built.

4.4 Physical Components of the Development

4.4.1 Supporting Structures

The structures will be spaced along the line to ensure safe clearances are maintained. The exact location of each structure will depend on engineering considerations and property owner requirements.

There will be three structure types: suspension, angle, and tension structures.

The majority of the structures will be of the suspension type. Suspension structures will be single pole structures with angle and tension structures having two poles.

Typical structure arrangements are shown in **Plates 4** and **5**.

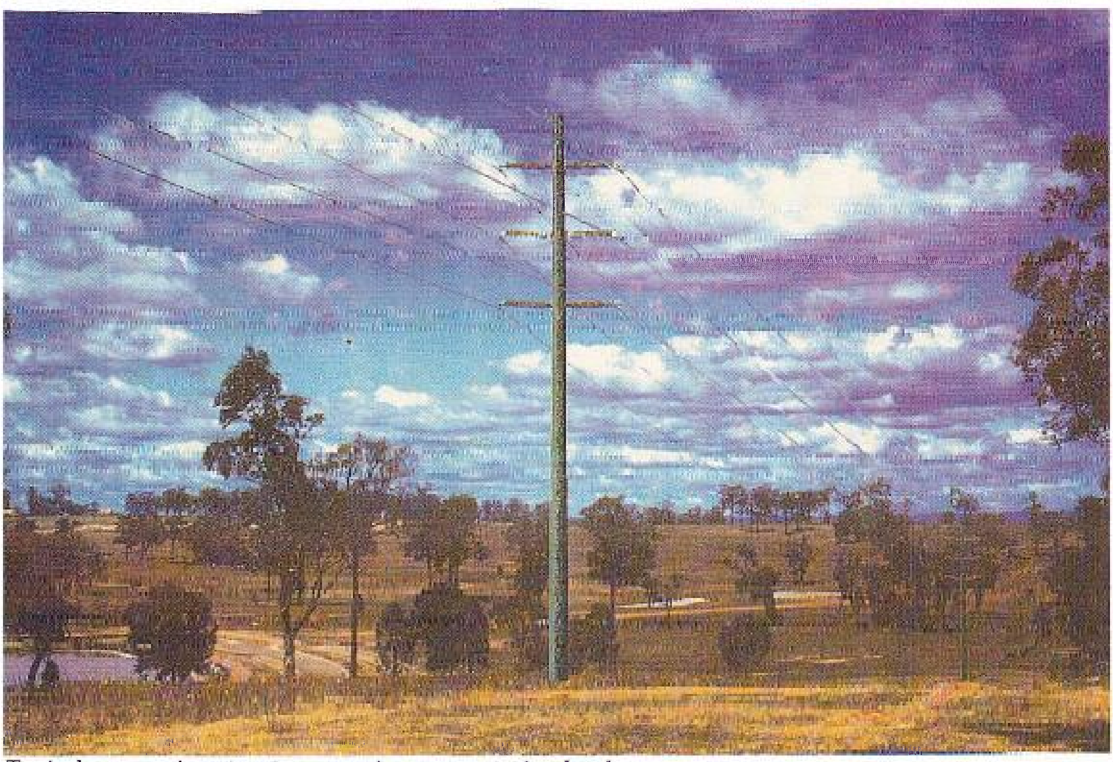
The structures are designed to ensure the wires maintain the required ground clearance at all points in the span. The height and spacing of individual structures will vary depending on the terrain, but the typical height of structures will be 25 metres, with taller structures being required at some special locations (such as over macadamia plantations or prime native flora areas).

The safe electrical clearances from the "live" conductors of the transmission line to the ground, vegetation or other services influence the height and location of the supporting structure. There are a number of other conditions that need to be examined to ensure appropriate clearances are maintained at all times. These conditions are summarised below.

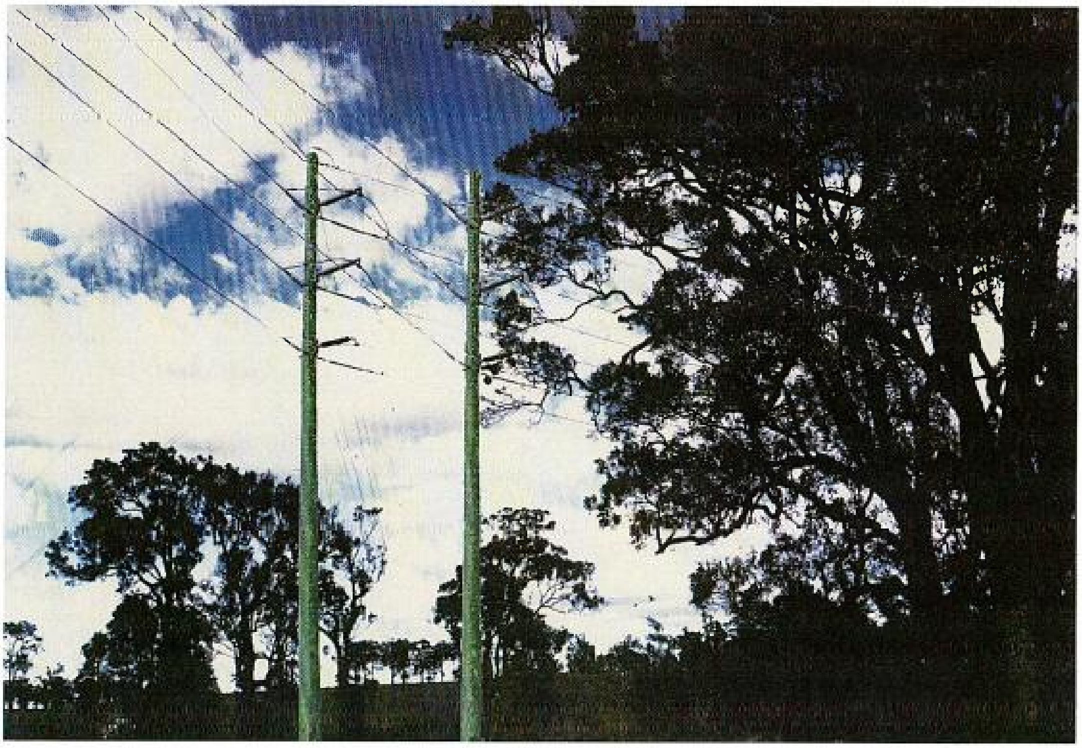
- Standard Design Clearance

  The clearance laid down by the Overhead Line Safety Regulations for 132 kV transmission lines is 6.7 metres from the ground to the conductors in any direction. PacificGrid's standard design clearance for 132 kV transmission line conductors under maximum operating temperature is 7.5 metres. The design clearance provides for vehicles up to 4.3 metres in height (standard legal height for vehicles) and for people walking under the line.


Typical suspension structure crossing macadamia plantation


Typical suspension structure crossing open grazing land

Typical angle structure



Typical tension structure

- Additional Ground Clearances

  Additional ground clearances will be specified where the transmission line crosses certain features. These design clearances also exceed statutory requirements and are listed in **Table 4.1**.

Table 4.1 Specified Minimum Design Conductor Clearances for 132 kV

Location	Minimum Clearance at Maximum Operating Temperatures (m)
From ground in any direction	7.5
Above a 1 in 100year flood level	6.7
Over existing power lines	3.5
Over roads not likely to be reticulated with low voltage power lines	
a) main roads, freeways, tollways	10.0
b) council roads and tracks	8.0
Over roads likely to be reticulated with low voltage power lines	12.0
Height over railway tracks	12.0
Height over telephone lines	3.5

Additional clearance can be incorporated into the transmission line to accommodate agricultural or horticultural activities or where sensitive vegetation occurs. In these areas, the additional clearance may reduce the physical impact of the transmission line. The proposed transmission line route crosses a number of areas where macadamias and bananas are grown and the requirements for safe clearance above the top of these crops will be discussed with each owner to determine if additional clearance will reduce or eliminate vegetation control requirements. Similarly, sensitive vegetation areas will be examined to determine if additional clearance will reduce clearing requirements in these areas.

Suspension Structures

A typical suspension structure is shown in **Plate 4**. These structures are designed principally for locations where the transmission line runs in a straight line. The structures are designed to support the weight of the conductors and loads from wind on the conductors and on the pole itself. In some cases, the poles can support a minor change in the direction of the transmission line.

Supporting the conductors on each suspension structure will be six "post" insulators. Three insulators will be mounted on each side of the pole. The insulators ensure safe clearance between the pole and the "live" conductors. Each insulator will be mounted horizontally on the supporting pole, at right angles to the conductors.

The insulators will be "composite' insulators comprising a fibreglass core, covered by "weather sheds" of a polymer material. Each insulator will be approximately 1.6 metres long.

Angle Structures

Angle structures will be used at locations where a change in direction of the transmission line occurs. Angle structures will comprise two poles located about 5 metres apart as shown in **Plate 5**. Each pole will support three phase conductors and an earthwire. Each pole is designed to support the weight of the conductors, wind on the conductors and on pole, plus the load from the change in direction of the transmission line.

Angle structures will normally be guyed to assist the pole resist the loads resulting from the change in direction of the transmission line. Guys will rise at 45 degrees to the horizontal and will be fitted with "sight sleeves" of white conduit to make them more visible near ground level. The guy wire will connect to a metal rod which will be embedded in a buried concrete foundation block installed within the easement area.

To support the conductors on each angle structure, six composite "long rod" insulators will be used. Three insulators will be on each pole with each one supporting a conductor. Typically, each insulator will hang at an angle of about 45 degrees to the horizontal.

Composite long rod insulators are similar to post insulators being made of fibreglass with a polymer covering. They will be about 1.6 metres long and quite slender.

Tension Structures

Tension structures are used at locations where termination of the conductors is required. Tension structures will be required near Lismore and Dunoon substations and Mullumbimby Power Station and at other locations determined by the final design.

Each tension structure will comprise two poles, approximately 5 metres apart, with each pole supporting three phase conductors and an earthwire, as shown in **Plate 5**. Each pole will be designed to support the weight of the conductors and loads from wind, the longitudinal tension from the conductors and any loads due to a change in direction of the transmission line.

Tension structures will require guys, similar to those on angle structures to assist the poles resist the loads applied by the conductors.

To support the conductors on each tension structure, twelve "long rod" insulators will be used, six on each pole of the tension structure. The conductors will be cut on each side and connected to the pole by a long rod insulator. To maintain electrical continuity across the structure, a "jumper" conductor will connect the two ends of the main conductor on either side of the structure. The long rod insulators will be the same as those used on the angle structures, about 1.6 metres long.

Pole Foundations

Each pole will be embedded into the ground, approximately 3-4 metres and around each pole a concrete annulus will be constructed to support the pole. If ground conditions are unsuitable for this form of foundation, a larger reinforced concrete foundation may be required. Unsuitable ground conditions would be soft soils, or wet or swampy areas. The need for special foundations will be assessed as construction of the line proceeds.

Only about 300 mm of the foundation will normally protrude above the ground.

4.4.2 Conductors and Earthwires

There will be six main current carrying conductors, each approximately 25 mm in diameter. The conductors will be made of aluminium alloy strands built up in a number of layers. The three phase conductors of each circuit will be arranged vertically, with one circuit on each side of the pole.

Located above the conductors at the top of the structures are the two earthwires. The earthwires provide protection for the transmission line from lightning and will be designed to "shield" the conductors from lightning strikes and discharge the lightning safely to ground.

The earthwires will be approximately 13 mm in diameter and made of galvanised steel or aluminium alloy strands.

The conductors will be treated during manufacture to produce a dull finish to eliminate the shine of the conductor when new, reducing the visual impact of the new line.

4.5 Construction Procedures

The construction of the transmission line will have a number of discrete activities and these are described below. The specific pattern of construction activities will generally follow this sequence although some activities may be carried out concurrently depending on the work program, the availability of labour and equipment, and extent of work at any specific location.

□ **Centreline Survey**

Initial line design and structure locations along the preferred alignment will be completed using ground level data drawn from topographic information and aerial survey data.

Access to individual properties will be negotiated with each landowner and at the same time, the detailed location of the centreline and individual structures will be negotiated. A survey team will mark each structure location and carry out "check" survey to confirm ground levels and site conditions. Adjustments to suit ground conditions and additional property owner requirements will be made at this time.

The survey work will be carried out by a survey party of 2 or 3 in a four wheel drive vehicle.

□ **Access Track Construction**

Access to each old and new structure location will be required. Access for a pole erection crane and trucks transporting the pole sections and other equipment, and construction materials will be required.

Where possible existing access tracks will be used with upgrading of these tracks where required. Where new access is required, the location will be determined by the prevailing conditions and property owner preferences. The location of any new tracks will be discussed with each owner.

There is no specific need for continuous access along the entire route of the transmission line, although where there are no major terrain barriers or clearing constraints, continuous access would generally provide the simplest and least extensive method of access to individual structures and easement areas where vegetation removal is required. The proposed access will be discussed with each owner.

Where new tracks are required, road plant may be used to construct the track, with a backhoe or similar being used for final trimming and construction of drains. The Soil Conservation Service (CaLM) will be consulted about upgrading of existing tracks and the location and construction of any new tracks and the recommendations contained in the "Guidelines for the Planning, Construction and Maintenance of Trails" will be followed.

Temporary erosion control measures will be installed during the construction work. Measures may include installation of silt fences, haybales and drains. Further details on erosion and sedimentation control measures are contained in Section 6.5.5.

Where additional material is required for the construction of tracks, local material will be used.

It is anticipated that a construction gang of four or five workers will be engaged on access track construction and upgrading of existing access. There will be one or two working on track construction as required, and a further two or three engaged in the construction of drains and final trim and maintenance of tracks.

It is PacificGrid's policy that the tracks be maintained in a condition suitable for the construction work until the completion of the works. Where tracks are required for maintenance after the completion of the line, these tracks will remain but only to four wheel drive standard. Where access tracks are no longer required following construction, the tracks will be removed and grass seeds and fertiliser spread to enable the track to be rehabilitated, if requested by the landowner.

- **Vegetation Control**

The proposed line will be generally replacing an existing transmission line within an already largely cleared right of way and no major new removal of vegetation is anticipated. Final assessment of the extent of vegetation control and any other work would be normally carried at the same time as the access track construction work, although this will depend on the amount of vegetation control required, and the rate of movement of the various work crews.

Vegetation control will be kept to a minimum and will be confined to areas within the proposed easement where changes in structure locations necessitate work to ensure safe clearances and at the edges of the proposed easement where trees and shrubs could infringe electrical clearance requirements under high wind conditions. Vegetation which is not infringing safe clearances will be retained. However, infringing vegetation generally will be selectively removed rather than lopped due to the risks and prohibitive expense of continuing lopping.

At locations near residences, at road crossings or prominent locations, on steeply sloping land and near watercourses, vegetation control will be restricted to ensure maximum retention of vegetation to preserve the natural appearance of the area. Faunal corridors will be retained wherever possible. In sensitive areas, and where topography allows, the structures will be designed and located to span over these areas without clearing. No vegetation removal will be carried out in gullies where clearances to the conductors can be maintained above the tree tops.

Where the transmission line traverses lands "protected" and "prescribed" streams, permission will be sought from the Commission of Soil

Conservation Services before undertaking vegetation control. The requirements of the Commissioner will be met.

Vegetation control requirements will be discussed with individual owners and the extent of work will be clearly indicated.

It is expected that most of the work will be carried by a small team of perhaps 5 or 6, with most removal being by hand methods, using small plant. In areas where more extensive vegetation removal is required, larger equipment may be used. A "tree pusher" may be used for the safe removal of larger trees, without leaving a stump.

The preferred method of disposal for cleared vegetation will be by stacking and burning within the proposed easement. This will be dependent on seasonal conditions and landowner requirements and will be done in consultation with relevant local authorities. Where stacking and burning is not possible other removal or dispersion methods (such as site chipping or mulching or removal off site) will be considered.

Consideration will be given to replanting of areas of the proposed easement with low growing native shrubs and trees to assist with screening of structures. Tree and shrub planting will only be considered in appropriate areas and with the owner's agreement.

- **Foundation excavation and pole erection**

Each pole will be embedded 3 to 4 metres into the ground. The lower section of the pole will be embedded in the ground, with the upper 1 to 2 metres being encased in a concrete annulus, approximately 300 mm wide.

A truck mounted boring machine and small ready mixed concrete trucks will be required for the foundation work, with a crane being used to erect the pole.

The process of foundation and pole erection work will normally require a truck mounted auger and a crane. After excavation and removal of loose material, the pole will be erected using a crane and after stabilising in a vertical position, the excavated material will be backfilled in the hole. The soil will be replaced in layers and progressively compacted until about 2 metres below ground level. Concrete will be placed to complete the foundation. The foundation will protrude from the ground about 300 mm in a cylinder with either straight or corrugated sides. The top of the foundation will be finished smooth with the centre of the concrete remaining slightly higher than the edge to prevent water pooling on the foundation.

Where the excess material from the foundation is similar to the surface material, it will be spread evenly on the surface around the structure. Material unsuitable for surface spreading will be disposed of off-site.

This type of foundation is expected to be suitable in most areas. Standard excavation methods are anticipated for most structures, but where hard rock is encountered, light blasting to fracture the rock in the foundation may be required.

Where ground conditions are too soft for this type of foundation, a full depth reinforced concrete foundation will be required. The specific details of the foundation will depend the ground conditions encountered but the construction technique and equipment will be similar to that of the normal foundation. A backhoe for excavation work may be required in place of the auger.

The work crew involved in the foundation and pole erection work is expected to be seven or eight people. The work on each pole is expected to take about one to two days to complete, with most poles being excavated and erected within one day.

- **Conductor and Earthwire Erection**

Following erection of the structures, stringing of the conductors and earthwires will occur. This activity is known as "stringing". A process known as "tension stringing" will be used. The conductors are drawn from the drums and a braking machine applies tension to the conductor as it is pulled out. The tension keeps the conductor from touching the ground, or trees and other obstacles. Each section of the line will be strung separately.

The process of stringing starts with a light wire, called the draw wire, being fed through "sheaves", or pulleys, supported below the end of the insulators. Where possible, the draw wire will be run along the ground between structures and through the sheave attached to each structure. The draw wire is then tightened and pulled into the air. Where it is not possible to run the draw wire along the ground, because of terrain difficulties or disturbance to vegetation, a nylon draw wire is fed through the sheaves from a helicopter. The nylon rope will be held at tension above the ground and is "pulled through" the sheaves and replaced by the normal steel draw wire.

The draw wire will be attached to the end of the conductor and the conductor will be pulled through the sheaves. The conductors and earthwires will be kept under tension during this operation to prevent them coming in contact with the ground.

At the completion of the "pull", the tension in the conductors will be adjusted to ensure that correct ground clearance is obtained. The conductor will then be fixed in position at each structure and the sheaves recovered and moved along the line to be used again.

Stringing requires specialised truck mounted equipment, known as the "winch" and the "brake", to pull out the conductor and to maintain and adjust the tension in the conductors. These two pieces of plant are normally positioned to allow 4 to 5 km of the transmission line to be strung in a single "pull". The conductor and earthwire are stored on reels, called "drums", approximately 2 metres in diameter. Each drum holds about 3.5 km of conductor so a number of drums will be stored adjacent to each site. Plant required at each site are the winch and/or brake equipment, trucks for delivery of conductor drums, and concrete anchor blocks. Winch and brake sites are normally located roughly in the centre of a span. Sites which are relatively level and flat will be required to allow the drums to be manoeuvred easily and safely.

The stringing operations will involve 15 to 20 people, spread over the section being strung. It is expected that each section of 4 to 5 km of transmission line will take 1 to 2 weeks to string with the actual "pulling out" of the conductors taking 1 to 2 days. The rest of the time will be spent on preparation and final tensioning.

- **Dismantling of Existing Line**

The existing 66 kV wood pole transmission line will be dismantled as part of the construction work.

The work will involve the removal of the conductors from the existing poles. The poles will be completely extracted from the ground or cut off approximately 500 mm below ground, and then removed from site and the structure site restored to a natural condition.

The existing conductor is made largely of copper and would be sold as scrap for recycling. The age of the conductor together with practical difficulties and the expense of rewinding the old conductor onto drums prevents its re-use as conductor in its current form.

The dismantling work will involve a crew of 5 or 6, requiring a crane to stabilise the poles while they are removed. It may require a backhoe or similar to assist with the removal and trucks would be required to transport dismantled materials from the site.

4.6 Easement Requirements

It is PacificGrid's policy to acquire easement rights for transmission lines. The easement for the transmission line has two major functions:

- It provides right of access to PacificGrid to construct, operate and maintain the line; and
- It ensures the safety of the public and the security of the line by restricting certain activities within the easement area.

The standard width of an easement for a 132 kV transmission line is 45 metres.

PacificGrid practice is to negotiate the purchase of easement rights for the transmission line across private and certain forms of public lands. Individual negotiations are held with each landowner to determine the precise location of the transmission line and its associated easement and access.

Within the easement, certain rights and limitations are applied to both the landowner and PacificGrid. These limitations are designed to ensure the two primary functions of the easement outlined above are fulfilled for the life of the transmission line. These rights and obligations are outlined further in **Appendix F**.

4.7 Operation and Maintenance of the Proposed Transmission Line

4.7.1 Structure and Conductor Maintenance

Once the transmission line is completed and comes into operation, maintenance patrols will make regular inspections of the structures, the easement and the conductor and line hardware, taking particular note of clearance conditions, damage to components or evidence of vandalism. The maintenance program typically calls for both ground and air patrols with officers of PacificGrid making a visual inspection of each structure every year. All structures will be climbed every five years for a close examination of the components at the top of the structures. A helicopter will patrol the line from one to three times annually, depending on the need.

4.7.2 Easement Maintenance

Maintenance of the transmission line easement is necessary to ensure that the safe electrical clearances are not infringed. Generally the easement will be inspected twice a year, in conjunction with the inspections of the structures.

Where necessary, vegetation control activities will be carried out. Three basic types of control are employed:

- Mechanical Control: tractor driven brush cutting equipment capable of clearing small trees are commonly used to maintain access tracks and where heavy re-growth is occurring within the easement. A work team of 2 or 3 people would be involved.
- Hand Clearing: In visually or environmentally sensitive areas or in areas too steep for mechanical control, hand clearing of regrowth is used. Only a portion of the regrowth is removed so as to keep the disturbance to a minimum. A team of 3 to 4 people would be used on this work.
- Chemical Control: Chemical vegetation control is used selectively to remove fast growing species within the easement, generally in places where mechanical control is not appropriate because of terrain or environmental constraints. Several different control treatments are used with the particular treatment being selected based on the type of vegetation and the terrain.

4.8 Associated Infrastructure

The proposed Mullumbimby 132/66 kV Substation does not form part of the development. It is expected that this substation will be required about 2001 and will be covered by a Development Application to Byron Council at the appropriate time.

4.9 Cost of Construction

The proposed transmission line will cost approximately $4.5 million.

4.10 Project Scheduling and Hours of Operation

4.10.1 Construction Schedule

It is anticipated that construction will commence in September, 1995, with a scheduled completion of June, 1996.

The work program will be dependent on the final location chosen for both the line and the individual structures and on the resources and preferred approach of the contractor. It will not be possible to completely dismantle the old line before constructing the new line because of the need to maintain electricity supply to Dunoon.

Construction activities will generally be concentrated on a 4 to 5 km section of line at any one time.

All work on any section is expected to take 5 to 6 weeks to complete. Delays to the construction progress may result from an inability to release the existing line from service because of extended and increased risks of interruptions of supply to customers.

4.10.2 Workforce

The workforce engaged on the project will vary during the construction program and will be dependent on the specific activities underway. Labour requirements will generally be around 25 to 30, comprising approximately five on clearing and access track work, five engaged on structure erection and 10 to 15 on stringing work with a number of others engaged on miscellaneous other activities. As outlined above, it is anticipated that most activities will be undertaken concurrently, although not generally on any one property at the same time.

The arrangements for accommodation of the workforce will vary according to the preferred practice of the contractors but it is expected that the workforce will be accommodated in existing facilities in Lismore or possibly Mullumbimby.

4.10.3 Hours of Operation

Because of the expected need to work under "outage" conditions of the existing line, and to co-ordinate the construction of the new line with the operation of the existing line, working hours will be 9 or 10 hours per day, working from Monday to Saturday. Some Sunday work can be anticipated, particularly for the stringing work.

4.11 Transportation

During the construction period, the vehicles likely to be used are as follows:

- 1-2 x non-articulated flat bed truck
- 1-2 x small concrete truck
- 1-2 x truck for the drill rig
- 1 x crane
- 1-2 x bulldozer/grader/backhoe
- 5-10 passenger vehicles.

For the stringing operations two heavier brake and winch trucks and one truck delivering conductor wire, earthwire, and temporary anchor blocks will need access to specific sites.

The major impacts on most properties associated with the construction traffic will occur over a period of 2-3 days during the erection of the pole structures. Additional occasional visits will occur for a period of approximately 6 weeks until the line is strung.

4.12 Rehabilitation Program

Rehabilitation of work sites will be carried out as work proceeds and as soon as possible after the completion of work on each site. Erosion control measures in accordance with CaLM requirements will be implemented at each work site during the work period and following the completion of work at the site, measures to restore the pre-existing ground condition will be implemented. Revegetation techniques such as loosening of ground compacted by construction equipment, improving soil quality of excavated material spread around structure sites, spreading of fertiliser and grass seeding will be implemented as required. Stabilised spray mulches or grass matting may be used in steep areas.

Planting of trees and shrubs in cleared easements as replacement for additional clearing and to planting of suitable trees and shrubs beside structures or elsewhere for screening purposes will be considered. Such planting will be undertaken after discussion and with the agreement of property owners.

4.13 Fuels and Lubricants

Contractors will be responsible for the transport, delivery and handling of the fuels and lubricants required during the construction operations. Any oil spills occurring during construction works will be absorbed using a suitable material, removed from site and disposed of by the contractor.

4.14 Fire Protection

It is very rare for fires to be caused by a transmission line such as that proposed for the 132/66 kV Lismore to Mullumbimby line. The high standard of design and maintenance required to provide the necessary reliability of service of such a major element in the electricity system almost precludes fire risk. Maintenance of the condition of the line and the easement occurs regularly. The greater mechanical strength of the structures and the specified clearances between conductors and vegetation for the 132 kV line provide a much better margin of safety than the comparable factors associated with some lower voltage distribution lines.

It is possible that bushfires may cause temporary interruptions to the operation of the line, especially where the line traverses heavily vegetated terrain. Appropriate control of the vegetation in the easement is a key point in PacificGrid's maintenance policy, which, while minimising any risk of the line starting a fire, and reduces the possible hazard to the electricity system from bushfires travelling across the easement and burning underneath the conductors. PacificGrid trains its maintenance teams in the use of appropriate methods and equipment to ensure that bushfire hazard is minimised.

Access tracks and sections of cleared easement benefit fire-fighters by acting as firebreaks against small bushfires and providing access to vegetated areas.

4.15 Energy Statement

The main energy impact of the proposed line will be to reduce energy losses in the supply of electricity in the area. As the existing electricity network is placed under greater strain by increasing loads, there are increasing losses on the transmission lines. That is, energy is lost through the heating of the conductors by the current. The augmentation of the electricity network by the proposed line will significantly reduce these losses.

Energy will be consumed during the construction phase of the proposed transmission line in the form of liquid fuel used to power plant and equipment and through the energy used to manufacture materials used in construction such as concrete, conductors, insulators, fittings etc.

Energy required for operational aspects of the line include that consumed in line maintenance operations and the energy consumed by the line itself. The fuel consumed during periodic maintenance activities (by vehicles or helicopter) and occasional repair works is minor. The loss of energy in the network will decrease due to the improvement in conductors to be used with the new line. When the line is eventually operated at 132 kV these transmission line losses will decrease further.

The proposed line will provide an increased electricity supply capacity between Lismore and Mullumbimby, providing for the demand of the growing community in the region.

4.16 Greenhouse Gases

PacificGrid is committed to reducing greenhouse gas emission from its operations. Improvements in efficiency in power station operations have led to a reduction in carbon dioxide emissions of nearly 8 million tonnes since 1988. As part of PacificGrid's efforts to reduce greenhouse gas emissions, improvement in the efficiency of the transmission network are also pursued.

The operation of the new line will lead to a real reduction in the greenhouse gas production as the energy lost in transmitting the electricity will be less than is currently occurring through the existing smaller lines. As shown in **Table 2.3**, a direct reduction in carbon dioxide emissions will result from the operation of the proposed transmission line.

5

Environmental Effects - Air, Noise, Water & Waste Disposal

5. Environmental Effects - Air, Noise, Water & Waste Disposal

This Section describes the existing air, noise and water environment of the area through which the proposed line will pass and outlines anticipated net effects on the environment. Safeguards to be implemented to protect the environment are also described.

5.1 Climate and Air Quality

Due to the nature of the works associated with the construction and operation of the transmission line, air quality issues associated with the proposed development are limited. The following sections provide a description of the climate of the study area and an assessment of the potential impacts on air quality during the reconstruction of the existing transmission line.

5.1.1 Climate

The study area is located in the Far North Coast region of New South Wales. The scenic quality, temperate climate and proximity to the east coast combine to create an attractive environment. The Far North Coast region possesses a temperate climate of warm to hot summers and mild winters. Rainfall is regular, though extremes of droughts associated with tropical cyclonic depressions can occur. Much of the area may be classified as humid sub-tropical.

The nearest recording stations within the study area are situated at Lismore (Centre Street) which is 11 metres above sea level (asl) and Mullumbimby (Billinudgel Road) which is 10 metres asl. The station at Mullumbimby only has records for rainfall. From 102 years of data, the average annual rainfall at Lismore is 1 358 mm and from 94 years of data at Mullumbimby, the average rainfall is 1 714 mm. The average number of raindays experienced annually is 127 at Lismore and 91 at Mullumbimby. Annual rainfall declines from the east to the west and is distinctly seasonal, with the majority falling in late summer to autumn. Intense rainfall events derived from easterly winds of cyclones may cause short term flooding. Mean annual minimum and maximum temperatures are 13.5 and 25.4^{0}C respectively (see **Table 5.1**).

Winds in the region vary throughout the year. Wind speeds and direction have been recorded at the Lismore Meteorological Office since 1957. Analysis of wind data indicates prevailing winds in the morning and afternoon are not similar. In summer, winds are from the south east to north west, depending on the movement of tropical cyclones within the area. In winter, cool westerly or south westerly winds occur and these are associated with eastward moving low pressure cells and cold fronts. High winds are usually associated with the tropical cyclones.

Table 5.1 - Temperature, Humidity and Rainfall Data for Lismore Meteorological Office (Station Number 058037 Latitude 28 Deg 49 Min S Longitude 153 Deg 16 Min E Elevation 11.0 metres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Relative Humidity (%) 29 Years of Record													
Dry-bulb	23.9	23.2	22.3	19.5	15.7	12.7	11.4	13.4	17.3	20.5	22.2	23.6	18.8
Wet-bulb	21.0	20.9	20.0	17.4	13.9	11.1	9.6	11.1	14.0	16.7	18.5	20.2	16.2
Humidity	76	80	80	80	81	81	78	74	67	66	68	72	75
3 pm Mean Temperatures (C) and Mean Relative Humidity (%) (29 years of record)													
Dry-bulb	28.5	28.1	27.0	24.9	21.6	19.5	19.1	20.4	23.0	24.8	26.8	28.1	24.3
Wet-bulb	22.5	22.4	21.4	19.2	16.5	14.5	13.4	14.2	16.1	18.2	20.1	21.7	18.4
Humidity	57	59	59	56	57	55	49	46	45	49	51	54	53
Daily Maximum Temperature (C) (29 Years of record)													
Mean	29.7	29.2	28.2	26.0	22.5	20.2	19.8	21.3	24.1	26.2	28.0	29.5	25.4
86 Percentile	32.8	32.2	31.2	28.9	25.0	22.6	22.1	24.0	27.2	30.3	32.2	33.4	
14 Percentile	26.5	26.2	25.5	23.3	20.0	17.8	17.8	18.6	20.9	22.5	24.4	25.6	
Daily Minimum Temperature (C) (29 Years of record)													
Mean	19.1	19.2	17.7	14.6	11.0	8.4	6.4	7.5	10.2	13.4	16.0	18.0	13.5
86 Percentile	21.4	21.4	20.0	17.7	15.0	12.7	10.7	11.3	14.0	17.0	19.3	20.7	
14 Percentile	16.5	16.7	15.2	11.5	6.7	4.0	1.7	3.6	6.6	9.8	12.8	15.0	
Rainfall (mm) (102 Years of record)													
Mean	161	185	192	124	113	99	82	57	53	77	95	120	1358
Median	132	146	167	90	94	59	54	39	45	62	74	94	1287
Raindays (Number) (102 Years of record)													
Mean	13	14	15	12	11	9	8	7	8	9	10	11	127

Source: Bureau of Meteorology

5.1.2 Emissions and Impacts

Existing sources of air pollutants in the area include agricultural activities in the region, existing quarry activities, urban and industrial activities and emissions associated with private, local and regional roads.

The construction and operation of the transmission line will not result in any new major sources of air pollutants in the area. The primary air quality impacts associated with the proposed development will be limited to dust generation during the construction phase of the project and the minor emissions associated with the vehicles used during construction and maintenance activities. The level of dust generation by construction vehicles will be comparable to that of other vehicles on gravel roads in the area.

A little dust may arise from excavation activities associated with transmission line construction and general handling and transportation of spoil material removed during the construction works. In addition, some winning of road material may be necessary for placement on the access tracks. If required, the winning of this material will take place either on the landholders property or from nearby quarries. This may result in the local generation of dust for short durations.

During erection of the transmission line structures, holes approximately 1 metre diameter and 3-4 metres deep will be dug, resulting in the excavation of about 4 m^3 of material. Following placement of the poles within the holes, approximately half of this material will be replaced in the hole and the remainder either thinly spread in a layer around the area or in an area required by the land owners. Should the material prove unsuitable for spreading on the surface, it will be removed in covered trucks and disposed of off-site.

The exhausts emitted from construction vehicles and equipment will contribute to carbon monoxide, carbon dioxide, hydrocarbons and nitrogen oxides in the atmosphere. However, such emissions will occur only intermittently and are unlikely to significantly affect air quality.

In some areas along the transmission line, it may be necessary to burnoff tree loppings or cleared vegetation. Any burning activities will be of short duration and well removed from residences. However, the amount of vegetation to be removed is small. Discussions with the affected property owners will be held concerning any timber which needs to be removed along the line. The landholders will be free to re-use, burn or sell the timber or have it removed from their properties. The use of portable diesel powered chippers will be considered. This need to burn material along the line will be minimised if not entirely avoided.

Once operational, the transmission line will have no major impacts on the air quality of the surrounding area.

5.1.3 Air Quality Safeguards

As indicated above, potential effects on air quality during the construction phase of the proposal will include the generation of dust associated with minor excavation earthworks, burning off, emissions from construction equipment and exhausts from vehicles travelling to and from the site.

Effects of any dust generated will be localised and short term. The minor dust effects of the construction period will be mitigated by careful management procedures including minimising disturbance to the natural ground cover. The surface area to be disturbed by the construction of the transmission line will be restricted at any given time to the current construction location. Following completion of the installation of transmission line structures, the area surrounding the poles will be left tidy, with spoil and other wastes being removed. Revegetation of disturbed areas in accordance with the erosion and sediment control plan will prevent any long term dust generation.

If required, burning off activities will be carried out in accordance with relevant regulatory requirements and in consultation with fire control authorities.

The contractor commissioned to undertake the construction works will be a reputable contractor who will be required to operate all equipment to comply with Section 19A and 19B of the Clean Air Act, 1961. These sections of legislation require the contractor to ensure that all equipment used on site is maintained in an efficient condition and operated in a proper and efficient manner.

The impact of the proposed reconstruction on the air quality of the surrounding environment will be low. In operation, the new transmission line will not be a source of air pollution.

5.2 Noise

5.2.1 Existing Conditions

Traffic and agricultural machinery are the main existing noise sources in the area. In addition, helicopter maintenance flights and maintenance vehicles currently used along the existing line contribute to the existing noise in the area.

The EPA's Recommended Outdoor Background Noise Levels are set out in Chapter 21-1 of their Environmental Noise Control Manual. The relevant zoning is "Rural (Category. R1, AS1055)" for which an Acceptable Limit of 45 dB(A) is specified for the L_{90} background noise level during the daytime and 35 dB(A) at night. For the purposes of this investigation, it has been assumed that these are the typical background noise levels along the preferred route.

5.2.2 Noise Assessment Criteria

Construction Noise
The Noise Control Guideline for Construction Site Noise recommends the following:

- Construction period of 4 weeks and under, the L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

- Construction period greater than 4 weeks and not exceeding 26 weeks, the L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

As construction of the transmission line will be progressive along the route, construction noise would only be experienced at any one location for a period of no longer than five days. Therefore, the relevant construction noise criterion is that the background noise level must not be exceeded by more than 20 dB(A).

Operational Noise
Given the rural nature of the area, recommended planning levels for operational noise outlined in the EPA Environmental Noise Control Manual are 10 dB(A) below the acceptable L_{90} background noise level (i.e. 45 dB(A) during the day and 35 dB(A) during the night).

5.2.3 Noise Emissions and Impacts
During construction of the line, noise generation will occur from vehicles moving to and from the site, and machinery used for activities such as earthmoving, drilling and conductor stringing. The majority of construction activities will generally be carried out during Monday to Saturday throughout the construction period, with some Sunday work required to reduce the risks of supply interruptions.

Maximum noise levels from the plant items to be used during construction are outlined in **Table 5.2**.

An assessment has been carried out for the worst case situation, assuming that all the equipment (with the exception of the helicopter) is used simultaneously at any one site. This scenario is unlikely to occur given the nature of the construction works to be carried out.

At a distance of 20 metres the expected noise levels during a worst case scenario would be approximately 74 dB(A). Generally, residences will be considerably further away from the line than this, and at 100 metres from the construction activities, noise levels associated with the rig would be in the order of 60 dB(A). Noise levels in a worst case situation would drop to approximately 40 dB(A), which is below background, for residences 1 km from the line due to attenuation factors such as distance, topography, and vegetation. Thus, generally, the construction noise criteria will be met, but in isolated instances where residences are close to construction activities, recommended construction noise levels may be exceeded for short periods of time.

Table 5.2 - Typical Equipment and Associated Maximum Noise Levels (at 1 metre from the source)

Equipment Type	Noise Level (dB(A))
Helicopter	130
Dozer	105
Excavator	105
Trucks	95
Truck mounted drill rig	95
Grader	95
Concrete Vibrator	90
Peak Power Level*	**108**

Under the worst case conditions, residences affected by the reconstruction of the line may be as close as 22.5 metres to the line. Given the noise levels produced by the helicopter to be used in the conductor stringing activities, the increase in noise at the worst affected residence will exceed the 65 dB(A) assessment criteria. The Bell Jet Ranger used by PacificGrid to carry out stringing work has a maximum effective noise level of 88 dB(A) at a distance of 50 metres. It is expected that a similar helicopter will be used. While these noise levels exceed the criteria, they are similar to that of a motor mower operating nearby and are less than that of an accelerating motor cycle. The duration of these high noise incidents will be very limited.

Given that high noise incidents will be of brief duration, generally less than one hour, and that stringing of the new line will only take 1-2 days at any location, this construction noise level is considered to be acceptable, and does not represent a significant impact on the local area.

The construction noise criteria will not be exceeded at the majority of residences along the line. Given that construction noise will be short term and intermittent in nature, it is not considered that construction activities will cause significant noise annoyance.

Operational Noise
As the line will generally be silent during operation, it will not have any significant effect on the background noise levels along the proposed route. Consequently, the operational noise criteria will be readily met.

Due to the size of the conductors of the new line, any corona noise emitted under wet conditions will be less than that from the existing line.

5.2.4 Noise Controls and Safeguards
It may be necessary to carry out stringing works on weekends. Other works will normally be confined to weekdays. The following hours of work are anticipated:

- Monday to Friday - 7 am to 6 pm
- Saturday - 7 am to 5 pm if inaudible on residential premises, otherwise 8 am to 5 pm
- Sundays or Public Holidays - only as required.

Construction equipment will be equipped with standard noise control devices which will be maintained in a proper and efficient manner. PacificGrid will inform residents in the vicinity of the transmission line of the timing and duration of construction activities, to give residents forewarning of the temporarily changed noise conditions in the area.

5.3 Blasting

At some locations it may be necessary for minor blasting to achieve the required foundation depths. If this occurs near residences, blasting will be designed to meet the EPA limits of 115 dB linear for overpressure and 5 mm/s vibration at the nearest residence.

5.4 Hydrology and Water Quality

5.4.1 Existing Hydrological Regime
The Lismore plateau is drained by several significant watercourses which come from the Nightcap Range, including Coopers and Numulgi Creeks, Boomerang and Leycester Creeks, Terania Creek and the Wilsons River. The Wilsons River, which drains in a southwesterly direction, occupies a broad flood plain to the south of the transmission line corridor. The creeks mentioned above are all tributaries of Wilsons River. Of these streams Leycester Creek, Coopers Creek and Wilsons River.are prescribed streams under the Soil Conservation Act.

Streams in the plateau area generally flow in a southerly direction from the Nightcap Range in the north to the Richmond River South of Lismore.

A second catchment within which part of the line is located lies to the northeast of the coastal escarpment and drains in an easterly direction to the sea. The major watercourse of this catchment is the Brunswick River which flows through Mullumbimby. Tributaries include Mullumbimby Creek, Kings Creek and Pipeclay Creek. The area affected by the transmission line drains into Yankee Creek, a tributary of Mullumbimby Creek.

Floodprone Land

The area near the proposed line affected by the 1 in 100 year flood is limited to the southeastern section of the line near the urban area of Lismore, running from the Lismore Substation across the Leycester Creek floodplain, and up Booerie Creek to the junction of Blakebrook Creek.

Lismore City is one of the most flood prone urban areas in New South Wales. A Lismore Flood Study (1993) has recently been prepared by Sinclair Knight Merz to define the nature and extent of the flood problem in Lismore. The study determined the 1% and 5% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) behaviour for Wilsons River and Leycester Creek.

As part of the Lismore Floodplain Management Plan, the Lismore levee scheme has been proposed to provide protection for 1 in 20 year floods in Lismore. The scheme involves construction of 13.4 km of levee in Central, South and North Lismore and will be either concrete or earthen. The levee will have an average height of 1.7 metres and will vary from 0 metres to 8.9 metres. While the proposed levee will not floodproof the highly vulnerable areas of North, South and Central Lismore, it would repel the majority of floods, preventing flooding of 215 homes and 498 commercial and industrial properties in a flood similar to the 1989 flood.

In order to reduce the hydraulic impacts of the levee, an existing overland flowpath from Leycester Creek to Wilsons River via the Lismore Substation and Aerodrome will be improved so that its flow capacity is increased. This work will involve the construction of an extra 300 metres of culverts under the railway line and a section of the existing South Lismore levee will be relocated further to the east.

5.4.2 Flooding and Water Quality Impacts and Safeguards

The proposed transmission line will not alter local drainage patterns or flood regime. Flood affected areas that the transmission line crosses are the Leycester Creek and Booerie Creek valleys. The depth of the 1 in 100 year flood levels vary in the area from approximately 1.64 metres at Three Chain Road to 2.24 metres at the railway, 2.25 metres adjacent to Leycester Creek and 2.99 metres at the junction of Booerie Creek and Leycester Creek. The pole structures used in the transmission line will be designed to withstand flood waters and will not form a significant obstacle to flood flows. As a result the potential for flooding will neither be decreased or increased due to the proposed line reconstruction.

Statutory clearance requirement for transmission lines crossing floodplains is 6.7 metres above the height of the 1 in 100 year flood level, which ensures that rescue boats can safely pass beneath them. During such a flood, between 1 and 3.25 metres of water can cover floodplain areas crossed by the transmission line. The height of the line will be designed to ensure that this requirement is met.

Water quality can be affected by soil erosion. Soil erosion associated with the disturbance of the areas in which the transmission line poles will be erected, clearing required in the easements and the construction of access tracks. In addition, in the event of spillage of machinery fuels and oils, local water quality in the area can also be affected.

Erosion and sediment controls and safeguards will control potential impacts on hydrology and water quality resulting from the release of sediment or other pollutants into surrounding waterways.

In addition, the emergency spill response plan will ensure that any spillage of liquids are contained and minimised, thus avoiding significant water quality impacts due to the construction and operation of the proposed line.

Impacts on the Proposed Regional Dam

Three proposals to augment water supplies in the region are:

- a new dam on Rocky Creek between the Channon and Dunoon
- a new dam on Wilsons River near Federal (the W7 site)
- raising the existing Rocky Creek Dam level.

The two proposals involving Rocky Creek would be located to the north and northeast of the proposed transmission line. The Wilsons River dam would be located to the east of the line. None of the proposed water supplies would be affected by, or would affect the proposed transmission line.

5.5 Waste Disposal

5.5.1 Construction Activities

During construction, a number of solid and liquid wastes will be generated. These will include the removed pole structures, drums, surplus conductors, removed vegetation from clearing, spoil from pole excavation sites and drums and lubricants from machinery services.

The wooden pole structures from the existing 66 kV line will be disposed of in consultation with the local landholder. Many landholders have expressed an interest in using wood poles for their agricultural activities. If the poles are not required by the landholder they will be transported off site.

Empty drums, surplus conductors, insulators and waste lubricants will be removed from site and recycled. Other waste will be disposed of in landfill sites.

Removed vegetation will be disposed of in consultation with the local landholder. Wood from clearing will be left for landholder use or will be chipped and mulched or burned depending on the requirements of the landholder.

Excavated soil from pole foundation sites and access tracks will be disposed of in consultation with the landholder either as clean fill on the property or off site.

Any waste from servicing of plant and equipment will be safely removed.

5.5.2 Operational Activities

Wastes associated with maintenance activities will be limited to minor amounts of vegetation from lopping and trimming. This will be disposed of in consultation with the local landholder and will be either left for the landholders use or disposed of by burning or mulching.

6

Land Use and Environmental Effects

6. Land Use and Environmental Effects

This Section provides details of the land uses surrounding the proposed development, provides details of expected impacts and proposed measures to minimise the impacts on the environment.

6.1 Land Ownership and Planning Controls

6.1.1 Land Ownership

The majority of the properties are large grazing or horticultural blocks with some smaller rural residential blocks. The bandwidth associated with the proposed line affects some 210 properties. About 140 people are affected by the nominated route alignment.

6.1.2 Local Government Planning Controls

The proposed transmission line route is located within the local government areas of Lismore City Council and Byron Council. The area is covered by the Lismore Local Environmental Plan (LEP), 1992 (as amended) and Byron LEP 1988 (as amended). The objectives of State Government policy are reflected in the aims of both Council LEP's. Policies have been developed for the preservation and enhancement of natural and man-made resources, the provision of a variety of settlement options, and protection of agricultural resources.

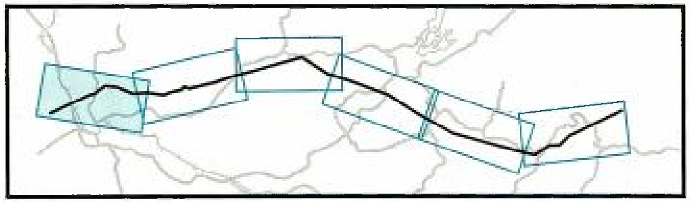
The areas through which the transmission line passes are zoned as follows (refer **Figures 6.1a** - **6.1f**):

Lismore Local Environmental Plan, 1992

- 1(a) General Rural Zone - this zone aims to encourage and permit a range of uses creating a pattern of settlement at a scale that maintains or enhances the natural, economic, cultural, social and scenic quality of the rural environment.
- 1(b) Agricultural Zone - this zone aims to protect identified prime agricultural land and preserve this land from fragmentation and ensure that any development maintains the rural character of the locality and minimises disturbance to the landscape.
- 1(c) Rural Residential Zone - this zone provides land to meet the demand for residential housing in rural surrounds, and to ensure that the development of this land does not adversely affect the rural environment of the area.
- 1(d) Investigation Zone - this zone identifies land in the vicinity of Lismore which has a strategic locational advantage for future population growth.

Figure 6.1a

LISMORE AND BYRON LAND ZONINGS

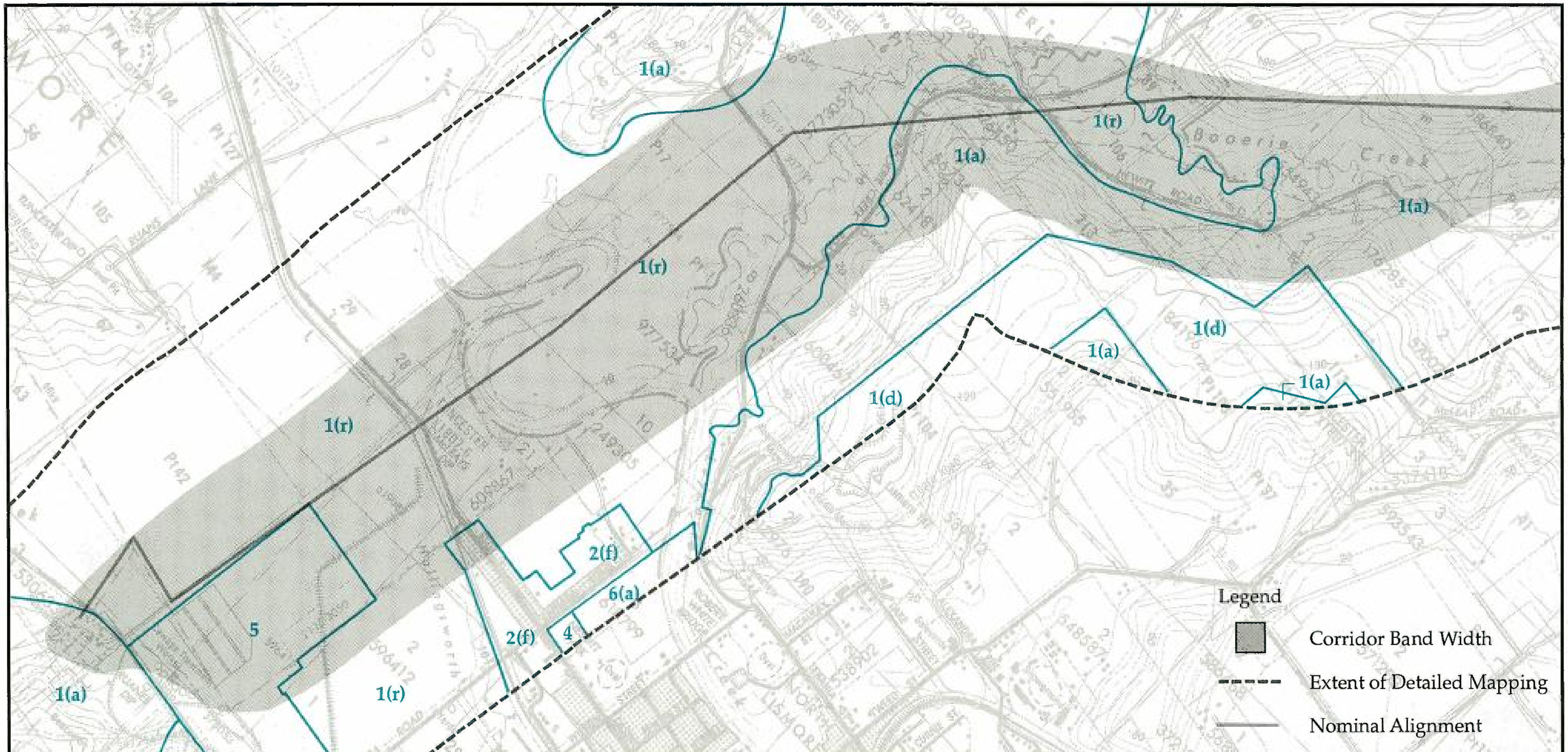


Lismore Local Environmental Plan 1992

1(a)	General Rural Zone
1(b)	Agricultural Zone
1(c)	Rural Residential Zone
1(d)	Investigation Zone
1(r)	Riverlands Zone
2(f)	Residential Zone (Flood Liable)
2(v)	Village Zone
4	Industrial Zone
5	Special Uses Zone
6(a)	Recreation Zone

Byron Local Environmental Plan 1988

1(a)	General Rural Zone
1(b1)	Agricultural Protection (b1) Zone
1(c1)	Small Holdings (c1) Zone
1(e)	Extractive Resources Zone
7(c)	Water Catchment Zone
7(d)	Scenic/Escarpment Zone
7(k)	Habitat Zone



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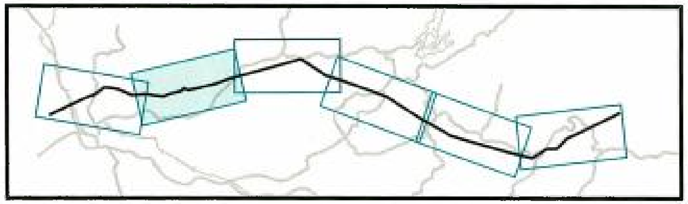
LISMORE AND BYRON LAND ZONINGS



Lismore Local Environmental Plan 1992

1(a)	General Rural Zone
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1(d)	Investigation Zone
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2(v)	Village Zone
4	Industrial Zone
5	Special Uses Zone
6(a)	Recreation Zone

Byron Local Environmental Plan 1988

1(a)	General Rural Zone
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1(e)	Extractive Resources Zone
7(c)	Water Catchment Zone
7(d)	Scenic/Escarpment Zone
7(k)	Habitat Zone

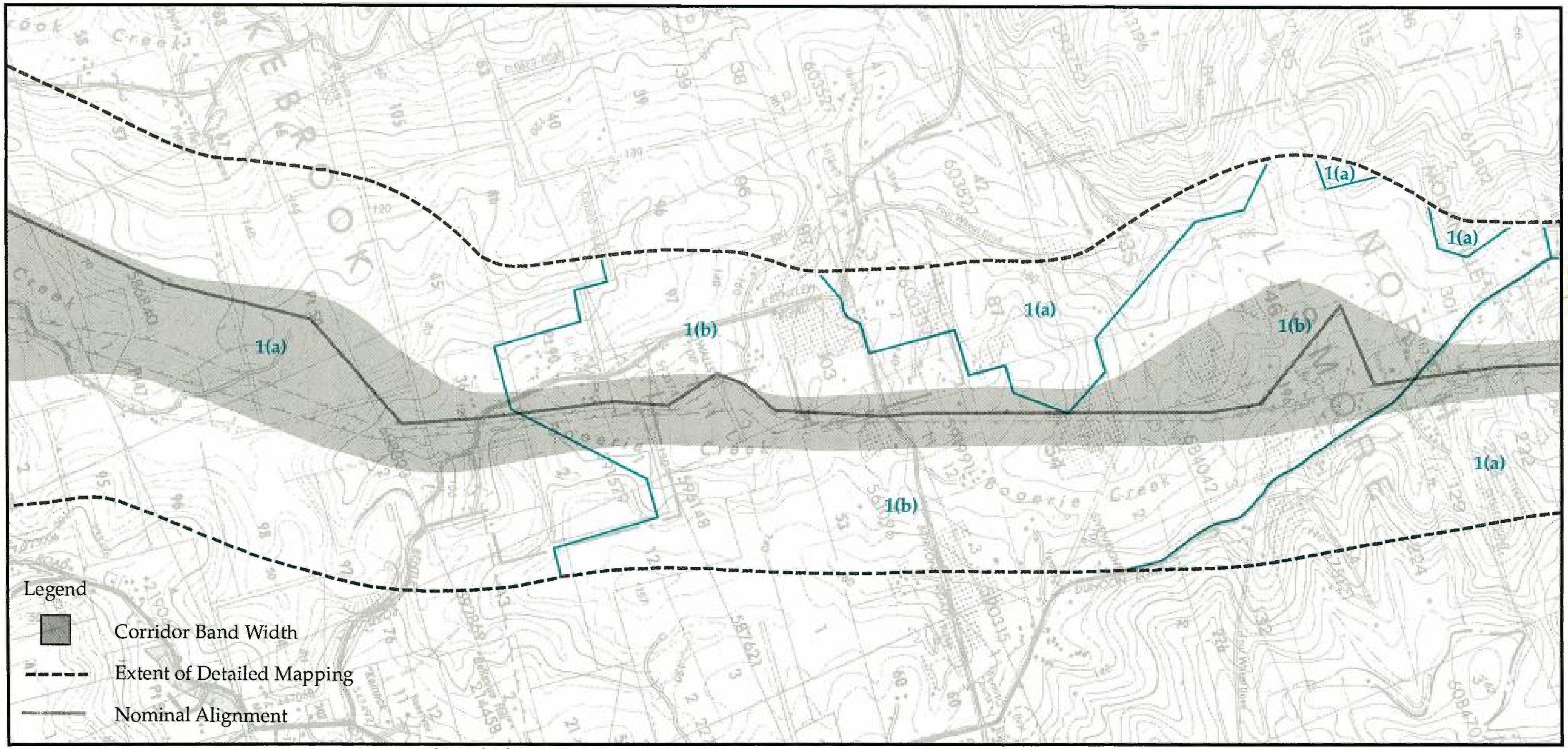

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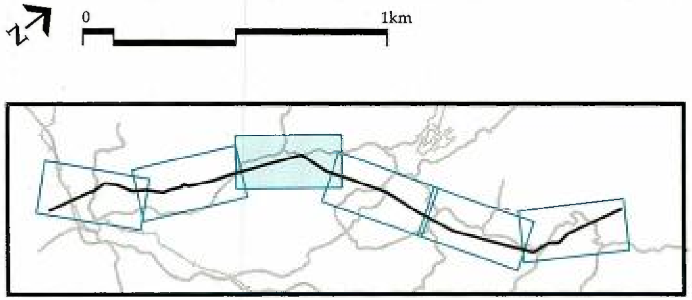
Figure 6.1c

LISMORE AND BYRON LAND ZONINGS

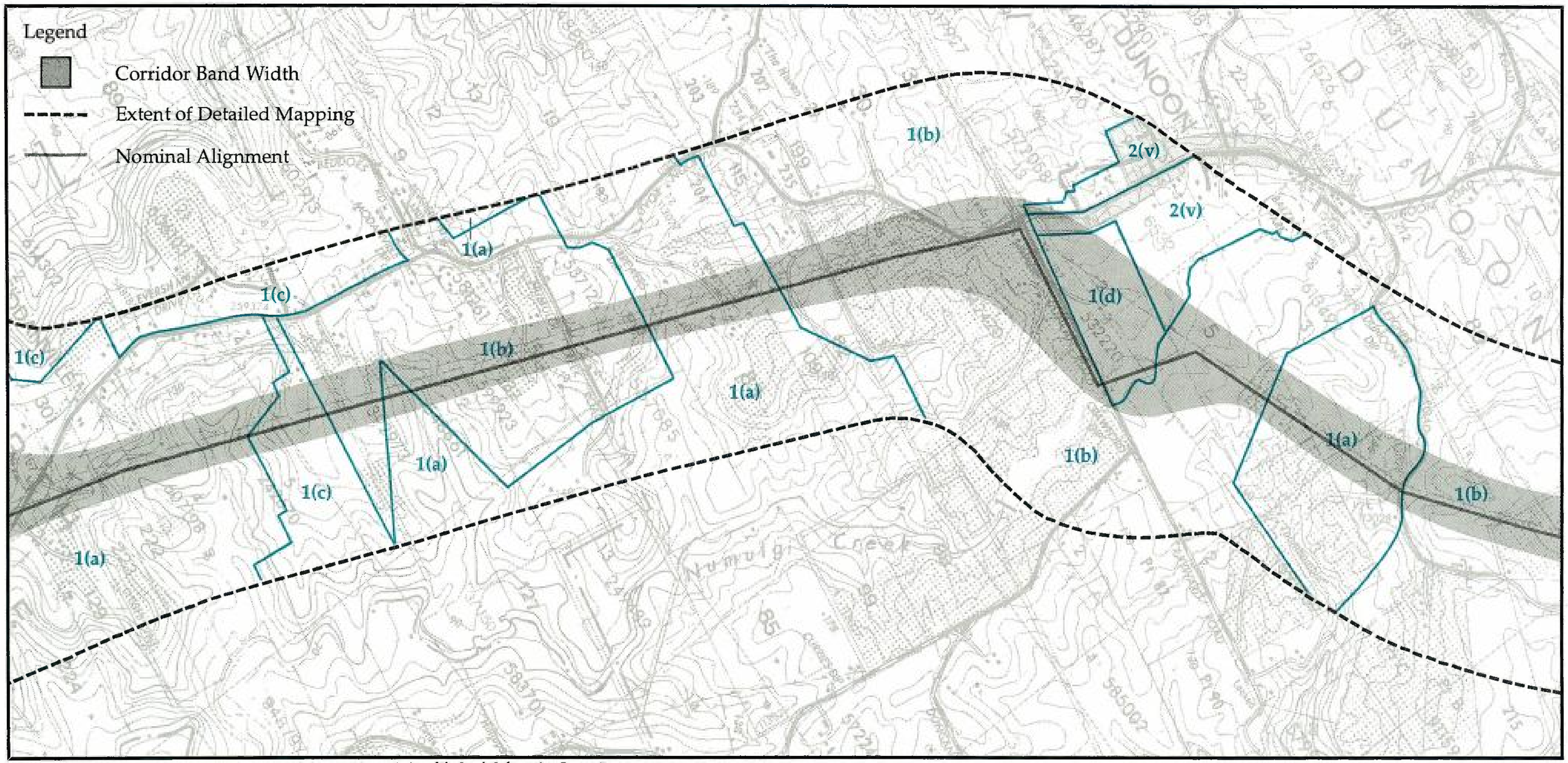


Lismore Local Environmental Plan 1992

- 1(a) General Rural Zone
- 1(b) Agricultural Zone
- 1(c) Rural Residential Zone
- 1(d) Investigation Zone
- 1(r) Riverlands Zone
- 2(f) Residential Zone (Flood Liable)
- 2(v) Village Zone
- 4 Industrial Zone
- 5 Special Uses Zone
- 6(a) Recreation Zone

Byron Local Environmental Plan 1988

- 1(a) General Rural Zone
- 1(b1) Agricultural Protection (b1) Zone
- 1(c1) Small Holdings (c1) Zone
- 1(e) Extractive Resources Zone
- 7(c) Water Catchment Zone
- 7(d) Scenic/Escarpment Zone
- 7(k) Habitat Zone



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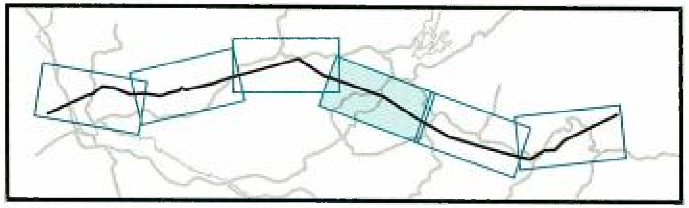
LISMORE AND BYRON LAND ZONINGS



Lismore Local Environmental Plan 1992

1(a)	General Rural Zone
1(b)	Agricultural Zone
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2(v)	Village Zone
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6(a)	Recreation Zone

Byron Local Environmental Plan 1988

1(a)	General Rural Zone
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7(d)	Scenic/Escarpment Zone
7(k)	Habitat Zone

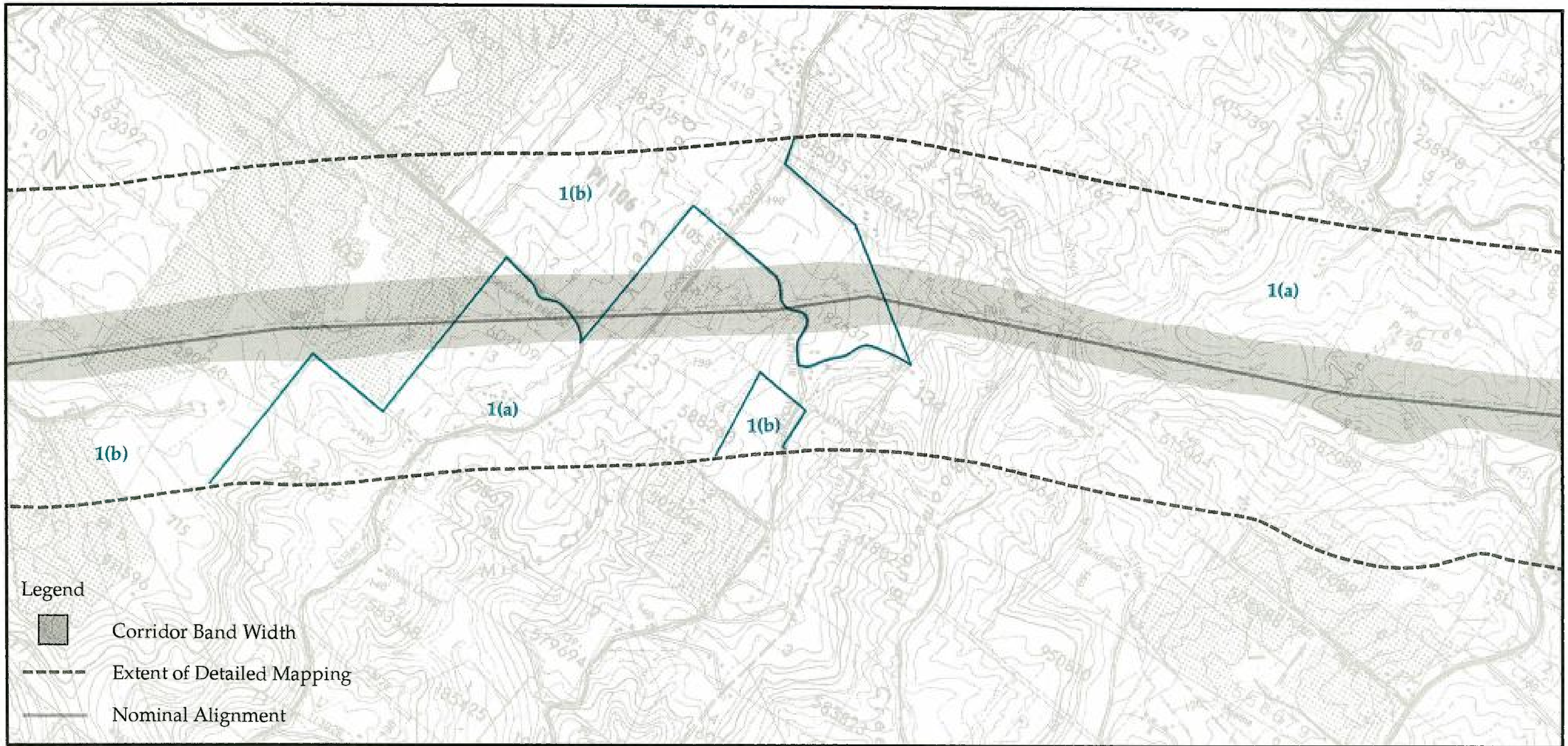

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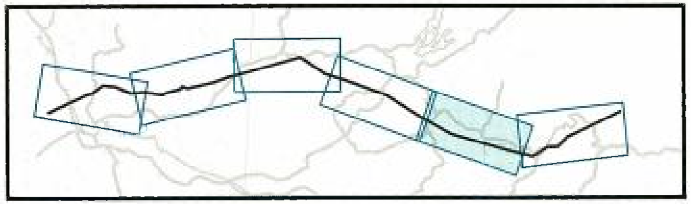
Figure 6.1e

LISMORE AND BYRON LAND ZONINGS

0 1km

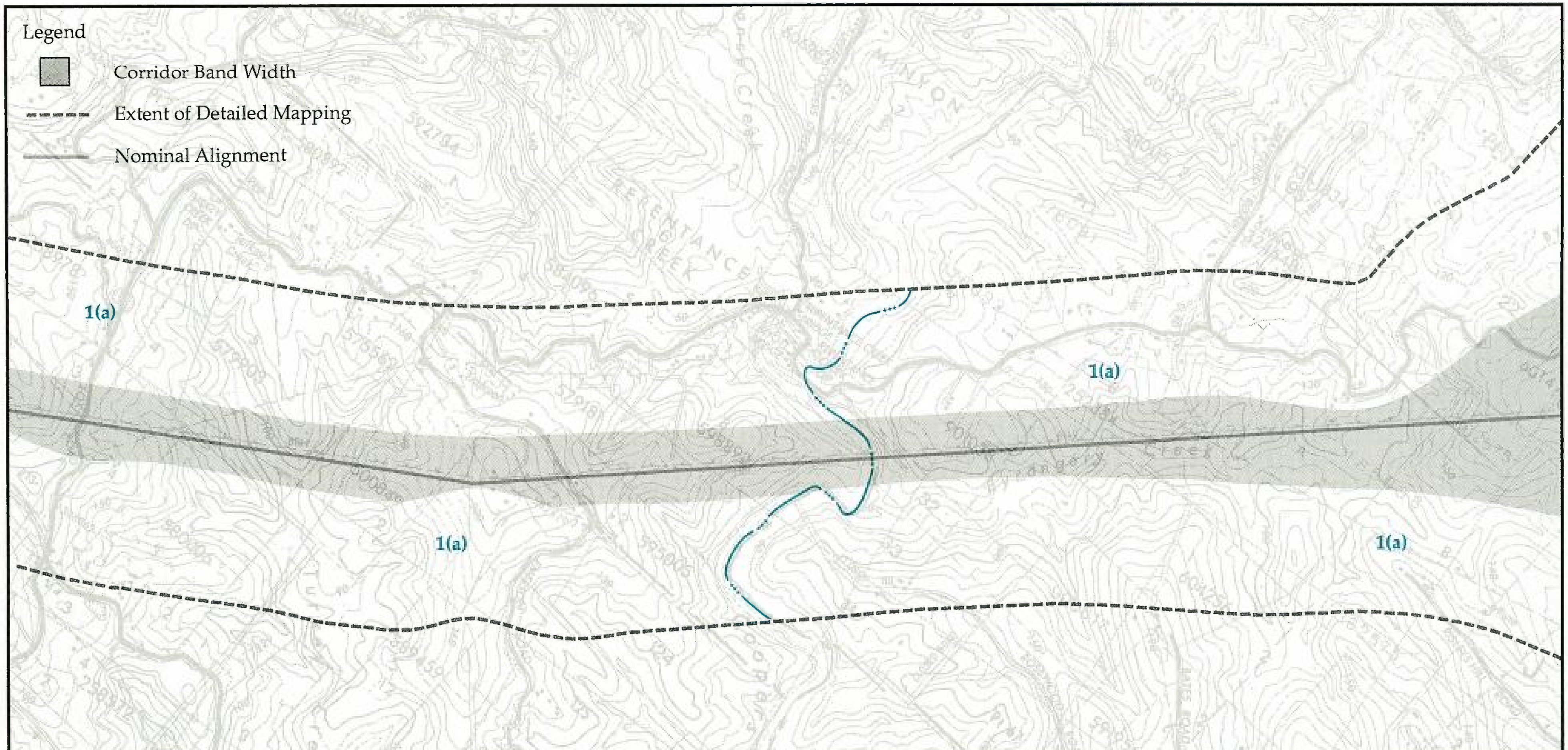


Lismore Local Environmental Plan 1992

1(a)	General Rural Zone
1(b)	Agricultural Zone
1(c)	Rural Residential Zone
1(d)	Investigation Zone
1(r)	Riverlands Zone
2(f)	Residential Zone (Flood Liable)
2(v)	Village Zone
4	Industrial Zone
5	Special Uses Zone
6(a)	Recreation Zone

Byron Local Environmental Plan 1988

1(a)	General Rural Zone
1(b1)	Agricultural Protection (b1) Zone
1(c1)	Small Holdings (c1) Zone
1(e)	Extractive Resources Zone
7(c)	Water Catchment Zone
7(d)	Scenic/Escarpment Zone
7(k)	Habitat Zone



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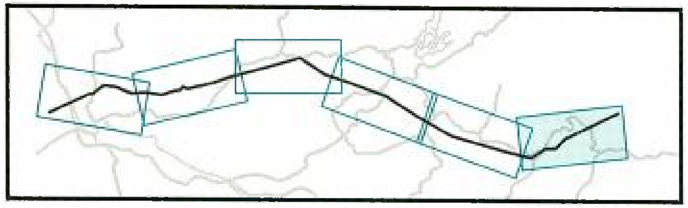
LISMORE AND BYRON LAND ZONINGS



Lismore Local Environmental Plan 1992

1(a)	General Rural Zone
1(b)	Agricultural Zone
1(c)	Rural Residential Zone
1(d)	Investigation Zone
1(r)	Riverlands Zone
2(f)	Residential Zone (Flood Liable)
2(v)	Village Zone
4	Industrial Zone
5	Special Uses Zone
6(a)	Recreation Zone

Byron Local Environmental Plan 1988

1(a)	General Rural Zone
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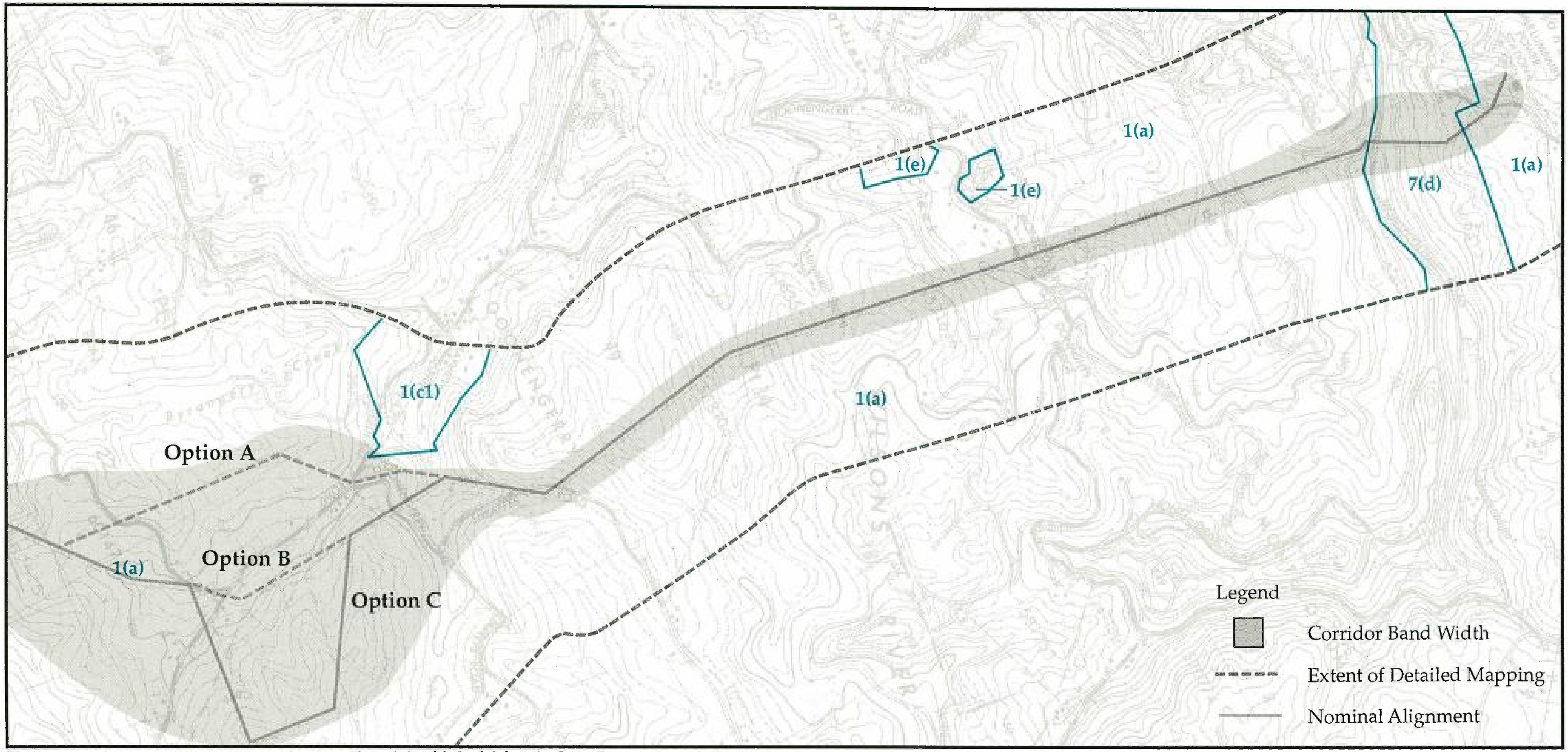

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- 1(r) Riverlands Zone - this zone seeks to allow for the continual beautification of the river corridor in the city and to ensure that land is used to optimise its production potential.

- 2(v) Village Zone - the aim of this zone is to retain the character of the rural villages and to provide for the development of a full range of rural village facilities in locations that are compatible with the character and amenity of the village.

- 5 (Special Use) - the objective of this zone is to designate lands which are now used or intended to be used for particular public or community purposes and to ensure the land is used for a purpose appropriate to its location, community needs and economic utilisation.

- Lismore City zoning including urban residential zoning, business and industrial zones, recreational zoning and river zoning.

Under Draft LEP Amendment No. 10, Lismore City Council proposes to change the zoning of certain areas of land zoned Agricultural zone 1(b) land to a 2(v) Village zoning in the village of Dunoon. Initially, it was also proposed to rezone the area zoned 1(d) Investigation as 2(v) Village Zone, however, Council has stated that this area is now excluded from the rezoning. Consequently village expansion will not occur to the southeast of the existing village in the direction of the transmission line. The transmission line will therefore not affect additional residential zoning in this area.

Utility installations, including transmission lines are not prohibited developments in these zonings.

Byron Local Environmental Plan, 1988

- 1(a) General Rural Zone - aims to encourage and permit a wide range of uses creating a pattern of settlement, at a scale and character that maintains or enhances the natural, economic, cultural, social and scenic amenity of the rural environment.

- 1(b1) Agricultural Protection Zone - this zone identifies land units within prime agricultural quality, and aims to preserve this land for agricultural purposes and prevent fragmentation of rural holdings.

- 1(e) Extractive Resources Zone - major sites of extractive resources are identified in this zone, to avoid conflicting uses that may prejudice any existing or potential quarry operation.

- 7(c) Water Catchment Zone - this zone aims to prevent development within the catchment of existing or future water supply systems which would have a significant detrimental effect on the quality or quantity of the water supply.

- 7(d) Scenic/Escarpment Zone - major objective of this zone is to protect and enhance areas of major scenic quality in the Shire. It identifies land of high scenic significance.

Utility installations, including transmission lines are not prohibited developments in these zonings.

A Tree Preservation Order applies to the whole of Byron Shire, including the village areas. This order states:

> *No person shall cut down, lop, top, remove or wilfully destroy any species of tree, palm, or fern, exceeding 3 metres in height except with the written consent of Council being obtained beforehand..... Coral trees and all noxious plants are exempted from the provision of this Order. Camphor Laurel trees in rural zones are also exempted.*

Consequently, prior to removal of trees greater than 3 metres in height (excluding noxious plants and Camphor Laurel trees in rural zones) an application to Byron Council must be made.

6.1.3 State Government Planning Policy

NSW government landuse planning is administered through the Department of Planning (DoP). The DoP supervise local planning initiatives and undertake regional planning through the State Environmental Planning Policy's (SEPP) directives under Section 117 of the EP&A Act and Departmental Planning Circulars.

The relevant regional planning instrument is the North Coast Regional Environmental Plan (REP) 1988 (Amendment No. 2). This REP covers the north coast region including the Lismore and Byron local government areas.

In general, the main aims of the REP which are relevant to this study are to:

- develop regional policies that protect the natural environment, encourage an efficient and attractive built environment and guide development to a productive, yet environmentally sound future

- provide a basis for the co-ordination of activities related to growth in the region and encourage optimum economic and social benefit to the local community and visitors to the region.

Part 3 of the REP outlines the objectives of the plan in relation to the natural environment as follows:

- to protect areas of natural vegetation and wildlife from destruction and to provide corridors between significant areas

- to protect the scenic quality of the region, including natural areas, attractive rural areas and areas adjacent to waterbodies, headlands, skylines and escarpments

- to protect water quality, particularly within water catchment areas.

Part 5 of the REP outlines the objectives of the plan in relation to regional infrastructure, and the objectives of Division 2 (Utility Services) are to:

- provide for the economic and timely provision of utility services to new urban and residential areas.

6.2 Flora

A review of the flora of the broad study area was undertaken as part of the preparation of the Route Options Paper (Lembit 1993). Following the selection of the preferred route, a subsequent flora survey was undertaken by Lembit of the vegetation along the proposed line route (refer **Appendix G**).

The survey for the Route Options Paper involved:-

- mapping of the vegetation of the study area into ten classes representing broad structural forms and disturbance history at a scale of 1:25 000 prepared with the aid of 1:25 000 colour aerial photographs of the area
- a review of literature relating to vegetation of the study area
- a field survey to confirm the aerial photograph interpretation

The studies for the EIS involved field surveys within all of the more extensive areas of native vegetation traversed by the proposed line. These included areas where fauna surveys were undertaken. Vegetation mapping of the route bandwidth and nearby lands was revised to show the plant communities and rainforest sub-alliances present with some information on the level of disturbance to rainforest communities. During this revision recent colour aerial photographs (scale 1:16 000) taken during May 1994 of the route corridor were used.

Mapping of rainforest communities follows the rainforest sub-alliances described by Floyd (1990b) whilst other communities are classified using the scheme derived by Specht (1970).

During the field inspections observations were made of the plant species present, the composition, height and cover of the dominant plant stratum, the density and composition of understorey strata, the presence of weed species and the extent and nature of previous disturbance to the vegetation. The entire route was inspected, including areas where deviations have been proposed and each of the more extensive stands of vegetation occurring along the proposed route were surveyed in detail.

Whilst every effort was made to identify all tree and shrub species occurring in the areas surveyed, it is likely that some species were not identified or collected due to dense infestations of weed species and the steepness of the terrain in some locations. Accordingly results of the field survey for the current proposal were supplemented with previous studies of the vegetation of the Big Scrub area including those reported in Lott and Duggin (1993), Milledge (1988) and Electricity Commission (1987). These surveys have been undertaken over a range of seasons, including winter, summer and autumn.

Plant species unable to be identified in the field were collected for further study. Species identification was completed with the aid of Harden (1990, 1991, 1992), Williams, Harden and McDonald (1984), Williams and Harden (1980) and Beadle (1971-1987).

6.2.1 Existing Regional Vegetation

North-eastern New South Wales is an area which supports an extremely high diversity of plant species and one of the highest concentrations of rare or threatened plant species in Australia. The majority of these species are associated with rainforest communities.

Floyd (1990b) states that the fertile soils derived from the basaltic lava flows of the Mount Warning Shield Volcano supported an almost unbroken expanse of subtropical rainforest known as the Big Scrub until 100 years ago. Extending over 75 000 ha, it was the largest area of lowland subtropical rainforest in Australia.

Within the area known as the Big Scrub (subtropical rainforest communities), Floyd (1990b) found that four rainforest sub-alliances occur. These four sub-alliances and their occurrence in the Big Scrub and along the preferred route are discussed below.

Another three sub-alliances occupy small areas within the Big Scrub (Lott and Duggin 1993). These are Blue Quandong Sub-tropical Rainforest, Palm Sub-tropical Rainforest and Whalebone Tree-Austromyrtus spp. Dry Rainforest.

Eucalypt dominated communities also occur in the study area, but are less extensive than rainforest communities.

The high fertility of the area and the favourable climate resulted in much of the original lowland rainforest being cleared for agriculture. There are extensive horticultural plantations - notably Macadamias, along the proposed route bandwidth.

With increased community awareness of the significance of the remaining rainforests, active regeneration of rainforest stands has been undertaken over the past twenty years. Plantations of forest trees such as Hoop Pine have also been developed in the area.

6.2.2 Flora in the Area of the Proposed Route

A summary of the plant communities which occur along and near the proposed route bandwidth are described below and shown in **Figure 6.2a - 6.2f**. **Appendix G** should be referred to for a complete description of the vegetation communities and the plant species common within these communities.

1. White Booyong Sub-tropical Rainforest

The sub-alliance characterised by White Booyong (*Argyrodendron trifoliolatum*) is found at low altitudes on fertile volcanic soil in sheltered valleys.

This sub-alliance is the most widespread natural vegetation type along the proposed route. In an undisturbed form it is typified by large, buttressed canopy trees, with a wide diversity of species present, numerous epiphytes, a shrub layer of tall ferns and rainforest shrubs and a sparse ground layer dominated by ferns. Climbing plants are common.

Two sub-classes have been recognised within this vegetation unit to indicate condition of particular stands. Rainforest areas of better condition along or near the corridor have been mapped as unit 1A. Areas where disturbance is greatest or where natural regeneration is relatively recent have been mapped as unit 1D. These areas do not have a continuous tree canopy.

Examples of White Booyong Sub-tropical Rainforest in the Big Scrub area include Victoria Park, Johnston's Scrub, Booyong Recreation Reserve and the higher parts of Big Scrub Flora Reserve. In their mapping of remnants within the Big Scrub area Lott and Duggin identified two small remnants in the vicinity of the route corridor. One remnant is about 1 km south-west of the Repentance Creek Bridge whilst the other is adjacent to the Wilsons River just south of Donaghys Bridge. During the field survey these remnants were found to support a diversity of rainforest species.

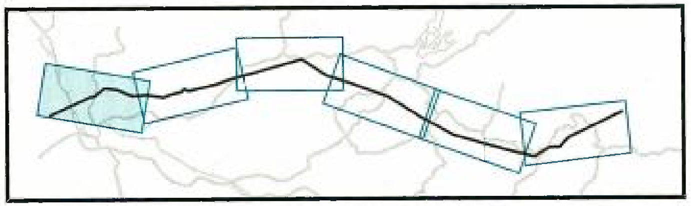
Other remnants of relatively high value in the vicinity of the proposed route occur at Boomerang Creek, Turkey Creek and the Wilsons River, south of Montecollum Road.

Figure 6.2a

VEGETATION MAP UNITS AND FAUNA HABITATS

N

0 1km

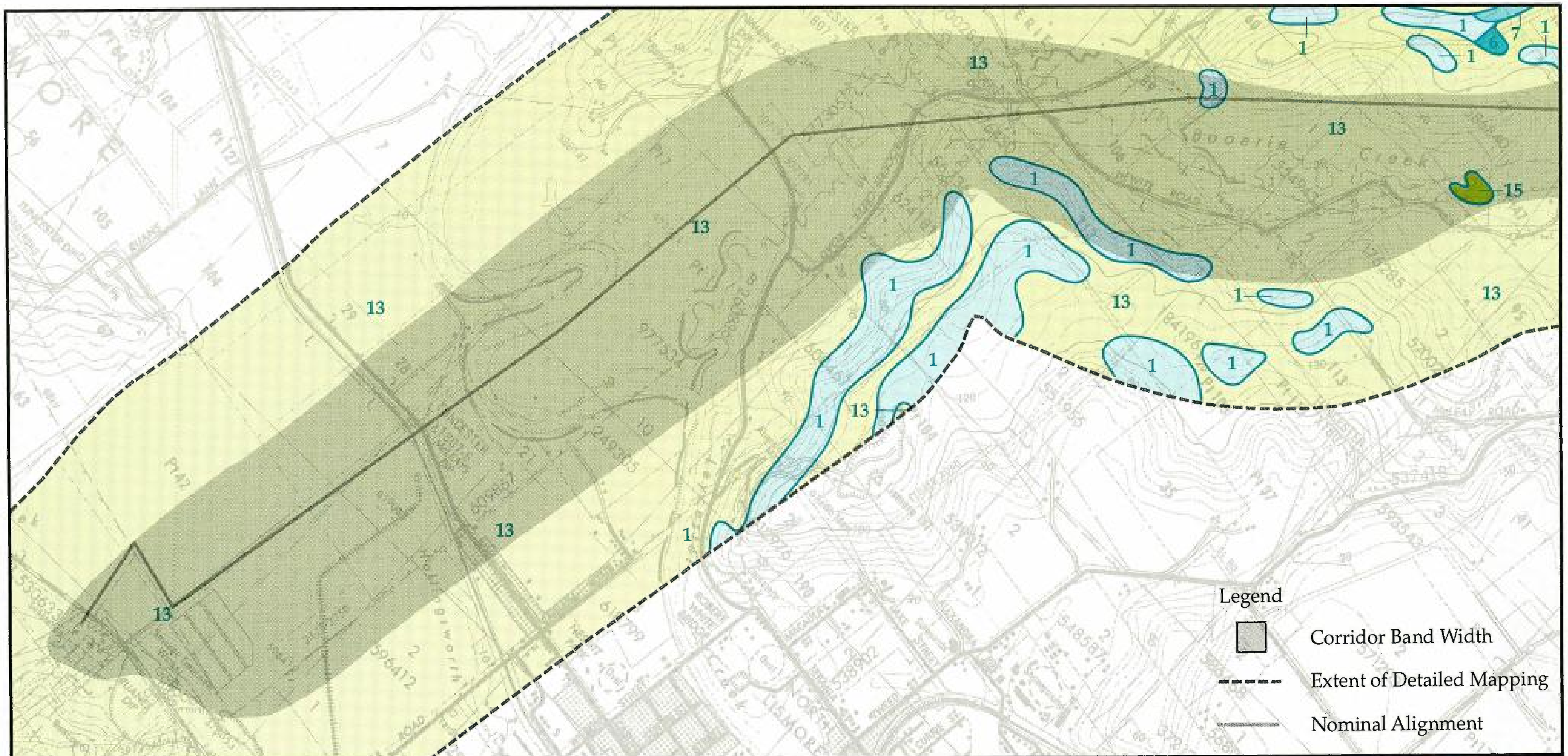


VEGETATION MAPPING UNITS

1 White Booyong Subtropical Rainforest
1A Good Condition
1D Significant Disturbance
2 Pepperberry Tree-Stinging Tree Subtropical Rainforest
3 Black Bean-Red Bean Subtropical Rainforest
4 Hoop Pine Dry Rainforest
5 Palm Subtropical Rainforest
6 Brush Box Tall Open-Forest; Rainforest Sub-Canopy
7 Brush Box Open-Forest
8 Sydney Blue Gum Tall Open Forest
9 Blackbutt Open Forest
10 Tallowwood Open Forest
11 Forest Red Gum Open Forest
12 Pink Bloodwood-Grey Gum-White Mahogany Open Forest
13 Cleared
14 Horticulture/Plantation
15 Forest Plantation/Rainforest Regeneration

FAUNA HABITAT UNITS

- Cleared/open areas with some trees
- Horticultural areas
- Plantation and regeneration of eucalypts and/or rainforest
- Rainforest, generally in good condition
- Eucalypt dominated sites, without rainforest understorey
- Eucalypt or Brush Box dominated sites, with rainforest understorey
- Rainforest, disturbed, canopy dominated by Camphor Laurel



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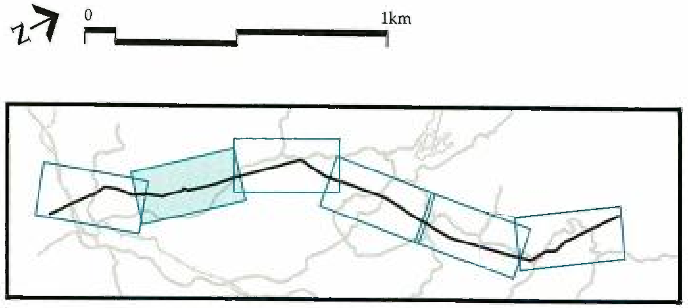
VEGETATION MAP UNITS AND FAUNA HABITATS



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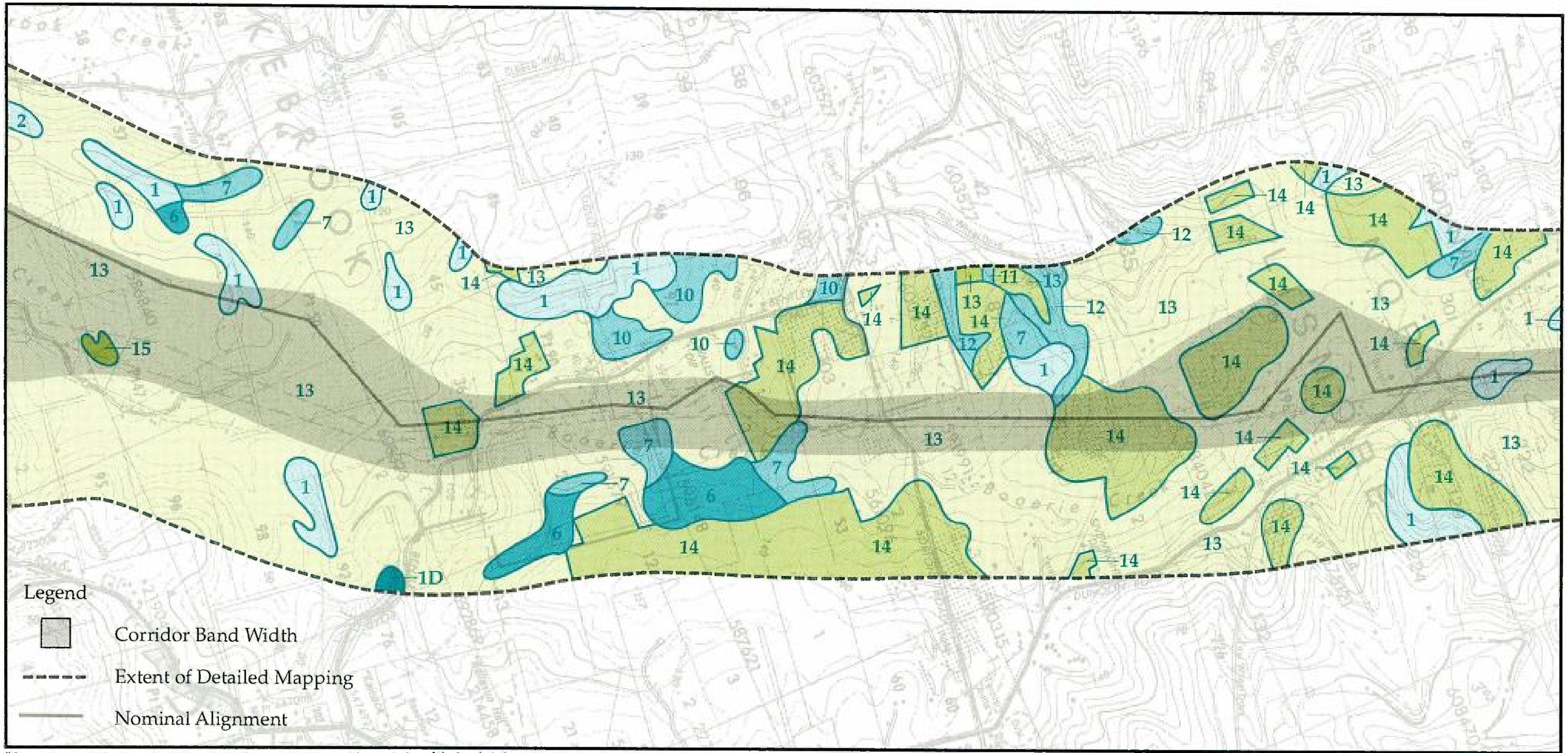

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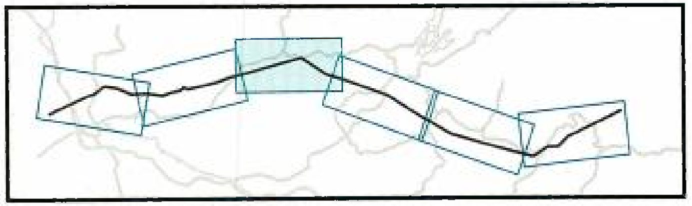
Figure 6.2c
VEGETATION MAP UNITS AND FAUNA HABITATS



VEGETATION MAPPING UNITS

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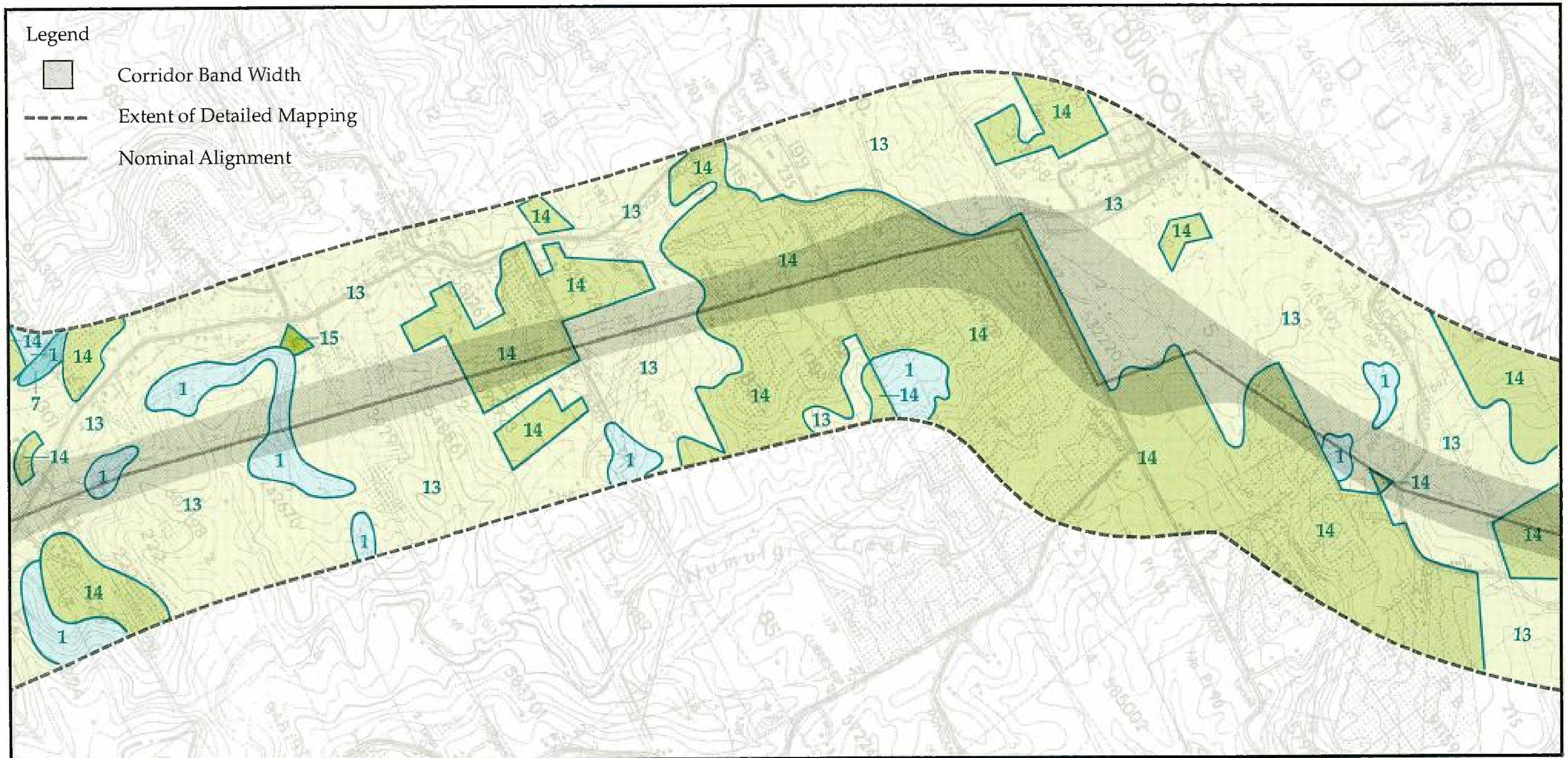

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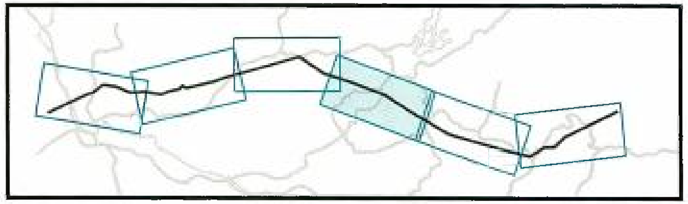
Figure 6.2a

VEGETATION MAP UNITS AND FAUNA HABITATS

0 1km



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- Eucalypt dominated sites, without rainforest understorey
- Eucalypt or Brush Box dominated sites, with rainforest understorey
- Rainforest, disturbed, canopy dominated by Camphor Laurel

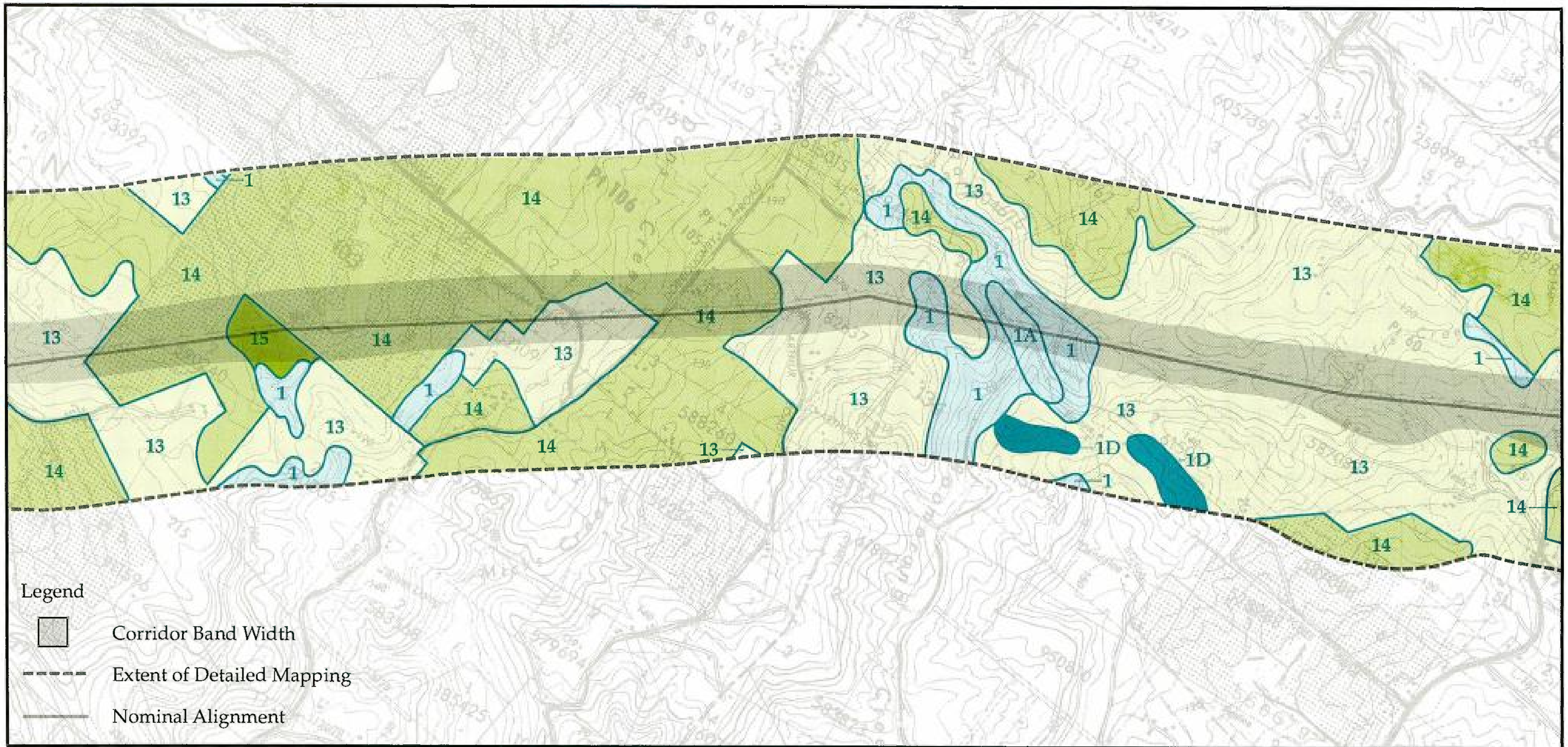

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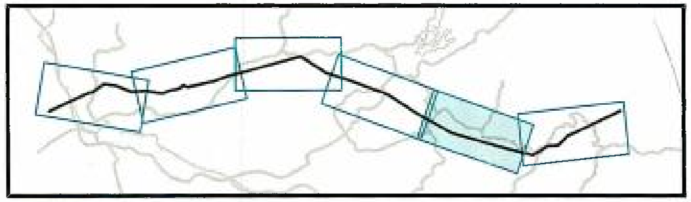
Figure 6.2e

VEGETATION MAP UNITS AND FAUNA HABITATS



VEGETATION MAPPING UNITS

1	White Booyong Subtropical Rainforest
1A	Good Condition
1D	Significant Disturbance
2	Pepperberry Tree-Stinging Tree Subtropical Rainforest
3	Black Bean-Red Bean Subtropical Rainforest
4	Hoop Pine Dry Rainforest
5	Palm Subtropical Rainforest
6	Brush Box Tall Open-Forest; Rainforest Sub-Canopy
7	Brush Box Open-Forest
8	Sydney Blue Gum Tall Open Forest
9	Blackbutt Open Forest
10	Tallowwood Open Forest
11	Forest Red Gum Open Forest
12	Pink Bloodwood-Grey Gum-White Mahogany Open Forest
13	Cleared
14	Horticulture/Plantation
15	Forest Plantation/Rainforest Regeneration

FAUNA HABITAT UNITS

- Cleared/open areas with some trees
- Horticultural areas
- Plantation and regeneration of eucalypts and/or rainforest
- Rainforest, generally in good condition
- Eucalypt dominated sites, without rainforest understorey
- Eucalypt or Brush Box dominated sites, with rainforest understorey
- Rainforest, disturbed, canopy dominated by Camphor Laurel

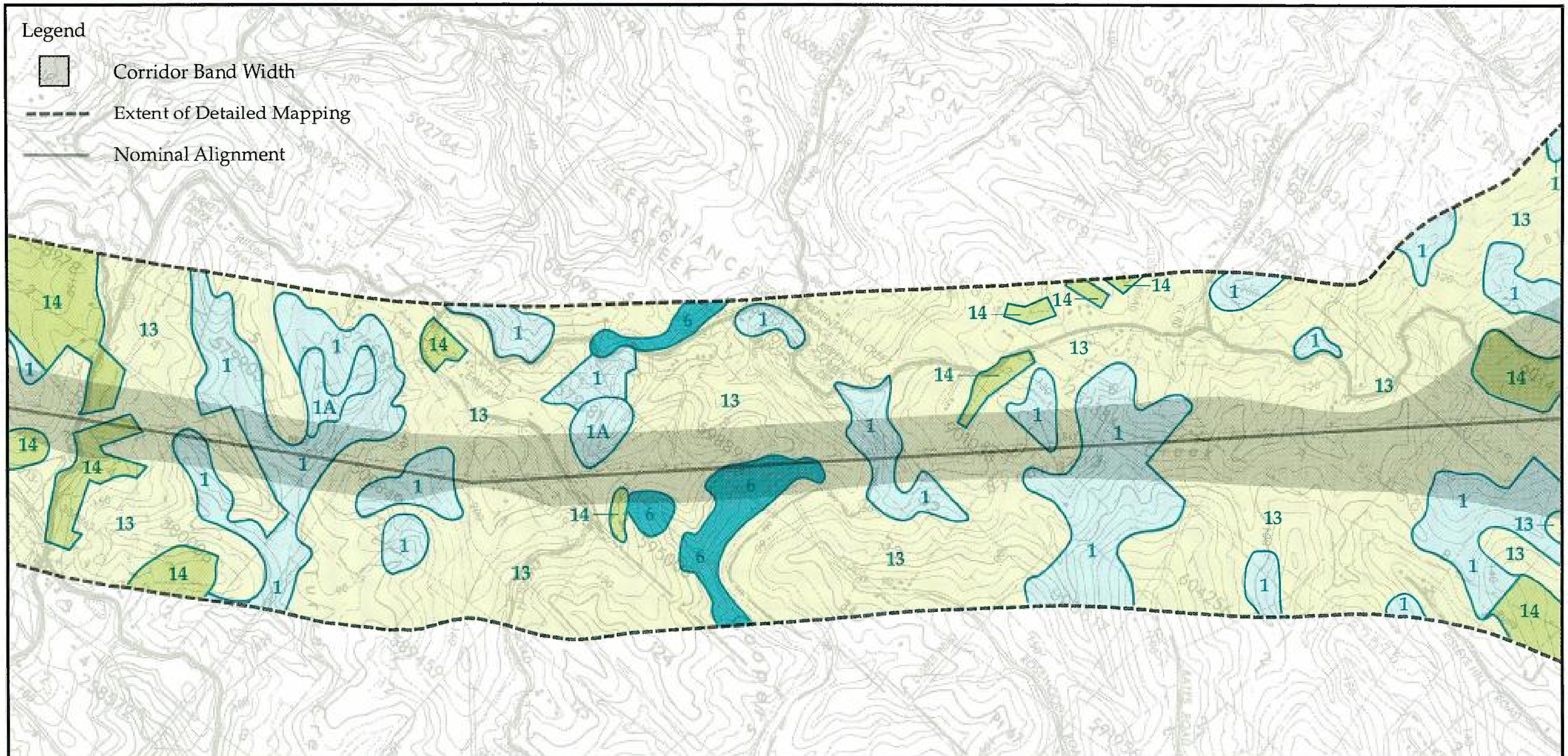


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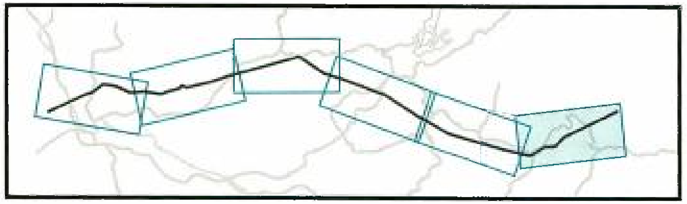
Figure 6.2f

VEGETATION MAP UNITS AND FAUNA HABITATS

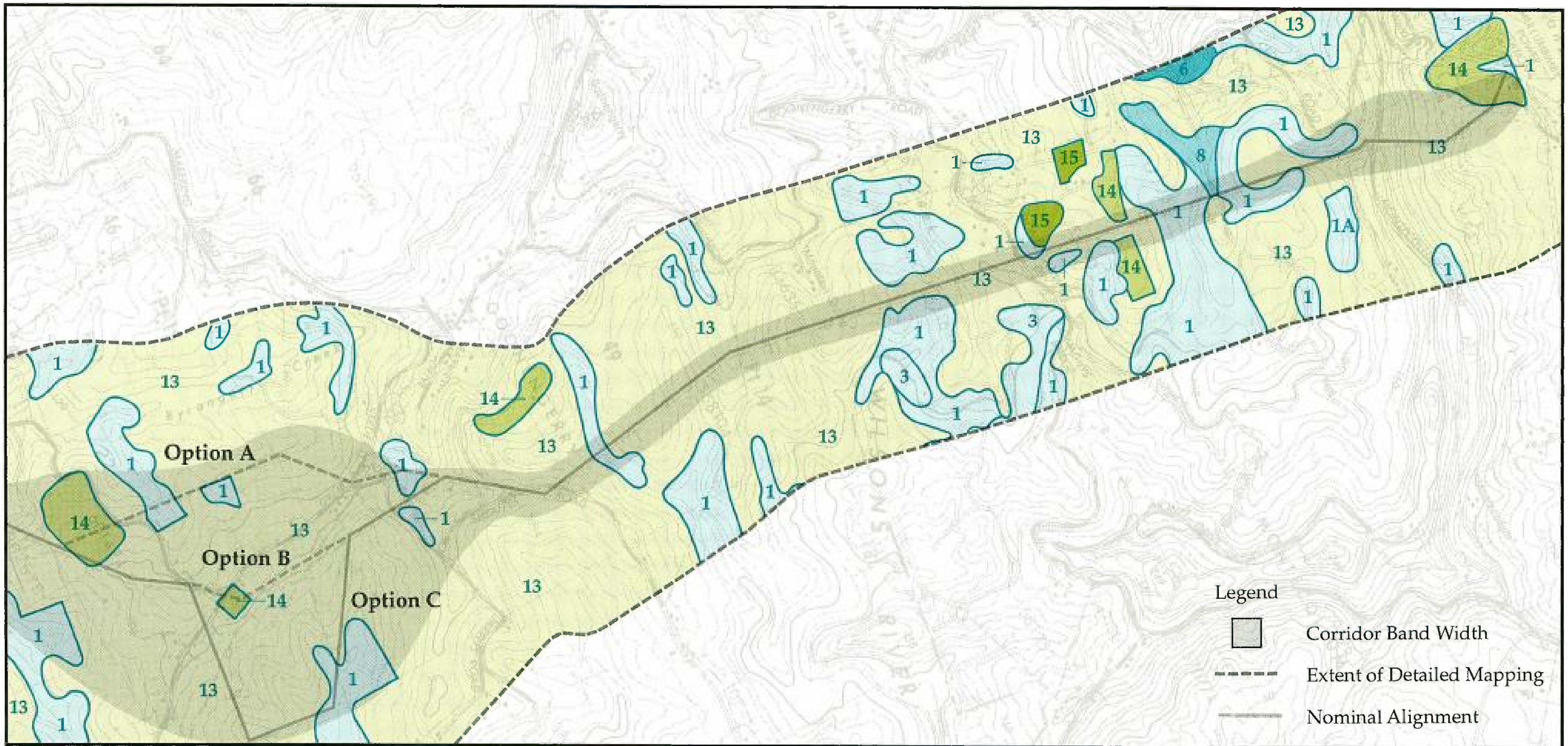


VEGETATION MAPPING UNITS

1 White Booyong Subtropical Rainforest
1A Good Condition
1D Significant Disturbance
2 Pepperberry Tree-Stinging Tree Subtropical Rainforest
3 Black Bean-Red Bean Subtropical Rainforest
4 Hoop Pine Dry Rainforest
5 Palm Subtropical Rainforest
6 Brush Box Tall Open-Forest; Rainforest Sub-Canopy
7 Brush Box Open-Forest
8 Sydney Blue Gum Tall Open Forest
9 Blackbutt Open Forest
10 Tallowwood Open Forest
11 Forest Red Gum Open Forest
12 Pink Bloodwood-Grey Gum-White Mahogany Open Forest
13 Cleared
14 Horticulture/Plantation
15 Forest Plantation/Rainforest Regeneration

FAUNA HABITAT UNITS

- Cleared/open areas with some trees
- Horticultural areas
- Plantation and regeneration of eucalypts and/or rainforest
- Rainforest, generally in good condition
- Eucalypt dominated sites, without rainforest understorey
- Eucalypt or Brush Box dominated sites, with rainforest understorey
- Rainforest, disturbed, canopy dominated by Camphor Laurel



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2. Pepperberry Tree-Stinging Tree-Fig-Hoop Pine Sub-tropical Rainforest
This sub-alliance occurs on well-drained fertile alluvial lowland plains. The main example in the Big Scrub area occurs at Boatharbour Nature Reserve where 14 hectares of rainforest on alluvium is reserved. Floyd (1990b) has described the plant species and strata which occur at Boatharbour, however, no examples of this rainforest type have been recorded along the proposed route and none of the sites surveyed supported this type.

3. Black Bean - Red Bean Sub-tropical Rainforest
This sub-alliance occurs on deep fertile soils associated with alluvial flats and benches where soil moisture is reliable. There is a canopy stratum consisting of Black Bean (*Castanospermum australe*), Red Bean (*Dysoxylum muelleri*), Strangling Fig, Stinging Tree (*Dendrocnide excelsa*) and White Booyong. Emergent Moreton Bay Fig trees rise above the canopy and this sub-alliance may also have a dense shrub layer. Examples in the Big Scrub include Davis Scrub Nature Reserve, Johnston's Scrub, Minyon Falls and Boomerang Falls.

Within the proposed bandwidth an example of this sub-alliance was found to occur at Wilsons River, south of Donaghys Bridge. This vegetation type would have been more extensive in the route corridor prior to clearing of the Big Scrub for agriculture.

4. Hoop Pine Dry Rainforest
Dry Rainforest dominated by Hoop Pine occurs on well-drained, rocky basalt plateau and steep slopes. Hoop Pine is typically an emergent over a dense canopy of small trees. Fig trees may also be present as emergents. There is a shrub layer of medium to high density with spiny shrubs being noticeable. The ground layer is of very low density, but vines are common particularly in disturbed areas. The examples in the Big Scrub include Wilson Park and Rotary Parks in Lismore.

None were found to occur within the proposed bandwidth although this sub-alliance may have occurred in the area prior to clearing.

5. Palm Sub-tropical Rainforest
Sub-tropical rainforest dominated by Bangalow Palm (*Archonotphoenix cunninghamiana*) occurs on poorly drained alluvial flats. Associated tree species may include Maiden's Blush (*Sloanea australis*), Sandpaper Fig (*Ficus coronata*) and Hairy Walnut (*Endiandra pubens*). There is a shrub layer of low density dominated by Straw Treefern. Vines include Lawyer Cane Palm and Pothos longipes. Occurrences of this sub-alliance in the Big Scrub area include Minyon Falls and Terania Creek.

No occurrences of this sub-alliance were located within the proposed bandwidth during the course of the field survey.

6. Sub-tropical Rainforest - Brush Box Emergents

Rainforest stands with emergent Brush Box (*Lophostemon confertus*) trees have been mapped as a distinct vegetation type. This vegetation type may point to a history of disturbance or chance wildfire or may occur in areas more marginal for rainforest development e.g. soils of slightly lower fertility. A diverse range of rainforest trees occur with a variable density of emergents. Examples of this community occur in the Booerie Creek catchment and on steep slopes above Coopers Creek where the proposed transmission line traverses this community.

7. Brush Box Open-forest

This map unit includes Brush Box dominated tall forests with an understorey of ferns of grasses and lacking a well developed understorey of rainforest trees. There is a tall shrub layer of low to medium density and a ground layer dominated by grasses or ferns with the latter being present in wetter, more sheltered areas. Vines are a common component of the understorey. Areas of Brush Box Open-forest are most common in State Forests to the north-west of the study area, but also occur in the Booerie Creek catchment. Examples traversed by the proposed transmission line occur between Bentley Road and Borton Road.

8. Sydney Blue Gum Open-forest

Open-forest dominated by Sydney Blue Gum is not common in the Big Scrub area. Where this plant community occurs it tends to be in sites of high fertility which have apparently been subject to disturbance in the distant past. Tree species present include Sydney Blue Gum, Flooded Gum (*E. grandis*) and Tallowwood. The understorey includes a small tree layer dominated by rainforest species and a ground layer of low to medium density dominated by ferns. This vegetation type tends to occur towards the north of the proposed route in the Wilsons River area.

9. Blackbutt Open-forest

Blackbutt open-forest occurs on coarse sandy soils of moderate fertility or areas subject to more frequent fires in the Nightcap Ranges. The understorey may include a shrub layer of medium to high density and a ground layer of medium to high density dominated by ferns in wetter sites or a grassy understorey in drier sites. This vegetation type occurs along the north-western edge of the study area. No examples of this community were found to occur along the preferred route, but plantations of Blackbutt have been planted in the vicinity of the proposed route.

10. Tallowwood Open-forest

Open-forest dominated by Tallowwood occurs in soils of moderate fertility in the Booerie Creek valley. Associated tree species include White Mahogany and Brush Box. The understorey often includes a stratum of small rainforest trees, but drier sites support a ground layer of high density dominated by grasses and herbs.

No intact examples of this community occur along the route corridor, however, scattered Tallowwood trees east of Bentley Road will be affected by the proposed transmission line.

11. Forest Red Gum Open-forest
Open-forest dominated by Forest Red Gum occurs on soils of moderate fertility on hill crests exposed to sun and wind. Pink Bloodwood and Brush Box are associated tree species. There is a layer of small trees of low density and a ground layer of high density. The most common small tree is Forest Oak (*Allocasuarina torulosa*).

This community occurs north of Borton Road, near Modanville, outside of the area directly affected by the proposed transmission line.

12. Pink Bloodwood-Small-fruited Grey Gum-White Mahogany Open-forest
This open-forest community occurs in similar situations to Forest Red Gum open-forest on soils of lower fertility. Canopy tree species include Pink Bloodwood, Small-fruited Grey Gum and White Mahogany. There is a small tree layer of low density and a ground layer of medium to high density dominated by grasses.

This community is not affected by the proposed route.

13. Cleared Land
This map unit denotes areas which have been substantially cleared of native vegetation, but not developed for plantations. This vegetation unit occurs along the length of the route, where land is used for grazing.

14. Horticulture
This map unit includes horticultural plantations including Macadamias, Bananas and other tropical fruit. Horticultural plantations occur within the bandwidth on the Lismore Plateau, being particularly prevalent in the Dunoon area.

15. Rainforest Regeneration/Forest Plantations
This map unit includes recent plantings of rainforest species and forest plantations such as Hoop Pine, Flooded Gum, Sydney Blue Gum and Blackbutt.

Rare or Threatened Plant Species
Information on the rare or threatened plant species occurring in the study area was obtained by accessing the data base of the Hurstville office of the National Parks and Wildlife Service and reference to other literature relating to the vegetation of the study area including the list provided in Lott and Duggin (1993). The list was included in the flora survey completed for the Route Options Paper (1993). No comments regarding the composition of the list were made in community responses to the

Route Options Paper. The species are listed in **Appendix G** with discussion of their ecology and presence along the proposed route.

6.2.3 Impacts on Flora

The proposed transmission line traverses a variety of vegetation map units, with the most prevalent units traversed being Cleared Land, Horticulture and White Booyong Sub-tropical Rainforest. The other native plant communities which may be directly or indirectly affected include Black Bean - Red Bean Sub-tropical Rainforest, Sub-tropical Rainforest with Brush Box Emergents, Brush Box Open-forest and Sydney Blue Gum Open-forest.

The existing 66 kV transmission line has had an impact on the vegetation within the bandwidth. The proposed line will require minor vegetation removal along the route to maintain a safe distance between the line and overhanging branches. In areas where the line spans gullies, clearing under the line will not be necessary. The extent of vegetation control will not be significantly greater than that which already exists for the 66 kV transmission line.

Access tracks to pole structures may require some additional removal of vegetation. Access tracks will generally utilise existing roads or tracks, avoiding significant forest stands.

The proposed route crosses or passes in close proximity to rainforest areas of relatively high species diversity. The specific locations of these areas are:

- about 1 km south-west of the Repentance Creek Bridge
- adjacent to the Wilsons River just south of Donaghys Bridge
- Boomerang Creek (the rare species, Veiny Lace Flower has been recorded in this vicinity)
- Turkey Creek, and,
- the Wilsons River, south of Montecollum Road (this area supports the rare plant species, Rough-leaved Macadamia).

A proposed deviation along a closed road, south of Goonengerry (Option A) would traverse an area of rainforest supporting trees including Red Cedar (*Toona australis*), White Booyong (*Heritiera trifoliolata*), Cudgerie (*Flindersia schottiana*), Foambark Tree (*Jagera pseudorhus*), Red Ash (*Alphitonia excelsa*), Stinging Tree (*Dendrocnide excelsa*), Black Bean (*Castanospermum australe*), Blue Quandong (*Elaeocarpus grandis*) and Red Kamala (*Mallotus philippensis*). This is not the preferred alignment (see Section 4.2).

6.2.4 Impact on Rare or Threatened Plant Species

Rough-leaved Macadamia was recorded in the vicinity of the route corridor at Byrangerry Creek and near Wilsons River, south of Montecollum Bridge.

Velvet Laurel was recorded in 1987 in a rainforest patch south-east of Mullumbimby Power Station about 250 metres east of the route corridor.

Red Lilly Pilly was found to occur in the rainforest stand south-west of the Repentance Creek Bridge.

Veiny Lace Flower, while recorded in the vicinity of Boomerang Creek close to the location traversed by the proposed route, was not observed during the field survey.

Arrow-head Vine is found in many rainforest remnants in the Big Scrub area (Electricity Commission, 1987), but has not been confirmed as occurring along the proposed route for the current proposal. It is considered likely that this species does occur along the route.

The disturbed nature of the vegetation underneath the existing transmission line generally provides poor habitat for the rare or threatened plant species which occur along the route. However, where forest stands are spanned by the existing line, suitable habitat for these species remains. The current proposal is unlikely to result in significant additional impact, but some individual plants of the rare species may be affected.

6.2.5 Mitigation of Impacts

The impact of the proposed transmission line on areas of relatively high species diversity can be reduced by constructing the line in a manner which seeks to span across these areas which generally occur in gullies. Additional protection may be achievable by use of taller poles in the areas which include the rainforest stands at Boomerang Creek, Turkey Creek, south-west of Repentance Creek and Wilsons River.

Where impact cannot be avoided by spanning, realignment within the bandwidth may improve viability of rainforest stands.

In areas, including Boomerang Creek and south-west of Repentance Creek, where rare plants occur in the vicinity of the proposed line, the affected property owners will be contacted at the time of construction to avoid direct impact where possible. Where such impact cannot be avoided due to other constraints, regeneration programs in the vicinity will include propagation of the rare species involved.

Weed control will be necessary to prevent the spread of exotic plant species in any cleared areas underneath the transmission line.

While the proposed development will have minor impacts on rainforest stands of high conservation significance and individuals of rare or threatened plant species, the mitigation measures to be adopted will avoid significant impact on the rainforest stands and will limit the impact on the rare or threatened plant species.

6.3 Fauna

A fauna study for the proposed transmission line was carried out by Gunninah Consultants. The full report is provided in **Appendix H**. A summary of the findings of the study and the ameliorative measures to be adopted are provided below.

The study examined the fauna and fauna habitats present within the bandwidth. Information obtained through access to existing databases, review of information and reports from the general area, and the conduct of specific and detailed fauna surveys along the bandwidth of the proposed transmission line has been incorporated into this report. The investigation focused on assessing the nature and condition of fauna communities and habitats, and the potential impacts of the proposed transmission line on native species and their habitats.

6.3.1 Background

The area between Lismore and Mullumbimby occupies a broad gentle plateau which was originally covered by the largest single tract of rainforest in NSW, known as the Big Scrub. The rainforest of the Big Scrub was a heterogeneous environment, comprising a range of rainforest and moist forest types. The remnants of the Big Scrub represent at least four different vegetation associations, but do not include many associations which would have been present originally (Floyd 1990, in Lott & Duggin 1993). Substantial clearing during the late 1800's (primarily for timber and agricultural pursuits) reduced the Big Scrub to a network of small remnants scattered through a substantially cleared landscape by the early 1900's (Lott & Duggin 1993). This situation is essentially that which prevails today.

A number of previous investigations have been conducted on the Big Scrub remnants, on specific features of the Big Scrub or on native fauna which inhabits the Lismore/Mullumbimby area, and these studies have been examined and the findings incorporated into this study.

6.3.2 Methodology

A substantial proportion of the proposed transmission route consists of grazing lands or horticultural areas generally considered to be of relatively low significance for the conservation of native fauna. Few species rely on such habitats, and those present are generally common to abundant and widespread, or species which are tolerant of disturbance. Consequently, detailed field surveys were not conducted through areas which had been substantially cleared or disturbed for agricultural purposes.

The fauna surveys conducted for the Environmental Impact Statement (detailed in this report) included detailed field studies along the existing transmission line and at sites adjacent to it. Fauna habitat units identified were mapped (see **Figure 6.2a** - **6.2f** and **Appendix H**).

Detailed aerial photography and topographic maps were used to locate areas of natural or regenerating forest along the transmission line corridor. It was evident from the aerial photography that a broad range of conditions pertained to vegetation along the transmission line corridor: previously grazed areas where stock had been removed, and natural regeneration areas and more substantial sites (such as around Boomerang Creek), where substantial remnants of Big Scrub vegetation appear to have been retained over a long period.

Areas identified from the maps and aerial photographs were then assessed on the ground. Their nature and condition was initially assessed by driving along roads and tracks, and recording the size and nature of patches of vegetation, essentially by observation from the road. Subsequently, patches of vegetation were investigated on foot, and a final assessment made in the field regarding the suitability of individual patches as field survey locations.

In some instances, access was extremely physically difficult, and several sites were surveyed primarily by observations on foot but no trapping was carried out. In a few instances, access to tracts of forest or natural vegetation was restricted by landowners, and it was not possible to carry out a detailed survey. However, observations from adjoining land enabled a preliminary fauna assemblage to be acquired for some of these sites.

Standard biological survey techniques were adopted for the conduct of fauna surveys in the field along the proposed transmission line bandwidth including trapping, indirect methods of determining the presence of species, general observations and habitat searches. Spotlighting surveys were also conducted. Detailed surveys were also conducted for the microchiropteran bats using mist nets, harp type bat traps and by recording their calls using an Anabat II detector.

Other survey methods employed along the transmission line bandwidth involved specific surveys for birds in each of the locations and habitats investigated, and habitat searches (particularly targeted at reptiles and amphibians, and conducted by the movement of logs, rocks and other debris or potential cover).

Because of the nature of the general landscape along the proposed route, and the scattered and patchy nature of native habitats, it was not considered appropriate to restrict investigations to particular endangered species. Consequently, all patches investigated were thoroughly surveyed using appropriate methods and search patterns to detect the presence of endangered fauna species.

6.3.3 Fauna Records

The native fauna considered for the proposed line include species recorded during the field investigations for this EIS, as well as a number of additional species which have been recorded by other researchers in the general area and in databases maintained by ornithological groups and the National Parks & Wildlife Service.

Records from other sources include species and sites located at some distance from the proposed transmission line, boosting the number of species considered, and including many species unlikely to be present along the route.

The sources of the species lists obtained are detailed in **Appendix H**. Many of the species included in the regional lists rely on disturbed habitats, are widespread and common in the area, or are dependent on habitat types which are not characteristic of the proposed transmission line. Species which inhabit open grassland and grazing country, or which are tolerant of agricultural practices such as orchards, are likely to be widespread throughout the Lismore/Mullumbimby landscape. They are not dependant on habitats which are restricted to the transmission line.

The following discussion considers the four main groups of vertebrate native fauna known or likely to occur through the forest remnants and habitats along the proposed route. With each group, the species recorded during surveys along the route are considered, as well as those which may be present based on previous studies in the area or on data from the databases accessed.

- **Avifauna**

One hundred and four bird species were recorded from the 18 survey sites investigated along the proposed transmission line (**Appendix H**). Additional species were included on other databases searched for this investigation. Due to the extended area covered by those databases, many of these species are not considered likely to be present along the proposed route, or to be solely dependent upon them. Most of the species recorded during this survey and listed in the various databases are relatively widespread and common to abundant. They are likely to be present throughout the general landscape.

Of the avian species specifically recorded along the proposed route, four endangered species were reported. Three rainforest pigeons (the Superb, Rose-crowned and Wompoo Fruit-doves) and the Marbled Frogmouth. All of these species are dependent upon rainforest habitats and are consequently unlikely to be broadly scattered throughout the landscape, but will be concentrated in the Big Scrub remnants.

A number of other endangered bird species are either likely to be found in the Big Scrub area or may be expected to occur in the region. Several were considered by Lott & Duggin (1993) as likely to be present, including species such as the Yellow-eyed Cuckoo-shrike, White-eared Monarch, Alberts Lyrebird and the Sooty Owl (**Table 6.1**).

Table 6.1 - Rainforest Vertebrates Known or Expected to Occur in the Big Scrub Region

Common Name	Scientific Name
Amphibians	
*Pouched Frog	*Assa darlingtoni*
Fletchers Frog	*Lechriodus fletcheri*
*Loveridges Frog	*Philoria loveridgei*
Reptiles	
Southern Angle-headed Dragon	*Hypsilurus spinipes*
Blue-speckled Forest Skink	*Eulamprus murrayi*
Leaf-tailed Gecko	*Phyllurus cornutus*
*Three-toed Snake-tooth Skink	*Coeranoscincus reticulatus*
Rainforest Cool-skink	*Pseudemoia zia*
Dwarf-crowned Snake	*Cacophis krefftii*
Mammals	
Mountain Brushtail Possum	*Trichosurus caninus*
Red-necked Pademelon	*Thylogale thetis*
*Red-legged Pademelon	*Thylogale stigmatica*
Fawn-footed Melomys	*Melomys cervinipes*
Birds	
Australian Brush Turkey	*Alectura lathami*
*Superb Fruit-dove	*Ptilinopus superbus*
*Rose-crowned Fruit-dove	*Ptilinopus regina*
*Wompoo Fruit-dove	*Ptilinopus magnificus*

Common Name	Scientific Name
Topknot Pigeon	*Lopholaimus antarcticus*
White-headed Pigeon	*Columba leucomela*
*Sooty Owl	*Tyto tenebricosa*
*Marbled Frogmouth	*Podargus ocellatus*
Noisy Pitta	*Pitta versicolor*
*Albert's Lyrebird	*Menura alberti*
Russet Thrush	*Zoothera heinei*
Pale Yellow Robin	*Tregellasia capito*
Black-faced Monarch	*Monarcha melanopsis*
Spectacled Monarch	*Monarcha trivirgatus*
*White-eared Monarch	*Monarcha leucotis*
Logrunner	*Orthonyx temminikii*
Large-billed Scrubwren	*Sericornis magnirostris*
Yellow-throated Scrubwren	*Sericornis citreogularis*
Brown Warbler	*Gerygone mouki*
Spangled Drongo	*Dicrurus hottentottus*
Regent Bowerbird	*Sericulus chrysocephalus*
Green Catbird	*Ailuroedus crassirostris*
Paradise Riflebird	*Ptiloris paradiseus*
*Yellow-eyed Cuckoo-shrike	*Coracina lineata*

* Schedule 12 (NP&W Act 1974): Part II Vulnerable & Rare fauna.

The majority of avifauna recorded during the surveys along the proposed transmission line, and the majority of those included on other databases and in other reports, are birds associated with forest communities. These may be divided into two groups, those more regularly associated with drier eucalypt forests, although many of these also occur regularly in rainforest environments. Similarly, birds which are predominantly associated with rainforests may also forage in eucalypt forest environments. However, most of the species considered as rainforest birds are dependent primarily on the existence of rainforest habitats for their continued survival.

Most of the forest birds recorded during the site surveys are relatively common to abundant and widespread. Most of the pigeons, cuckoos, kingfishers and parrots are regular inhabitants of forest environments, along with common species such as the Black-faced Cuckoo-shrike, Varied Triller, the robins, Grey Fantail, Willy Wagtail, shrike-thrushes, thornbills, treecreepers, and the Pied Currawong. Many of these species were recorded at every survey site investigated, indicating their widespread distribution and abundant status.

The avifauna of most conservation interest with regard to the proposed transmission line bandwidth are those birds associated with rainforest habitats. Four endangered Australian bird species were recorded from the rainforest remnants investigated along the proposed route, including the three Fruit-doves and the Marbled Frogmouth. The diversity and abundance of rainforest-dependent bird species appears to be related primarily to the size of the rainforest patches and to their degree of isolation from major areas of native forest (such as the Nightcap or Blackwall Ranges). One of the most significant features of the Big Scrub remnants scattered through the Lismore region is their use as 'stepping stones' by rainforest-dependent pigeons.

Rainforest pigeons were recorded throughout the survey sites with some species such as the White-headed Pigeon occurring in most of the sites surveyed. Similarly, the Topknot Pigeon was recorded at most of the survey sites, whilst the more endangered species (the Superb, Rose-crowned and Wompoo Fruit-doves) were recorded at fewer sites. The Superb Fruit-dove was located in only two Big Scrub remnants along the preferred corridor (E2), whilst the Wompoo Fruit-dove was located in five and the Rose-crowned Fruit-dove in six. The Rose-crowned Fruit-dove is noted by Lott & Duggin (1993) as a "widespread" rainforest species recorded at 23 out of the 32 sites listed in their report. The Wompoo Fruit-dove was listed as a "common" rainforest species, occurring in 14 of the 32 sites.

- **Mammals**

A total of 14 native mammal species were recorded from the sites surveyed along the proposed route. Of these, four are microchiropteran bats. The rest include the Short-beaked Echidna, the Northern Brown and Long-nosed Bandicoots, the Brown Antechinus, Bush Rat, Koala, Common Ringtail Possum, Grey-headed Flying Fox and the Mountain and Common Brushtail Possums. Of these species, only the Mountain Brushtail Possum is considered rainforest-dependent or rainforest-obligate (Smith *et al* 1989), although it has been recorded in other moist forest habitats in NSW (D Fanning *pers obs*).

The Big Scrub remnants in the Lismore region (including those along the proposed route) appear to be depauperate in terrestrial mammal fauna. This is due to their small size, mostly isolated nature, levels of disturbance and lack of shelter for small terrestrial mammals, and to the impacts of human and animal interference.

Four arboreal species were recorded during the intensive surveys conducted along the proposed route. Of these, the Mountain Brushtail

Possum is regarded by Smith *et al* (1989) as a rainforest-obligate species, although it is regularly recorded in moist sclerophyll forest as well, and is not specifically restricted to rainforest (D Fanning *pers obs*). This species was located in a number of the remnants scattered along the proposed route (7 of the 18 plots surveyed). All of these were dominated by a rainforest understorey, but in several instances were characterised by either a Camphor Laurel or eucalypt overstorey. The Common Brushtail Possum, on the other hand, is a species of eucalypt forest but is capable of utilising a range of vegetation communities and developed environments.

The Koala *Phascolarctus cinereus* was recorded at several locations during this investigation, with evidence for its presence (including scratches on trees and droppings) located at five of the survey sites. Similar evidence was found on other trees not included on the survey sites. Koalas are clearly scattered throughout the Lismore region, particularly in the Dunoon area and around Goonengerry. The Koala is not a rainforest species, and generally avoids such moist habitats. It is generally dependent on woodland and open dry forest communities. Distribution of these resources through the open grazing lands of the Lismore region are clearly suitable for this species.

Two other native mammal species, the Australian Water Rat and the Platypus, have been recorded in the Lismore/Mullumbimby area, and may occasionally be associated with rainforest remnants. They may also occur in the streams crossed by the proposed route. The Australian Water Rat and the Platypus are associated primarily or entirely with waterways. Neither species is considered likely to occur in substantial numbers in the area to be affected by the proposed route, although both may occur on occasions.

The final group of native mammals which is relevant to the proposed route and the remnants of Big Scrub vegetation scattered throughout the Lismore area are the bats. Bats are divided into two separate groups, the flying foxes or megachiropteran bats (which feed on pollen, nectar and fruit), and the microchiropteran bats (which principally eat small vertebrates and insects).

Two megachiropteran bats are known from and commonly recorded in the Lismore region, the Grey-headed Flying Fox *Pteropus poliocephalus* and the Black Flying Fox *Pteropus alecto*. Flying Foxes were recorded at many of the survey sites, but the species involved was generally not able to be identified as the animals were flying overhead and did not alight (although one Grey-headed Flying Fox was captured in a mist net at site P7). However, both species are likely to feed in any remnant rainforest vegetation throughout the region during the fruiting season. The Grey-headed and Black Flying Foxes are widespread species, capable of travelling substantial distances in an evening to fruiting and flowering trees. One other species, the Little Red Flying Fox *Pteropus scapulatus*, may also be expected occasionally.

Intensive surveys for microchiropteran bats during this investigation along the proposed route revealed the presence of four species, the White-striped Mastiff-bat, Little Bent-wing Bat, Goulds Wattled Bat and Large-footed Myotis. All species occurred at a relatively small number of sites (between three and four survey sites investigated).

The Little Bent Wing Bat *Miniopterus australis* was recorded at three locations during surveys of the proposed route, although no substantial caves which might function as maternity roosts were located. The Little Bent-wing Bat is a "*localised and common*" species (Parnaby 1992), which is considered of conservation concern primarily because of its restricted maternity roosting requirements.

The Large-footed Myotis *Myotis adversus* was located at three sites during this investigation of the proposed route. One of the locations surveyed near the Mullumbimby Power Station during this investigation (Site P14) supported substantial numbers of *Myotis adversus*. This site was characterised by a large pool in the Wilson River, which flows through a rainforest remnant.

□ **Reptiles**

A total of thirteen reptiles have been recorded during the field investigations along the proposed route. Several of these were located in a substantial number of the sites surveyed, including the Eastern Snake-necked Turtle (which was located in virtually all water bodies investigated), the Eastern Water Dragon (located adjacent to most watercourses), the Dark-flecked Garden Sun-skink (which is an extremely widespread and abundant species), and the Carpet Python (which was located in 9 of the 18 sites surveyed). Other species were less frequently recorded, appearing in between 1 and 6 of the sites investigated. None of the species recorded during this investigation are considered threatened or endangered, as defined by inclusion on Schedule 12 of the NP&W Act. Furthermore, none of the species which were located during this investigation are considered rainforest-obligate, although the Land Mullet *Egernia major* tends to occur most frequently in such habitats.

The Big Scrub rainforest remnants surveyed during the current investigation for the proposed route support a relatively modest to depauperate reptile assemblage. Most sites contained between one and four species, with only four of the 18 survey sites supporting more than four reptile species. The three sites in this study (P7, P11 and P15) which supported nine or 10 species were the largest remnants investigated.

- **Amphibians**

Five native and one introduced amphibian species were recorded during the field investigations of the proposed route. Of these, the Green Tree Frog *Litoria caerulea* and Eastern Dwarf Tree Frog *Litoria fallax* are common and widespread, and were located in most of the sites surveyed. The Brown Striped Frog *Limnodynastes peronii* was located in approximately half of the survey sites, whilst the Spotted Grass Frog *Limnodynastes tasmaniensis* and Lesueur's Frog *Litoria lesueurii* were recorded in fewer sites (one and three sites respectively). The introduced pest, the Cane Toad *Bufo marinus* was located in two sites near Lismore. None of the species recorded during this investigation are threatened or endangered.

Other amphibian species identified in the area during other studies which are considered of conservation concern are discussed in **Appendix H**. While several additional species could be present along the proposed route, it is considered unlikely that the reconstruction of the existing transmission line will have an adverse impact on the habitats or features of significance for these species.

6.3.4 Endangered Species

Endangered fauna species are defined as those listed on Schedule 12 of the National Parks & Wildlife Act 1974. This Schedule lists species which are considered of conservation concern because of restricted distributions or habitat requirements, or because of significant population or distributional range declines and where threats to species' survival still prevail. The list used for this assessment is that gazetted on 18 December 1992, which is the most current lists for this assessment.

A number of endangered native fauna species are known to or could possibly occur in the Lismore/Mullumbimby region (see **Table 6.2**), and doubtless a considerable number of now threatened species would have been common in the Big Scrub prior to its substantial disturbance during the second half of the nineteenth century. **Table 6.2** is derived from distributional maps and databases and many of the species included have not been recorded from the vicinity of the transmission line corridor.

Of the species listed in **Table 6.2**, seven were recorded during the field investigations along the proposed route, and an additional 17 have been recorded in habitats through the Lismore/Mullumbimby area or in rainforest remnants scattered throughout the original Big Scrub area (as mapped in Lott & Duggin, 1993). Of these additional species, however, ten have been recorded only in the Big Scrub remnants which are adjacent to the contiguous forests of the Nightcap Range. These species are considered unlikely to occur in the smaller isolated remnants on other than an occasional 'non-viable basis. Additionally, one species (Albert's Lyrebird), was recorded only from remnants adjacent to the Nightcap and Blackwall Ranges. This species is also not likely to be present in the smaller or more isolated tracts of remnant rainforest vegetation.

Table 6.2 - Vulnerable & Rare Fauna of the Big Scrub region, including the Lismore to Mullumbimby area (modified from Lott & Duggin (1993)), with additional known records included.

Common Name	Scientific Name	Known Site	This Study
Amphibians			
Pouched Frog	*Assa darlingtoni*	1,SG	
Loveridge's Frog	*Philoria loveridgei*	19,21,26,SG, **F**	
Mammals			
Koala	*Phascolarctus cinereus*		●
Long-nosed Potoroo	*Potorous tridactylus*	1,21?,30?	
Red-legged Pademelon	*Thylogale stigmatica*	1,SG	
Tiger Quoll	*Dasyurus maculatus*	1?, **F**	
Common Planigale	*Planigale maculata*	**38 or 39**	
Queensland Tube-nosed Bat	*Nyctimene robinsoni*	2?,SG	
Black Flying-fox	*Pteropus alecto*	2,13,19,26,27,30?,35,SG,**F**	
Queensland Blossom Bat	*Syconycterus australis*	30,SG	
Common Bent-wing Bat	*Miniopterus schreibersii*	1	
Little Bent-wing Bat	*Miniopterus australis*	1,SG	●
Large Pied Bat	*Chalinolobus dwyeri*	1	
Large-footed Myotis	*Myotis adversus*	1,16	●
Northern Long-eared Bat	*Nyctophilus bifax*	1,13,21,26,30,SG	
Birds			
Osprey	*Pandion haliaetus*	27	
Bush Hen	*Gallinula olivacea*	SG	
Superb Fruit-dove	*Ptilinopus superbus*	1,2,SG	●
Rose-crowned Fruit-dove	*Ptilinopus regina*		●
Wompoo Fruit-dove	*Ptilinopus magnificus*		●
Red-tailed Black-cockatoo	*Calyptorhynchus magnificus*	extinct?	
Glossy Black-cockatoo	*Calyptorhynchus lathami*	SG	
Sooty Owl	*Tyto tenebricosa*	2,3,SG,**F**	
Marbled Frogmouth	*Podargus ocellatus*	1,2,3,24,SG,**F**	●
Yellow-eyed Cuckoo-shrike	*Coracina lineata*	SG	
Albert's Lyrebird	*Menura alberti*	1,2,3,28,29,SG	

Common Name	Scientific Name	Known Site	This Study
White-eared Monarch	*Monarcha leucotis*	1,3,23,28,SG,**F**	
Black-necked Stork	*Ephippiorhynchus asiaticus*		*

Notes: The 'known sites' are those described by Lott & Duggin (1993), and other records (Preistley 1992; Arrens 1992; Bohm 1991; Purcell 1993). Those in bold are on or are close to the proposed route.
'This study' includes records obtained during specific field surveys along the proposed route (●).
* recorded from a site near Federal (Purcell 1993).

Species profiles have been compiled for each of the endangered species listed in **Table 6.2** and these are given **Appendix H.** Those identified during the study are discussed below.

The Koala *Phascolarctos cinereus*

The Koala primarily inhabits eucalypt woodland and open forest, and is rarely recorded within rainforest or dense closed eucalypt forest. It is able to cross large areas of open ground and is consequently not restricted to locations where trees are dense (Martin 1989). Koalas were recorded at several of the study sites along the transmission line route with apparent foci of Koala activity at Goonengerry and Dunoon.

Little Bent-wing Bat *Miniopterus australis*

The Little Bent-wing Bat was recorded at four survey sites during investigations along the proposed route. Habitats at these sites included rainforest regeneration, eucalypt plantations, weed infested riparian vegetation and small patches of intact rainforest. No caves or tunnels were located in the sites surveyed, and the areas along the corridor consequently constitute foraging habitat, rather than roosting areas.

Large-footed Myotis *Myotis adversus*

The Large-footed Myotis roosts in caves, tunnels, mines and under bridges, nesting in colonies of up to several hundred. It has also been recorded roosting in dense rainforest foliage (Strahan 1992). This species feeds by flying over open bodies of water, such as pools, dams and ponds in streams, raking the water surface with its hind feet and catching small fish and insects.

The Large-footed Myotis was recorded at 4 survey sites along the proposed route, and has also been recorded at some distance from the corridor (Priestley 1992). At site P14, located on Byrangerry Creek, a high density of Myotis were observed, indicating a habitat of particularly high value for this species. The existing line passes directly over the study site, indicating that the line does not currently pose a threat for the bat at this location.

Wompoo Fruit-dove ***Ptilinopus magnificus***

The principal habitat requirement of the Wompoo Fruit-dove is rainforest. Strictly arboreal and locally nomadic, this species favours the upper canopy, feeding on a wide variety of fruits in tall rainforest trees, with some local movement noted in response to abundances of fruiting trees (Blakers *et al* 1984). It nests in the outer foliage of rainforest trees, high in the canopy (Lindsey 1992). It also utilises introduced plants, feeding on the fruit of the abundant Camphor Laurel (Date *et al* 1989).

The Wompoo Fruit-dove has been recorded at five of the survey sites along the proposed route, and has been located in several other remnants in the region (Date *et al* 1989). Lott & Duggin (1993) regard the Wompoo Fruit-dove as "*common*", being recorded in 14 of 32 rainforest remnants through the region.

Rose-crowned Fruit-dove***Ptilinopus regina***

The Rose-crowned Fruit-dove generally lives in rainforest (Blakers *et al* 1984), but also inhabits mangroves, adjacent eucalypt forest with rainforest shrubs, beachside scrub and riverine forest (Lindsey 1992). It feeds primarily on a wide variety of fruits from tall rainforest trees, and nests in trees, bushes or vine tangles nearby. This species is locally nomadic in response to the abundance of fruiting trees and appears to be partially migratory, with a large part of the population moving to tropical rainforest in northern Queensland during winter (Blakers *et al* 1984).

Within the Lismore/Mullumbimby study area, the Rose-crowned Fruit-dove was recorded at six of the 18 survey sites, and is considered a "widespread" rainforest species by Lott & Duggin (1993), being recorded in 23 out of 32 sites considered in that report.

Superb Fruit-dove ***Ptilinopus superbus***

The preferred habitat of the Superb Fruit-dove is rainforest, although it also feeds in adjacent moist eucalypt forest and occasionally in mangroves (Blakers *et al* 1984). It feeds primarily on the fruit of tall rainforest trees and on the fruit of lower rainforest and moist vegetation, and nests in small bushy trees to tall trees in similar habitat. In the Big Scrub area, Camphor Laurel also provides an important food resource (Date *et al* 1992).

The Superb Fruit-dove was recorded infrequently during this investigation along the transmission line corridor, being located in only two survey sites. Other localities for this species include three of the remnants of the Big Scrub adjacent to the Nightcap Range (Lott & Duggin 1993). Thus, the Superb Fruit-dove appears reliant on larger, more intact rainforest than the other rainforest-dependent pigeons.

Marbled Frogmouth ***Podargus ocellatus***

The Marbled Frogmouth inhabits "*subtropical rainforest and tall wet eucalypt forests*" (Garnett 1992b), including areas with a rainforest understorey beneath an emergent eucalypt canopy (Blakers *et al* 1984). These forests have been extensively cleared for agriculture. It is considered a rainforest-dependent species by Lott & Duggin (1993).

The Marbled Frogmouth was recorded during the field investigations along the corridor at site P7, and has also been recorded at the 'Federal' site and several of the Nightcap Range sites (Lott & Duggin 1993).

6.3.5 Potential Impacts

The proposed Lismore to Mullumbimby transmission line has the potential (at least theoretically) to impose significant impacts on native fauna or their habitats through the landscape over which the proposed line will pass (if inappropriately located or insensitively constructed).

Installation of the transmission line along a new route would have the potential for imposing significant impacts on native fauna and their habitats. Using the route of the existing line for the proposed new line substantially reduces the potential for significant impacts on native fauna and fauna habitats.

The construction works have potential to impact upon native fauna and their habitats. The first possible impact arises from removal or disturbance of native vegetation and fauna habitats, in particular areas of undisturbed or relatively intact rainforest, eucalypt forest and riparian vegetation. It should be noted, however, that substantial tracts of relatively undisturbed vegetation communities or fauna habitats are rare along the route of the existing line. The second potential feature or process involves the possibility of birds and megachiropteran bats striking the actual transmission lines, or being electrocuted. Again, given the existence of the current 66 kV transmission line along the preferred corridor, this would involve the modest intensification of an existing impact rather than the imposition of a novel one. PacificGrid considers that electrocution is highly unlikely due to the wide spacing of the conductors of the 132 kV line. However, there is the potential for direct strike on the transmission line by some birds and megachiropteran bats in flight.

Significant clearing, if undertaken, could impose adverse impacts on the native fauna dependent on rainforest patches along the proposed route.

However, use of the existing line route and the avoidance of substantial tracts of rainforest vegetation, as well as the use of sensitive installation procedures, should enable potential adverse effects to be minimised or avoided altogether. Given this approach, it is considered unlikely that the proposed line will impose a significant impact on native fauna or their habitats.

Another habitat which is considered of significance for native fauna is riparian vegetation. As with rainforest through the Lismore Plateau, most the riparian vegetation communities have been cleared or significantly disturbed as a result of agricultural activities. Consequently, remaining riparian communities are of potentially high value for native fauna, by providing microhabitat features and special resources for species (such as the Australian Water Rat, kingfishers, some reptiles and microchiropteran bats). Riparian corridors may also provide movement corridors between other tracts of vegetation, for example between stands of remnant rainforest. The remaining riparian corridors in the Lismore/Mullumbimby area are regarded as of particular relevance.

With respect to the potential impacts of the proposed transmission line on riparian vegetation, similar considerations apply as are relevant for the rainforest vegetation communities. Thus, those riparian corridors which are of substantial size or which are relatively undisturbed are considered of proportionately greater value than smaller or more disturbed areas.

With the reconstruction option and with taller structures enabling sensitive vegetation areas to be spanned over, extensive removal of native vegetation is not required. On this basis, it is considered possible to avoid or minimise the potential for adverse impacts.

Removal of, or disturbance to regenerating vegetation, particularly rainforest communities, on the Lismore Plateau would also be considered likely to impose some adverse impact upon native fauna. These communities generally are dominated by Camphor Laurel and other introduced weeds, which provide cover and protection for regenerating rainforest. Furthermore, Camphor Laurel is an abundantly fruiting plant, which provides food resources for several species of native fauna (particularly for the rainforest pigeons - the Rose-crowned, Superb and Wompoo Fruit-doves). These birds also utilise patches of Camphor Laurel as 'stepping stones' between larger tracts of rainforest vegetation in the region, including for seasonal migration between high and low elevation forest (Date & Recher 1990; Date *et al* 1991). Consequently, while already disturbed and dominated by non-native species, these regenerating patches may be of considerable value for native fauna.

As for rainforest, the proposed line could impact significantly on regenerating forest communities, if substantial vegetation removal or disturbance occurred. The proposed transmission line can be located or designed to minimise such impacts upon these Camphor Laurel dominated vegetation communities. Naturally occurring or regenerating patches of eucalypt forest, often associated with patches of rainforest, is another potentially significant vegetation community.

The bandwidth of the proposed line does not significantly affect any substantial tracts of eucalypt forest vegetation. However, there are some sites at which eucalypt forest is present on or adjacent to the existing line, and the removal of some trees may be necessary for the proposed new line.

Koalas are known to occur throughout the Lismore region, and were recorded at five of the survey sites studied for the proposed transmission line. They were also located outside the study sites, and are clearly widely distributed, although not appearing abundant in the Lismore/Mullumbimby area. As some eucalypts may be removed for the proposed line, there is some potential for an adverse impact on Koalas and other fauna which may use the eucalypts present. Impact amelioration and minimisation measures are discussed below.

The second potential effect of the proposed transmission line involves the possibility of birds and bats striking the transmission line conductors and earth wires. In this regard, the existing transmission line already presents the potential for such phenomena although no specific incidences of bird and bat strike have been recorded along the existing line (J Purcell, D Charley *pers comm*).

For most aerial fauna, the striking of transmission lines is unknown or is not common. This phenomenon is considered unlikely to impose any adverse impact on the vast majority of native fauna present through the Lismore/Mullumbimby area. However, for a few species there is some potential for adverse impact. Megachiropteran bats (the flying-foxes) are often electrocuted on distribution lines, and probably also strike the lines on occasions (D Charley *pers comm*). PacificGrid draws attention to the absence of recorded incidence of bats strike along the existing line and has suggested that the recorded cases may be attributable to electrocution occurring on lower voltage lines where conductors are not so widely spaced. The proposed transmission line may present some limited hazard to a relatively small number of megachiropteran bats but the potential impacts of such a phenomena are considered of no significance.

The most significant species known from the Lismore/Mullumbimby area which could potentially be adversely affected by transmission line strike is the Jabiru or Black-necked Stork *Ephippiorynchus asiaticus*. This is an endangered species, which is present in the Richmond River catchment in only small numbers (Purcell 1993). Wetlands and appropriate foraging sites for the Black-necked Stork do not appear to occur along the transmission line corridor, but the species has been recorded in the vicinity of Federal (Purcell 1993), and could possibly utilise some of the farm dams along the proposed route. Consequently, there is some slight potential for the Black-necked Stork to be affected by the proposed transmission line.

The proposed transmission line between Lismore and Mullumbimby involves a rebuilding of the existing facility, rather than the imposition of a novel impact. It is not considered likely that the proposal will impose a significantly increased adverse impact upon the natural environment or fauna habitats along the route. Potential impacts during construction of the proposed line can be reduced through the adoption of safeguards discussed below.

6.3.6 Safeguards

Minimisation of the potential for impacts by the proposed transmission line has been achieved in substantial measure by the approach adopted to this project, involving review of the various route options and the selection of the existing transmission line as the 'preferred route' for the proposed new line.

The existing route was chosen partly on the basis of imposing the least impacts on native fauna and their habitats. Consequently, a substantial level of impact amelioration has already been applied to the proposed Lismore to Mullumbimby transmission line. Whilst the project involves the intensification of an existing impact, this will occur to a relatively minor degree, and is preferable to the imposition of new impacts on previously undisturbed habitats. Nevertheless, a number of measures are proposed for the installation of the new 132 kV line to further minimise the potential for adverse impacts on native fauna and their habitats.

The specific location of the transmission line within the bandwidth will involve minimum clearing. At all locations along the route, the clearing of vegetation (especially remnant rainforest or intact riparian vegetation, but also including regrowth forests and eucalypt forest) will be limited to a minimum.

Sites for location of the new pole structures should also be chosen with respect to the maintenance of vegetative cover. Wherever possible, poles should be located on open land, and should not involve the removal of native or regenerating vegetation. Where the existing power line crosses 'extensive' tracts of rainforest or other native vegetation, it is preferable to use the existing disturbed corridor for the location of new poles. Alternatively, the line can be realigned to avoid native vegetation would be preferable, with support structures sited in cleared paddocks or patches abutting such tracts of native forest.

One of the features of the rainforest and riparian remnants through much of the Lismore Plateau area is their location in sheltered gullies. By siting pole structures on higher ground, it will be possible in many instances to span the rainforest remnants in the gullies and thus avoid disturbing these areas. In some instances, this may require the use of helicopters to install conductors across gullies.

Specific protocols for implementing this measure will need to be considered at each point along the transmission line, once the precise route is determined or as construction activities proceed.

The use of existing roads and farm tracks for access to the transmission line, both for construction purposes and for subsequent maintenance, is considered preferable to installing new tracks. The creation of a cleared track for maintenance, running the full length of the transmission line corridor, is considered undesirable with respect to fauna habitat conservation.

It is considered appropriate that a 'minimalist' approach be adopted in removal of vegetation below the transmission line. Thus, installation of the transmission line between ridgetops, spanning rainforest or other remnant vegetation in gullies, is important to permit the existing canopy to remain intact. This approach is of particular significance with respect to rainforest, where canopy clearing usually constitutes a significant adverse impact.

Where it is necessary to remove vegetation beneath the transmission line for access or maintenance purposes, it is proposed that such clearing be limited in extent, and that native vegetation communities below the transmission line not be replaced by open grassland (wherever possible). Where it is necessary to remove forest vegetation, it should be possible to maintain a native habitat. Maintenance of this type of vegetation community would permit the continued movement of many native species from one forested site to another. Conversely, the creation of open grassland between two previously connected patches of forest could potentially prevent many species from moving between them, and could thus reduce the population viability of fauna communities at both locations.

Similarly, with respect to the eucalypts which are of significance for Koalas, it is likely that in a few locations some Koala food trees may have to be removed. This will be ameliorated by adopting a supplementary planting program to ensure that these trees are replaced. This would involve planting of a greater number of eucalypts for use by Koalas than have been removed. The species to be planted would include Tallowwood, Flooded Gum, Blackbutt and Sydney Blue Gum.

One additional feature with respect to Koalas will be the development of a protocol to deal with any animals located during construction activities. Close contact with the NP&WS and local WIRES groups should be maintained to deal with any displaced animals. A similar protocol should be implemented for other native fauna along the route.

Other measures which are appropriate for ameliorating the potential adverse impacts of the proposed transmission line on fauna and fauna habitats will involve weed control and the management of silt and sediment, as well as appropriate protocols for the management of wastes or other possible contaminants during construction. Weed control is addressed in Section 6.2.5. Erosion and sedimentation control is addressed in Section 6.5.5 and management of waste is addressed in Section 5.

Weed control will be instituted. In open paddocks where grazing is to continue, weed control is not likely to be of particular significance, although the potential for introducing new weeds will be addressed where necessary.

Where access through native communities requires disturbance or where pole installation involves temporary disturbance to a native community, it is suggested that a replanting program be initiated, involving the mulching of bare ground, planting of native shrubs, broadcasting of native seed, and a monitoring program over the ensuing one to two years to minimise the invasion of weed species. Where substantial areas require clearing, the use of hydro-mulching techniques or fibre matting to protect the soil surface and to limit weed growth are proposed as suitable weed control protocols.

It is not anticipated that any species affected by the proposed development are likely to become non-viable in the vicinity because of the potential impacts of the proposed transmission line. The measures to be adopted in the construction of this feature through the Lismore/Mullumbimby area are intended to ensure that there is no significant adverse effect on the survival of protected or endangered native fauna, and are designed to enhance the chances of survival of many species and populations.

6.4 Geology

The Lismore Plateau is a moderately to highly dissected plateau of basaltic material derived from lava flows from the original Mount Warning volcano approximately 21-23 million years ago. The lava flows formed the Lismore Basalt, the Nimbin Rhyolite and most recently the Blue Knob

Basalt.

The basaltic material is underlain by earlier formations consisting of the Bundamba and Neranleigh Groups which are aged between 135 - 430 million years old. Following volcanic activity, differential uplift of the land occurred, followed by Quaternary erosion and subsequent alluvial deposition partially filling valleys and forming floodplains.

6.5 Topography, Land Capability and Soils

6.5.1 Topography

The existing 66 kV transmission line follows the Leycester Creek floodplain out of Lismore before traversing the hillslopes of the Booerie Creek valley. The central portion of the route passes through undulating to steep terrain in the vicinity of Modanville, Dunoon and Repentance Creek. At a point approximately 1.5 km south of Goonengerry, the line deviates to the north through steep terrain before joining the 66 kV systems near Lavertys Gap.The proposed line crosses the costal escarpment which forms the edge of the Lismore Plateau. The elevation of the escarpment where the line currently crosses it varies from approximately 20 to 160 metres asl. The site at Lavertys Gap is situated at the footslopes of the escarpment, to the southwest of Mullumbimby, which is situated on the coastal plain.

Under the Soil Conservation Act, 1938, sections of the existing route are classified as "Protected Land". Protected land is defined as land which has a slope generally in excess of 18 degrees from the horizontal, land within 20 metres of the bed or bank of any river, stream, lake, lagoon or swamp mapped or listed by the Commissioner of CALM, or land mapped by the Commissioner as being environmentally sensitive, or affected by or liable to erosion, siltation or degradation. In general, trees taller than 3 metres may not be cleared from Protected Land without the approval of CaLM. Thus, any new vegetation removal to be undertaken on Protected Lands will require an application to the Murwillumbah office of CaLM. Underneath existing transmission lines, it is permissible to remove trees less than 3 metres high, or trees within 15 metres of the existing lines.

The use of the existing transmission line route minimises additional intrusions into Protected Lands.

6.5.2 Land Capability

Land capability maps prepared by CaLM classify land into eight categories. Classes I to III are suitable for regular cultivation, classes IV and V are suitable for grazing with occasional cultivation, class VI is suitable for grazing but not cultivation, class VII is best suited for green timber with stock generally excluded and class VIII covers cliffs, lakes and swamps.

The existing line traverses all land capability classes except classes I, V and VIII. Most of the line traverses class III and class VI land. Class III is characterised by sloping land suitable for cropping on a rotational basis and generally is fair to good agricultural land, however, soil erosion problems may be severe. Class VI comprises the less productive grazing lands, with productivity varying with soil depth and fertility. Class VII land is also traversed for a significant proportion of the line, and consists of areas of steep slopes and shallow soils. Class II land, characterised by gently sloping land suitable for a wide variety of agricultural uses and Class IV land, which is land not suitable for cultivation on a regular basis owing to limitation of slope, gradient, soil erosion, shallowness or rockiness, climate or a combination of these factors, are traversed by the line to a lesser extent.

6.5.3 Soils

The soil landscape groups along the proposed route are shown on **Figure 6.3**. In summary, the soils along the proposed route are characterised by fertile soils derived from the basaltic parent geological unit, with krasnozems being the most common soil in the region. Chocolate soils are also found in the region, particularly in the drier areas and hillslopes of the plateau. Brown podzolic soils have formed on the more acidic rhyolite flows which occupy areas associated with the Nightcap Range. Alluvial soils can be found along the Wilsons River, its tributaries and the coastal plain. The alluvial soils are comprised of Black Earths and Weisenbodens, which form largely from the eroding basalt capping.

The following more detailed description of the soils along the proposed route is based on the Lismore-Ballina Soil Landscape Sheet provided by CaLM.

Residual Landscapes:-

- *Frederick (fr)*:- poorly drained Prairie soils with localised well drained Krasnozems and poorly drained Black Earths/Weisenbodens in drainage depressions. They are shallow, plastic soils with aluminium toxicity potential and seasonal waterlogging.
- *Wollongbar (wo)*:- mostly deep well drained Krasnozems, highly acid soils, moderately erodible with high aluminium toxicity potential and low water holding capacity.
- *McKee (mc)*:-characterised by well drained stony Prairie soils and structured Plastic Clays on crests and Prairie/Chocolate Soils on intergrades and Chocolate soils on slopes. These are shallow reactive soils, where there is potential for mass movement hazard and localised seasonal waterlogging.

Colluvial Landscapes:-

- *Coolamon (co)*:- well drained Chocolate Soils and Krasnozems, limited by steep slopes, mass movement hazard, shallow and stony soils and localised waterlogging.
- *Georgica (ge)*:- Chocolate Soils and Prairie Soils on crests, upper slopes and midslopes, well drained Black Earths on lower slopes. They are erodible soils with mass movement and waterlogging potential.
- *Nimbin Rocks (nr)*:- moderately well drained podzolic soils and Krasnozems. This group is limited by rock falls, debris avalanche hazard and steep slopes.

Erosional Landscapes:-

- *Minyon (mi)*:- moderately well drained Podzolic Soils throughout plateau with shallow Grey Leached Earths on plateau margins. This Group is limited by moderate to highly erodible soils of low fertility. These soils can also be residual landscapes.
- *Rosebank (ro)*:- shallow well drained Krasnozems and brownish red Krasnozems on crest margins and moderately deep to deep Krasnozems and brownish red well drained Krasnozems on slopes. These soils are limited by their highly acidic nature and high aluminium toxicity potential combined with steep slopes that have the potential for mass movement hazard.

Transferral Landscapes:-

- *Disputed Plain (dp)*:- poorly drained Black Earths, Black Earth/Weisenboden intergrades and Dense Clays. Highly plastic soils of low permeability, high surface movement potential with localised stoniness and waterlogging and permanently high watertables.

Alluvial Landscapes:-

- *Leycester (le)*:- moderately well drained black earths and structured clay throughout the flood plain, Weisenbodens in the wetter areas and earthy sands along channels. These soils are moderately erodible and are limited by flooding and stream bank erosion.
- *Mullumbimby (mu)*:- well drained Structured Alluvial Clays. These soils are limited by flood hazard, localised seasonal waterlogging and moderately erodible soil materials.

Although there are some pockets of soil in the area which have acid sulphate potential, this is not the case for soils which the transmission line traverses.

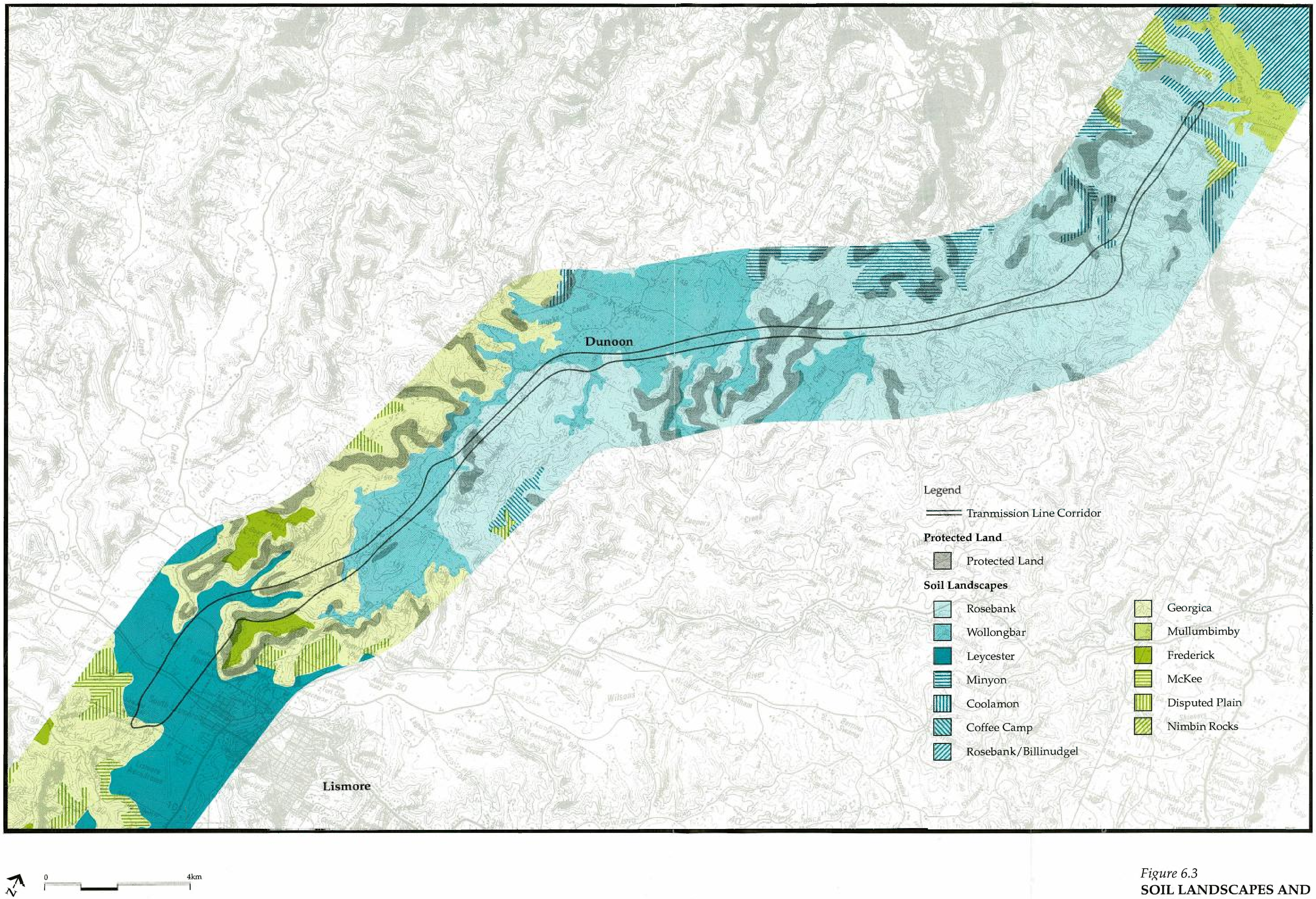


Figure 6.3
SOIL LANDSCAPES AND PROTECTED LANDS

6.5.4 Impacts on Soil

The primary risks associated with soil erosion will occur due to disturbance and vegetation removal associated with the proposed line and any additional access tracks that will be required. In addition, compaction of the soil structure may occur due to the use of heavy machinery used during construction.

During construction works there is some minor potential for soil erosion and sedimentation from access tracks, creek crossings, clearing and excavation work for the poles, stockpiling and disposal of spoil material and ground disturbance during dismantling of the existing line.

Where the route passes through krasnozem and chocolate soils there would be a minor gully erosion risk. The greatest stability and soil erosion hazards would arise in areas where deep profiles of these soils occur in protected lands (i.e. lands with slopes steeper than 18^0), where mass movement could also be a problem unless mitigation measures are implemented.

In order to protect the land from erosion and soil damage, control measures are recommended, to minimise the impacts of the new line on the soils of the area. These are discussed below.

6.5.5 Erosion and Sedimentation Control Measures

During construction, particular attention will be paid to erosion control measures, particularly where the transmission line traverses krasnozem and chocolate soils in steep country. To minimise soil erosion, tree removal in Protected Lands will be kept to a minimum. In instances where vegetation removal is unavoidable, the disturbance to ground vegetation will be minimised by the use of hand clearing methods wherever possible, and suitable grasses established where necessary to minimise erosion risk by retaining the soil binding benefits of vegetation. Where required, fibre matting and mulch will be used to stabilise the ground. Vegetation which is not likely to infringe on the required electrical clearances will be retained wherever practicable.

As mentioned in Section 4.5.3, vegetation removal activities will generally be carried out selectively by hand, and where necessary, tree pushers will be used to remove the tree without leaving a stump.

During construction, access to the transmission line route will use public and private tracks as much as possible. In some cases, existing tracks may need to be upgraded or new access tracks built. In areas of high soil erosion risk, or where mass movement may occur, attention would be given to new track location. In particular, long uninterrupted slopes and areas where there would be need for substantial cut and fill will be avoided wherever possible. New and upgraded access roads will be constructed with appropriate drainage and erosion control measures, in accordance with the CaLM guidelines.

Where it is anticipated that significant disturbance of any area will be necessary, runoff controls during construction works will be required to prevent soil erosion from disturbed areas where vegetation is removed. Disturbance would occur primarily from the construction of additional access tracks or areas within the proposed easement where vegetation removal is needed to provide the required clearance from conductors. Erosion and runoff can be controlled generally by conforming to guidelines issued by EPA and CaLM. Erosion will be minimised by restricting the area disturbed at any one time and by diverting water from upstream around the disturbed site.

Temporary erosion control measures will be implemented during the construction phase to control sediment runoff. Such measures may include the installation of silt fences and haybales and the construction of diversion channels to keep clean water away from disturbed areas. Measures to be used are described below.

- installation of silt barriers - where considered necessary adjacent to access tracks, silt fences or hay bales may be installed to prevent the movement of sediment into the local waterways while the area stabilises
- installation of cross-banks and mitre drains on access tracks in accordance with published guidelines
- installation of coarse gravel or rock pitched protective measures where unstable drainage lines are crossed
- installation of headwalls as required on access track culverts, and stabilisation of pipe outlet discharge points
- mulching of removed vegetation and prompt revegetation of all disturbed areas.

In order to minimise soil compaction, advice from landholders will be obtained prior to taking heavy machinery on their properties.

Progressive rehabilitation works will be undertaken (seeding with grass) on freshly cleared areas under the transmission line when work is complete. The erosion control measures outlined above will minimise the potential for sediment runoff to enter local watercourses.

6.6 Surrounding Land Uses and Impacts

The proposed transmission line is located in a region which is valuable for agricultural, residential and recreational uses. The principal existing land uses in the region are:

- residential areas including towns, villages and rural residential areas
- agriculture activities including grazing, dairying, and horticulture
- recreational uses including National Parks and Nature Reserves
- forestry
- extractive industries.

The proposed transmission line route predominantly passes through grazing and horticultural land and areas of native vegetation. From the Lismore substation, the route passes through the flat, cleared agricultural land of the Leycester Creek and Booerie Creek floodplains on the western perimeter of Lismore city. Agriculture consists of both grazing and cultivation.

The route traverses the rural/agricultural land along the Booerie Creek floodplain until it reaches the horticultural area of north Lismore, near Modanville. Horticulture in the Modanville area consists primarily of bananas and macadamia plantations. Land use in this area is also characterised by cleared pasture land. The route also traverses horticultural areas (macadamias) and cleared pasture land around Dunoon.

Although the section of the route between the crossing of Weigall and Boomerang Creeks to Lavertys Gap does pass through some horticultural areas, this section of the route is characterised by a mixture of cleared pasture and densely vegetated areas. Areas of dense vegetation cover are prevalent along the creeks.

The proposed line will have little additional impact on the existing land uses. Existing land uses underneath the line, consisting primarily of horticultural and grazing activities, with certain areas in the north being heavily vegetated, will be largely unaffected. Some existing impacts will be reduced as a result of the proposed works.

Horticultural activities such as macadamias and bananas take place along the route of the existing 66 kV line. It is likely that the new line will have less effect on these activities given that there will be fewer structures and greater clearance to the conductors. Few banana plantations utilise aerial spraying. However, this activity can continue subject to adjustment of flight paths if necessary.

6.6.1 Agriculture

Agricultural Suitability

The Department of Agriculture defines agricultural stability in five classes, taking into account biophysical parameters (climate, topography, soils) social factors (labour availability, land tenure) and economic considerations (production potential, long-term viability, return on capital and present land use. Areas of class 1, 2 and 3 agricultural suitability are considered to constitute prime quality agricultural land.

Within both Lismore City and Byron Shire area, class 1 lands are confined to very limited areas on the volcanic plateau (on krasnozem soils) and highest alluvial levees. Class 1 comprises land suitable for regular cultivation or intensive horticulture. Class 2 areas occur on higher, well drained floodplain areas and many small areas on the plateau, again confined to krasnozem soils. Class 2 lands are suitable for vegetable and other crop production, but not continuous cropping. Class 3 land, suitable for grazing, is found in moderately sloping krasnozem areas on the plateau, and moderately to gently sloping land derived from sedimentary rocks.

Extensive areas of moderate to steep hill country are classified as class 4 land. These lands are suitable for grazing, but not for cultivation, while class 5 land is only suitable for rough grazing or is land not suited to agriculture. Class 5 lands are confined to steep, mountainous country.

Some areas of prime quality agricultural land (classes 1-3) are found along the existing 66 kV transmission line route. The existing line traverses a considerable length of prime quality agricultural land, i.e. approximately 15 km. The route passes through approximately 3 km of prime agricultural land through the western edge of Lismore City and Booerie area, 4.5 km between Tullera and Modanville, 1 km to the northeast of Modanville, 2 km to the south of Dunoon, and 2 km to the northeast of Dunoon. The route passes through some smaller patches of prime agricultural land to the east of Repentance Creek (0.5 km), south of Goonengerry (1.5 km), and south of Lavertys Gap (0.5 km).

Impacts of the Proposed Line

With the progressive change of agricultural land use in the area affected by the existing line, from grazing pasture to horticulture, the precise location of poles and conductors is of greater concern to current landholders than landholders working the land when the existing line was installed.

Of all agricultural activities, horticulture has the potential to be most affected by the transmission line. The location of a transmission line in a horticultural plantation may require continual lopping of trees, limiting the productivity of these trees and increasing the maintenance required in the plantation. During the construction of the new line, a number of potential impacts on agricultural practices are possible. Impacts associated with the construction of access tracks to the structures may include:

- damage to soil structure and vegetation cover due to the use of heavy transportation machinery, particularly under wet conditions
- damage to existing crops or orchards due to machinery
- removal of windbreak trees
- impacts of helicopters on orchard trees during stringing (associated with the possible removal of flowers or fruit)
- soil erosion due to excavation associated with structures and access tracks
- impacts on planning of plantations re layout and additional plantings
- impacts on aerial spraying options
- operational impacts associated use of machinery and the height of machinery under line

In order to minimise the adverse impacts of the construction activities the following mitigation measures will be adopted.

Detailed discussions will be held with the landholders regarding the location of access routes and the timing of access and construction. Access routes will be located to minimise damage to crops, orchards and paddock layout, and this will be determined in consultation with the landholders. Landholder advice regarding wet weather conditions should be heeded, to prevent bogged vehicles damaging the soil on properties.

Where access tracks are no longer required following construction, and if requested by the landholder, the tracks will be removed by ripping with a bulldozer and rehabilitated. Where it is not possible to avoid removal of existing windbreak trees, they will be replaced with other suitable species as agreed with the property owner.

In the event of crops or orchards being damaged by the construction activities, compensation will be negotiated with the landholder to minimise the financial impact of the line construction. Compensation issues are further discussed in Section 7.

During operation of the transmission line, clearance requirements associated with the line have particular relevance to horticultural pursuits such as macadamia, pecan, avocado and custard apple orchards.

Such orchards are currently crossed by the existing line in many places. Safe operation of the proposed line requires that there is a clearance between the trees and the conductors of no less than 2.5 metres. In some instances, orchard layouts have been planned to avoid the route of the existing line, while in other situations, trees underneath the line are lopped to ensure that there is an adequate clearance between the trees and the conductors. The potential impacts of the new line on orchards includes:

- continual lopping of trees, limiting their productivity and subsequent profits

- loss of productive horticultural land as a result of the line location.

Discussions held with existing orchard owners have indicated that in obtaining the required clearances within the orchards, careful placement of the structures in relation to existing and planned orchards and taller pole structures would assist in mitigating the effects of the new line. In addition, regular maintenance is required to ensure that the clearances initially established are not subsequently reduced.

As discussed in Section 4.4.1, it is possible to incorporate additional clearance into the design of the transmission line in order to reduce the impact on macadamia plantations.

The route also runs through other areas of prime quality dairying, grazing and cropping land. However, the proposed line will not cause any significant decline in productivity due to the following factors:-

- the operation of the line will have little effect on the behaviour, health or productivity of livestock;

- it is not necessary for the proposed easement to be fenced, allowing activities within the easement to continue;

- land under the line can continue to be cultivated by mechanical means, provided that machinery used under the lines is no higher than 4.3 metres and crop production would not be affected by the line;

- maintenance and the need for line access would be infrequent and this would not interfere with general livestock or pasture management.

There will be some impact on agricultural activities during the construction phase as a result of the movement of vehicles, construction workers and associated machinery along the transmission line corridor. These activities will result in minor and temporary losses of pasture production and some inconvenience to landholders who choose to relocate stock for the duration of the activities.

6.6.2 Rural/Urban Subdivisions

Rural and urban impacts have been considered in terms of amenity and visual quality. During the route location phase the community made it clear that there was a strong desire for the proposed line to be located away from both population centres and individual residences. The community perceived that there would be a deterioration of the visual amenity of subdivision areas, issues of safety, health effects associated with EMF, and a reduction in property values with the construction of any additional line. In addition, concerns regarding the existing right of way corridor conditions were raised and all these were seen as impacting on the value of the land affected and saleability.

The proposed line will have some impact on the existing view catchments of towns, villages and subdivision areas, similar in nature to the impacts of the existing line. In some areas, the impacts will increase due to additional wires and taller structures, and in other areas the impacts will decrease as a result of deviations away from the towns, villages and potential subdivision areas, and a reduction in the number of structures required.

Potential impacts of the new line on areas designated for future residential uses include a subdivision currently underway in the southern area of Modanville and designed around the existing 66 kV line. An easement for overhead power reticulation of 20 metres currently occurs on these blocks. The proposed line will follow the route of the existing line with some minor deviations. The impacts of the proposed line will therefore be limited to additional visual impacts and the additional impacts of the proposed 45 metres easement required on the subdivided blocks directly affected by the easement.

Certain areas in Dunoon were rezoned from 1(b) Agricultural Zone to 2(v) Village Zoning in the LEP Amendment No. 10 (Gazetted June 8 1994). None of these areas are crossed by the existing line and consequently, will not be directly affected by the new transmission line. Other areas in the village currently zoned 2(v) may be subdivided in the near future and consequently, discussions with affected landholders are taking place in an attempt to place the line in the most appropriate location to accommodate any future subdivision.

Other areas with future potential for subdivision, although having no existing formal subdivision plans, have been discussed with various individual landholders. In some cases where the existing line has a considerable impact on subdivision potential, it is possible to realign the new line within the proposed bandwidth to minimise the impacts on possible future subdivision.

6.6.3 Recreation and Tourism

Recreation areas within the region include Nightcap National Park, Big Scrub Flora Reserve, Minyon Falls Flora Reserve, and Rocky Creek Dam Recreation Reserve.

The existing transmission line route does not affect any of these areas and consequently, the proposed line will not have a significant impact on the recreation and tourism within these areas.

Coolamon Scenic Drive, a major tourist route in the area, is within the outer visual catchment of the transmission line. These views, however, are limited due to the distance of the line from the road, and additional impacts of the proposed line reconstruction on these views will be minimal.

Concerns regarding transmission lines in close proximity to recreational playing fields and school playgrounds have been raised. However, the proposed line is not expected to have any significant impact on playing areas.

It is considered that the proposed transmission line will have no measurable effect on the recreational and tourism value of the area.

6.6.4 Forestry

State Forests located within the region include the Whian Whian, Dorroughby and Goonengerry State Forests. No State Forests are affected by the existing line nor the proposed line. Consequently there will be no impact on forestry activities as a result of the reconstruction.

6.6.5 Extractive Industries

A number of quarries are located within the study area, one west of Booerie Hill and the other north of Goonengerry. Both quarries are outside the bandwidth of the proposed route and will not be affected by construction or operation of the proposed transmission line.

6.7 Transportation Impacts

6.7.1 Existing Traffic Flows

Table 6.3 provides the AADT (Annual Average Daily Traffic) figures between 1982 and 1990 for roads within the study area. Traffic volume in the area is highly variable since some roads are major routes servicing the urban areas of Lismore, and others are less used rural roads, providing access to less densely populated areas. State Highway 16 (Bruxner Highway) and the Pacific Highway are the major transport links providing access to the region.

Table 6.3 - Existing AADT Traffic Flows

Location	Station No.	1982 AADT	1986 AADT	1990 AADT
Bruxner Hwy (east of Lismore)	04030	14 550	16 821	20 547
South of Lismore, State Highway No. 16	04094	7 440	5 580	8 133
Federal Rd, S of MR 306	04556	220	277	-
Wilsons Creek Road, W of MR 306	04557	640	733	
Corndale Rosebank Rd, 2.5 km S of MR 306	04570	110	398	-
South of Huonbrook Rd	04673	560	1 299	-
MR 306 at Byron Shire Border	04444	140	168	-

The roads within the area consist primarily of one and two lane sealed and unsealed, and cater for existing traffic requirements satisfactorily.

6.7.2 Expected Traffic Generation

During the construction phase of the transmission line, a variety of road registered vehicles will be used to transport personnel, materials and equipment to and from specific sites along the line.

The vehicles which are likely to be used in construction include:

- light personnel transportation vehicles
- small concrete trucks
- a truck mounted auger
- mobile cranes
- earthmoving machinery
- specialised vehicles used in erecting transmission line conductors.

These vehicles will either already be located within the region, being owned by local contractors, or will enter the area via the major routes into the area, i.e. the Bruxner and Pacific Highways, before following the smaller regional road network to specific sites.

6.7.3 Assessment Criteria

The Austroad Traffic Assessment Criteria for Rural Roads is provided in **Table 6.4**. This data provides the basis for establishing the expected level of service for various road formation and design. Roads to be affected by this proposal include "Unsealed" and "Sealed and Undivided" roads.

Table 6.4 - Austroad Traffic Service Assessment Criteria for Rural Roads

Road Stereotype	Quality of Traffic Service		
	Poor (vpd)	Fair (vpd)	Good (vpd)
Unsealed			
Natural Surface	over 100	61 to 100	up to 60
Formed	over 100	61 to 100	up to 60
Gravel one lane (up to 4.5 m)	over 100	61 to 100	up to 60
Gravel two lane (up to 4.5 m)	over 150	61 to 150	up to 60
Sealed Undivided			
One lane (up to 4.5 m)	over 300	151 to 300	up to 150
Narrow two lane (4.6 to 6.4 m)	over 4 000	1 001 to 4 000	up to 1 000
Wide two lane (6.5 to 9.1 m)	over 6 000	4 001 to 6 000	up to 4 000
Three lane (9.2 to 11.6 m)	over 10 000	6 001 to 10 000	up to 6 000
Four lane (over 11.6 m)	over 15 000	10 001 to 15 000	up to 10 000
Divided			
Four lane (up to 9.1 m x 2)	over 30 000	15 001 to 30 000	up to 15 000

vpd = vehicles per day

6.7.4 Transportation Impacts

Construction vehicle movements are expected to exceed 60 per day at any time. Construction traffic will only be a small portion of total local traffic over the construction period and inconvenience of any kind will be limited to a day or two in any one area.

Where construction works are undertaken in close proximity to residential areas, there may be a temporary impact on the local residential amenity of the area due to increased traffic noise, however, such impacts will be very limited in duration.

As work progresses, various local roads used to access the transmission line may include:

- Nimbin Road
- Hewitt Road
- Bentley Road
- Numulgi Creek Road
- Fletcher Road
- Dorroughby Road
- Fox Road (Rosebank Road)
- Federal Road
- Sheafes Road
- Montecollum Road
- Booerie Creek Road
- Dunoon Road
- Borton Road
- Duncan Road
- Missingham Road
- Arthur Road
- Emerson Road
- Jarrets Road
- Goonengerry Road
- Wilsons Creek Road.

While the majority of these roads are sealed two lane roads, others are sealed one lane roads or unsealed one or two lane roads. The impacts of the construction traffic on such roads will be dependent on the road design and alignment.

Trucking of materials will occur during daylight hours, generally between the hours of 7 am and 6 pm. Given the low volume of the trucking associated with the transmission line in any one area, the impacts of traffic and transportation on the standard of the local roads will not be significant.

Given that long loads will be transported on large flat top trucks, it is proposed that where the topography is steep and roads narrow and winding, lead and/or chase vehicles will be employed to warn local traffic as appropriate.

Operation
Once operational, the impact of traffic levels associated with the transmission line will be negligible. Traffic movements will be restricted to PacificGrid officers periodically inspecting and maintaining the line.

6.8 Aboriginal Archaeology and European Heritage

Mills and Wilkinson Consulting Archaeologists, were engaged to undertake a preliminary archaeological assessment of the proposed route. Their complete report is provided in **Appendix I**.

The assessment involved:

- an examination of the National Parks and Wildlife Service Register
- a review of academic studies, cultural studies and consultants reports
- a survey of bio-geographical, flora and fauna reports
- examination of Richmond River Historical Society Archives
- consultation with local Aboriginal Land Councils
- consultation with the National Trust
- development of a predictive model to identify site types and likely locations
- field examination of thirteen sites.

The preliminary archaeological survey did not identify any sites of Aboriginal or European heritage significance in the vicinity of the route of the proposed transmission line. In addition, no areas of potential archaeological significance were identified. This may be attributable to the highly disturbed nature of area, the intensity of horticultural and agricultural activities and the poor ground surface visibility associated with dense pasture land in the survey area. For the same reasons, the likelihood of encountering any intact sites of significant value during the construction of the proposed transmission line is considered to be low.

Notwithstanding the above, a further archaeological survey of the easement and access areas will be carried out prior to construction. The survey will nominate any areas of potential archaeological deposit and, if recommended by the archaeologist, test excavations will be carried out in selected areas.

Further discussions will be held with the Nguligah and Tweed Byron Aboriginal Land Councils on possible areas which may be of significance.

If any specific archaeological sites are identified, it would be possible to avoid them by a variety of strategies, including protective safeguards during construction, careful selection of sites for pole structures or, where necessary, making variations to the route. In the unlikely event that an archaeological site has to be disturbed, PacificGrid will seek prior approval from the Director of the NPWS.

As previously requested by the NPWS, in the event that archaeological sites or relics are discovered during construction, work will cease, the area will be protected from further disturbance, and the NPWS will be contacted.

Advice of a qualified archaeologist and that of the NPWS will be sought before proceeding with further work at the site.

6.9 Visual Impact and Assessment

A visual impact assessment of the proposed 132 kV transmission line on the landscape has been carried out. Recommended amelioration treatments have been proposed to minimise the visual impacts associated with the work.

The study involved:

- evaluating the existing visual resources of the region
- assessing the likely visual impacts associated with the proposed transmission line
- preparing recommendations designed to minimise the visual impact the proposed transmission line.

6.9.1 Existing Visual Environment

The existing visual environment of the study area has resulted from the combination of natural landscape features, land-use patterns and the presence of the existing 66 kV line in the current landscape. The area is renowned for the scenic landscape, with forested, mountainous slopes of the Nightcap Range contrasting with the largely cleared and settled valleys of the plateau.

With the exception of the City of Lismore the region is generally rural in character, with small urban villages or clusters of rural dwellings being located along the route of the line at Tullera, Modanville, Dunoon, Repentance Creek and Goonengerry. The flat Wilsons River floodplain at the southwestern end of the existing transmission line gives way to rolling hills along the majority of the line which is located on a volcanic plateau. Steeper, less accessible forested land occurs towards the northeastern portion of the line north of Goonengerry. This area adjoins the scenic Nightcap Range which consists of steep, forested slopes forming part of the Mt Warning range system. Towards Mullumbimby, the line crosses the escarpment separating the volcanic plateau from the coastal plain on which the proposed substation is situated.

Views containing sections of the existing line are available from various ridges and spurs in the area, and the generally scenic rural landscape character of the study area makes it attractive for rural residential development and scenic roads.

In general terms, the study area can be divided into a number of broad landscape units, each of which has a visually distinctive combination of landform and landcover (vegetation/development). These units are the

- Lismore Floodplain
- Volcanic Plateau
- Escarpment
- Alluvial Plain.

These units are briefly described below to provide a broad indication of the existing landscape character of the proposed corridor of the transmission line:

- **Lismore Floodplain**

  The Lismore Floodplain consists of flat to gently undulating land with low relief surrounding the Wilsons River. It is predominantly cleared for open pasture. This landscape unit extends across Leycester Creek towards the Booerie Creek Valley, before the land rises towards the plateau. The Lismore Substation is located within the floodplain. The transmission line coming out of the substation is readily visible from parts of suburban Lismore and areas of higher elevation surrounding the floodplain.

- **Volcanic Plateau**

  This landscape of gently to steeply undulating system of hills, ridges and spurs, contrast sharply with the flat floodplain, coastal plain and escarpment terrain along which the existing transmission line runs. The transmission line rises up to the plateau along Booerie Creek and remain on the plateau until it reaches the escarpment above the proposed Lavertys Gap Substation. Located on this plateau are the villages of Modanville, Tullera, Dunoon and Goonengerry.

  The existence of horticultural plantations on the undulating hill plateau, and extensive cleared areas for other agricultural pursuits give this landscape unit a distinctive visual character. The regular pattern of horticultural plantations create a landscape character which has a high level of visual diversity.

  Views of the line in this area are generally restricted to the foreground and mid-distance but longer distance views are available from elevated ridges and spurs and scenic viewing areas, such as Coolamon Scenic Drive.

- **Escarpment**
  The escarpment is a narrow strip of steeply sloping land separating the volcanic plateau from the coastal plain. The transmission line crosses the escarpment at its northern extremity, near to the proposed Substation site at Mullumbimby Power Station.

  The escarpment is a visually prominent unit within the landscape to the north of the line and can readily be viewed from an extensive area to the north of Lavertys Gap. The escarpment has a low visual diversity due to the steepness of the slopes and the general inaccessibility of the area.

- **Alluvial Plain**
  The proposed substation site is located on the edge of the flat colluvial/alluvial deposits of the coastal plain inland from Byron Bay. The coastal plain is largely grassed, having been cleared for grazing and some horticultural activities and trees are generally scattered and limited to small clumps or rows.

  Adjoining ridges and spurs are visually prominent from the proposed Lavertys Gap substation due to the flat character of this landscape zone and the dramatic nature of the steep country immediately to the south and west of the proposed substation.

6.9.2 Assessment Criteria

In assessing the visual impacts of the proposed line, the visual catchment around the corridor was mapped according to the visual sensitivity of the areas within the catchment and the nature of the development.

Visual Sensitivity - Visual sensitivity is a measure of the sensitivity of the viewer to change in the visual environment, or the ability of an area to absorb the visual impacts of a development. As shown in **Table 6.5** the principal determinants of visual sensitivity are topography, vegetation cover and distance.

Table 6.5 - Visual Sensitivity

Landscape Components	Degree of Visual Sensitivity		
	High	Moderate	Low
Topography	ridgelines and areas of high elevation	valley floor	hillslopes
Vegetation Cover	dense (>70% cover)	open pasture (20% cover)	scattered vegetation (20-70% cover)
Distance	foreground views from towns and villages	middleground views from rural clusters	background views from towns and villages
	foreground views from rural dwelling clusters	middleground views from lookouts and scenic drives	background views from rural dwelling clusters
	foreground views from lookouts and roads with major scenic destinations	middleground views from towns and villages	background views from lookouts and scenic drives
		foreground views from main roads and local roads	middleground views from main roads and local roads

In terms of topography, areas of high elevation close to the line, which overlook the transmission line have the highest degree of visual sensitivity, since the line will be clearly visible from such areas but against a green background. Valley floor areas, which lack differences in elevation and are visually relatively uniform, are moderately visually sensitive, since transmission lines may be readily discerned within them. Topographically, hillslopes have the lowest visual sensitivity, due to their ability to provide a varied backdrop for the transmission line, preventing it silhouetting against the sky.

Dense vegetation has a high degree of visual sensitivity since any clearing of it will have a high impact on the visual landscape. Open pasture and perennial cropping constitute areas of moderate sensitivity, while scattered vegetation has a low sensitivity due to its variation in form and texture and its ability to partially screen the supporting structures.

Visual sensitivity also depends on the locations and angles from which the line will be viewed, the duration of viewing and the distance over which the line is viewed. Static views (i.e. residences, recreational areas and tourist lookouts) have been regarded as more important than transitory views (i.e. roads).

Within the visual catchment view lengths have been divided into foreground (0-0.5 km), within which the transmission line would form a prominent feature in the landscape, middleground (0.5-2 km), within which the transmission line can be readily seen but would not be highly prominent, and background (2-5 km), within which the transmission line is difficult to perceive, even to those who are aware of its location.

The proposed line has the greatest potential visual effect in areas of high visual sensitivity, due to the prominence of the line and lack of vegetative screening in these areas.

Under average light conditions, when the line is located below the sky line and the view to it is unimpeded, the supporting structures and conductors are highly visible within 0.5 km of the line. The line is moderately visible between 0.5 km and 1 km from the line and visible between 1 and 2 km from the line. Over distances greater than 2 km, the line becomes difficult to perceive, even to an observer who is aware of the location of the line. If the line is silhouetted against the sky, the visual impacts become greater, particularly within 1 km of the line.

The visual effect of the proposed transmission line reflects a combination of factors including:

- the existing visual environment
- visual sensitivity
- form and scale of the proposed line within the view catchment
- landform and the position of the transmission line within the terrain
- land cover and the extent to which vegetation masks the location of the line
- the extent of clearing involved with the reconstruction, and the degree of visual contrast between the existing situation and the proposed situation
- the distance of the viewer from the proposed transmission line
- the number of people who will view any particular section of the line
- duration of viewing.

The following categories of visual impact were established for the visual assessment, based on the character of the line and the visual effect the proposed line is likely to have in the visual catchment:

- High Visual Impact - areas within 0.5 km of the line with an unimpeded line of sight to the structures and conductors

- Moderate Visual Impact - areas up to 1 km from the line with unimpeded views of the line or closer areas with impeded views of the line (due to vegetation or topography)

- Low Visual Impact - any areas within the visual catchment located between 1 and 2 km from the line having unimpeded views of the line or closer areas with impeded views of the line

- Negligible Visual Impact - areas within the view catchment greater than 2 km from the transmission line.

6.9.3 Visual Assessment

The visual assessment evaluates the visual effect of the proposed line on the existing environment and viewers of the line (refer **Figure 6.4a - 6.4c**).

The fact that the existing landscape currently has a 66 kV transmission line in place along the length of the proposed line, was taken into account during the visual assessment. The impacts of the proposed line are regarded as lower than the visual impacts would have been had there been no existing transmission line. The visibility of the new line has been compared to the visibility of the existing line in the assessment.

The visual effect of the proposed line results from interactions between the physical characteristics of the new line and the existing environment. The visual effect of the line is described in terms of the level of contrast between the components of the existing physical structure of the line and the existing environment, and the new line and environment, including aspects such as size, form, colour and shape of the elements.

For the purposes of this study, rural dwelling clusters have been defined as concentrations of five or more residences in an area of approximately 20 ha or less.

The physical components of the proposed development as relevant in the assessment of the visual impact are summarised below.

General - The existing line consists of single or double wood pole structures approximately 17-20 metres high with three conductors. The poles are a weathered grey in colour and the conductors consist of strands of wires wound together. During the reconstruction of the line the existing 66 kV structure will be dismantled.

The proposed line will primarily consist of single pole structures typically 25 metres high, supporting fibreglass insulators, six conductors and two earthwires. Double pole angle and tension structures will be required at some locations. Guy wires are also associated with these double pole

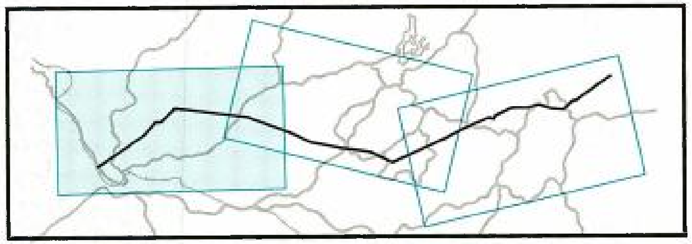


Figure 6.4a
VISUAL CATCHMENT AND IMPACT ASSESSMENT

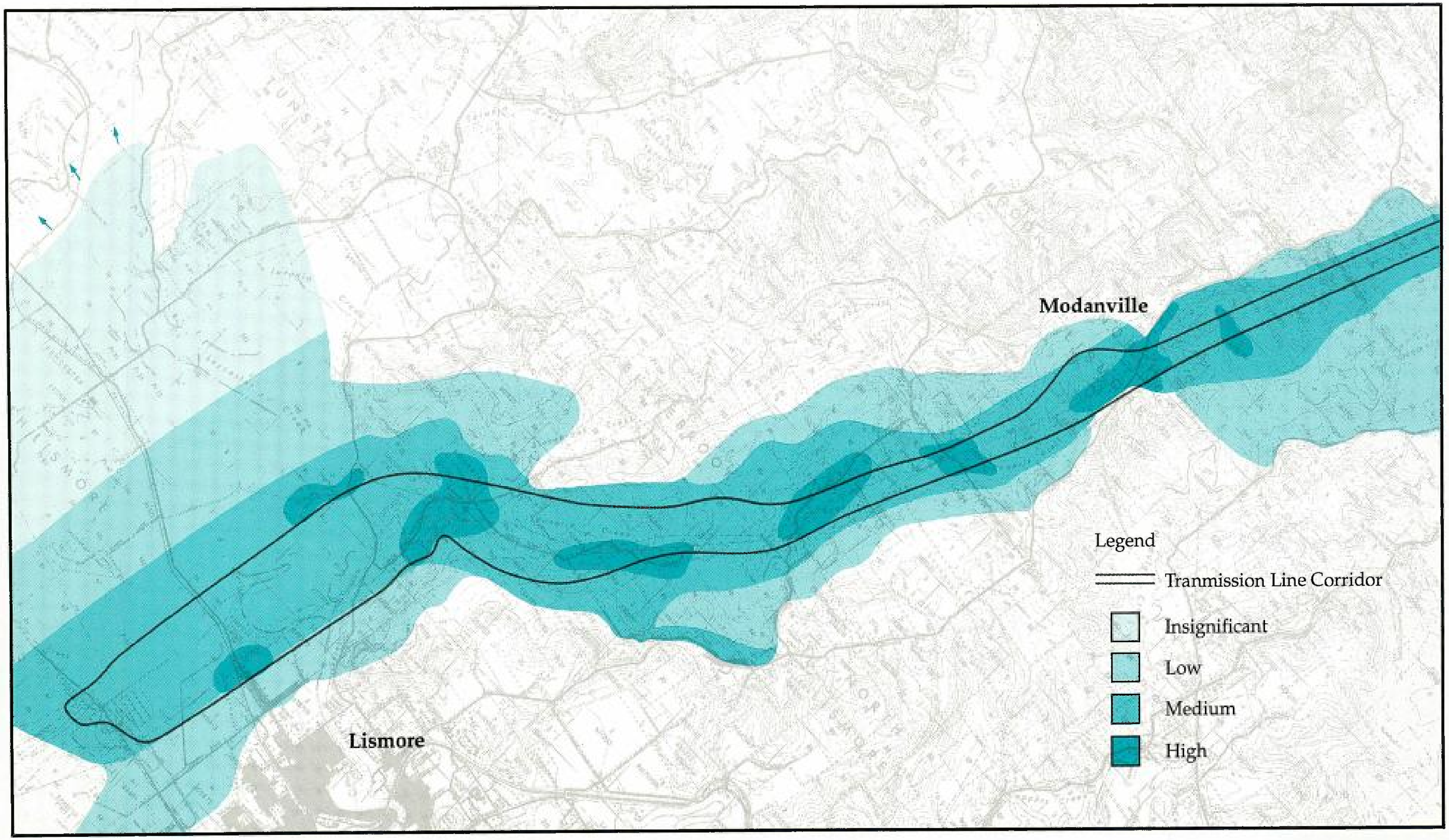
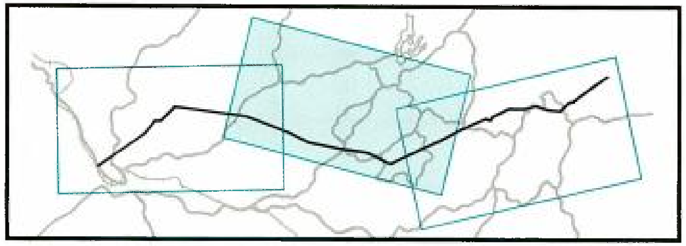
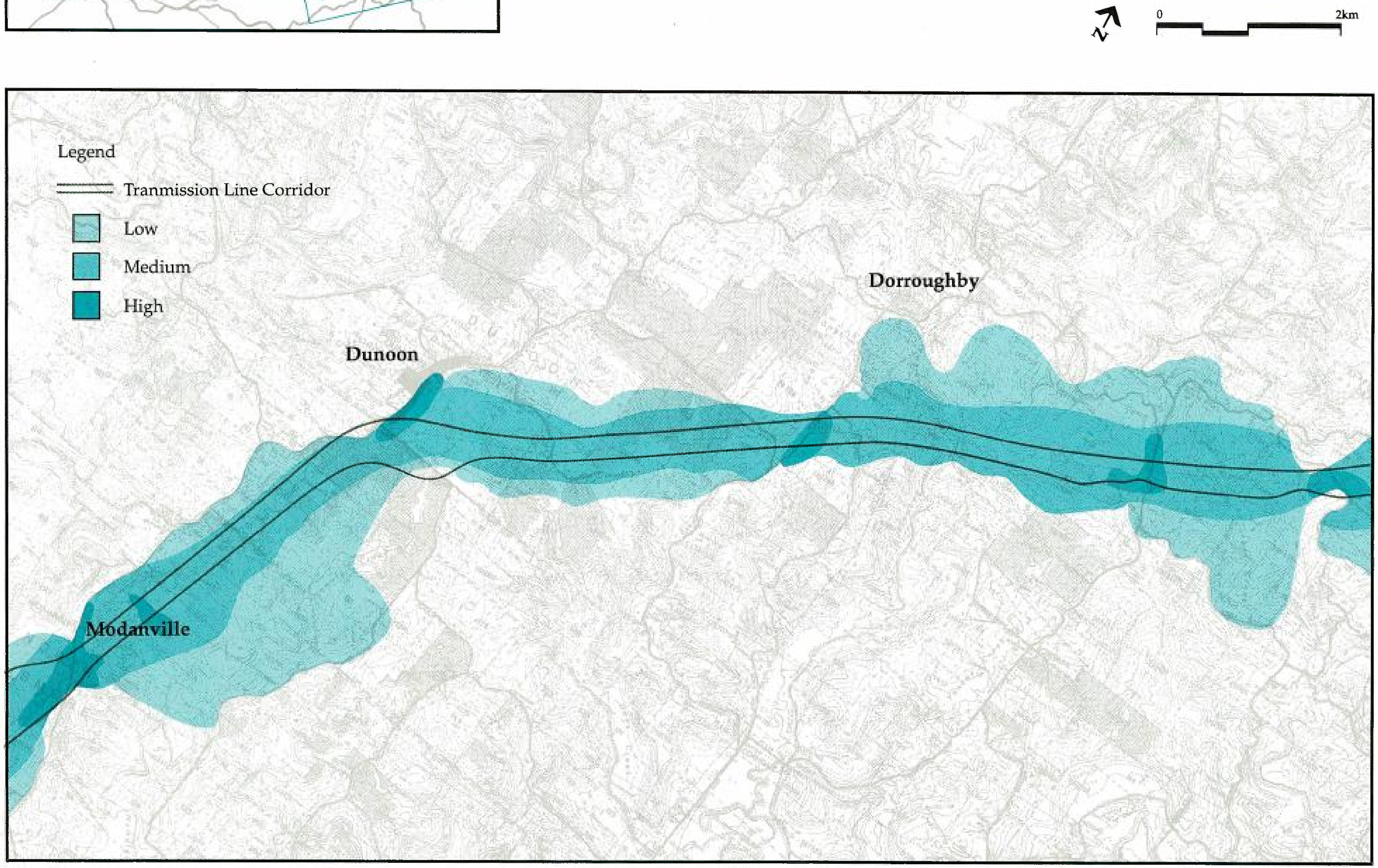


Figure 6.4b

VISUAL CATCHMENT AND IMPACT ASSESSMENT





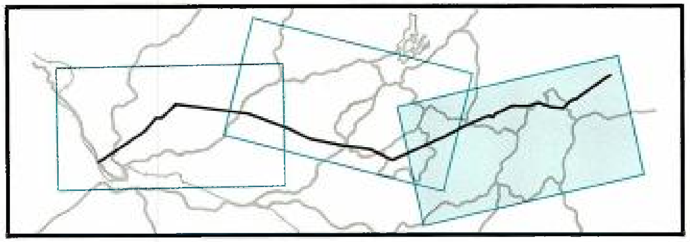
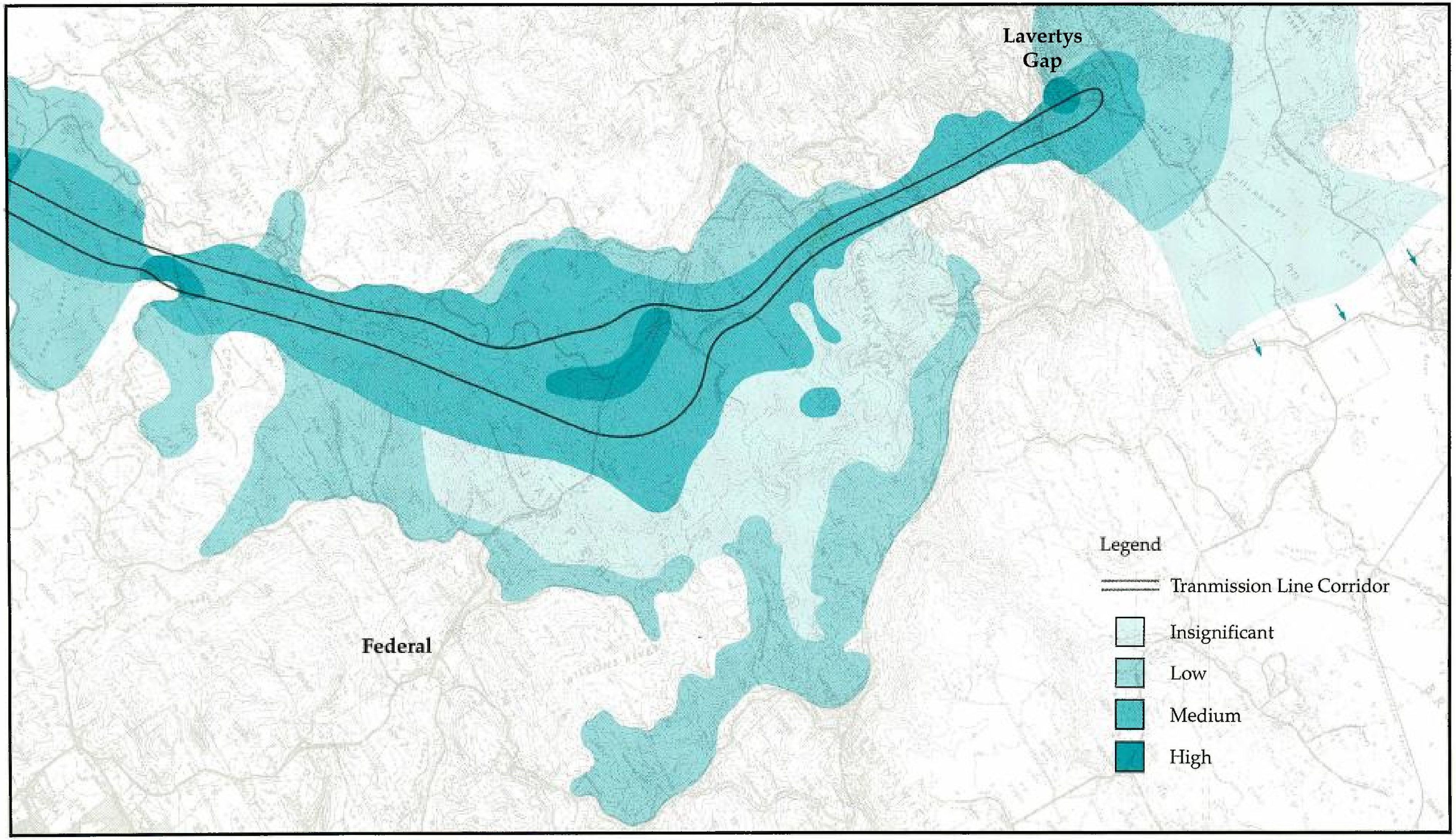


Figure 6.4c
VISUAL CATCHMENT AND IMPACT ASSESSMENT



structures. Exact heights of the poles will be site dependant and determined according to the terrain and the loadings of the line.

The existing line has about 220 structures while the new line will require approximately 150 structures. These structures will be located approximately 280-300 metres apart on the new line.

The existing line is currently contained within an informal right of way. An easement will be formalised by PacificGrid and may require additional clearing in some sections.

Since the reconstruction of the transmission line will occur primarily along the route of the existing line, no scenic preserves will be affected, and no additional roads with major scenic destinations will be affected.

Lismore to Bentley Road Via Booerie

- Existing Impacts - The existing 66 kV line leaves the Lismore Substation and crosses the flat, cleared pastureland of the Lismore floodplain and Leycester Creek before entering the Booerie Creek Valley. The visual impacts of the line along the majority of this section of the route are low to medium, due to the ability of the landscape to absorb the existing line, and the open, unsettled nature of the floodplain.

  In certain areas the impacts are currently high, since the line passes within 10 metres of houses in the South Lismore urban area in Casino Street, within 10 metres of residences on 5 acre blocks adjacent to Nimbin Road and across the corner of one house at Booerie. Consequently, the visual impacts of the line are high near these residences due to the proximity of the line to the dwellings, and the fact that the line is silhouetted against the skyline in places.

  Between Booerie and Bentley Road where the topography is open, the existing line is highly visible from dwellings as it crosses the ridge and travels up the Booerie Creek valley.

- Impacts of the Proposed Line - the resultant visual impacts will be mainly positive as a result of realigning the line further away from existing dwellings. The proposed line will be moved away from the Casino Street homes. In addition, the preferred route will locate the line some 400 metres to the west of the existing line, as shown in **Figure 6.4a** removing the majority of the visual impacts from the rural cluster of dwelling on the 5 acre blocks. Impacts of the line on some Booerie residents have the potential to be higher than current impacts as a result of the line moving closer to certain residences.

From Booerie to Bentley Road, the impacts of the line will be no greater than at present. The preferred route is some 200-250 metres to the north of the existing route, which will move the line away from the residences on the southern side of Booerie Creek, thus reducing visual impacts.

The transmission line will cross land which is flat to undulating, primarily cleared and, with the exception of the rural clusters in the area, the landscape has the potential to readily absorb the visual impacts of the line. The line will be located along the edge of the Booerie Creek valley, below the sky line, within a landscape containing varied vegetation. Minimum clearing will be required for the easement and access tracks in this area, so impacts associated with removal of vegetation will be minimal.

The preferred alignment in this area has been developed with the Booerie Creek community, in order to reduce the visual impacts of the transmission line in their area. This proposal has been adopted since it also minimises the impact on properties.

Bentley Road to Modanville

- Existing Impacts - the existing line passes across land that is primarily cleared, approximately following Booerie Creek. Existing impacts are associated with the existing 66 kV line and two 11 kV lines. The visual impact is exacerbated by the proliferation of lines in this area, resulting in a high existing visual impact on residences in the area from the conductors and the poles.

- Impacts of the Proposed Line - the corridor in this area is fairly narrow, and the possibilities of moving the line from its existing location without significant additional visual impact (as a result of vegetation control required and proximity to existing residences) are limited. Consequently, the new line will have an increased visual impact. The additional impact will be associated with the taller poles and the additional conductors and earth wires. There is the potential for some impacts to be reduced as fewer poles will be required and the there is the likelihood of single rather than double poles in some locations.

  The majority of the visual catchment along this section will have at least moderate visual impacts as a result of the new line. Areas containing dwelling clusters will be highly impacted as a result of the foreground views of the line. These clusters are located along Bentley Road, Borton Road and Modanville (see **Figure 6.4a**).

The proposed line will cross the ridge at Modanville, and in the event of the line following the preferred alignment, the visual impacts will be reduced at the school, but increased for other dwellings.

The Modanville Estate subdivision has taken place around the existing line. The slight deviation which may occur in this area will not have a significant visual impact when compared with the existing high visual impacts associated with the current situation.

Modanville to Dunoon

- Existing Impacts - Between Modanville and Dunoon the existing line currently crosses extensive areas of macadamia plantations and cleared open pasture land. The landscape becomes more hilly along this section of the line, preventing direct views to the line from many areas relatively close to the line. Existing impacts of the line are notable at the southern end of the Dunoon village where views from residences on Dunoon Road overlook the line. The substation adjacent to Dunoon Road is also visually prominent when viewed from Dunoon Road.

  The visual impact of the line from the southern edge of the visual catchment (i.e. Ross Road) is negligible due to the distance from the line and the fact that the line is located on a hillslope with varied vegetation, making the location of the line difficult to identify.

- Impacts of the Proposed Line - impacts within the visual catchment along this section of the corridor will generally be moderate in close proximity of the line and low where the view is obscured by topography, vegetation or distance.

  No additional visual impacts in the area of the substation will result due to the proposed work.

  The proposed realignment of the proposed line from the Dunoon Substation will have a positive impact on the visual characteristics of the area. This realignment will have the effect of moving the line away from the view of Dunoon residents, thus reducing the visual impact of the line on the village.

Dunoon to Repentance Creek

- Existing Impacts - Between Dunoon and Repentance Creek the terrain is hilly and native and plantation vegetation cover increases. Unimpeded views of the existing line become less frequent in comparison to the line further to the southwest. The visual impacts of the line in the area are generally low to moderate, with highly impacted areas occurring where the existing line crosses roads in the area, and where clusters of residences are located.

- Impacts of the Proposed Line - the visual impact of the proposed line will remain predominantly moderate immediately adjacent to the line, and low in areas further from the line or where intermittent views of the line occur due to vegetative cover.

  The visual impact of the proposed line on dwellings adjacent to Dorroughby Road, Fox Road and Emerson Road will be similar to that of the existing line in these areas. Additional impacts associated with the proposed line will occur due to the taller nature of the structures and additional conductors and earthwires. However, a reduction in the number of structures required in the landscape, placement of structures in consultation with local landholders, and efforts blend the line in with the environment as much as possible, will reduce the visual in the area.

Repentance Creek to Goonengerry

- Existing Impacts - the nature of the topography and the vegetation along the existing line between Repentance Creek and Goonengerry renders the impact of the existing line low to moderate. Unimpeded views of the line are limited, though it is possible to gain intermittent views of the line throughout the area. Along the majority of the public roads in this area, views of the line are difficult to obtain, because the line is obscured by vegetation or by spurs and hillslopes. Where the line is visible along roads, the distance to the line and the variety of the landscape renders the visual impact of the line low.

  The existing line crosses the Goonengerry ridge near the junction of Federal Road and the road to Repentance Creek. It crosses a number of cleared paddocks before passing over a cleared knoll immediately to the west of Federal Road. This cleared, elevated knoll is a visually prominent topographical feature in the landscape and may be seen from locations up to 4.5 km away. For example, the knoll is readily discernible from Coolamon Scenic Drive, Emerson Road and Mafeking Road, though at distances greater than 2 km the poles and conductors are barely discernible. The line also passes within 10 metres of one house located on the knoll, resulting in a very high visual impact here.

  The current visual impact of the existing line is high in Goonengerry due to the close proximity of the line and the elevated nature of the terrain. Residences located along this ridge have clear foreground views of the line and the fact that the line is sometimes silhouetted against the skyline on the ridge increases the visual impact. In addition, the conductors may be clearly seen crossing views to the east toward the coast due to the location of the line in the landscape.

- Impacts of the Proposed Line - the visual impact of the new line will be similar to that currently occurring in the area. As is the case along the entire line, additional impacts due to the taller structures and additional wires will occur, while reductions in the visual impacts will occur as a result of the need for fewer structures along the line.

  A number of proposed realignments in the area have been proposed. Option A (see Section 4.2) would result in the line crossing the ridge some 700 metres to the north of its current crossing. This would reduce the visual impact of the line for certain dwellings close to the line and in areas at a distance from the line by placing it lower in the landscape, and against a more varied and textured backdrop, lowering the visibility of the line within the landscape. However, the visual impacts on other areas would be greater. The impacts would increase for dwellings near the saddle, and for residences accessed via Mafeking Road, since the line would be closer to them and some vegetation removal would be required. In Option B, the visual impact would remain similar to the existing impact with some increase from the taller poles and additional conductors and some decrease from the reduced number of structures.

  The second proposed deviation to the east of the existing line, would increase the visual impact of the line, as the line would be moved further up the knoll, becoming more visually prominent. Visual impacts on this knoll could be reduced with tree plantings, which would have the effect of screening the line from nearby residences and varying the texture of the area, making the line less prominent from distant sites.

Goonengerry to Lavertys Gap

- Existing Impacts - to the northeast of Goonengerry the terrain becomes increasingly steep and more densely vegetated. This minimises the visual impact of the existing line in the general area, making it increasingly difficult to discern in the landscape unless viewed directly along the line. The visual impacts of the line are highest when viewed along its length due to the clearing of the existing right of way corridor and the straight alignment of the route. For residents located near the line at Montecollum Road the visual impacts are moderate to high, as the structures and conductors are visually prominent in the landscape. The visual catchment to the north of the escarpment leading down to Lavertys Gap is extensive, though distinct views of the line are limited to distances within 2 km of the line. As the line crosses the escarpment it is silhouetted against the skyline, and is therefore visually prominent.

- Impacts of Proposed Line - visual impacts of the proposed line along this section of the line will be similar to those currently occurring with additional impacts associated with the taller structures and additional wires. A proposed realignment near Sheaffes Road in the area will minimise the visual impacts by lowering the location of the line in the landscape, and reducing the impact of the taller poles. In addition, fewer structures will be required, and new structures will be placed within the landscape in consultation with the local community, to reduce their impact.

  The major visual impacts associated with the line in this area are related to possible removal of the dense vegetation surrounding the line. Where an unimpeded view is afforded along the line, the impacts of the line are moderate to high, though few viewers view the line in this manner.

  The ridgeline formed by the escarpment of the Mount Warning caldera must necessarily be crossed by any transmission line to Lavertys Gap. A number of residences occur on this ridge, though the closest residence to the existing line is approximately 80 metres away. To reduce the visual impacts of the proposed line, it may be possible to move the line lower in the landscape, approximately 20 metres west of its current location. This would have the effect of mitigating against the increased height of the structure, and preventing additional views of the line. A minor deviation of this nature would marginally improve the foreground visual impact of the line in this area and would also have a positive impact in the middle distance.

  The visual catchment of the line at this point is immense, as the escarpment overlooks the Chincogan Mountains and the coastal valley running from Mullumbimby to the coast. However, since the line is virtually not discernible over distances greater than 2-4 km, the visual impact on the majority of the catchment is negligible. Closer to the line, the impacts increase and may be regarded as moderate.

6.9.4 Mitigation Measures

To reduce the visual impacts of the proposed transmission line on the landscape, a number of techniques will be employed. These will include the following:

- "painting" the poles green, to make them blend in as much as possible with the surrounding landscape

- treating the conductors during manufacture to produce a dull finish, minimising light reflection

- reducing the number of structures along the line decreasing the visual impacts caused by the large number of structures currently in the landscape

- planting selective tree screens to prevent direct views towards the line in certain areas where the line is visually prominent in the landscape

- placing the transmission line lower within the landscape, and placing structures on properties in consultation with local landholders

- minimising vegetation removal during construction and ongoing maintenance clearing. The latter will reduce as a result of the taller poles. New maintenance techniques now allow for greater vegetation cover within easements.

6.9.5 Conclusions

The visual impacts associated with the proposed line are primarily related to the increased height of the poles and the greater number of conductors. When compared with the visual impacts of the existing line, the visual impact of the proposed line will be greater in some places, and lower in other places due to the mitigation measures which form part of the proposed development.

The overall visual impact of the new transmission line is not considered to be significantly greater than the impact of the existing line.

Locations where high impacts will occur include suburban streets, villages or rural dwelling clusters located within 500 metres of the proposed line. Such locations occur at Booerie, Hewitt Road, Bentley Road, Borton Road, Modanville, Dorroughby Road, Fox Road, Emerson Road, Goonengerry and above Lavertys Gap. Where these are located on elevated terrain and views to the line are unimpeded, the impacts are greatest.

The mitigation measures outlined will reduce the visual impacts of the proposed line. Treatment of the conductors to reduce their reflectivity, painting of the poles, and undertaking appropriate tree planting where necessary will assist in reducing the impact of the line.

7

Social Impact and Economic Considerations

7. Social Impact and Economic Considerations

This Section provides information on the social and economic factors of the region as relevant to the proposed works. The expected interactions are described and the net impacts discussed.

7.1 Social Impacts

The assessment of social impacts takes into account the likely and potential impact of the proposal on private property, social activities and public and private amenity of the proposal. A brief description of the community profiles of the Lismore and Byron areas is provided below.

Community Profiles of Lismore and Byron Local Government Areas
The following information is based on the Australian Bureau of Statistics' (1991) Basic Community Profile data for the Lismore and Byron local government areas.

Lismore LGA
The population of the Lismore Local Government Area (LGA) is 41 393 (Australian Bureau of Statistics, 1991). The number of males and females within the area in 1991 was 20 518 and 20 875 respectively with the median age of males 30 and females 32 years.

Approximately 26% of the population is skilled and semi skilled. The median annual income for a household falls within the $20 001 to $25 000 bracket with over 95% of people in the region living in private dwellings.

The Australian Bureau of Statistics 1991 census states that the number of persons unemployed in the Lismore LGA was 3 133. This is approximately 17% of the available workforce. A higher number of males are unemployed in comparison to females. The figures for each are 1 941 and 1 192 respectively.

The main sources of employment for the males in the area are wholesale and retail trade employing about 21% of the male workforce. Other major employers include community services, manufacturing and construction industries. Males are fulfilling roles primarily as tradespersons, managers and administrators.

The main source of employment for females in the area is community services which employs approximately 35% of the female workforce. The other major employers for females include wholesale and retail trade and finance, property and business services. Women are primarily fulfilling roles as clerks and sales and personal service workers.

The highest proportion of unemployed persons above the age of 15 falls within the 25 to 34 age bracket. Of these, 88% males are looking for full-time employment compared to 67% females. A total of 12 605 persons are not in the labour force which could be attributed to factors such as retirement, disability or full time education.

Byron LGA
Byron LGA is one of the most rapidly growing local government areas in NSW, having undergone the highest proportional population growth out of any area in NSW between 1981 and 1989, excluding the Sydney Metropolitan Area. This is in keeping with the high growth rates in the entire North Coast region where it has been estimated that the Region has experienced 16.8% of NSW's overall population growth during this period (Department of Planning, 1990).

The total population of the Byron LGA in 1991 was 22 772, comprised of 11 431 males and 11 341 females. Byron LGA has one of the highest number of families in NSW living on low incomes with 31.7% of families earning below $20 000 per annum and 82% of single parent families earning $20 000 per annum and less as compared with 24% of two parent families. Of the total population, 97% live in private dwellings. The low incomes are also indicative of high unemployment.

There are 9 428 persons in the total workforce, of which 2 065 are unemployed, representing 22% of the available workforce. Of these, 89% of males are seeking full-time employment compared with 65% of females. The unemployment levels within the LGA are comparable with that of the entire North Coast Region where unemployment levels are above the state and national average. The high unemployment figures can be attributed to the state of the economy as a whole and the coastal environment and climate of the locality attracting unemployed persons to the area.

Approximately 28% of the workforce is skilled or semi skilled. Most males (17%) are employed by wholesale and trade, with construction and agriculture, forestry, fishing and hunting other major employers. Females are primarily employed in community services (27%) with wholesale and retail trade and recreational and personal services other major industries where females are employed.

Property and Land Use Effects
The proposed transmission line will have a number of impacts on agricultural activities as described in Section 6 of this EIS. With the implementation of the recommended mitigation measures, the potential for agricultural activities to be adversely affected will be minimised.

As discussed in Section 4, land located within the proposed transmission line easement may be used for agricultural activities such as grazing and horticulture provided that a minimum 2.5 metres clearance between the transmission lines and plantation trees is maintained at all times.

Sufficient clearance can be achieved by the use of taller pole structures within horticultural plantations, planting of trees that will not grow too tall, and where necessary, lopping of taller trees.

Dairying, grazing and cropping land will not suffer any significant decline in productivity as the proposed easement will not be fenced. The supporting poles will occupy an insignificant amount of the total easement area and the land under the line can be cultivated by mechanical means provided that care is taken with machinery used. There is no evidence suggesting that the line will have any adverse effect on the behaviour or productivity of livestock. Maintenance personnel will only need access to the line infrequently and their activities will not interfere with agricultural activities.

Greater potential exists to impact on horticultural activities and the mitigation measures recommended in Section 6.6 will minimise these potential impacts.

It is anticipated that property values will be only marginally affected by the proposed line in the area, given that a line currently exists on the majority of affected properties. However, since there is currently no formal easement for the existing 66 kV line on the properties, compensation negotiations will take place with affected landholders as if there were no transmission line on the properties. In this way, full compensation to the affected owners is assured.

7.2 Employment Generation

The operation of the proposed transmission line will not result in any direct significant long term employment opportunities for the local community. The construction workforce will be a skilled team employed to carry out specialised work. It is anticipated that the workforce employed to undertake this work will consist of 20-30 people. Local contracting of activities such as earthworks, the materials provision, installation of gates, construction of access tracks, fence erection or general duties is anticipated.

Local materials will be used for improving the surface of access tracks and pouring concrete foundations. Maintenance facilities and consumables would also be locally sourced.

The construction workforce of approximately 20-30 people and six PacificGrid personnel, would also contribute to the local economy in their food and daily recreational requirements, which would usually be supplied through towns and villages in the region.

7.3 Accommodation

Arrangements for accommodation would vary according to the preferred practice of the contractors undertaking the work. It is expected that the majority of the contractors will be residents of the local area, and will not require temporary accommodation. For those that do require temporary housing, adequate housing is available in local hotels, motels, rented premises or caravan parks. PacificGrid personnel will be accommodated at local hotels or motels for the periods that they are working in the region.

7.4 Social Amenity Issues

The character of the area will not be altered as a result of the proposed development given that the 66 kV line already exists in the area. There may be some localised effects due to construction noise and traffic but these will be limited in nature and short term in duration. The impact of traffic on the local community during the operation of the line would be minimal with traffic movements limited to regular line maintenance vehicles.

7.5 Access Issues

As indicated in Section 4.5.3, access to each transmission line structure location will be required for the plant and equipment necessary for the construction of the line and its maintenance. Wherever possible, existing roads and tracks will be used, after consent for use of access has been obtained. Where existing access is not available, new tracks would be constructed. Their location will be discussed with each landowner to minimise impacts and maximise the usefulness of the tracks.

Once the construction of the transmission line has been completed, if tracks are no longer required by the owner, they will be removed and rehabilitated accordingly. Tracks required for maintenance will remain.

7.6 Project Costs

As indicated in Section 2, the estimated capital cost for the proposed double circuit transmission line is $4.5 million.

7.7 Compensation Issues

The establishment of an electricity line easement confers the right to construct, operate and maintain a transmission line. PacificGrid obtains easements for all their transmission line routes. Where private lands are crossed by the transmission line, it is the policy of PacificGrid to purchase easement rights by negotiation with the landholder.

PacificGrid will make contact with the affected landowners in order to reach a compensation agreement for acquisition of the easement and right of entry for PacificGrid and its contractors. Compensation for easement acquisition and activities associated with the construction of the preferred transmission line would be assessed by a registered valuer, who would be available to discuss the basis of the assessment with landowners. PacificGrid's valuers are qualified members of the Australian Institute of Valuers and are registered to practice as valuers by the Valuers' Registration Board. The actual compensation has regard to the actual affect of the transmission line on the current market value of the property.

Once a landholder has signed a consent to permit construction, an advance cash payment will generally be paid. After the agreement has been reached, the balance of the compensation will be paid when the easement is registered on the title, with PacificGrid meeting any reasonable legal costs incurred by the landholder in the process.

If a landholder disagrees with the compensation offer, they can obtain an independent valuation by engaging a registered valuer. The two valuers would meet to discuss the compensation offer in an attempt to resolve any major discrepancy. The valuer's fees would be reimbursed when the final agreement was reached, provided that PacificGrid's policy on the payment of valuation fees is followed.

Any damage incurred during the construction of the transmission line e.g. damage to fencing, crops, pasture or access roads would be repaired to the owners satisfaction, otherwise a monetary settlement would be negotiated. Once all construction activities and rehabilitation are carried out (or compensation paid), the landowner would be asked to sign a Damage Release.

An easement would be acquired by Compulsory Acquisition only where it proves impossible to settle the matter by negotiation, or in cases where the existing title prevents the normal registration of the easement by way of transfer and grant. Acquisition by Compulsory Acquisition would not affect the owner's right to receive compensation, which in these cases would be determined by the Valuer General, in accordance with the Land Acquisition (Just Terms) Compensation Act 1991.

In general, the easement right acquired allows PacificGrid to construct, maintain, secure, operate the preferred transmission line in the defined easement area. Limitations are placed on the landholder in regard to the erection of structures or undertaking of activities that could interfere with the operation and security of the line, as outlined in **Appendix F**.

7.8 Conclusion

From the above discussions, it can be concluded that with the adoption of mitigation measures, socio-economic impacts of the proposed transmission line will be minimised.

8

Electric and Magnetic Fields

8. Electric and Magnetic Fields

A discussion of the current information concerning electric and magnetic fields is presented in this Section and the impacts associated with the proposed transmission line are outlined.

8.1 Introduction

A field is a concept used to describe a region where certain objects experience a force, even though not physically connected to the source of the force.

Electric fields result from the forces that electric charges exert on one another. For a given charged object, the higher the voltage, the higher the electric field. Electric fields are strongest close to their source and reduce in magnitude quickly as one moves away from the source. Electric fields are normally measured in volts per metre or kilovolts (kV) per metre.

Magnetic fields result from the movement of electric charges which is commonly known as the electric current and is measured in amps. The higher the current, the stronger the magnetic field will be. When a piece of electrical equipment is switched off, there is no flow of current so there is no magnetic field. Magnetic fields also reduce in magnitude quickly as one moves away from the source.

Magnetic fields are normally measured in milligauss (other alterative units of measurement are Gauss, Teslas and Microteslas).

Examples of natural electric and magnetic fields (EMFs) are thunderstorms, the earth's magnetic field and the fields associated with neuromuscular and cell activity within the body. Although these examples are all electric or magnetic fields, they are generally not identical to one another or to the common man-made EMFs.

Man-made electric and magnetic fields are produced by electrical equipment and occur wherever electricity is being used, including near high voltage power lines, lower voltage street distribution lines, wiring in homes and offices, electric clocks, computers, hair dryers, electric blankets and any device which uses electric power. They are not unique to high voltage power lines.

Due to the large number of potential EMF sources in a modern industrialised society, people move from one source of EMF to another for much of the time.

8.2 Electric and Magnetic Fields Associated with this Project

The fields associated with this project have been characterised for three different periods as follows:

- Existing - Existing 66 000 volt wood pole transmission line.
- 66/66 kV - New double circuit construction with operation at 66 000 volts. This is the initial operating arrangement for the transmission line as discussed in Section 4.
- 66/132 kV - New double circuit construction with one circuit operating at 132 000 volts and the other at 66 000 volts. As discussed in Section 4, one circuit of the line will be converted to 132 000 volt operation when the load growth reaches a stage where 66 000 volt supply can no longer support the supply requirements. Based on current predictions, this would occur in the early 2000's.

A brief description of the electric and magnetic field environment (measured at 1 metre above ground level) for each of the three stages follows:

Electric Field
The voltage present on the transmission line is normally stable and varies very little. The typical voltage is considered to be 3% above the nominal voltage of either 66 000 or 132 000 volts. Occasionally, under emergency conditions it could be required to operate the line up to 7% above the typical voltage. This increase in voltage, together with the conductors sagging, results in a higher than 'normal' electric field near ground level. This emergency situation is expected to occur infrequently and for short periods of time and is not discussed further.

- Existing - The electric field profile is shown graphically in **Figure 8.1**. The maximum electric field strength under average load conditions for the existing line is approximately 0.59 kilovolts per metre (kV/m) under the line, decreasing to between 0.04 and 0.05 kV/m at the edge of the proposed easement, 22.5 metres from the centre line.
- 66/66 kV - The electric field profile when the new line is constructed and operating at 66 000 volts is shown graphically in **Figure 8.2**. The maximum electric field under average load conditions for the line is approximately 0.24 kV/m under the line, decreasing to approximately 0.02 kV/m at the edge of the proposed easement, 22.5 metres from the centre line.
- 66/132 kV - The electric field profile in the final stage with one circuit operating at a voltage of 132 000 volts and the other at

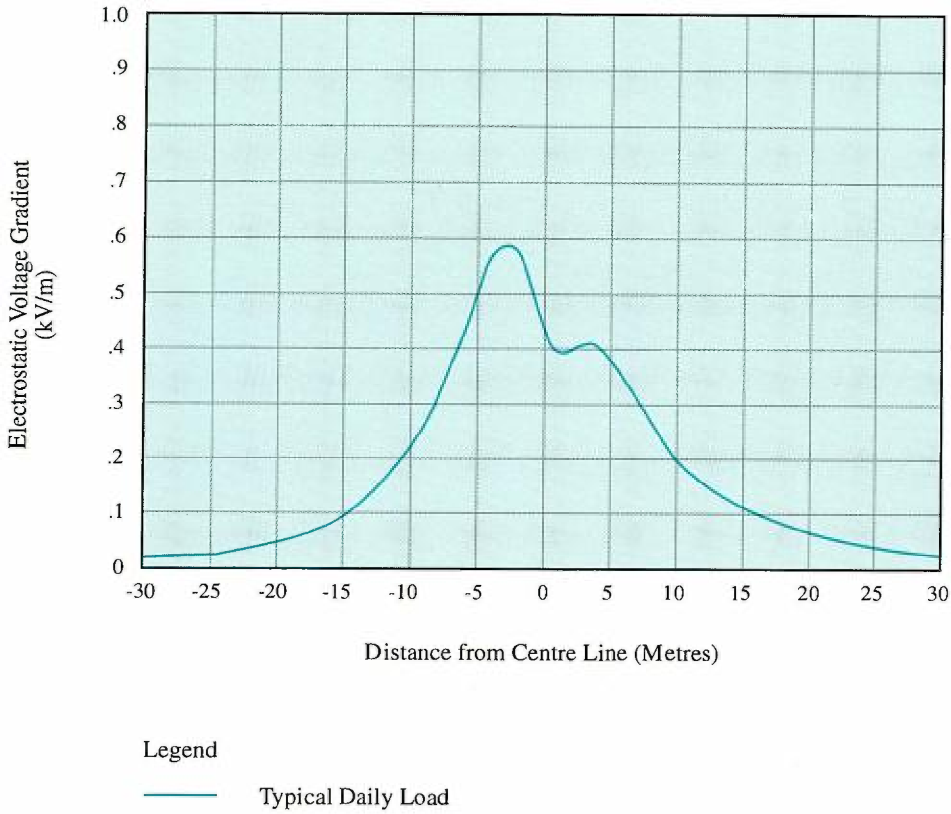


Figure 8.1
EXISTING 66 000 VOLT OPERATION ELECTRIC FIELD PROFILE

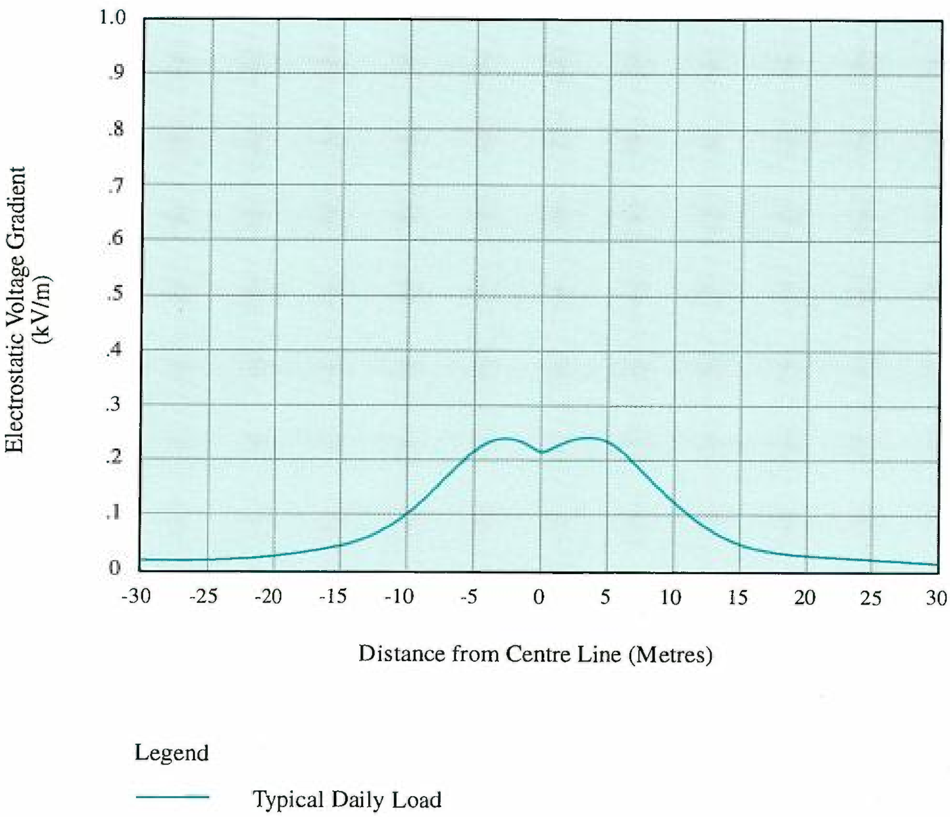


Figure 8.2
66 000 VOLT OPERATION ELECTRIC FIELD PROFILE

66 000 volts is shown graphically in **Figure 8.3**. The maximum field under average load conditions for the line is approximately 0.64 kV/m under the line decreasing to between 0.03 and 0.04 kV/m at each edge of the proposed easement, 22.5 metres from the centre line. This increase both under the line and at the edge of the proposed easement is due to the increase in the operating voltage of the line.

Magnetic Field

Because the magnetic field depends on the current flowing in the line which varies with the load being supplied, there is no single curve which describes the magnetic field profile. As a consequence, a series of curves has been produced to characterise the magnetic fields. The maximum load represents maximum load expected in the line in about 2020 under emergency conditions and is not discussed further. The infrequent high load represents the load which is unlikely to be exceeded for more than 5% of the time in 2020. The average load represents the average value of load in 2020.

- Existing - The magnetic field profile is shown graphically in **Figure 8.4**. The magnetic field strength produced by the existing line under typical daily load conditions has a maximum value of approximately 13.7 milligauss (mG) under the line, decreasing to approximately 1.2 mG at the edge of the proposed easement, 22.5 metres from the current centre line.

- 66/66 kV - The magnetic field profile when the new line is constructed and operating at 66 000 volts is shown graphically in **Figure 8.5**. The maximum magnetic field under typical daily load conditions for the line is approximately 3.4 milligauss (mG) under the line, decreasing to approximately 0.30 mG at the edge of the proposed easement, 22.5 metres from the centre line.

- 66/132 kV - The magnetic field profile in the final stage with the line operating at 132 000 volts is shown graphically in **Figure 8.6**. The maximum magnetic field under typical daily load conditions for the line has a maximum value of approximately 13.4 milligauss (mG) under the line, decreasing to between 2.0 and 2.8 mG at the edge of the proposed easement, 22.5 metres from the current centre line.

The above results are summarised in **Table 8.1**

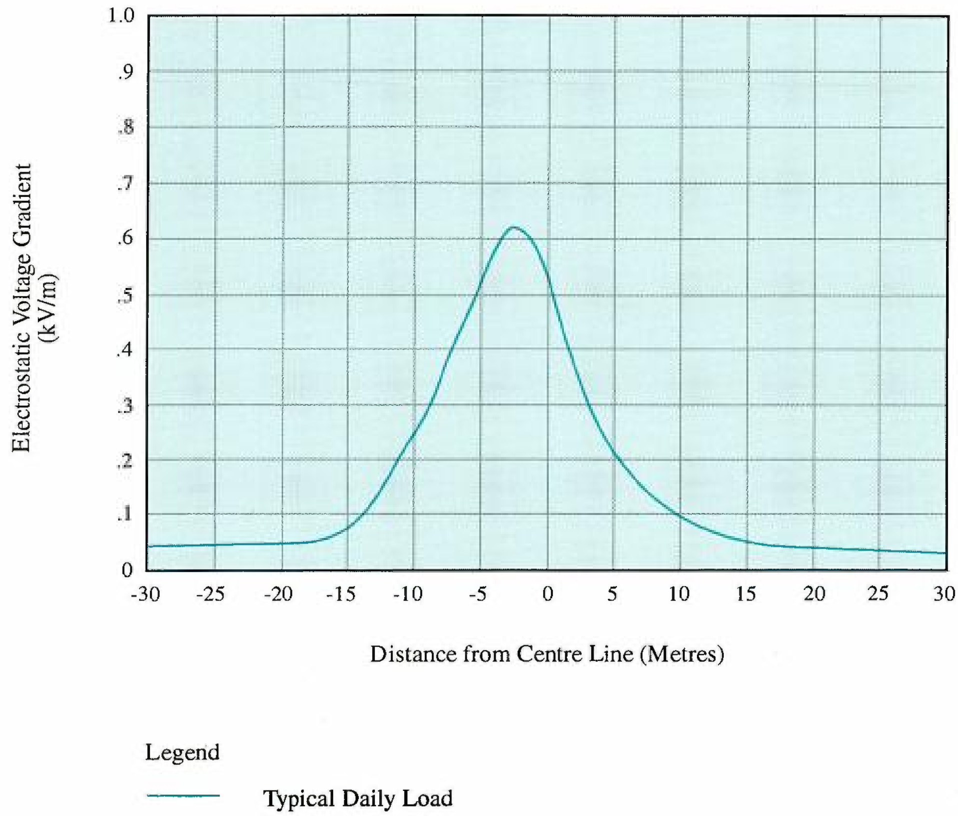


Figure 8.3
132 000/66 000 VOLT OPERATION ELECTRIC FIELD PROFILE

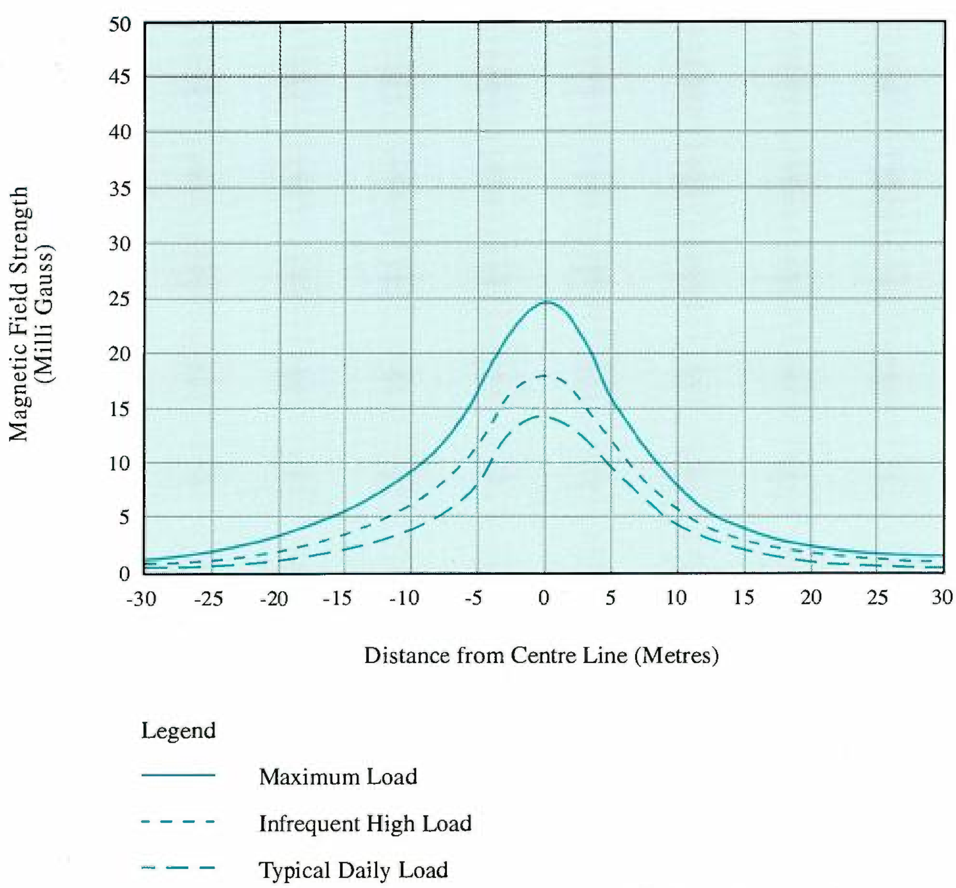


Figure 8.4
EXISTING 66 000 VOLT OPERATION ELECTRIC FIELD PROFILE

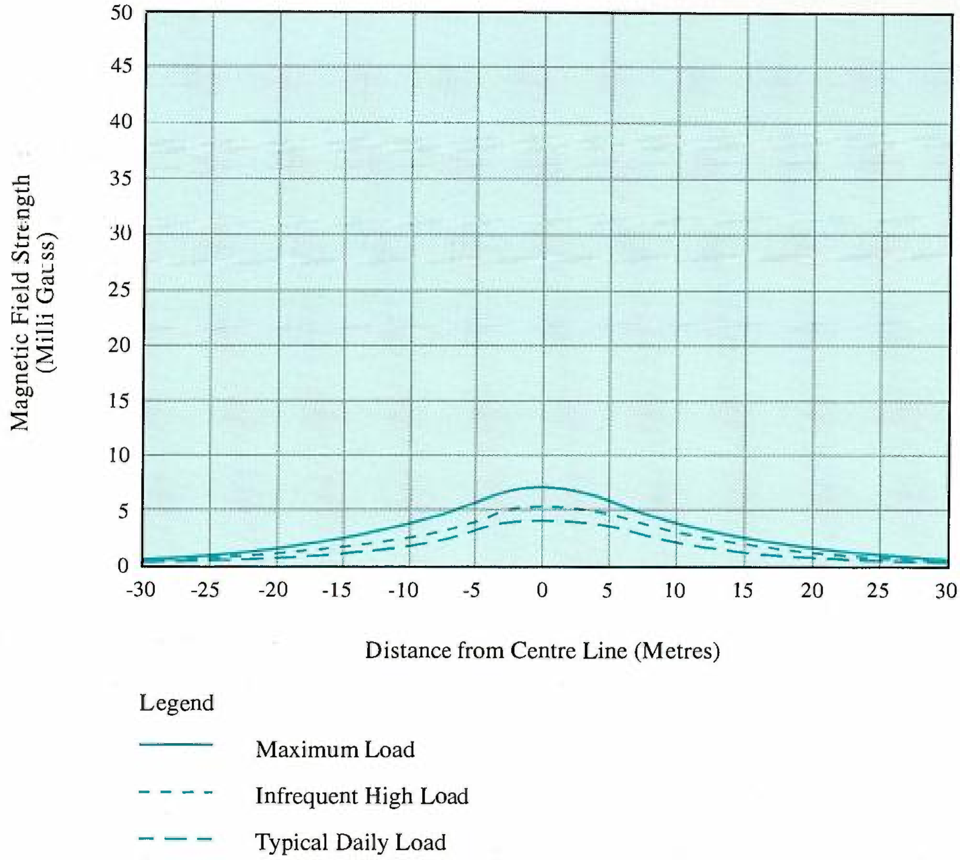


Figure 8.5
66 000 VOLT OPERATION LOW REACTANCE PHASING MAGNETIC FIELD PROFILE

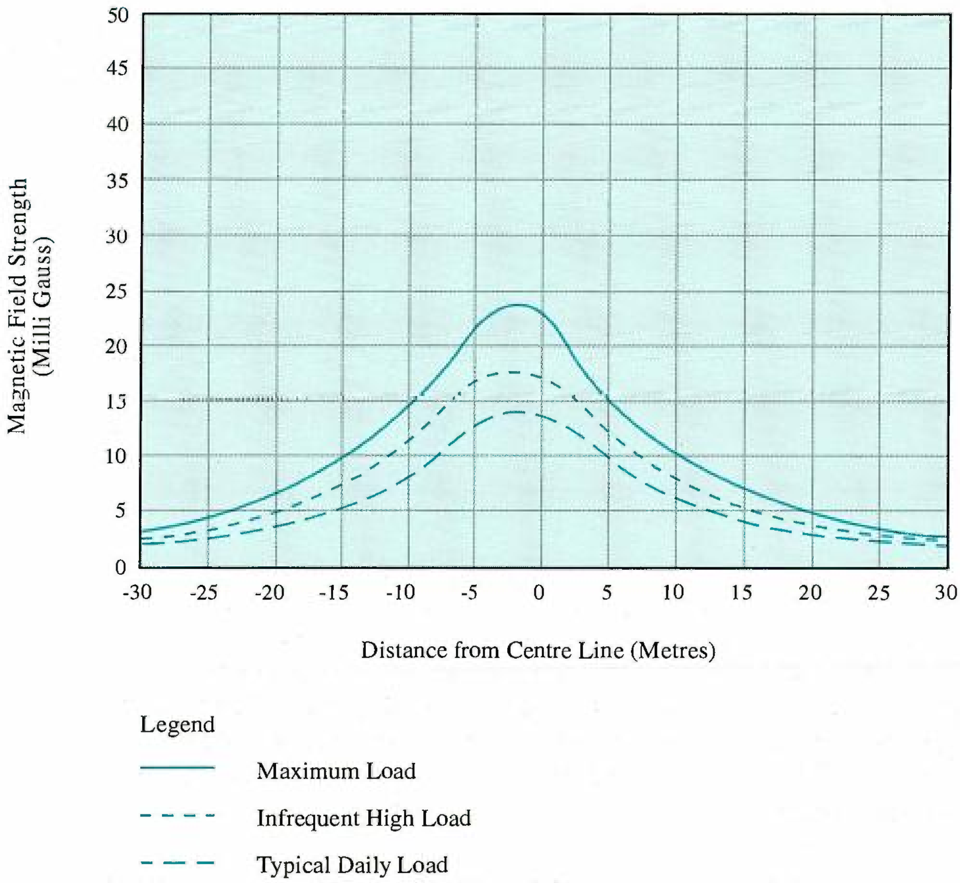


Figure 8.6
132 000/66 000 VOLT OPERATION LOW REACTANCE PHASING MAGNETIC FIELD PROFILE

Table 8.1 - Typical Electric and Magnetic Fields for Each Stage

	Existing	66/66 kV	66/132 kV
Maximum Magnetic Field (milliGauss)	13.7	3.4	13.4
Maximum Magnetic Field at the edge of proposed (45 metre) easement (milliGauss)	1.2	0.30	2.0-2.8
Maximum Electric Field (kV per metre)	0.59	0.24	0.64
Maximum Electric Field at the edge of the proposed (45 metre) easement (kV per metre)	0.04-0.05	0.02	0.03-0.04

Note: All values were calculated at a level of 1 metre above ground. In all cases, the fields decrease quickly with increasing distance from the line.

8.3 Health Concerns

In recent years, questions have been raised as to whether the electric and magnetic fields associated with electrical equipment may be harmful to health. Most recently, the questions have focused on magnetic fields rather than electric fields. Whilst debate continues in the scientific community, there is general agreement that the issue will only be resolved through high quality research and informed discussion.

In response to public concern and recognising the scientific uncertainty surrounding the issue, a number of independent scientific review panels and public inquiries have been commissioned throughout the world to review the state of EMF scientific research, and in some cases, to recommend appropriate policy responses.

A brief commentary on some of these reviews follows:

(i) Inquiry Into Community Needs and High Voltage Transmission Line Development (Gibbs Inquiry)

In 1991, following a comprehensive inquiry, Sir Harry Gibbs, an ex Chief Justice of the High Court of Australia, produced a report on transmission lines for the NSW Government. In the Report he noted that:

> "...transmission lines are by no means the only source of extremely low frequency electric fields and magnetic fields...
> ...In addition, electrical appliances in the home, office, workplace, shopping centre or hospital, and electric trains and other systems of electrical transportation all create electric and magnetic fields. If electric fields or magnetic fields create a hazard to health, the danger is not created by transmission lines alone."

Sir Harry found that:

> "The fact that evidence on the question whether exposure creates a risk to health is so inconclusive suggests that if a risk exists it is a comparatively small one ...."

In commenting on the large number of scientific studies, Sir Harry Gibbs observed:

> "It would serve no useful purpose to review all of the numerous studies done in vitro or in vivo with a view to attempting to discover the effect of ELF fields on biology or health. It is quite apparent that the studies do no more than show that the fields can cause biological changes; they certainly do not enable it to be concluded that the fields are harmful to health. Whether there is evidence that exposure to 50 Hz fields is harmful must depend on the result of the epidemiological studies."

And his overall conclusion was that:

> "It has not been established that electric fields or magnetic fields of power frequency are harmful to human health, but since there is some evidence that they may do harm, a policy of prudent avoidance is recommended. No reason exists for concern as to the effect of the fields on animals or plants."

The matter of 'prudent avoidance' is discussed further in Section 8.5.

(ii) Report of the National Radiological Protection Board (NRPB) "Electromagnetic Fields and the Risk of Cancer"

In 1992, an expert scientific advisory group led by prominent epidemiologist, Sir Richard Doll of Oxford University, was established by the British NRPB. After considering the group's report, the NRPB concluded that:

> "....there is no clear evidence of a carcinogenic hazard from the normal levels of power frequency electromagnetic fields, radiofrequency or microwave radiation to which people are exposed ."

In late 1992, the results of several Scandinavian studies were released, some of which were supportive of an association between EMF and cancer.

In early 1993, the NRPB scientific advisory group referred to above, reconvened and considered a number of studies issued in Sweden, Denmark and Norway.

In considering the residential studies (from Sweden and Denmark), they concluded that:

> "The Group concluded that these studies were well controlled and substantially better than those that previously reported associations with childhood cancer. However, the new studies report few cases. They do not establish that exposure to EMF is a cause of cancer, although they provide weak evidence to suggest the possibility exists. The risks, if any, however, would be very small."

In considering the occupational studies (from Norway, Denmark and Sweden), they concluded that:

> "The Group concluded that the three new occupational studies (from Sweden, Denmark and Norway) strengthened the evidence for believing that some groups of workers in industries where exposure to EMF may have been elevated have an increased risk of leukaemia, but not of brain cancers. No increase in the risk of leukaemia has, however, been seen in workers exposed to high levels of EMF. These new studies add little to those previously reviewed by the Group. The conclusion remains that whether the hazard, if one exists, is due to exposure to EMF or to some chemical associated with the work is impossible to decide at present."

In June 1994 the NRPB updated its position on the EMF issue in these terms, after reviewing three more recent Nordic childhood cancer studies:

> "The Group concluded that all these studies were well controlled and substantially better than those that previously reported associations with childhood cancer. The studies do not establish that exposure to electric and magnetic fields is a cause of cancer but, taken together, do provide some evidence to suggest the possibility exists in the case of childhood leukemia. The number of affected children in the studies is, however, very small."

The Group also commented on a recently released (April 1994) study of utility workers in Canada and France:

> "More recently still there has been a report of an increased risk of leukemia in electrical utility workers in France and Canada, whose jobs involved exposure to electromagnetic fields above the median values for all the other workers in the groups studied. The results of the new studies are, however, neither consistent in the type of leukemia found to be increased nor

> consistent in finding a progressive increase with increasing exposure and further research is clearly required."

and they also noted:

> "Thus, at present, there is no persuasive biological evidence that ELF electromagnetic fields can influence any of the accepted stages in carcinogenesis. There is no clear basis from which to derive a meaningful assessment of risk, nor is there any indication of how any putative risk might vary with exposure."

(iii) Health Effects of Low-Frequency Electric and Magnetic Fields prepared by Oak Ridge Associated Universities (ORAU) Panel

In October 1989 the U.S. Department of Labour requested the assistance of the Committee on Interagency Radiation Research and Policy Co-ordination (CIRRPC) in evaluating a series of articles in the popular press reporting various health effects from exposure to Electric and Magnetic Fields. As a response to the request, CIRRPC requested Oak Ridge Associated Universities (ORAU) to establish a panel and conduct an independent scientific review and evaluation of the reported health hazards. The panel reviewed about 1 000 journal articles published within the previous 15 years.

In a report published in June 1992 the Panel concluded:

> "This review indicates that there is no convincing evidence in the published literature to support the contention that exposures to extremely low frequency electric and magnetic fields (ELF-EMF) generated by sources such as household appliances, video display terminals and local power lines are demonstrable health hazards."

Also that:

> "Epidemiological findings of an association between electric and magnetic fields and childhood leukaemia or other childhood or adult cancers are inconsistent and inconclusive. No plausible biological mechanism is presented that would explain causality. Neither is there conclusive evidence that these fields initiate cancer, promote cancer, or influence tumour progression. Likewise, there is no convincing evidence to support suggestions that electric and magnetic fields result in birth defects or other reproductive problems. Furthermore, any neurobehavioural effects are likely to be temporary and do not appear to have any health consequences."

and

> "Although exposure to ELF-EMF does not appear to constitute a public health problem, there is evidence that these fields may produce some biological effects, such as changes in the pattern of secretion of the hormone melatonin and enhancement of healing bone fractures".

They found:

> "This review does not provide justification for a major expansion of the national research effort to investigate the health effects of ELF-EMF."

In early 1993 the ORAU panel considered the 1992 Swedish studies and stated in April 1993:

> "Because the two Swedish studies were made public when the ORAU report was in the printing process, we consider it necessary to indicate that, in our opinion, the evidence presented in these studies is not sufficiently compelling to alter the conclusions of the ORAU report."

(iv) (French) National Institute of Health and Medical Research (INSERM) Synthesis of the Literature on Health Effects from Very Low Frequency Electric and Magnetic Fields

The French National Institute of Health and Medical Research (INSERM) has conducted an extensive literature review, which was published in February 1993. This review was undertaken to enable a definitive statement on the subject to be made, particularly in relation to the epidemiological studies. The experts reviewed both the NRPB report and the 1992 Scandinavian studies.

They concluded:

> "Electric and magnetic fields were implicated in highly diverse diseases. The studies made are, however, limited in number. The great methodologic difficulties of epidemiologic studies on the subject, notably the measurement of exposure, identifying and taking into account other risk factors, explain their relative rarity."

and

> "Among the effects considered in the present report, those that concern health in general, depression and suicide, reproduction, cancer in the children of exposed subjects, were evoked as a result of a very few discordant studies, often with a methodology highly subject to criticism. At present, there does

not seem to exist any serious argument that permits the implication of electric and magnetic fields in these pathologies."

and

"The studies of the association between residential exposure to electric and magnetic fields and cancer in children are not all in agreement. They suggest, however, taken as a whole, with the present state of knowledge, that the plausibility of an effect of magnetic fields on the appearance of leukaemia is possible."

and

"Any epidemiological data must be interpreted in light of its biologic plausibility and experimental result. Now, animal experiments have never demonstrated carcinogenic effects of exposure to EMF."

and

"In conclusion, the epidemiological results presently do not permit the exclusion of a role for magnetic fields in the incidence of leukaemia, particularly in children. New investigations are necessary to confirm or deny this role".

(e) Report of the Panel on Electromagnetic Fields and Health (Peach Panel)

In January 1991, the Victorian Department of Health and Community Services established a panel to:

"...review the range of approaches which are taken in relation to powerline fields and, where appropriate, to recommend appropriate courses of action in the areas of public policy process, practical strategies and in the development and dissemination of community education material."

In relation to the public policy processes the Panel identified the need to share information, provide community input, to respond to expressed concerns of the community, profile clear information on government/utility responses and to maintain an ongoing community dialogue on the issue.

Concerning practical strategies the Panel stated:

"The Panel's recommendations regarding practical strategies are based on a policy of prudent avoidance."

and described the concept as:

> "Thus prudent avoidance means looking systematically for strategies which can restrict field exposure and adopting those strategies which seem to be prudent investments given their costs and the level of scientific understanding about possible risks."

The Panel also noted:

> "At the same time, the Panel recognises that a policy of prudent avoidance is not a health based policy, and that the implementation of the policy cannot be seen as necessarily being of benefit to public health, and to any individual".

This concept of prudent avoidance is consistent with Sir Harry Gibbs recommendations and is discussed further in Section 8.5.

8.4 National Health and Medical Research Council (NH&MRC) Guidelines

The (Australian) National Health and Medical Research Council (NH&MRC) has issued a document "Interim guidelines on exposure to 50/60 Hz Electric and Magnetic Fields" (1989). These guidelines were previously developed by the International Non-Ionising Radiation Committee of the International Radiation Protection Association (IRPA/INIRC) (which has since been replaced by the International Commission on Non Ionizing Radiation Protection). The NH&MRC recommended exposure limits are shown in **Table 8.2**.

Table 8.2 - NH&MRC Limits of Exposure

Exposure Characteristics	Electric Field Strength kV/m	Magnetic Flux Density mG
Occupational		
Whole working day	10	5 000
Short term	30[a]	50 000[b]
For limbs		250 000
General Public		
Up to 24 hours/day[c]	5	1 000
Few hours/day[d]	10	10 000

Notes:
(a) The duration of exposure to fields between 10 and 30 kV/m may be calculated from the formula $t <= 80/E$, where t is the duration in hours per work day and E is the electric field strength in kV/m.
(b) Maximum exposure duration is two hours per work day.
(c) This restriction applies to open spaces in which members of the general public might reasonably be expected to spend a substantial part of the day such as recreational areas, meeting grounds and the like.
(d) These values can be exceeded for a few minutes per day provided precautions are taken to prevent indirect coupling effects.

On the 12 May 1993 the "International Commission on Non Ionising-Radiation Protection confirmed the above guidelines with the issue of the following statement:

> "The International Commission on Non-Ionizing Radiation Protection (ICNIRP) reviewed the data about possible carcinogenicity of power frequency magnetic fields at its first annual meeting on May 7-12, 1993 held in Neuherberg, Germany. This review considered all scientific data that have been published or publicly presented since the "Interim Guidelines on limits of exposure to 50/60 Hz Electric and Magnetic Fields" were published in 1990 by the predecessor International Non Ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA). The major reason for the interim nature of these guidelines was the inability to arrive at a scientifically based judgement concerning any causal relationship between 50/60 Hz magnetic field exposure and the excess occurrence of cancer."
>
> "The most recent data reflect some improvements in methodology in laboratory studies and in epidemiological studies of both occupational and general populations. After careful consideration of this evidence, the Commission concludes that the data related to cancer do not provide a basis for health risk assessment of human exposure to power frequency fields. Accordingly the Commission confirms the interim guidelines published in 1990 (IRPA/INIRC 1990)."
>
> "The Commission will periodically review new evidence in this area as it develops."

8.5 Prudent Avoidance

Both major public inquiries conducted on EMF in Australia, namely the Gibbs Inquiry and the Peach Panel, recommended the adoption of a policy of prudent avoidance in response to this issue.

In discussing prudent avoidance, Sir Harry Gibbs noted that:

> "It is not possible to give other than the most general guidance as to the manner in which the doctrine of prudent avoidance may be applied when a new transmission line is being constructed."

He also recognised that it is:

> ".. a very difficult question to say what action it would be prudent to take to avoid a possible risk when it is not known whether it is probable or not that a risk exists or, if it does exist, what conditions create it or how serious it may prove to be."

In the case of new lines he indicated that:

> ".. it may be prudent to do whatever can be done without undue inconvenience and at modest expense to avert the possible risk".

In designing and siting this line, PacificGrid has undertaken the following steps which are consistent with a policy of prudent avoidance:

Design
PacificGrid considered two particular aspects with respect to the design of the line.

Firstly the structure design chosen for the transmission line was a "compact design" which has conductors in closer proximity to each other when compared to other possible structure designs. A compact design structure inherently produces a lower overall magnetic field than other designs as a result of the interaction of the magnetic fields from each conductor.

Secondly, PacificGrid was aware that the double circuit arrangement proposed had the capacity to produce even lower magnetic fields, depending on the conductor phasing arrangement chosen. The two phasing arrangements considered are known as "low reactance" and "super bundle" respectively.

Studies were undertaken to investigate the magnetic fields likely to be produced by two different phasing options. The results of these studies, with the line (both circuits) operating at 66 000 volts are shown in **Figure 8.7** for the typical daily load. The results for the line operating at 132 000/66 000 volts are shown in **Figure 8.8** for the typical daily load.

For the 66 000 volt operation shown in **Figure 8.7**, it can be seen that the typical daily magnetic field under the line is approximately 10 mG for the "superbundle" and approximately 3.4 mG for the "low reactance" arrangement. The fields at the easement edge are lower for the "low reactance" arrangement (0.3 mG as opposed to 2.1 mG).

For the 132 000/66 000 volt operation shown in **Figure 8.8**, it can be seen that the typical daily magnetic field under the line is approximately 16.3 mG for the "superbundle" and approximately 13.4 mG for the "low reactance" arrangement. The fields at the easement edge are lower for the "low reactance" arrangement (2.8 mG as opposed to 3.4 mG).

In summary, the low reactance arrangement gives lower magnetic fields both under the line and at the edge of the easement.

For the initial operation, with both circuits operating at 66 000 volts, additional conductor rearrangements outside Lismore substation,

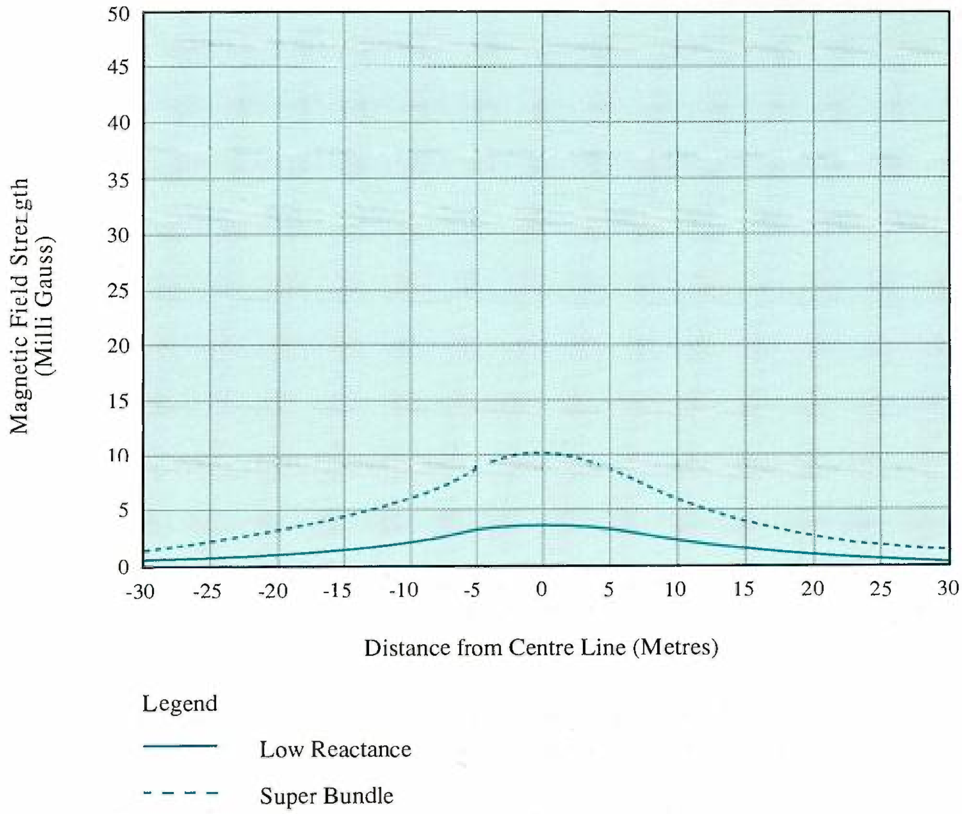


Figure 8.7
66 000 VOLT OPERATION MAGNETIC FIELD STRENGTH COMPARISON OF PHASING TYPICAL DAILY LOADS

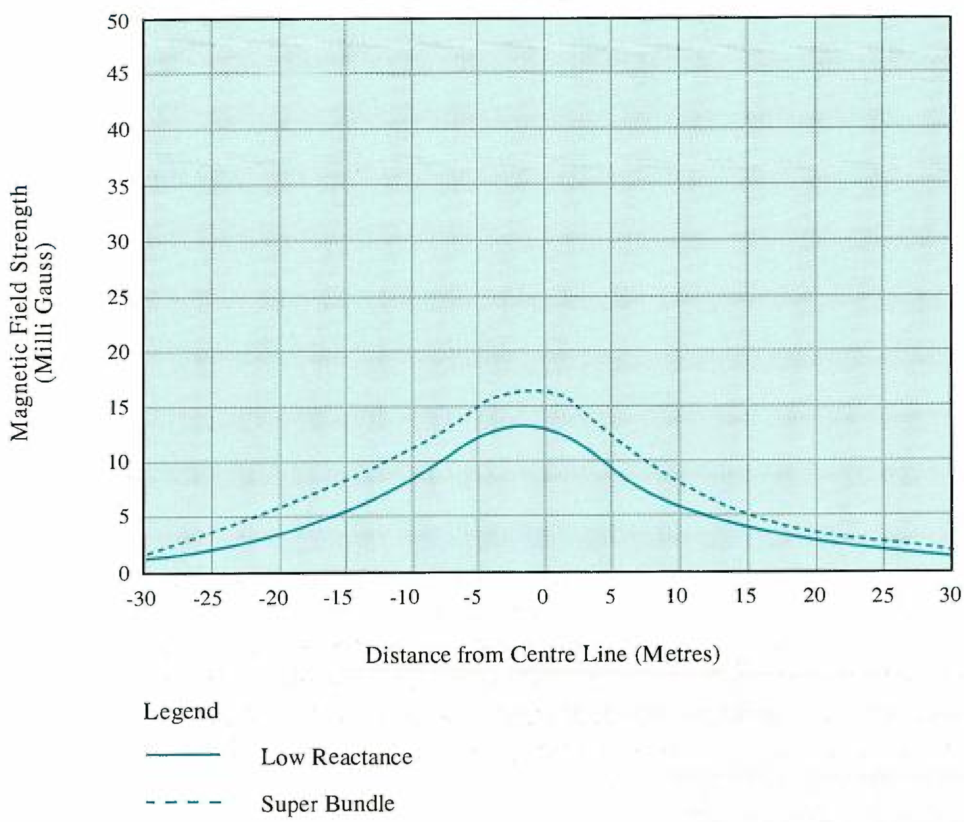


Figure 8.8
132 000/66 000 VOLT OPERATION MAGNETIC FIELD STRENGTH COMPARISON OF PHASING TYPICAL DAILY LOADS

together with some additional plant within the substation itself would be required to achieve a low reactance configuration. The additional works would not be required if super bundle phasing was adopted. The cost of these works is not significant.

For 132 000 volt operation, no additional works would be required to adopt either phasing arrangement, although simpler conductor arrangements would be required adjacent to Lismore substation if super bundle phasing was adopted.

Having regard to Sir Harry Gibbs' concept of doing what can be done without undue inconvenience and at modest expense, the adoption of low reactance phasing is proposed for the new line.

Siting
The general rationale for selecting the preferred line route is discussed in Section 3 and has been dictated by a number of factors.

Community Consultation - The question of health effects and electric and magnetic fields arose during the community consultation program leading to the selection of the preferred route. The issue first arose during the initial route options workshops with a number of people expressing the opinion that the new transmission line should be located as far as possible from homes and other public areas because of the 'potential' health risk. It was acknowledged, however, that this approach could have other direct environmental impacts and may not have universal support.

To assist the community to evaluate this issue, PacificGrid produced a brochure, 'Electric and Magnetic Fields - Sharing Information' in July 1993. This brochure was supplied to the community through the information centre in Lismore and was also available at the various displays of route corridors during the development and consideration of alternative route corridors. The brochure, 'Your Guide to Understanding EMF' was also made available during this time.

Measurements of existing magnetic fields on properties affected by the existing 66 kV transmission line were also undertaken. This was partly to verify the calculated results and also to assess the background levels of magnetic fields in the area. PacificGrid personnel visited Modanville Public School and measured the existing magnetic field levels in the school area and discussed them with school and community representatives. Northern Rivers Electricity personnel have also carried out magnetic field measurements at a number of residences in the area. Copies of the measurements taken at Modanville School (by PacificGrid) and at a residence in Tullera (by NRE) are presented in **Appendix J**.

Easement Widths - The question of easement widths was addressed by Sir Harry Gibbs in his report where he said:

> ".. there is no rational basis for saying that the easement widths now usually adopted by the Electricity Commission are inadequate. While it would appear prudent to ensure that future easements should not have widths smaller than those selected by the Electricity Commission as typical ...., it would appear premature, in the present state of knowledge, to fix easement widths by legislation."

The preferred line route follows the existing 66 000 volt line and where deviations were proposed attempts were made to avoid areas where individuals are likely to spend extended periods of time. Whether or not this is beneficial cannot be stated with certainty, but it is consistent with the concept of prudent avoidance.

8.6 Further Investigations

The scientific literature on this issue is extensive. Included in the bibliography is a listing of Review Panel reports and information brochures. Further bibliographies are included in most of the reference documents."

8.7 EMF Impact Assessment Along the Proposed Line

Given that the line will be designed with "low reactance" phasing, when the line is operated as a double circuit 66 kV line, the magnetic fields associated with the line will be lower than those occurring with the existing 66 kV line. Once the line is operated at 132/66 kV, the magnetic fields will be similar to those currently occurring.

9

Other Transmission Line Impacts

9. Other Transmission Line Impacts

This Section discusses the cumulative impacts of proposed works in the region, television and radio interference associated with the proposed line and electrical saftey issues.

9.1 Cumulative Impacts

There are currently a number of developments proposed, in various stages of planning, in the Lismore and Byron Shires. These developments in total will, to varying degrees, have a cumulative impact on the physical, economic and social environment of the region. The developments of particular relevance to the region affected by the preferred rebuilding of the Lismore to Mullumbimby transmission line include the:

- Rous Regional Water Supply Strategy study. In order to meet the increasing demand for water occurring as a result of the rapid population growth in the area, a long term water supply strategy is being developed. In the long term, a dam at one of two possible sites is being considered, these being
    - a site on the Wilsons River at Federal at a site known as W7
    - a site on Rocky Creek downstream of the existing dam.
- the proposed Club Med resort development at Byron Bay
- the proposed Lismore Levee Scheme, aimed at reducing the frequency of flooding in Central, South and North Lismore.

The above developments may have the following implications for the Lismore/Byron area

- increased population growth
- increased employment services
- increased investment and economic growth
- environmental impacts associated with dam construction
- additional demands on services such as electricity, water and sewerage
- potential for additional tourism in the area

These implications are both positive and negative and a detailed assessment of each of the above issues is outside the scope of this EIS.

However, it should be noted that the reconstruction of the Lismore to Mullumbimby transmission line will not have any impact upon the Rous Regional Water Supply Strategy, or the Byron Bay Club Med proposal since the proposed sites of these developments are not located in the vicinity of the proposed line.

It is anticipated that the proposed line will cross the Leycester Creek floodplain to the west of the proposed levee, and thus will not impact on the levee scheme.

9.2 Television and Radio Interference

Television and radio reception in the primary service area of transmitting stations is normally unaffected by transmission lines. Some momentary fading of radio reception may be experienced in a car passing underneath transmission lines, particularly if the radio signal strength is low. In fringe areas, experience has shown that a properly erected aerial generally overcomes any potential reduction in quality of television or radio reception arising from proximity of the transmission line. If a problem does occur, it can usually be rectified by minor modification to the aerial. If problems persist, PacificGrid can carry out modifications to improve reception in an area.

9.3 Electrical Safety

Various safeguards will be incorporated into the design of the transmission line to ensure the safety of the community and construction and maintenance staff. The transmission line would be constructed in accordance with the Overhead Line Regulations, 1988 and appropriate Australian Standards which will minimise the potential for accidental mechanical failure. Properly designed and maintained transmission lines are unlikely to contribute to hazards such as lightning strikes or bushfires. Regular maintenance patrols will ensure that clearance requirements between the conductors and surrounding vegetation is maintained. Patrols would be specifically mounted during spring and summer months for this purpose.

Transmission line safety is maintained by applying certain restrictions regarding the erection of structures and undertaking of certain activities within the easement, as described in Section 4 and **Appendix F**. These safeguards will ensure the community's well being. To prevent the build up of static charges, fences and gates in the vicinity of the transmission line are earthed. Irrigators of the high pressure gun type would not be permitted to be used in the easements in such a way that a dense jet of water could strike the conductors. Some restrictions on the use of electric fences may also be required in some cases.

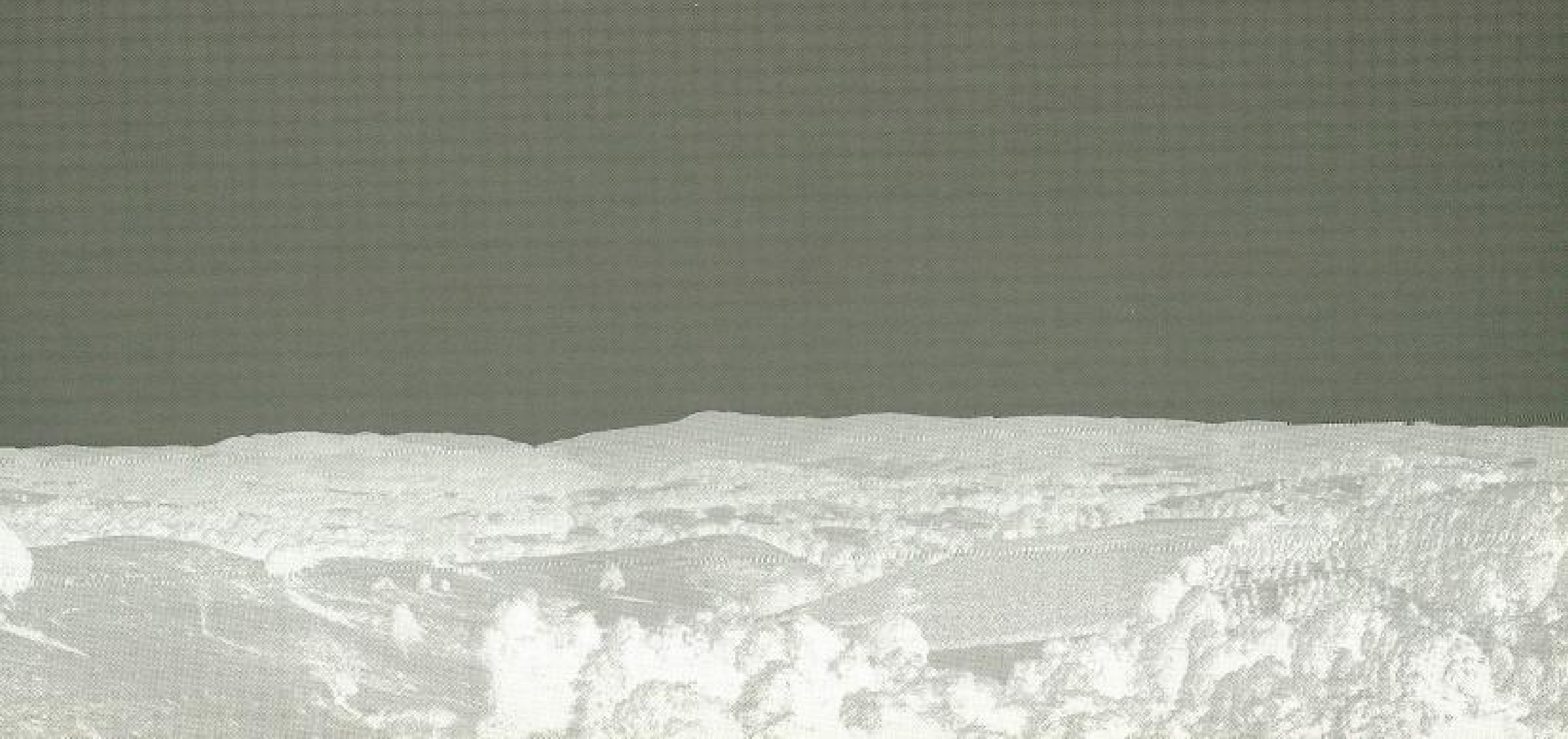
Unauthorised activities such as climbing on poles and flying kites near the line are discouraged by drawing attention to potential hazards through education programs.

Sensitive monitoring apparatus and high speed circuit breakers will be installed on the transmission line to ensure that any faults, such as those which might be caused by lightning strikes or by vandalism are immediately detected and the line de-energised.

The proposed line will ensure that the electricity supply of the Lismore, Byron and Ballina Shires is secure, enabling the continued population growth in the area to occur without jeopardising the supply of electricity to the region.

10

Conclusion



10. Conclusion

The conclusions of the EIS studies are presented in this Section.

The proposed double circuit transmission line from Lismore to Mullumbimby provides the best option for meeting the growing demand for electricity by the people of the Far North Coast region. Its implementation will have beneficial implications to future growth and development in the region.

On the basis of the assessments detailed in the various sections of this document, the Preferred Route (Reconstruction Option) clearly has the lowest impact when compared with the other route options requiring new corridors.

Considering that the proposed line will generally replace the existing 66 kV transmission line route, the line cannot be considered as a new element in the visual landscape of the area.

During construction of the line there will be a temporary increase in noise levels from the use of heavy machinery and helicopters. The impact on air quality arising from the use of construction vehicles and equipment is considered minor. When the line is in operation, the noise impact associated with maintenance vehicles and helicopter will be very limited.

The major impacts of the proposed transmission line are:

- increased visibility of the line with the use of taller structures and additional conductors
- vegetation removal associated with the line construction and access tracks, and
- potential impacts on native fauna arising from vegetation removal.

The use of painted structures and dull surface conductors will reduce visual impacts.

Impacts on vegetation will be reduced with the adoption of restricted removal of vegetation in the easement and the use of taller structures to span over gullies. Where vegetation has been identified as sensitive, selective and limited vegetation removal will be adopted. In areas where eucalypts are significant to Koalas, the trees will be retained if possible and will only be removed after consultation with the local LandCare Committee and the National Parks and Wildlife Service. Planting eucalypts at locations outside the easement to replace those removed will be undertaken.

With the mitigating measures discussed in Section 6, it is not anticipated that any species affected by the proposed transmission line will become non-viable. Further, the measures taken are intended to ensure that there are no adverse effects on the survival of protected or endangered fauna.

In this context, and provided the environmental safeguards are observed, a basis is provided for approval of the proposed transmission line.

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Abbreviations and Glossary

Abbreviations and Glossary

AADT	Average Annual Daily Traffic
Acceptable level of Voltage and Quality of Supply	A voltage level at some intermediate point which will result in the end users having voltages within the statutory requirement. Electricity supply must comply to certain standards in terms of magnitude, frequency, fluctuations and harmonics.
A Fault or Overload	An abnormally heavy current which could cause danger or damage to electrical equipment if no action is taken.
AHD	Australian Height Datum - a common national plane level corresponding approximately to mean sea level.
Alternating Current (a.c.)	An electric current whose magnitude continuously varies from a positive maximum through zero to a negative maximum (for electricity supply in Australia 50 times per second). This is in contrast to direct current (d.c.) whose magnitude remains steady.
ARI	Annual Recurrence Interval
Augmentation	Modification (expansion) to a substation or transmission line.
Bandwidth	The band within which the final transmission line route is expected to be located.
Blackout	Total interruption of supply to a customer's installation.
Brownout	Voltage at the customer's load drops below an acceptable level (resulting in possible damage to electrical equipment).
Bulk Supply Point	A point in the network to which electrical energy is delivered for the use of an Electricity Distributor or to a direct supply customer (typically the low voltage busbar of a substation).
Busbars	Common connectors which carry large amounts of energy in substations. Frequently copper or aluminium tube, or stranded copper or aluminium wire.

Capacity	Amount of electricity able to flow through transmission lines or substation equipment.
Capacity Factor	Ratio of the average load over a period for equipment such as generators, transmission lines, etc., to the possible load over the same period if it had operated continuously at rated capacity.
Circuit	Conductor (wire) or assembly of conductors through which an electric current flows.
Circuit Breakers (CB)	Are switches that include provision for opening automatically on overload or fault current.
Cogeneration	Is the combined production of useful heat and electricity from the one fuel or energy source.
Conductors	The wires (or underground cables) on a transmission line that carry the electric current.
Consumption	Consumption of electricity relates to energy. One 100 watt globe burning for ten hours (0.1 kW x 10 hours or one 1 000 watt (1 kW x 1 hour) appliance operating for one hour) consumes one kilowatt-hour of electricity.
Current	Is the flow of electricity, and is measured in amperes, (amps. or A).
Demand and Load	Are power-related terms, often used to refer to the amount of power required by a large number of customers at one time and this is measured in kilowatts (kW) or KVa. The term "load" can refer to a customer, an appliance, a group of customers or appliances or a network.
Demand Management	Is any action to change the way the community uses electricity in order to achieve predefined goals. This could be to shift electricity use into off-peak periods or to use less energy to do the same task.
Distribution System	This term applies to the parts of the electricity supply system from the power lines leaving a zone substation to the customer premises. This includes 33 kV, 22 kV and 11 kV lines and substations. One voltage level below distribution

	forms the reticulation network (415 volts) to customers.
Energy	Is the work which electric power does in a given period; it is power multiplied by time. Energy is measured in kilowatt-hours (known commercially as "units", kWh).
Environmental Impact Statement (EIS)	A formal description of a project and an assessment of its likely impact on the physical, social and economic environment. It includes an evaluation of alternatives and an economic justification of the project. The EIS is used as a vehicle to facilitate public comment and as the basis for analysing the project with respect to granting approval under relevant legislation.
ELF	Extremely low frequency
EMF	Electromagnetic field
EP&A Act	Environmental Planning and Assessment Act, 1979
EPA	Environment Protection Authority
Fault	Any failure which interrupts the normal flow of current in transmission lines or substation equipment.
FIS	Fauna Impact Statement
Forced Outage	An unplanned situation in which a network, line, cable or transformer has to be taken out of service immediately or as soon as possible.
Gauss	A unit of magnetic flux density
Generator Trip	Unscheduled rapid shut down of a generator
GW	Gigawatt = 1 000 000 kilowatts (kw)
Interruption of Supply	A break in the continuity of electricity supply to a point of delivery. The interruption may be planned or unplanned.
Interruptable Loads	Loads such as aluminium smelters, water pumps, etc., which have a contractual provision for interruption by the supply authority for a specified

period in the event of either a sudden load increase or the unscheduled shutdown of a generator.

kV	kilovolt = 1 000 volts
LEP	Local Environmental Plan
Limits of Electrical Power System	Overheating of transmission lines that results in damage to or excessive sag of conductors. Low voltage levels at customer loads (brownouts). Substation overload (rating of transformers or other substation equipment is exceeded), Stability (transient, voltage, steady state) limit.
Load Factor	Is a term used to express as a percentage, the ratio of the average electricity demand in a given time period to the maximum demand in the same time period. The load factor is a measure of plant utilisation (0 - 100%).
Low Voltage Lines	Frequently carry three phases (415 volt lines), and an additional neutral. Single phase (240 Volt) domestic supply is given from one active phase line and the common neutral line.
Maximum Demand	The maximum amount of electricity used in a given time (usually measured over a 15 or 30 minute period).
MW	Megawatt
Network	A grouping of substations, lines, cables and other electrical equipment connected for the purpose of conveying electrical energy from power stations to customers.
NPC	Net Present Cost - In order to compare the costs and benefits flowing from a project it is necessary to bring them back to a common time dimension. Present cost moves future known costs to the present.
Outage	Temporary unavailability (removal from service) of a transmission line or substation equipment due to

fault conditions or planned maintenance requirement.

PMF	Probable maximum flood.
Power (kW)	The rate at which electrical energy is produced or consumed. Power is measured in watts, or more conveniently in kilowatts - kW (thousands of watts) or megawatts - MW (millions of watts).
Power Grid	The part of the electricity system consisting of the transmission and subtransmission systems or networks.
Radial Supply	Only one supply to a load/customer
Re-build	A method of constructing a transmission line where the new line is built on the same route as the old line. One section of the old line is removed at a time and replaced by a new section. This ensures that a minimum amount of time is required for the line to be re-connected to the system.
Reliability	A measure of the number and duration of outages that occur for components of the power system.
Ring System	A system where the loads are connected in a 'ring' formation so that each load has two or more lines connected to it.
Risk of Supply Interruptions	The backup supply to an area is unable to provide supply for 100% of the load, therefore in the case of an outage, blackouts would be experienced by some customers connected to part of the network.
Security of Supply	The ability of the system to maintain continuous supply to customers, even following the failure of a system component (eg. a transmission line) during normal service, or when major lines or plant items are out of service for maintenance.
Stability	Stability refers to the property of an alternating current electricity supply system whereby all generators are constrained to operate at the same frequency, that is, in synchronism. Instability may result in disturbances and interruptions to supply.

Stability Limit	The power flow limit adopted for each component of an electricity system, such that the occurrence of any of a defined set of disturbances will not result in the loss of stability and the consequential shutdown of at least part of the system.
Static or Dynamic Reactive Plant	Devices which assist in the control of power system voltage and which contribute to power system stability.
Substations	Distributing points for electricity supply, using transformers to reduce voltage to convenient levels for distribution.
Subtransmission System	Next level of electricity supply network below transmission system, typically 132 kV, 66 kV, 33 kV.
System Losses	Energy dissipated from the system in the form of heat.
REP	Regional Environmental Plan
SEPP	State Environmental Planning Policy
Tesla	A unit of magnetic flux density. 1 Tesla = 10^4 gauss)
Thermal Limitations	Amount of electricity that can flow through a transmission line or substation item before the heat produced causes damage to, or excessive sag of conductor or damage to insulation.
Three-phase Conductors	Large scale alternating current transmission systems use a method known as three-phase supply whereby three conductors or bundles of conductors are required for each transmission line.
Transformer	Is a piece of electrical equipment used for converting power at one voltage for use at another voltage, usually a lower one. A transformer is usually described by quoting its capacity and voltage ratio, eg. 150 MVA, 330 000/132 000/ 66 000 V. Transformers may reduce or increase voltage. The available current varies in inverse proportion: that is, when the voltage is halved, the available

	current is doubled. The power remains the same, except for small losses in the transformer.
Transmission Line	An electric power line transmitting bulk power, usually at voltages of 132 kV or above.
Transmission System	Main part of electricity supply network where electrical energy is transferred, generally in large amounts, at the higher voltage levels typically 500 kV, 330 kV, 132 kV.
Uprating of Transmission Line	Increasing the capacity of a transmission line by installing larger conductors, or raising conductor height above ground.
Voltage	Is the pressure of electricity and is measured in volts, (v). The higher transmission voltages are traditionally multiples of 11 000 eg. 22 000, 33 000, 66 000, 132 000 and 330 000 volts. 1 000 volts - 1 kilovolt (kV)
Voltage Limitations	Amount of electricity that can flow through a transmission line or substation item before the voltage drop becomes excessive.
Zone Substation	An Electricity Distributor's substation at which voltage is transformed from a subtransmission voltage to a distribution voltage.

A

Appendix A Director's Requirements

Table A.1 - Directors Requirements

Requirement	Where addressed in EIS
Justification for the Proposed Scheme.	2
Evaluation of the alternatives and justification for the selected option giving details of costs and benefits. Where social or environmental costs/benefits are not quantifiable they should be described.	2
Assessment of any increase in fire risk and measures proposed to minimise such risks.	4.11
Justification for size of easement and extent of clearing, description of any associated restrictions on the use of land and arrangements for maintenance access.	4.3, 4.2, 6.6, 4.4
Assessment of impact during construction and operations on the natural environment:- - a survey of flora and fauna, identifying and rare or endangered species - assessment of the ability of identified stands of vegetation and fauna populations to withstand any increased pressure resulting from the proposal - measures to mitigate impact, including wildlife corridors - measures for ongoing management of the natural environmental and the prevention of the introduction of pests and weeds.	6.2, 6.3
Assessment of measures to prevent erosion both during construction and operation:-	6.5
- identification of any impacts on local catchment areas including Wilsons River, Coopers Creek and Terania Creek, as appropriate	5.4
- measures for site rehabilitation including revegetating and landforming.	4.9, 6.2
Identification of environmental hazards which may impact on the proposal and the likelihood of increase in risk and measures to minimise risk:-	
- bushfire	4.11
- mass movement	6.5
- flooding.	5.4
Compatibility with surrounding land uses, including agricultural land. Any loss in agricultural land should be assessed in terms of cumulative impacts.	6.1, 6.6
Results of consultation with the local community, particularly affected landholders.	3.5
Heritage issues, including Aboriginal Archaeology, European Heritage and landscape character.	6.8
Implications of electromagnetic fields.	8

Results of consultation with:- - Environmental Protection Authority - National Parks and Wildlife Service - Department of Conservation and Land Management - NSW Agriculture - Department of Mineral Resources - NSW Bushfire Brigade - Lismore City Council - Byron Council - Ballina Council.	3.4, Appendix B

New South Wales Government

Department of Planning

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Contact : J Croft

Our Reference : G93/00174

Your Reference : MLY/[TPG] :22300

Noted 27/1/94

C ~~Fitzgerald~~
Pacific Power Services
GPO Box 5257
SYDNEY NSW 2001

Dear Sir

RE: PROPOSED 132Kv TRANSMISSION LINE FROM LISMORE TO MULLUMBIMBY

Thank you for your letter of 9 December 1993 indicating that you are consulting with the Director with regard to the preparation of an environmental impact statement (EIS) for the above development.

2. An EIS is required to be prepared where the proposal is an activity referred to in Section 112(1) of the Environmental Planning and Assessment Act, 1979. The EIS shall be prepared in accordance with clause 57 of the Environmental Planning and Assessment Regulation, 1980, as amended and shall bear a certificate required by clause 59 of the Regulation (see Attachment No 1).

3. It is noted that Pacific Power is still to identify a preferred route corridor. A preferred corridor should be identified and addressed in the EIS, although proper consideration should also be given to alternatives.

4. In addition, pursuant to clause 58 of the Regulation, the Director requires that the following matters be specifically addressed in the EIS:

- justification for the proposed development;
- evaluation of alternatives and justification for the selected option giving details of costs and benefits. Where social or environmental costs/benefits are not quantifiable, they should be described;
- visual impact of the proposed powerline;

- justification for size of easement and extent of clearing, description of any associated restrictions on the use of land, and arrangements for maintenance access;

- assessment of impact, during construction and operations, on the natural environment. A description of the natural environment should be provided including a survey of flora and fauna, identifying any rare or endangered species and species at the limit of their distribution. An assessment of the ability of identified stands of vegetation and fauna populations to withstand any increased pressure resulting from the proposal should also be included. Measures proposed to mitigate impact, including wildlife corridors, should be assessed for their adequacy and effectiveness. Measures for the ongoing management of the natural environment and prevention of the introduction of pests and weeds should also be considered;

- assessment of measures proposed to prevent erosion and siltation during both construction and operation of the powerline. This should include an identification of any impacts on local catchment areas including Wilsons River, Coopers Creek and Terania Creek, as appropriate to the option under consideration. Measures proposed for site rehabilitation including revegetation and landforming should also be assessed;

- identification of any environmental hazards which may impact on the proposal, such as bushfire, mass movement and flooding. Any increase in risk resulting from the proposal should also be assessed. Measures proposed to minimise such risk should be identified;

- compatibility with surrounding land uses including agricultural land. Any loss in agricultural land should be assessed in terms of the cumulative impact of this type of development;

- results of consultation with the local community, particularly affected landowners;

- heritage issues, including Aboriginal Archaeology, European Heritage and landscape character;

- electro magnetic radiation. The EIS should consider this issue and identify any implications for the proposed development;

- results of consultation with:-

  - Department of Conservation & Land Management (Soil Conservation Service),
  - National Parks and Wildlife Service,
  - NSW Agriculture,
  - Department of Mineral Resources,
  - Lismore City Council,
  - Byron Council,
  - Ballina Council,
  - Environment Protection Authority, and
  - NSW Bushfire Brigade.

5. Attachment No 2 is a guide to the type of information most likely to be relevant to the development you propose; not all of the matters raised therein may be appropriate for consideration in the EIS for your proposal; equally, the guide is not exhaustive.

6. When an adequate EIS has been prepared for the subject proposal, as determining authority, you should then proceed with the matter in accordance with Sections 112 and 113 of the Act, and place the document on public exhibition. The procedures for public display that are to be followed by the proponent and/or determining authority are as in clauses 60 to 64 of the Environmental Planning and Assessment Regulation, 1980.

7. When the EIS is completed, four (4) copies should be forwarded to the Secretary, Attention: Manager, Assessments Branch pursuant to Section 112(2) of the Act, as well as details of the exhibition period and public display locations.

8. The determining authority should also note that section 113 of the Environmental Planning and Assessment Act, 1979, and clause 61 of the associated Regulation, requires that the EIS be made available for inspection at the same time in the offices of the determining authority and the Department as well as any other agencies nominated by them. To ensure that simultaneous exhibition occurs, Pacific Power should forward the necessary documents to the Department prior to the commencement of the public display period. This will enable concurrent exhibition in the Department's head office and the relevant regional office where appropriate.

9. Should any submissions be made during the period of public exhibition, it is advised that such submissions should be forwarded to the Secretary in accordance with Section 113(3) of the Act.

10. If the determining authority has not received a reply within 21 days of sending submissions to the Secretary, it should proceed to determine the matter. The Department will only contact the determining authority after the receipt of submissions if an issue of major significance is involved.

11. If there are no submissions to the proposed development as a result of the exhibition, the determining authority may determine the matter at any time after the last day upon which submissions are accepted.

12. It would be appreciated if a copy of the determination could be forwarded to the Department for our information.

13. The Director has no specific comment in regard to making copies of the EIS available for sale to the public (Clause 63(3) of The Regulation).

14. Should you require any further information regarding this matter please do not hesitate to contact us again.

Yours faithfully

Neville Osborne
for B. Adams
Manager
Assessments and Major Hazards Branch
As Delegate for the Director

20/1/94

DEPARTMENT OF PLANNING
ATTACHMENT NO. 1

STATUTORY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENTS.

In accordance with Part V of the Environmental Planning and Assessment Act, 1979, an environmental impact statement (EIS) must meet the following requirements.

Pursuant to clause 57 of the Environmental Planning and Assessment Regulation, 1980, as amended:

(1) An environmental impact statement referred to in section 112 (1) of the Act shall be prepared in written form and shall be signed by the person who has prepared it.

(2) The contents on an environmental impact statement referred to in subclause (1) shall include the following matters:-

(a) a full description of the proposed activity;

(b) statement of the objectives of the proposed activity;

(c) a full description of the existing environment likely to be affected by the proposed activity, if carried out;

(d) identification and analysis of the likely environmental interactions between the proposed activity and the environment;

(e) analysis of the likely environmental impacts or consequences of carrying out the proposed activity (including implications for use and conservation of energy);

(f) justification of the proposed activity in terms of environmental, economic and social considerations;

(g) measures to be taken in conjunction with the proposed activity to protect the environment and an assessment of the likely effectiveness of those measures;

(g1) details of energy requirements of the proposed development and measures to be taken to conserve energy;

(h) any feasible alternatives to the carrying out of the proposed activity and the reasons for choosing the latter;

(i) consequences of not carrying out the proposed activity.

The EIS must also take into account any matters required by the Director of Planning pursuant to clause 58 of the Regulation, which may be included in the attached letter.

The EIS must bear a certificate as required by clause 59 of the Regulation.

DEPARTMENT OF PLANNING
ATTACHMENT NO 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR A TRANSMISSION LINE

It is the responsibility of the determining authority to decide whether an EIS is required (unless the proposal is a prescribed activity).

Pursuant to S112 of the Environmental Planning and Assessment Act, 1979, where a proposal is a prescribed activity or where a proposal is likely to significantly affect the environment, a determining authority must, before deciding whether to proceed with the proposal, consider an EIS prepared in respect of the proposal.

In general transmission lines have the potential to create problems for local residents and landholders due to acquisition of easements, loss of access, severence effects on agricultural activities. Other impacts may include sterilisation of minerals, impacts on landscape, conservation areas, flora and fauna, and visual amenity. Location of the transmission line also requires consideration of the health, safety and amenity of the local community.

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for transmission lines. It is the applicant's responsibility to identify and address, as fully as possible, the matters relevant to the specific development proposal in complying with the statutory requirements for EIS preparation (see Attachment No 1).

The matters nominated in this paper are not intended as a comprehensive identification of all issues which may arise in respect of transmission lines. Some of the issues nominated may not be relevant to a specific proposal. On the other hand, there may be other issues, not included, that are appropriate for consideration in the EIS.

Information provided should be clear, succinct and objective and, where appropriate, be supported by maps, plans, diagrams or other descriptive detail. The purpose of the EIS is to enable members of the public, the determining authority and the Department of Planning to properly understand the environmental consequences of the proposed development.

1. Description of the proposal

The description of the proposal should provide general background information on the location of the proposed transmission line.

- Details of the form and physical dimensions of structures, lines and conductors and any associated facilities that may be required;

- Proposed management and scheduling of construction including staging of works, source and transport and assembly of plant and materials, employment details, construction camps, access arrangements, temporary and permanent earthworks, hours of operation for construction works,.

- Description of existing easements and possible new easement requirements including procedures for the creation of such easements.

- Rehabilitation and maintenance proposals on completion.

2. The objectives of construction of the proposed transmission line should be described as well as its compatability with the existing regional transmission line network, including any provisions for rationalization with existing lines to avoid proliferation and any proposals for longer term augmentation of that network.

3. Description of the Environment

This should provide details of the environment in the vicinity of the development area and also of aspects of the environment likely to be affected by any facet of the proposal. In this regard, physical, natural, social and economic aspect of the environment should be described to the extent necessary for assessment of the environmental impact of the proposed development. In particular:

- Topography, geology and geotechnical data, ecology, meteorology, hydrology etc.
- Noise and air quality where appropriate for impact consideration.
- Aesthetics.
- Areas of visual significance and/or with potential for visual impact from the constructed line, eg skylines, treelines, river crossings, etc.
- Flora and fauna with particular regard for sensitive environments such as wetlands.
- Agricultural and mining activities that may be affected by the proposed works.
- Utilities and communications.
- Buildings and/or sites having architectural/ archeological/heritage/conservation significance.
- Socio economic aspects including local agricultural/ commercial activities, recreation, employment etc.

4. Analysis of Environmental Impacts

Environmental Impacts usually associated with transmission lines are listed below. Where relevant to the specific proposal, these should be addressed in the EIS:

- Impact on areas likely to be subject to urban growth or other land use change (eg conservation proposals).
- Impact on management or development of agricultural lands, commercial forests or other established or proposed urban uses.
- Cumulative impact taking into consideration existing linear developments including transmission lines, service corridors, roads and railways.
- Visual impact in relation to skyline, topography etc.
- Impacts on features or areas of local or community concern eg in respect of recreation or conservation etc.
- Impact on historic or archeologically significant sites and/or buildings.
- Impact on natural or conservation areas which may have wildlife or habitat or aesthetic conservation value.
- Impact on health or safety or amenity.

Proposed safeguards in respect of those matters relevant to the proposal should be clearly described and the EIS should provide an objective assessment of their efficacy, both during construction and on completion of the project, as well as proposals for monitoring environmental safeguards where applicable.

5. Assessment of Feasible Alternatives

the EIS should include a detailed assessment of the feasible alternatives considered for the proposal including the key physical and engineering constraints as well as pertinent environmental and economic factors including clear reasons for rejecting such alternatives in favour of the recommended proposal.

6. Contact with relevant Government Authorities

In preparing the EIS, it is suggested that authorities, such as those listed below, should be consulted and their comments taken into account in the EIS.

- The relevant local council(s) and regional planning authorities.
- The Environment Protection Authority in regard to air, water and noise impacts and relevant pollution control legislation requirements.
- The Department of Conservation and Land Management with regard to erosion control.
- The Department of Agriculture with regard to impact on agricultural activities.
- The Department of Mineral Resources with regard to mineral sterilisation and subsidence.
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance for the State.
- Any servicing authorities which may be required to supply water, power, etc.
- Any other authority that may have an interest and/or administrative responsibility in the area affected.

It is the responsibility of the person preparing the EIS to determine those Departments relevant to the proposed development.

7. Supporting Information

The EIS should refer by suitable appendices to all relevant studies/investigations that may have been carried out in support of the proposal. This supporting documentation should be made available during the period of public display of the EIS.

B

Appendix B
Responses from Public Agencies

Table B.1 - Summary of Responses to Public Agency Consultation

Authority Consulted		Comments
1. Department of Planning	□	The Director's Requirements are listed in **Appendix A**.
2. Department of Planning - Northern Regional Office	□	- Recommended obtaining a copy of the Byron Council Residential Development Strategy - Noted that Lismore City Council was preparing a comprehensive strategic plan for the entire LGA - North Coast Regional Environmental Plan 1988 (as amended) applies to study area. - North Coast Urban Planning Strategy being finalised. Strategy provides regional overview of potential for urban development on North Coast.
3. Lismore City Council	□	The Council has two areas within the bandwidth that could be developed as rural or rural residential. One area is in the Dunoon/Modanville precinct which is currently partly developed for rural residential purposes and this form of development may spread in the precinct in the near future. The second area is currently the subject of a study to determine whether the area is suited for future residential or rural residential development.
4. Byron Council	□	Provided relevant sections of zoning maps and lot numbers along preferred route.
5. Department of Mineral Resources	□	Activities unlikely to have an impact on mineral resources in the area and is likely to enhance the area's mineral prospectivity. An area of gas resources potential - i.e. the Walloon Coal Measures, is crossed by the preferred route though the route is not affected by any applications or titles administered by DMR.
6. NSW Agriculture	□	Indicated that the proposed route of the transmission line traverses four main areas of agricultural land; grazing, soybean and winter cereal crop for grain and annual ryegrass for cattle, macadamia plantations and banana crops. May be some land lost because of the need to construct bigger/stronger towers. If the new line covers a wider spread of land than the existing line an issue that may arise is the devaluation of the land. If the line is 7.5 m above ground level, it may restrict potential macadamia land from being used because of the problem with overhead irrigation. Provided an indication of the likely agricultural classification of land along the proposed transmission line route.
7. Australian Heritage Commission	□	No places listed in the Register of the National Estate are affected by the route and the Commission therefore has no comments to make.
8. The Heritage Council	□	No specific areas of concern - need to assess heritage significance of the land that will be affected by the proposed activity and the assessment should include natural areas and places of Aboriginal or historical significance, as well as buildings and works.
9. AGL Gas Companies	□	No objections to proposal. Company has no reticulation in the area.
10. Public Works Department	□	- Flooding to be considered across the Lismore Floodplain. - Augmentation of STP in progress and will require additional effluent ponds in floodplain - PP will need to liaise with Council for exact location during siting of final position of line.
11. Environment Protection Authority	□	Issues to be addressed:- - Details of proposed measures for control of air, noise and water pollution during the construction of the line. No formal approvals or licences will be required from the EPA with respect to these works. - Avoid disturbance of cattle tick dip sites. Report by Cattle Tick Dip Management Committee provided. - EPA received submissions re health effects from EMF and recommend that the EIS address this issue.
12. Forestry Commission of NSW	□	No comment.
13. Telstra	□	No comment.
14. Department of Conservation and Land Management	□	Comments are as per July 1993 letter (see **Appendix E** of the EIS), will make further comments on the final EIS.

Authority Consulted		Comments
15. Civil Aviation Authority	☐	Civil Aviation Authority Regulation 89Y to be considered.
16. National Parks and Wildlife Service	☐	- Supports reconstruction option as minimises environmental impact. - have issues FIS requirements. - Need to consider the impacts of lines on rainforest pigeons in FIS/EIS. - While no recorded aboriginal sites are noted within the bandwidth of the preferred route, archaeological surveys should be carried out by suitable personnel.
17. Department of School Education	☐	- The Department feel that the easement should be located at least 150 m from the school site. - Advised that many parents had voiced their concern relating to the transmission line route.
18. Hunter Water Corporation	☐	Area outside Hunter Water Board's area of operations and therefore no comments relevant to this proposal.
19. Bushfire Services	☐	Department has no comment regarding the preferred route. However, should consult with Byron district fire committee to provide local view on the project. Department is interested in viewing the EIS on completion.
20. National Trust of Australia	☐	The National Trust Register revealed no items of significance within the bandwidth of the preferred route.
21. Australian Nature Conservation Council of NSW	☐	Needs to be determined whether species listed as rare or endangered in the Route Options Paper occur within the vicinity of the preferred route.
22. Mine Subsidence Board	☐	As the subject area is not within a proclaimed Mine Subsidence District, the development is not subject to any building restrictions imposed by the Mine Subsidence Board.

C

Appendix C
Grid Planning Considerations

Appendix C - Grid Planning Considerations

Grid Equipment Electrical Ratings

All electrical equipment is designed with insulation capable of withstanding a range of voltages and most equipment is also designed to allow a maximum "rated" current to flow.

Insulation failure can occur on transmission lines and in substations where the voltage is large enough to cause damaging paths of electricity to form in the air or along surfaces (flashover). The most common cause of flashover is lightening strike on or near equipment. Areas with high air pollution would require a higher degree of insulation.

Equipment must be operated within current limits at all times. Otherwise, safety may be reduced and damage may occur due to overheating of insulating material. Conductors may also be damaged through metallurgical changes.

The thermal rating of a transmission line is based on two main principles:

(i) One aspect of safety near transmission lines is linked to the overheating of the wires. The wires must at all times maintain a minimum statutory clearance from the ground and other objects. As a transmission line carries more electricity the temperature of its conductors rise and consequently the conductors sag closer to the ground.

(ii) Overheating in transmission lines can also cause damage because high temperatures anneal the conductor. The annealing changes the metallurgical properties of the metal and subsequently reduces its strength over time.

Substation equipment affected by overheating includes conductors, solid insulation and the coolants inside equipment.

Both lines and substation equipment overheat more easily during summer because of the high air temperatures and sunshine working against natural cooling, even though cooling winds are more prevalent.

Supply Voltage Levels

Supply voltages throughout the network must be maintained within a certain range to avoid damage to customer equipment. Too high a voltage level will overstress equipment insulation, resulting in overheating or breakdown of the electrical insulation. A voltage which is too low can also cause electric motors to burn out.

Australian Standard AS 2926 prescribes a nominal consumer voltage of 240 V with a range of 94% to 106%. The NSW Distribution Authorities equal or better this standard.

Bulk supply to Distributors is provided by Pacific Power at nominal voltage levels ranging from 11 kV up to 132 kV, depending on the area involved. It is generally planned to provide a bulk supply voltage to PacificGrid customers varying between 105% of the nominal voltage level during times of high load. Depending on the customer's network, voltages outside this range may be necessary or acceptable in isolated instances.

Transformers and voltage compensation plant are installed to maintain the voltage at the bulk supply point and consumer premises to within the prescribed ranges. Most transformers are able to automatically control their output to meet consumer requirements.

In order to cater for local emergencies on the transmission grid, such as the forced disconnection of a critical line after a fault, PacificGrid has installed undervoltage load shedding (UVLS) equipment at several locations.

As the voltage after a supply equipment fault depends on the amount of electricity being used, controlling the interruption of customers can make a network failure less critical. Control equipment automatically disconnects a proportion of customers on occurrence of a which causes a low voltage, allowing the voltage to return to near normal levels. This avoids damage to customer equipment. The most extensive application of this scheme in NSW is on the Far North Coast. Following such an equipment failure, local generation can be started up and used to restore part or all of the load disconnected by these means until the failed equipment can be returned to service and normal operation resumed. This has enabled major works to be significantly deferred but with a reduction in the reliability of supply.

Bulk Supply Point Forecast

PacificGrid supplies the distribution in NSW at Bulk Supply Points (BSP). Bulk Supply Point (BSP) forecasting is a co-operative effort between PacificGrid and the Distributor whose officers carry out the initial forecast. This forecast is used primarily to determine the requirements for reinforcement of the grid to supply local area developments. The forecast is derived from the expected requirements for each Zone Substation in the Distributor's area.

The Distributor's forecast is based on the long involvement with customers and their needs and an intimate knowledge of the consumer behaviour in its district.

Typically the Distributor will consult the local shire councils, community groups, business, rural and service organisations.

The various factors that may influence the forecast are; new loads, changes in capacity of large consumers, demand trends and recorded demand data. The factors are discussed by both PacificGrid and the Distributor to produce a final forecast.

The Role of Economic Analysis in Planning the Transmission Network

Economic analysis plays a major role in the planning of the transmission grid. The economic viability of alternative options, including a no-build option, is usually a significant factor in the choice and timing of preferred developments.

□ **Factors Commonly Considered in Economic Analyses**

The following aspects are normally considered in the economic analysis of transmission network augmentation options:

- The capital cost of the plant and equipment is initially estimated from recent purchases and construction contracts. As design works proceed, these early estimates are progressively refined.

- The expected cost of interruption of supply to customers (commonly termed "the cost of unsupplied energy") is estimated in three stages. Firstly, the risk of system failure is calculated from historical records of equipment reliability levels. This is combined with forecast data of the periods of critical electrical demand, to estimate the likelihood of customer load being interrupted during such a failure, yielding a quantity of energy in kWh which is expected to be interrupted (unsupplied). Finally, a value is placed on this quantity which reflects the economic cost to customers of an unreliable supply.

- Differences in network electrical losses are quantified, using electrical models of the grid, in terms of kWh of energy dissipated or lost. The economic value assigned to these losses is based on the cost associated with producing the additional lost energy at power stations and its transmission to the point of consumption.

- Annual operation and maintenance costs are quantified for any additional plant and equipment involved. In some instances there may be an offsetting benefit, where an augmentation provides reserve capacity which allows maintenance to be scheduled more economically.

The procedures used by PacificGrid for economic analysis adhere to the State Treasury's guidelines. They are in widespread use and are similar to those used by all NSW State Departments and enterprises. Indeed, for major projects, such analyses are submitted to Treasury for review before budgetary approval is obtained.

Some of the consequences of each option are difficult to evaluate in terms of dollars and are qualitatively assessed and contribute to identifying the favoured option. Relative electricity losses are used as a measure of the unnecessary consumption of energy resources and the associated production of greenhouse gases in the global environment.

An important facet of economic analysis is the boundary of the study. PacificGrid carries out analyses on the basis of maximising benefits to the community, rather than from the narrower perspective of maximising benefits to PacificGrid. This is the reason that the cost of unserved energy is included in the analysis - it is a cost to the community. For the same reason, loss of revenue to PacificGrid or the Distributor is not included in an economic analysis because it is just a balanced transfer of money between the community and PacificGrid and not an overall cost to the community.

- **Choice of Option**

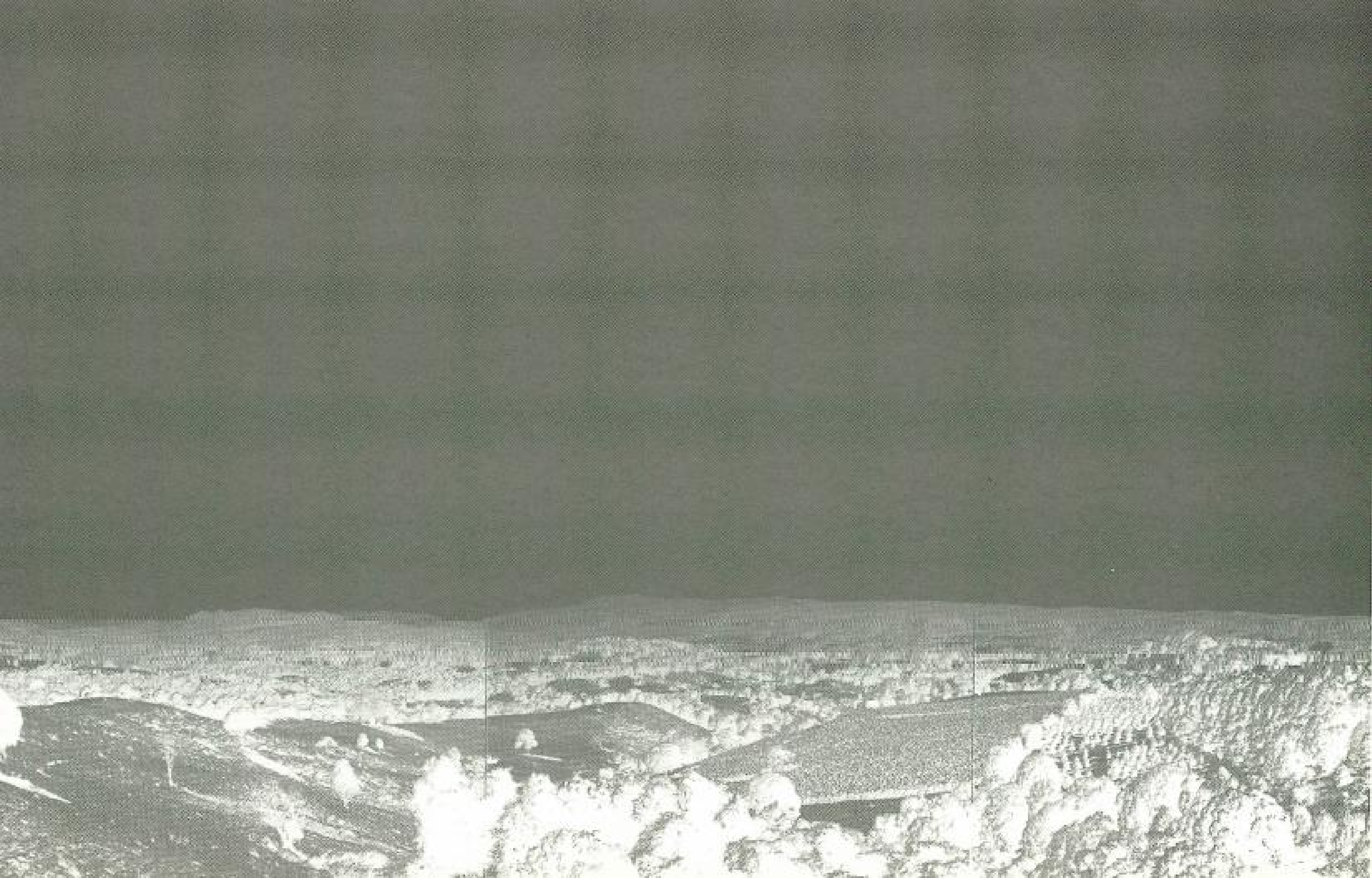
Alternative options are firstly subjected to economic analysis in order to determine the economic form of development. This least-cost option would ordinarily be selected for detailed study unless other considerations influence the choice of a preferred plan.

- **Choice of Timing**

The preferred option is then subjected to further detailed economic analysis in order to determine the most advantageous date on which to complete the project. In most instances, because of the growth of demand, the individual costs and benefits of a project change over time, frequently escalating. This may be offset by the discounting procedure, which lessens the value of future quantities, so that there is generally an optimal date at which a project's net cost is minimised.

D

Appendix D Alternative Energy Sources



Appendix D - Alternative Energy Sources

Small-Scale Renewable Energy

□ Solar photovoltaic

Cells transform sunlight directly into electricity. A number of different types of cells are currently under development, primarily silicon polycrystalline, monocrystalline and amorphous cells as well as cells based on less common materials such as gallium and arsenic.

As of 1994, the cost of cells in Australia was about $6 000/kW (Schuck, 1992) and the conversion efficiency of the cells in the market place was in the range of 15 to 20%, with laboratory types approaching 25% (Schuck, 1993) efficiency. The expected population growth in the area needs at least an additional 2 000 kW each year. In terms of solar photovoltaic energy consumption, this means a cost of $12 million each year.

Pacific Power is involved in a national project which covers the installation of, and data collection and analysis from, 14 solar insolation monitoring stations.

Pacific Power is proceeding with a kilowatt photovoltaic demonstration project at Mt Piper Power Station as part of its agreement with the UNSW Photovoltaic Centre.

□ Solar Thermal Energy

Solar Thermal Energy is the conversion of solar energy into electricity using a solar thermal electricity plant. Solar collectors concentrate the sunlight to create a high temperature fluid that can be used to power either a conventional steam turbine cycle, or a Stirling engine.

A number of different collector types are being developed around the world - the major ones are troughs, dishes, and central receivers. Dishes can generate steam at over 500^{0}C, while troughs can presently generate steam at nearly 400^{0}C (Stein, 1993).

A good feature of solar energy is that high air conditioning use coincides with maximum sunshine absorption by the cells. That is, when the energy demand is high, the amount of energy available is correspondingly high.

□ Storage of Energy

Energy storage systems offer a means of storing excess electrical energy available during 'off peak' periods for supply when the demand is high.

Energy storage systems include hydro pump storage and batteries, and innovative schemes such as flywheels, superconducting inductors and compressed air energy storage. The first two are still at the conceptual stage, while two compressed air energy systems are operating in the world, with others under construction.

Energy storage is often required with renewable energy sources to overcome their unpredictability. " Before solar energy can be used on a widespread basis, low-cost energy storage and transport systems must be developed. If solar energy could be converted to chemical energy in the form of substances that can be stored at ambient temperatures and can be transported, two of the most serious limitations of solar energy would be removed - its periodic unavailability and the need for space for solar collectors at the user site. " (Engineering World, August 1994).

Large-Scale Sources Connected to the Network/New Local Energy Sources

- **Coal-fired or Diesel/Gas Combustion Plant**

Before 1979, NRE owned a 29 750 kW coal-fired power station near Grafton. This plant closed after over 30 years of operation for economic and reliability reasons.

- **Solar Farm**

When Solar Photovoltaic Energy technology is implemented on a large scale extra costs occur due to land acquisition, construction and equipment to improve quality, which adds about $5 000/kW to the $6 000/kW capital cost of photovoltaic cells. These costs are nearly 10 times that for coal derived energy. Solar photovoltaic electricity connected to the network costs about 40 c/kWh or more, with 95% of this being the capital cost component (Schuck, 1993).

Technical advances recently announced by the UNSW Photovoltaic Centre could mean cost reductions in PV cells at the end of the planned 10 years development and commercialisation program. The use of poorer grade raw materials and thin film multi-layered techniques may see costs of $1 400/kW achievable in 10 years. However, added to this cost must be the Balance of System costs referred to above, required to make a complete power system.

354 MW of Solar Thermal Energy electricity plants using trough collectors are installed in southern California. Approximately 150 ha was required for an 80 MW plant (Stein, 1994). Energy from this plant is produced at 12.4 USc/kWh ($1989), which includes tax credits of an unspecified value.

□ Wind Farm

A new wind farm consisting of 9 x 225 kW turbines (2 025 kW) has recently been commissioned at a project cost of $5.8 million in Esperance, Western Australia.

The Victorian Solar Energy Council and SEC of Victoria erected a 60 kW Westwind wind generator at Breamlea. Units of up to 4 000 kW capacity have been installed in high wind areas of USA, Europe and Scandinavia but they are over 45 metres tall, costly and noisy during operation.

The economic use of wind energy depends heavily on wind conditions as the energy available in the wind is proportional to the cube of the wind velocity.

□ Hydro-Electric Plant

Hydro-Electric generating plant can be classified into two categories: Conventional Hydro- Electric Stations and Pumped Storage and Hydro-Electric Stations.

In Conventional Hydro-Electric Stations, water is released from an upper storage to pass through the power station and to be discharged downstream. The capacity of the conventional hydro-electric plant is set by the available water head and regulated flow rate of the upper storage. However, in Pumped Storage Hydro-Electric Stations, water is released from an upper storage and collected in a lower storage after it passes through the power station. The water is then pumped back to the upper storage during off-peak periods when spare electricity capacity is available for pumping. The value of a pumped storage scheme lies in its ability to store energy available during off-peak periods for use during periods of high demand.

Within the Far North Coast area, NRE owns and operates conventional hydro-electric power stations. One is at Lavertys Gap near Mullumbimby with a capacity of 280 kW, and the other at Nymboida, on a tributary of the Clarence River, with a capacity of 4 400 kW. The generating capacity of Lavertys Gap is able to supply only a part of the immediate distribution network (approximately 10% of the annual growth), and furthermore it is available only part of the year due to lack of water. It could provide supply to about 250 - 300 people. In 1991/92, the power station supplied 904 000 kWh. The availability of the station was less than 37% in 1991/92, primarily due to dry weather patterns.

Investigations have shown that there is potential for large scale hydro-electric power generation development on the North Coast, with numerous large schemes having been considered in the Clarence River Basin as well as a major site in the Macleay River Valley centred on the

Apsley River. While these sites are viable, the capital cost of these projects would be high and significant transmission connections would be required. However, these locations would not provide an alternative for increased transmission capacity to the Far North Coast in the Planning Area.

Another area which has been considered is the upper area of the Wilsons River around Lismore. This area is relatively flat and would necessitate damming which would cause flooding of many nearby properties and small towns. Further upstream, north of Nashua, the topography is more suitable but the flows are less than those near Lismore. A typical dam would only provide about the same amount of power as the generator at Lavertys Gap. This would not meet the energy needs for the area and it would fail to meet the growth even for a single year. A typical generator installation would cost at least $750 000 with a further $12 million being required to construct the dam. In addition, there would need to be a transmission line to connect the generator to NRE's distribution network.

□ Fuel Cells

Fuel cells can be thought of as batteries which have their electrolytes constantly replenished. The fuel is usually in the form of hydrogen or a hydrocarbon such as methanol which is converted to electricity by chemical reaction. Invented over 150 years ago, fuel cells have been sufficiently developed only in the last 10 years to the extent that they can be considered for commercial use for electric power and cogeneration.

Fuel cells offer considerable benefits including high efficiency, silent operation and modularity. The potential exists to couple integrated coal gasification plant directly to fuel cells giving overall thermal efficiencies in the range of 50-60%, (Pacific Power, 1992) compared to the present thermal efficiencies of about 36% for large coal-fired plant.

Three different types of fuel cells are currently being developed and evaluated for electric power production. They are generally classified according to the type of electrolyte used: Phosphoric Acid Fuel Cells, Molten Carbonate and Solid Oxide fuel cells (ECNSW, 1991).

□ Biomass

Biomass refers to energy sources derived from recent photosynthetic processes. Energy is usually extracted by combustion, gasification or fermentation of sources such as agricultural and forest residue, industrial and municipal wastes and crops specifically grown for conversion to fuels.

Schemes world- wide include rice husk gasification, use of rapeseed oil as a fuel, landfill gas power plants, combustion of vine pruning, bagasse combustion, sewage gas fired engines, nut hulls, cotton stalks, corn cob and stalk, woodchip waste and sawdust combustion and water hyacinth bio- gas generation, to name a few. In addition, fast growing forests could be harvested specifically for fuel.

Most biomass power plants today use combustion to convert the energy stored in dry biomass material to heat. The heat is used to create steam which drives a generator which produces electricity. The chemical energy stored in biomass was derived via photosynthesis from solar energy. The technologies for converting chemical energy in biomass to electricity are very similar to conventional technologies which convert chemical energy in coal, oil or natural gas to electricity.

Many biomass power plants are also designed to use agricultural, industrial and municipal waste as energy sources. Some are cogeneration plants which are designed to make use of the waste heat from industrial processes. The biomass energy technology is nearing maturity. It includes the production of electricity or the cogeneration of electricity and heat using gasified biomass with advanced conversion technologies.

Electricity generation utilising biomass resource to supply the grid has not previously been attempted in Australia and is therefore an option which requires a degree of experimentation in this country.

The biomass gasification technology which is considered cleaner, more efficient and therefore favoured as a future option is still in an early stage of development in Australia and overseas.

E

Appendix E
Route Corridor Identification Process

Appendix E - Route Corridor Identification Process

1.1 Route Options Paper

An investigation into potential corridors within which a transmission line could be constructed was undertaken by Sinclair Knight Merz in 1993. The purpose of the process was to involve the community in the development of the possible route corridors at an early stage in the process, and to provide the community with the opportunity to comment on the alternatives developed, to assist Pacific Grid with the selection of the preferred option.

The objectives of the route option process were to:

- identify the constraints relevant to route selection through consultation with the community, government agencies and other organisations
- undertake specific studies to supplement available information on identified constraints and opportunities
- develop potential route corridors within which a transmission line could be constructed.

The main phases involved in the selection of the corridor alternatives to identify constraints to route selection included consultation with the community and government agencies, constraint mapping, and development of possible route corridors.

A number of different routes were identified, using a methodology which could accommodate, as far as possible, the views of the community and the authorities in the light of the constraint mapping.

The following route corridors were identified as possible alternatives:

- reconstruction of the existing 66 kV transmission line owned by Northern Rivers Electricity, incorporating a western variation
- central corridor with northern and southern variations
- railway corridor with a link between the railway and central corridors
- southern corridor option.

1.1.1 Consultation Process

Community consultation was initiated in early June 1993 and involved discussions with established community and industry groups, key individuals and local councils. These groups assisted in identifying representatives for workshops which were then held in July 1993. Each of 3 workshops (held at Lismore, Dunoon and Eltham) was attended by approximately 40 people and consisted of a presentation followed by group discussions. During this period many individuals visited Pacific Grid's Lismore Information Centre which was staffed throughout the process, and contacted Pacific Grid using a "008" number set up for the program.

Those attending the workshops identified a number of constraints to the siting of the transmission line and also raised other matters, including questions concerning the need and justification for the line and issues of compensation and access.

The community was consulted further, following preparation of the preliminary route corridor alternatives. Maps showing the preliminary route corridors were displayed at a number of locations throughout the district (Bexhill, Tullera and Goonengerry) and the corridors discussed further with the community. Maps were also continually on display in the Information Centre located the Strand Arcade in Lismore. There were suggestions made for variations to the draft route corridors and these included modifications to corridors, removal of corridors or links, and some new links in certain areas. In many cases, the suggestions were adopted.

Liaison with government agencies was also undertaken and comments from government departments were taken into consideration during the preparation of the route alternatives.

1.1.2 Constraints Identified

Constraint mapping was carried out following specialist flora and fauna studies and discussions with the community. The major constraints to the location of the line identified during the preparation of the ROP included flora, fauna, land use and aesthetic considerations. In addition, concerns regarding electro-magnetic fields were raised.

Flora - The vegetation study carried out involved mapping 10 identified vegetation units in the region and determining the level of conservation significance accorded to each unit. The vegetation units broadly reflected the structural form of the vegetation and the extent of past disturbance.

The vegetation units identified in the region included:

1. Closed Forest
2. Closed Forest Communities with Eucalypt/Brush Box Emergents
3. Disturbed or Regenerating Closed Forest
4. Wet Sclerophyll Forest
5. Dry Sclerophyll Forest
6. Woodland or Regenerating Sclerophyll Forest

7. Swamp Sclerophyll Forest
8. Swamp Woodland
9. Horticulture
10. Cleared Land.

A large number of rare or threatened species were identified as occurring in the area during the course of the study, though some of these species may only occur on the edge of the study area or in the forested lands of the Nightcap Range. Remnant forests of the Big Scrub were identified as having high significance for nature conservation, as they are remaining remnants of a significant rainforest area in eastern Australia.

Fauna - A fauna study was undertaken to identify significant areas of fauna habitat which may be affected by the proposed transmission line. A large proportion of the native fauna recorded as potential or known inhabitants of the region, were regarded as unlikely to be affected by the proposed transmission line. This was due to the fact that most of the species were widespread and abundant, occurring in habitats which would not be significantly affected by the proposal. In addition, most of the fauna species were regarded as tolerant of a certain level of habitat disturbance and/or highly mobile.

Two groups of native fauna were considered to be of particular significance and these were those species restricted to or primarily dependent on rainforest habitats and endangered species (including the koala). Communities and habitats regarded as having potential value for native fauna in the Lismore Plateau included riparian vegetation corridors along streams and waterways, swamps and wetlands, remnant or regrowth eucalypt forest and woodland, and remnant or regenerating rainforest patches. Fauna constraints were mapped as primary, secondary or tertiary

Land Use - Information regarding existing and potential land use in the area was collected. Constraints taken into consideration included the location of inhabited buildings, horticultural plantations (including macadamia, pecan, and banana plantations) and planning considerations. In terms of land zoning, both Lismore City and Byron Councils stressed the need to avoid prime agricultural land, potential subdivisions and scenic protection zones.

Aesthetics - Aesthetic issues were identified as being significant since the region has a high scenic quality and value, with the mountains and slopes of the Nightcap Range providing an attractive backdrop to the settled valleys of the plateau. The high scenic quality of the area enhances its tourist potential and the value of the land for rural residential development. The main factors governing the visual impacts of a transmission line through the area included the topography, vegetation cover and visibility. In addition, the viewing background and distances between the line and residences needed to be considered.

Other - A range of other issues were also considered during the development of the route corridors. These related to the concerns raised by residents during the community consultation, and were primarily concerned with minimising the impact on the proposed transmission line on people in the area. The community also raised concerns regarding the effects of EMF.

1.1.3 Route Corridor Development

Inputs to the ROP route corridor development were from three major sources. These were:

- community views on the selection criteria to be used and specific route options
- specialist studies used in determining the location of constraints, particularly flora, fauna and land use constraints
- investigations by Pacific Grid to identify technical constraints on the transmission line and develop preliminary structural designs for the alternative route corridors.

Specific Routes Recommended by Community

During discussions held with the community, the community suggested a number of specific route corridors in which to locate any future line. These were the:

- Existing 66 kV Corridor - Within the community, there was a strong preference for upgrading the existing 66 kV line, currently owned by Northern Rivers Electricity. There was a general feeling amongst the community that by using the existing corridor, the overall impact in the region would be lower than that created by constructing a new line in a new corridor within the area.
- Railway Corridor - The alternative of erecting the line within the railway corridor was also suggested. It was highlighted that this could be achieved by using the State Rail reserve (rail easement) which would avoid interference with private property. Given that the rail line already exists, community members suggested that an adjacent transmission line would not represent a new element into the landscape and would therefore have a lower impact on the area. It should be noted that this route required a new corridor to take the line from the railway to the Lavertys Gap substation.

- Existing Service Corridors - The community advocated the idea of parallelling other existing service corridors such as roads, lower voltage (11 kV) local supply lines and pipeline easements.

The community also made it clear that any route selection methodology chosen must allow these options to be seriously considered.

Recommendations of the ROP Flora and Fauna Studies
Sinclair Knight Merz commissioned specialist flora and fauna studies reports which were made available to the community. The consultants made a number of recommendations on the potential route.

- Flora

  The recommendations of the report stated that the preferred route should:

  - pass through areas which have already been cleared of native vegetation;
  - be restricted to existing disturbed corridors such as major roads, railway lines and existing transmission line routes, as far as practically possible;
  - avoid patches of undisturbed forest areas with low density of Camphor Laurel;
  - avoid areas where active regeneration of rainforests is being undertaken;
  - avoid locations which will exacerbate or magnify existing threats to the survival of rainforest remnants.

- Fauna

  - In regard to native fauna, the specialist report noted that it is preferable to locate the transmission line entirely within cleared land, avoiding areas of rainforest, riparian forest or other natural communities which contain valuable fauna habitats. Habitats which are considered to be of high conservation value should not be disturbed by the construction of the transmission line.

These recommendations were taken into consideration during the route selection process.

Route Selection Methodology
A route selection process was devised that catered for community views and expectations, and the investigations carried out as part of the study, without favouring any particular option put forward.

It was considered important that a route selection process be devised that could accommodate community views and expectations without prejudicing particular options put forward by the community. It was also clearly stated by the community that the route selection methodology must not prejudice these options in any way. It was pointed out that in the 1987 EIS, the options of using the existing 66 kV line and rail line corridors were rejected on the grounds that they did not satisfy the constraint hierarchy.

Consultation with the community showed very clearly that some options should be considered, for example, the reconstruction of the existing 66 kV line option and the options to use other existing service corridors.

Since a single route selection system would limit the available route options, route corridor alternatives were generated based on separate criteria. These criteria have been grouped as follows:

- use existing service corridors (i.e. roads/railways/powerlines/water easements)
- reconstruction of the existing 66 kV line over all or part of its length
- minimise impacts on native fauna and flora including regenerating flora
- minimise impacts on primary producing land.

Criteria were also developed which were common to all route concepts. These include aesthetic values, maximising distance from residences and practical engineering constraints.

Route corridors, or route corridor sections, were developed for each of the above criteria. Every effort was made to develop route corridors which satisfied the criteria, but this was not always possible.

Each of the above groups of criteria were separately investigated and mapped. This initially resulted in a very large number of corridor sections or "links". From these sections, potential corridors were developed. Some additional links between options were also developed based on particular criterion. This allowed complete corridors between Lismore and Mullumbimby to be developed based on a combination of the criteria.

Some of the initial corridors were discarded in the early mapping phase. The main reason for this was repetition within a small area. In many specific cases there was the potential to develop either one very wide corridor or several narrow corridors within the same area.

In order to reduce the overall land area affected by the corridors, a single narrow corridor was adopted. In cases where all selection criteria were satisfied, the chosen corridor was based on engineering constraints and in some cases, the alignment of property boundaries.

A draft set of route corridors were presented to the community. The results of this display was a further refinement of the corridors. This refinement included both widening and narrowing of corridor options at specific locations to take into account land owner concerns and other information received, such as approved subdivisions and recent house construction, which did not appear on the air photos. Some corridor options were also eliminated.

The final route corridors were shown on a separate 1:25,000 map which formed part of the Route Options Paper. These routes are described in the following section.

1.2 Description of Route Corridors

Each of the route corridors identified in the ROP are discussed below and are shown in **Figure 4.1**.

1.2.1 Reconstruction of Existing 66 kV Line Option

This option involves the replacement of the existing Northern Rivers Electricity 66 kV wood pole line between Lismore and Mullumbimby, with a new double circuit transmission line carrying both the new 132 kV line and a replacement 66 kV line. The 132 kV line would initially be operated at 66 kV.

The existing 66 kV line passes over rainforest remnants, faunal corridors, regeneration areas and established agricultural plantations. Although improving the electricity supply in the region by upgrading the existing 66 kV line will result in an increase in the level of impact of the line in its location, the overall impact would not be as significant as if a separate line were constructed.

The upgrade of the line would involve the removal of old structures which would be replaced with new double circuit, single pole structures. The proposed upgrade would potentially have the same alignment, with possible deviations determined in consultation with affected landholders.

Western Variation - The Western Variation of the Reconstruction Option was an alternative link between Lismore and Dunoon which avoided rural residential areas between Lismore and Dunoon (see **Figure 3.1**). The variation would have imposed a new transmission line on another area with similar vegetation systems and development and it was considered that there were no significant benefits to be gained from this variation over the Upgrade Option.

1.2.2 Central Corridor Option

The Central Corridor Option was developed to minimise the impact of the line on native vegetation and prime agricultural land, although this option still required clearing of disturbed forest and crossed large areas with reafforestation potential.

The Central Corridor had two variations, a Northern and a Southern Variation, both aimed at avoiding significant vegetation systems. The Northern Variation avoided significant vegetation systems by passing through prime agricultural land.

1.2.3 Railway Corridor Option

This option consisted of using a corridor which parallelled the existing railway line from Lismore to just beyond Nashua, using the existing railway easement within the study area as much as possible. Some departures from the railway easement were necessary in villages and other built up areas and in areas of cut and fill where close parallelling would not have been possible.

A link between the Railway Corridor and the Central Corridor was identified in the Bexhill/Corndale area.

1.2.4 Southern Corridor Option

The southern corridor was also developed to minimise the impact on native vegetation and prime agricultural land, and was a variation of the Railway corridor. The corridor departed from the Railway Corridor at Woodlawn and headed eastward through McLeans Ridges and Pearces Creek to rejoin the Railway Corridor at Nashua.

The eastern section provides the only option to the existing line option into Lavertys Gap.

1.3 Summary of Submissions to the Route Options Paper

The ROP was put on display from 23 November, 1993 to 23 December, 1993 and submissions were invited from the community.

Nearly 200 submissions were received, which included many received after the advertised closing date. The common issues raised in the submissions are summarised below.

1.3.1 Community Submissions

- **Electric and Magnetic Fields** - Many submissions expressed concern at possible health risks from electric and magnetic fields. Submissions referred to reports of studies that claimed to show links between transmission lines and childhood leukaemia and other human illnesses, effects on animal health, difficulties in growing organic fruit and other implications such as a claimed effect on electrical equipment. Some submissions specified the minimum proximity to housing they considered acceptable.

With respect to the issue of possible health effects associated with electric and magnetic fields, Pacific Grid has a policy of working prudently within the guidelines of impartial competent national and international health authorities such as the World Health Organisation and the National Health and Medical Research Council of Australia.

- **Property Values** - Many submissions objected to the route corridor being located near their properties on the grounds that it would adversely affect property values. Submissions claimed that property values would be affected by visual impacts, restriction on usage and EMF concerns of potential purchasers. They pointed out that many residents have moved to, and built in this region as their investment for a secure retirement. Some requested full purchase of their affected property and others raised the question of compensation for the entire value of a property when the easement affected a major portion of a small landholding. The effect on subdivision potential was also raised.

  With regard to compensation, it should be noted that State legislation guarantees that the amount of compensation will not be less than the full market value of the land unaffected by the proposal.

- **Native Flora and Fauna** - Many submissions raised the issue of the effect of the proposal on native flora and fauna, in particular stressing that remnant rainforest and native vegetation areas should be avoided, as should fauna habitats and existing and planned fauna corridors. Submissions listed flora and fauna observed on individual properties or nearby, and detailed plans for extensions of fauna habitats and regeneration of forest.

  While the flora and fauna studies undertaken for the ROP and the submissions received on the ROP were taken into account in the selection of a preferred corridor, additional work has been undertaken on the preferred route corridor.

- **Primary Production** - Many submissions expressed concern at the impact of the proposal on agricultural activities. These concerns included the protection of wind breaks established to protect fruit trees, the impact on macadamia plantations, commercial timber plantations and aerial spraying and irrigation. Restrictions on future possible operations were also mentioned.

Impacts on primary production as a result of the transmission line are primarily financial and can be addressed by appropriate landowner compensation.

- **Visual Impacts** - Many submissions objected to the construction of the transmission line on the grounds of its visual impact in a region of high scenic quality and value. Factors such as distance between the line and residences, and the viewing background to the line, dictate the extent to which mitigating measures such as minimal easement clearing, avoiding visually prominent areas, selective tree planting, painting of poles and selection of compact designs will be successful in minimising the visual impact of the line.

- **Potential for Energy Conservation and Demand Management to Remove the Need for the Line** - Issues of energy conservation and demand management concerned many of those making submissions. A number felt that a new transmission line was not required, disputing the load growth figures and asserting that a genuine and active campaign to promote energy efficiency and conservation, demand management and renewable technologies would eliminate the need for extension of the high voltage system. They further claimed that such a campaign would assist in reducing greenhouse emissions. Some submissions called for an independent assessment of the need for system augmentation.

  Pacific Grid and Northern Rivers Electricity actively pursue programs encouraging the efficient use of energy. However, the growing population of the North Coast area is placing increasing demands on the electricity system and augmentation of the high voltage system is required now to ensure that a reliable and secure supply is maintained. The new line will reduce electrical losses in transmission and reduce generation requirements and carbon dioxide emissions.

- **Consultation** - A number of submissions were critical of a claimed lack of consultation by Pacific Grid during the route options process. This related to either specific instances of not receiving newsletters or other information, or to general assertions that the consultation conducted was not genuine. In contrast, a number of submissions complimented Pacific Grid on the time and effort put into the consultation program.

  During the route options selection process, every effort was made to inform everybody potentially affected by the proposal and extensive opportunities for comment and input were provided.

- **Pollution and Noise** - Pollution from the construction activities was raised by a few people. Noise impacts associated with humming and buzzing of the line and general noise associated with wind caused by structures were also raised.

- **Safety** - A few submission expressed concern regarding the immediate safety of people living in close proximity to the operating power line due to electrocution should the line fail.

- **Invasion of Privacy** - A couple of submissions expressed concern at the invasion of privacy represented by having to grant access to the easement for maintenance work.

- **Tourism** - Some submissions raised concerns about the impact of the line on the tourism potential of the district through loss of scenic amenity and fears associated with EMF issues.

- **Interference with TV, Radio and "Ham" Radio Reception** - Concern regarding the operation of electrical and radio equipment was raised in some submissions.

1.3.2 Submissions from Government Agencies

The government agencies approached during the preparation of the route options corridors are listed below. Their responses, comments, and suggestions are also given below.

- **Lismore City Council** - provided details of its Local Environmental Plan 1992 as well as particular areas where the transmission line, though permissible, would not be appropriate. These zones are 1(b) - Prime Agriculture and 7(a) - Environment Protection (Natural Vegetation and Wetlands). Both zones were mapped and form part of the Land Use Planning Constraint Map, which is available on request.

  At the Council's meeting of 21 September 1993, Lismore City Council adopted a "preferred position" that "the 132 kV line be built upon the route currently occupied by the 66 kV line".

- **Byron Council** - provided a copy of its Local Environmental Plan 1988 (as amended) and Tree Preservation Order. Council advised the following:

  - Areas zoned Environment Protection (7 zones) should be avoided
  - Utility installations are prohibited in zones 7(j) and 8(a)
  - Stands of native vegetation and significant native species should be avoided
  - Rous County Council should be contacted regarding the proposed Wilson's River Dam
  - Council's Tree Preservation Order is applicable

- Areas zoned Urban, Village, Small holdings 2(a), 2(v), 1(c1), 1(c2), should be avoided as should Agricultural Protection Zones 1(b1) and 1(b2)
- Council would favour the utilisation of the existing route/routes.

- **Ballina Council** - provided details of its Local Environmental Plan 1987 and other planning information relating to the study. In general terms Council did not wish to raise any matter of concern in the formulation of route selection for the transmission line.

- **AGL Gas Companies** - have no reticulation within the study area and were therefore unaffected by the proposal.

- **Civil Aviation Authority (CAA)** - raised the requirements of Civil Aviation Regulation 89Y - Structures 110 m or more above ground level, which outlines the need for anyone erecting such a structure to inform the Authority. Advice associated with Lismore Aerodrome was also mentioned.

  The proposed structures are not of sufficient height to affect CAA regulations.

- **Commonwealth Environment Protection Agency (CEPA)** - CEPA referred the consultation request to the Australian Heritage Commission (AHC) and the Australian Nature Conservation Agency (ANCA). The AHC advised that the Boatharbour Nature Reserve, Boomerang Falls Flora Reserve, Blackbutt Plateau and Nightcap National Park are on the Register of the National Estate. ANCA provided details of known sites of endangered, vulnerable and rare plant species as well as rare vertebrates which should be considered in the development of the route options and the preparation of the EIS.

  Areas identified by CEPA have been taken into account in the constraint mapping.

- **Department of Bush Fire Services** - mentioned that impacts on bushfire management and the potential impacts of a transmission line on the fire regime in the area be discussed in any EIS prepared for the project.

- **Department of Conservation and Land Management (CaLM)** - raised matters for consideration including the removal of trees from protected lands (i.e. land having slopes in excess of 18^0; land mapped as environmentally sensitive or affected by erosion, siltation or degradation; land within 20 m of non-tidal streams). CaLM also noted that major clearing of Crown Land should be avoided, and that Crown Land should also be avoided if it is assessed to have a perceived higher use.

- **Department of School Education** - supported the construction of the existing 66 kV line Western Variation or the Southern Corridor, and mentioned the significant level of community concern regarding EMF issues and its desire to see schools avoided by the proposed routes.

- **Department of Mineral Resources** - while mention was made of a number of potential and existing mineral resources in the area, it was noted that a transmission line through any part of the area would be unlikely to sterilise any resources in the region. It is more likely that the proximity of such a line would make extraction of any resource more economically viable.

- **Department of Planning** - indicated that the route options should show awareness of the local urban expansion areas, the Big Scrub rainforest remnants, koala habitat areas and riparian vegetation within the study area. The Department also contacted the Australian Heritage Commission who provided some guidelines relevant to construction of any line with regard to heritage items affected by a line, and listed the 6 current heritage items registered in the Council areas of Lismore, Byron and Tweed.

  Other than the Mullumbimby Power Station, registered heritage items are located in towns and villages and will not by directly affected. Impacts on Mullumbimby Power Station will need to be addressed in the EIS.

- **Environment Protection Authority (EPA)** - provided a list of matters to be addressed in the ROP and subsequent EIS. This included issues such as air quality controls, waste control, stormwater controls, noise emissions, land contamination and acid sulphate soils.

- **Forestry Commission of NSW** - stated that they would not encourage any proposed route within the Goonengerry State Forest due to concerns over clearing of trees and loss of a potential timber resource. The issue of endangered species was also mentioned as of concern, and other issues worthy of consideration included the potential for fire, and the means of regrowth control under the lines.

- **Greening Australia** - gave advice on mapping of vegetation systems within the study area and the need to avoid areas of significant vegetation, in particular, remnant stands of the Big Scrub rainforest. Greening Australia suggested that an environmental levy could be placed on the development which could be used for specific environmental projects in the area including demand management initiatives and reafforestation projects. Mitigation measures such as replanting trees to compensate for any necessary clearing caused by the new line was also suggested.

Information on vegetation systems in the study area was used in the constraint mapping. Other matters, although outside the scope of the ROP, have been forwarded to Pacific Grid for consideration.

- **Mine Subsidence Board** - did not have any requirements affecting the line since the study area does not pass through any proclaimed Mine Subsidence District.

- **National Parks and Wildlife Service (NPWS)** - noted that the study area contains a variety of nature conservation and cultural attributes, including endangered fauna and habitats, rare plants, native vegetation remnants and sites of Aboriginal cultural significance. Accordingly, NPWS outlined a number of issues which should be addressed in the EIS prepared for the proposal.

  Specific information on rare and endangered species was obtained from NPWS during the flora and fauna studies. This information was used in the constraint mapping.

- **National Trust of Australia (NSW)** - provided a list of classified items in the study area, and the main item of interest to the ROP is the Mullumbimby Power Station.

- **NSW Agriculture** - responded by providing the Lismore and Byron agricultural land classification maps which cover the study area. In addition, they raised issues such as impact on horticultural development, visual impact and electric and magnetic fields.

- **Office of Energy** - had no pipelines, electrolysis or petroleum issues which would be affected by the proposal. Specific comments made included the fact that the proposal must comply with the requirement of the Electricity (Overhead Line Safety) Regulation 1991, and that State Rail should be contacted if the railway were to be affected.

- **Public Works** - noted that works within the floodplain would need to be in accordance with the State Government's Flood Policy. Selection of the route should consider the impact of flooding on the transmission line and the effect of the line on flooding.

  The issue of flooding was not considered as a specific constraint to route selection since it was a matter that could be accommodated in the engineering design of the structures.

- **Rous County Council** - advised verbally that the Federal Dam proposal was no longer the preferred option for water supply augmentation, but is now one of several options under consideration. Accordingly, the dam site was not treated as a specific constraint to route corridor development.

- **Royal Botanic Gardens** - raised the issue of minimising the impact of the line on flora and fauna and concurred with the flora and fauna reports.

- **State Rail Authority of NSW** - advised that should Pacific Grid decide that the final route is to cross the railway line or Station Rail property, an application must be made for approval to cross the railway and determination of costs involved.

- **Telecom** - advised that Telecom plant exists on all routes and modifications to some installations may be necessary. Consultation with Telecom is ongoing and is standard practice for any new line. Telecom installations did not form a specific constraint to route option evaluation.

- **The Pipeline Authority** - made no comments since the study area does not affect the Pipeline Authority.

- **Water Resources** - regarded siting the transmission line within existing easements as appropriate since this would reduce requirements for permits to construct across streams, allow for easy access by using existing infrastructure, cut maintenance costs, and reduce the need for felling of vegetation for a new easement.

F

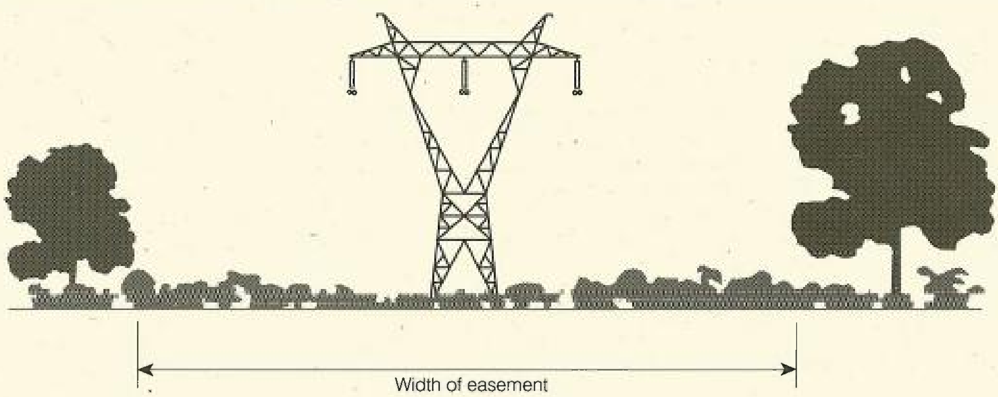
Appendix F
Transmission Line Easements

Easements

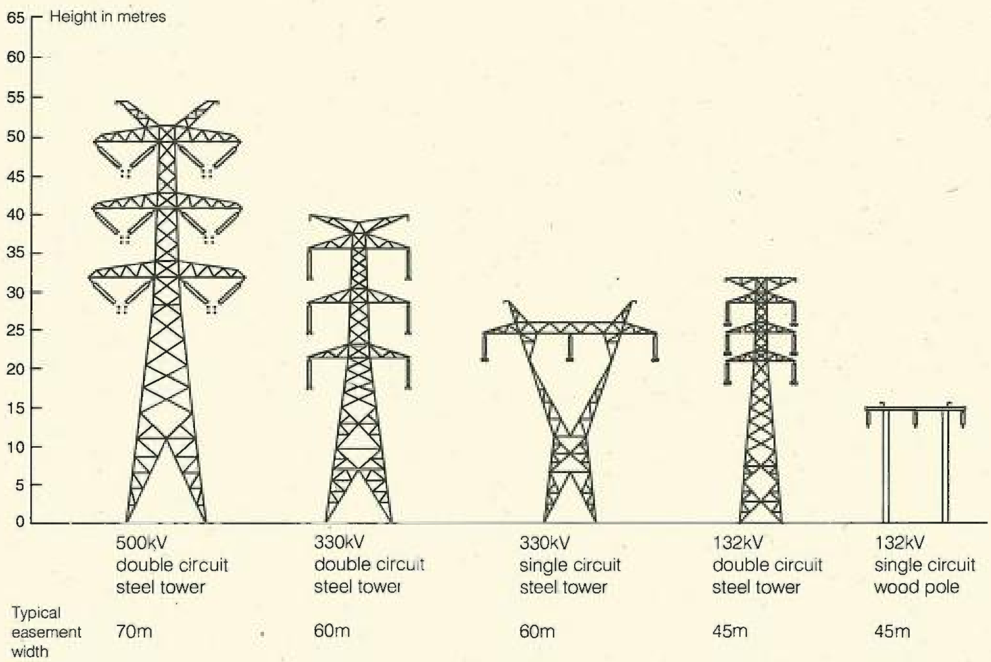
Transmission Line Easements

An easement is essentially a 'right of way' along the route of a transmission line by which public authorities such as Pacific Power gain access to the line to maintain it properly and ensure public safety.

Please remember that power lines carry high voltage electricity, which can arc across a gap with perhaps fatal consequences. Care should always be taken when working in the vicinity. This especially applies to certain activities such as handling long metal irrigation pipes, ladders, scaffolding poles, etc. This also applies to using equipment which, while safe when shut down, may be potentially dangerous when brought into operation - ie, cherrypickers, extending ladders, and the extended water spouts of high irrigation equipment.



Critical clearances for transmission easements. Note that line clearance - ie, height to powerline - is as critical as width, so beware of considerable backfilling in order to gain a flat surface for parking or tennis court.



Typical transmission structures and easement widths.

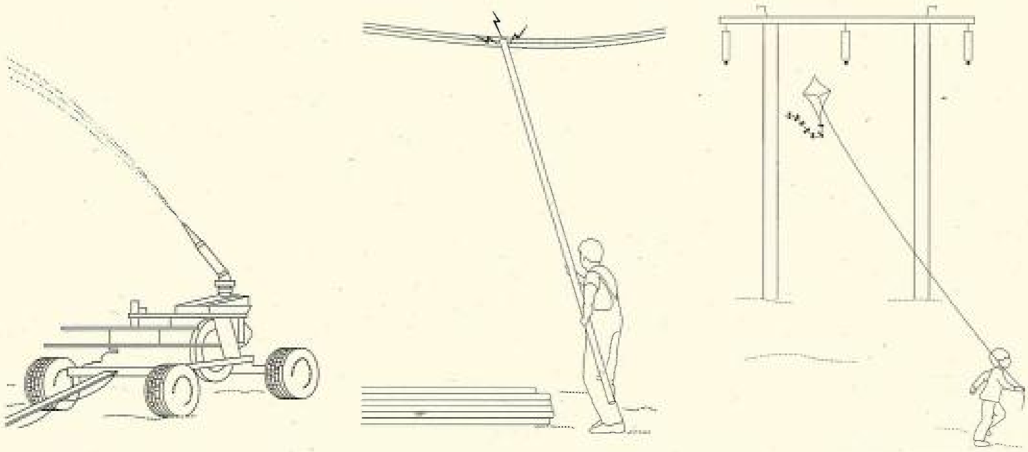
Produced by Pacific Power, Public Affairs
Park and Elizabeth Streets, Sydney
Telephone 02) 268 6800
FS No 7 - May 1993.
Printed on 100% recycled stock.

PACIFIC POWER

Most definitely not allowed!

Within an easement you cannot:

- construct houses, buildings or other substantial structures
- intall fixed plant and equipment
- store flammable liquids or explosives
- place garbage, refuse or fallen timber
- plant or cultivate trees or shrubs which will grow to a height exceeding four metres
- place obstructions of any type within 15 metres of any structure
- fly kites or model aircraft.



These activities are dangerous when close to transmission lines.

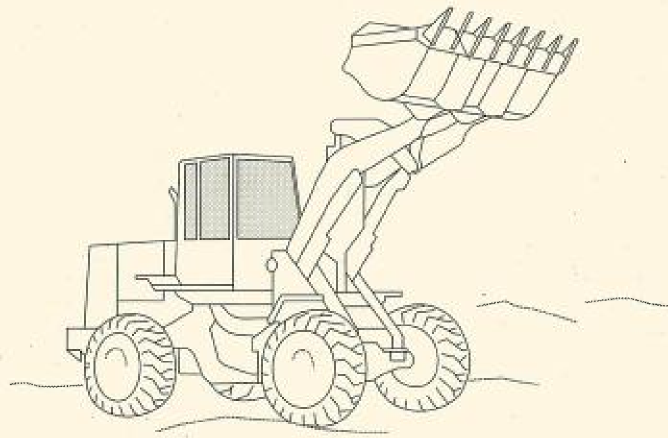
Easements - the rules

In general you can use the space available on an easement, provided that:

- unrestricted access is available to transmission structures at all times
- no obstruction is placed within 15 metres of a structure
- an unobstructed and continuous passage at least 4.5 metres wide is retained along the entire length of the easement
- adequate precautions are taken to protect transmission structures from accidental damage.

If you wish to use the easements you can:

- carry out normal gardening or agricultural activities such as grazing and farming
- grow trees or shrubs, but no higher than 4 metres
- park vehicles, provide height does not exceed 4.3 metres
- store non-flammable materials to a maximum height of 2.5 metres
- erect minor structures such as clothes hoists, barbecues, etc - but no higher than 2.5 metres; metallic parts must be earthed
- operate mobile plant and equipment provided their total height - ie when fully extended never exceeds 4.3 metres.



Mobile plant - You may be permitted to move or operate large machinery on a easement, which, when extended, will exceed 4.3 metres in height, provided you seek prior approval from Pacific Power.

The problem areas

Please make sure that you get prior permission from Pacific Power before carrying out any of the following activities:

- burn off (you must always get prior approval from Pacific Power before lighting any open fire on any easement)
- operate mobile plant or equipment exceeding 4.3 metres in height
- install utility services - ie, electricity, water, etc
- erect fencing - both electric and non-electric
- construct outbuildings, shed, garages, etc, where there is no suitable site clear of the easement area and where encroachments do not exceed three metres
- erect unroofed verandahs and pergolas attached to residences
- develop public sporting and recreational facilities
- carry out earthworks, dam construction, and quarrying activities
- develop subdivisions for residential or industrial purposes
- install and use irrigation equipment
- construct roads or tennis courts - but make sure you don't inadvertently reduce the line clearance height when backfilling
- construct inground or above-ground swimming pools, where there is no suitable site clear of the easement area and provided encroachments are less than 4.5 metres or not closer than 30 metres to transmission line support structure
- excavate ground.

In each of the above cases, please seek the advice of Pacific Power first before taking action - your structure may have to be removed if approval is not granted beforehand.

In some cases - ie, where the transmission line runs over a gully so the clearance is greater than usual - restrictions on part of an easement may be relaxed. Advice should be sought from Pacific Power if this is the case.

If you want more information about specific circumstances or a particular easement, please contact your nearest office.

Sydney	Old Wallgrove Road Wallgrove 2164	02) 620 1150
Newcastle	Wirra Crescent Waratah 2298	049) 678 678
Tamworth	Goonoo Goonoo Road South Tamworth 2340	067) 65 1666
Wagga Wagga	Copeland Street Wagga Wagga 2650	069) 21 4311
Orange	McLachlan Street Orange 2800	063) 63 8711
Yass	Wee Jasper Road Yass 2582	06) 226 9666

G

Appendix G
Flora Report

PROPOSED LISMORE/MULLUMBIMBY 132kV TRANSMISSION LINE

FLORA SURVEY

1.0 Introduction

Pacific Power is proposing to construct a 132kV transmission line from its substation near Lismore to a point near the Mullumbimby Power Station. This report forms part of the investigations and analysis of the environmental impact of the project.

In 1993 Pacific Power published a Route Options paper for the transmission line project (Sinclair Knight 1993). That paper considered transmission line route options within a broad study area bounded by Springrove Road to the south-west of Lismore, Terania Creek, The Channon, Rocky Creek Dam, Boomerang Falls, Coopers Creek, the Mullumbimby Power Station, Coolamon Scenic Drive, Bangalow, Newrybar, Fernleigh, Wollongbar and the Bruxner Highway.

A review of the flora of that broad study area was undertaken as part of the preparation of the Route Options Paper (Lembit 1993). This report draws upon information obtained during the review.

The flora survey undertaken for the Route Options Paper concluded that the impact of the proposed transmission line on significant native flora could be minimised by:

- siting the transmission line through areas which have been cleared of native vegetation

- restricting the route to existing disturbed corridors

- avoiding patches of undisturbed forest or rainforest stands with low densities of Camphor Laurel

- avoiding areas where active regeneration of rainforest is being undertaken

- avoiding compounding effects of existing disturbance on rainforest remnants.

Pacific Power subsequently selected the route of the existing 66kV tranmission line as the preferred route corridor. This route meets the second recommendation, namely, to restrict the route to existing disturbed corridors, and largely satisfies the requirements of other recommendations of the earlier survey.

This report describes the results of a survey of vegetation along the preferred route corridor.

2.0 Methods

In addition to work completed in the process of preparing the Route Options Paper, this report draws upon earlier surveys associated with the 1987 Environmental Impact Statement (Electricity Commission 1987) and submissions to that Statement, particularly Milledge (1988).

The survey for the Route Options Paper involved :

- mapping of the vegetation of the study area into ten classes representing broad structural forms and disturbance history at a scale of 1 : 25 000 prepared with the aid of 1 : 25 000 colour aerial photographs of the area

- a review of literature relating to vegetation of the study area

- a field survey to confirm the aerial photograph interpretation

The present survey involved field surveys within all of the more extensive areas of native vegetation traversed by the route corridor (locations of field survey sites are identified on an accompanying map). These included areas where fauna surveys were undertaken. Vegetation mapping of the route corridor and nearby lands was revised to show the plant communities and rainforest sub-alliances present with some information on the level of disturbance to rainforest communities. During this revision recent colour aerial photographs (scale 1 : 16 000) taken during May 1994 of the route corridor were used.

Mapping of rainforest communities follows the rainforest sub-aliances described by Floyd (1990b) whilst other communities are classed using the scheme derived by Specht (1970).

During the field inspections observations were made of the plant species present, the composition, height and cover of the dominant plant stratum, the density and composition of understorey strata, the presence of weed species and the extent and nature of previous disturbance to the vegetation.

Each of the more extensive stands of vegetation occurring along the preferred route were traversed during the field survey (see Figure 1). Forest stands surveyed included :

- rainforest remnants east of Booerie Creek Road,
- forest near Booerie Creek, east of Bentley Road,
- rainforest and open-forests, north of Borton Road,
- rainforest and regeneration at East Modanville,
- small patches of rainforest south of Fletcher Road,
- rainforest and plantation eucalypt forest on Dans Creek, off the end of Fletcher Road,

- rainforest near the Boomerang - Weigall Creek junction,
- rainforest along Turkey Creek,
- rainforest north of Emerson Road, near Repentance Creek,
- the slopes on either side of Coopers Creek,
- rainforest near Byrongerry Creek,
- rainforest south of Goonengerry along a closed road, proposed as a deviation to the preferred route,
- rainforest in a gully north of Sheaffes Road, near Goonengerry,
- rainforest and open-forest in the vicinity of Wilsons River, near Donaghys Bridge, and,
- rainforest and eucalypt forest near Wilsons River, south of Montecollum Road.

Whilst every effort was made to identify all tree and shrub species occurring in the areas surveyed, it is likely that some species were not identified or collected due to dense infestations of weed species and the steepness of the terrain in some locations. Accordingly results of the field survey for the current proposal were supplemented with previous studies of the vegetation of the Big Scrub area including those reported in Lott and Duggin (1993), Milledge (1988) and Electricity Commission (1987). These surveys have been undertaken over a range of seasons, including winter, summer and autumn.

Plant species unable to be identified in the field were collected for further study. Species identification was completed with the aid of Harden (1990, 1991, 1992), Williams, Harden and McDonald (1984), Williams and Harden (1980) and Beadle (1971-1987).

3.0 Physical Environment

The broad study area for the project largely corresponds to an area known as the Lismore Plateau. This Plateau is a moderate to highly dissected plateau of basaltic material derived from lava flows from the Mount Warning shield volcano.

The Lismore Plateau is drained by several significant watercourses which drain from the Nightcap Range. These include Coopers and Numulgi Creeks, Boomerang and Leycester Creeks, Terania Creek and the Wilsons River.

The landscape varies from undulating in the south to deeply dissected in the northern areas on the edge of the Nightcap Range. Much of the Plateau was originally covered by subtropical rainforest communities known collectively as the Big Scrub.

The route corridor passes from the Lismore Substation, to the west of Lismore, up the Booerie Creek valley, crossing to the east of Dunoon Road near Modanville. From near Dunoon the corridor heads in a generally north-east direction crossing Boomerang Creek near its junction with Weigall Creek and Turkey Creek near the head of its catchment. Coopers Creek is crossed downstream of Repentance Creek. South of Goonengerry the corridor heads north, through undulating to hilly country west of the Wilsons River before crossing the River about 1 km south of Mullumbimby Power Station.

4.0 Vegetation

North-eastern New South Wales is an area which supports an extremely high diversity of plant species and one of the highest concentrations of rare or threatened plant species in Australia. The majority of these species are typically associated with rainforest communities.

Floyd (1990b) states that the fertile soils derived from the basaltic lava flows of the Mount Warning Shield Volcano until 100 years ago supported an almost unbroken expanse of subtropical rainforest known as the Big Scrub. Extending over 75 000 hectares, Floyd states it was the largest area of lowland subtropical rainforest in Australia.

Within the area known as the Big Scrub, Floyd (1990b) found that four rainforest sub-alliances occur. These four suballiances and their occurrence in the Big Scrub and along the preferred route are discussed below.

Another three suballiances occupy small areas within the Big Scrub (Lott and Duggin 1993). These are Blue Quandong Sub-tropical Rainforest, Palm Sub-tropical Rainforest and Whalebone Tree-Austromyrtus spp. Dry Rainforest.

Eucalypt dominated communities also occur in the study area, but are less extensive than rainforest communities.

The high fertility of the area and the favourable climate means that much of the original lowland rainforest has now been cleared for agriculture. There are extensive horticultural plantations notably Macadamias along the route corridor.

With an increase in the community's awareness of the significance of the remaining rainforests, active regeneration of rainforest stands has been undertaken over the past twenty years. Plantations of forest trees such as Hoop Pine have also been developed in the area.

The plant communities which occur along and near the route corridor are described below.

4.1 Vegetation Map Units

1 White Booyong Sub-tropical Rainforest

The suballiance charcterised by White Booyong (Argyrodendron trifoliolatum) is found at low altitudes on fertile soil in sheltered valleys. Soils are kraznozems derived from basalts of the Mount Warning lava flows of 20 million years ago.

This suballiance is the most widespread natural vegetation type along the route corridor. In an undisturbed form it is typified by large, buttressed canopy trees, with a wide diversity of species present, numerous epiphytes, a shrub layer of tall ferns and rainforest shrubs and a sparse ground layer dominated by ferns. Climbing plants are common.

Tree species present include White Booyong, Cudgerie (Flindersia schottiana), Long Jack (Flindersia xanthoxyla), Rosewood (Dysoxylum fraserianum), Strangling Fig (Ficus watkinsiana), Moreton Bay Fig (Ficus macrophylla) and Myrtle Ebony (Diospyros pentamera).

Small trees and shrubs include Veiny Wilkiea (Wilkiea huegeliana), Twin-leaved Coogera (Arytera distylis), Banana Bush (Ervatamia angustisepala), Palm Lilies (Cordyline sp.), Orangethorn (Citriobatus pauciflorus) and Actephila (Actephila lindleyi). This stratum also includes Straw Treefern (Cyathea cooperi).

Ground layer plants include Giant Maidenhair (Adiantum formosum), Jungle Brake (Pteris umbrosa) and Shield Ferns (Lastreopsis spp.).

Stands of disturbed or regenerating rainforest have been generally included within this map unit for the purposes of this report. Such stands of vegetation are dominated often by the introduced species Camphor Laurel (Cinnamomum camphora), with a range of rainforest trees often associated with disturbance or rainforest edges. These include Red Ash (Alphitonia excelsa), Guioa (Guioa semiglauca), Foambark Tree (Jagera pseudorhus), Macaranga (Macaranga tanarius), Red Kamala (Mallotus philippensis) and Blackwood (Acacia melanoxylon).

Other weed species present include Mistflower (Ageratina riparia), Lantana (Lantana camara), Boneseed (Chrysanthemoides monilifera), Crofton Weed (Ageratina adenophora) and Wild Tobacco (Solanum mauritianum).

Two sub-classes have been recognised within this map unit to indicate condition of particular stands. Rainforest areas of better condition along or near the corridor have been mapped as unit 1A. Areas where disturbance is greatest or where natural regeneration is relatively recent have been mapped as unit 1D. These areas do not have a continuous canopy of trees.

Examples of White Booyong Sub-tropical Rainforest in the Big Scrub area include Victoria Park, Johnston's Scrub, Booyong Recreation Reserve and the higher parts of Big Scrub Flora Reserve. In their mapping of remnants within the Big Scrub area, Lott and Duggin identify two small remnants in the vicinity of the route corridor. They did not specifically discuss these remnants as they were relatively small. One remnant is about 1km south-west of the Repentance Creek Bridge whilst the other is adjacent to the Wilsons River just south of Donaghys Bridge. During the field survey these remnants were found to support a diversity of rainforest species. Other remnants of relatively high value in the vicinity of the route corridor occur at Boomerang Creek, Turkey Creek and the Wilsons River, south of Montecollum Road.

2 Pepperberry Tree-Stinging Tree-Fig-Hoop Pine Sub-tropcial Rainforest

This suballiance occurs on well-drained fertile alluvial lowland plains. The main example in the Big Scrub area occurs at Boatharbour Nature Reserve where 14 hectares of rainforest on alluvium is reserved.

Floyd (1990b) states that three tree strata occur at Boatharbour. There are emergents of Hoop Pine (Araucaria cunninghamii), Small-leaved Fig (Ficus obliqua), Moreton Bay Fig (Ficus macrophylla) and Pepperberry Tree (Cryptocarya obovata). The main canopy (second stratum includes Oliver's Sassafras (Cinnamomum oliveri), Red Ash (Alphitonia excelsa) and Giant Water Gum (Syzygium francisii). The lowest tree storey includes Red Kamala (Mallotus philippensis), Rough-leaved Elm (Aphananthe philippinensis) and Black Apple (Planchonella australis).

No examples of this rainforest type have been recorded along the route corridor and none of the sites surveyed supported this type.

3 Black Bean - Red Bean Sub-tropical Rainforest

This suballiance occurs on deep fertile soils associated with alluvial flats and benches where soil moisture is reliable. There is a canopy stratum consisting of Black Bean (Castanospermum australe), Red Bean (Dysoxylum muelleri), Strangling Fig, Stinging Tree (Dendrocnide excelsa) and White Booyong. Emergent Moreton Bay Fig trees rise above the canopy.

Examples of this sub-alliance may have a dense shrub layer with species present including Walking Stick Palm (Linospadix monostachyus), Smooth Wilkiea (Wilkiea austroqueenslandica) and Honeysuckle Bush (Triunia youngiana). The climber, Lawyer Cane Palm (Calamus muelleri) is also present.

Examples in the Big Scrub include Davis Scrub Nature Reserve, Johnston's Scrub, Minyon Falls and Boomerang Falls. Within the route corridor an example of this sub-alliance was found to occur at Wilsons River, south of Donaghys Bridge. This vegetation type would have been more extensive in the route corridor prior to clearing of the Big Scrub for agriculture.

4 Hoop Pine Dry Rainforest

Dry Rainforest dominated by Hoop Pine occurs on well-drained, rocky basalt plateau and steep slopes. Hoop Pine is typically an emergent over a dense canopy of small trees. Fig trees may also be present as emergents.

Common canopy tree species include Actephila, Crow's Ash (Pentaceras australis), Red Kamala, Native Cascarilla (Croton verreauxii), Yellow Tulip (Drypetes australasica), Ribbonwood (Euroschinus falcata var. falcata) and Python Tree (Austromyrtus bidwillii).

There is a shrub layer of medium to high density with spiny shrubs being noticeable. Species present include Brush Caper Berry (Capparis arborea), Finger Lime (Microcitrus australasica) and Deeringia (Deeringia amaranthoides).

The ground layer is of very low density, but vines are common particularly in disturbed areas. Vines include Water Vine (Cissus antarctica), Native Hoya (Hoya australis) and Corky Prickle-vine (Caesia subtropica).

The examples in the Big Scrub include Wilson Park and Rotary Parks in Lismore. None were found to occur within the route corridor, although this sub-alliance may have occurred in the area prior to clearing.

5 Palm Sub-tropical Rainforest

Sub-tropical rainforest dominated by Bangalow Palm (Archonotophoenix cunninghamiana) occurs on poorly drained alluvial flats. Associated tree species may include Maiden's Blush (Sloanea australis), Sandpaper Fig (Ficus coronata) and Hairy Walnut (Endiandra pubens).

There is a shrub layer of low density dominated by Straw Treefern. Vines include Lawyer Cane Palm and Pothos longipes.

Occurrences of this suballiance in the Big Scrub area include Minyon Falls and Terania Creek.

No occurrences of this sub-alliance were located within the route corridor during the course of the field survey.

The two other Big Scrub rainforest sub-alliances occur in specific habitats not encountered during the present survey, hence their exclusion from more detailed discussion in this report.

6 Sub-tropical Rainforest - Brush Box Emergents

Rainforest stands with emergent Brush Box (Lophostemon confertus) trees have been mapped as a distinct vegetation type. This vegetation type may point to a history of disturbance or chance wildfire or may occur in areas more marginal for rainforest development e.g. soils of slightly lower fertility. A diverse range of rainforest trees occur with a variable density of emergents.

Tree species may include Red Ash, Guioa, Blackwood, Foambark Tree, Scrub Turpentine (Rhodamnia rubescens), Red Cedar (Toona australis), Macaranga (Macaranga tanarius). Eucalypts present include Sydney Blue Gum (E. saligna), Flooded Gum (E. grandis) and Tallowwood (E. microcorys). Turpentine (Syncarpia glomulifera) was also observed within this community.

Examples occur of this community occur in the Booerie Creek catchment and on steep slopes above Coopers Creek where the proposed transmission line route traverses this community.

7 Brush Box Open-forest

This map unit includes Brush Box dominated tall forests with an understorey of ferns of grasses and lacking a well developed understorey of rainforest trees.

The tree species present include Brush Box, Tallowwood, Small-fruited Grey Gum (E. propinqua) and White Mahogany (E. acmenoides).

There is a tall shrub layer of low to medium density and a ground layer dominated by grasses or ferns with the latter being present in wetter, more sheltered areas. Vines are a common component of the understorey.

Shrub species include Scrub Turpentine, Red Kamala, Mock Olive (Notelaea longifolia) and Pimelea ligustrina.

Ground layer species include Weeping Meadow Grass (Microlaena stipoides), Hairy Panic (Panicum effusum), Rasp Fern (Doodia aspera)

Areas of Brush Box Open-forest are most common in State Forests to the north-west of the study area, but also occur in the Booerie Creek catchment. Examples traversed by the proposed transmission line occur between Bentley Road and Borton Road.

8 Sydney Blue Gum Open-forest

Open-forest dominated by Sydney Blue Gum is not common in the Big Scrub area. Where this plant community occurs it tends to be in sites of high fertility which have apparently been subject to disturbance in the distant past. Tree species present include Sydney Blue Gum, Flooded Gum (E. grandis) and Tallowwood.

The understorey includes a small tree layer dominated by rainforest species and a ground layer of low to medium density dominated by ferns.

This vegetation type occurs towards the north of the route corridor in the Wilsons River area.

9 Blackbutt Open-forest

Blackbutt open-forest occurs on coarse sandy soils of moderate fertility or areas subject to more frequent fires in the Nightcap Ranges. The understorey may include a shrub layer of medium to high density and a ground layer of medium to high density dominated by ferns in wetter sites or a grassy understorey in drier sites.

This vegetation type occurs along the north-western edge of the study area. No examples of this community were found to occur along the preferred route, but plantations of Blackbutt have been planted in the vicinity of the route corridor.

10 Tallowwood Open-forest

Open-forest dominated by Tallowwood occurs in soils of moderate fertility in the Booerie Creek valley. Associated tree species include White Mahogany and Brush Box.

The understorey often includes a stratum of small rainforest trees, but drier sites support a ground layer of high density dominated by grasses and herbs.

Small tree species present include Brush Turpentine, Red Kamala and the shrub Orangethorn.

Ground layer plants include Weeping Meadow Grass, Blady Grass (Imperata cylindrica), Pseuderanthemum variabile, Indian Weed (Sigesbeckia orientalis ssp. orientalis), Bracken Fern (Pteridium esculentum), Forest Hedgehog Grass (Echinopogon ovatus) and Desmodium varians. Vines and creepers are also common, including Native Yam (Dioscorea transversa), Wombat Berry (Eustrephus latifolius) and Rose-leaf Bramble (Rubus rosifolius).

No intact examples of this community occur along the route corridor, however scattered Tallowwood trees east of Bentley Road will be affected by the proposed transmission line.

11 Forest Red Gum Open-forest

Open-forest dominated by Forest Red Gum occurs on soils of moderate fertility on hill crests exposed to sun and wind. Pink Bloodwood and Brush Box are associated tree species.

There is a layer of small trees of low density and a ground layer of high density. The most common small tree is Forest Oak (Allocasuarina torulosa).

Ground layer species include Barb-wire Grass (Cymbopogon refractus), Blady Grass, Weeping Meadow Grass, Glycine clandestina, Kangaroo Grass (Themeda australis) and Kidney Weed (Dichondra repens). The introduced species Rhodes Grass (Chloris gayana), Kikuyu (Pennisetum clandetinum), Mistflower (Ageratina riparia) and Purple Top (Verbena bonariensis) are also common.

This community occurs north of Borton Road, near Modanville, outside of the area directly affected by the proposed transmission line route.

12 Pink Bloodwood-Small-fruited Grey Gum-White Mahogany Open-forest

This open-forest community occurs in similar situations to Forest Red Gum open-forest on soils of lower fertility. Canopy tree species include Pink Bloodwood, Small-fruited Grey Gum and White Mahogany.

There is a small tree layer of low density and a ground layer of medium to high density dominated by grasses.

Small tree species present include Red Kamala, Native Rosella (Hibiscus heterophyllus) and Koda (Ehretia acuminata).

The ground layer includes Weeping Meadow Grass, Kidney Weed, Rasp Fern, Indian Weed and Windmill Grass (Chloris truncata). Vines and creepers are common and include Snake Vine (Stephania japonica var. discolor), Wombat Berry, Native Passionfruit (Passiflora herbertiana), Red Coral Pea (Kennedia rubicunda) and Lawyer Vine (Smilax australis).

This community is not affected by the proposed route.

13 Cleared Land

This map unit denotes areas which have been substantially cleared of native vegetation, but not developed for plantations. This vegetation unit occurs along the length of the corridor, where land is used for grazing.

14 Horticulture

This map unit includes horticultural plantations including Macadamias, Bananas and other tropical fruit. Horticultural plantations occur within the corridor on the Lismore Plateau, being particularly prevalent in the Dunoon area.

15 Rainforest Regeneration/Forest Plantations

This map unit includes recent plantings of rainforest species and forest plantations such as Hoop Pine, Flooded Gum, Sydney Blue Gum and Blackbutt.

4.1 Rare or Threatened Plant Species

Information on the rare or threatened plant species occurring in the study area was obtained by accessing the data base of the Hurstville office of the National Parks and Wildlife Service and by searching other literature relating to the vegetation of the study area including the list provided in Lott and Duggin (1993). The list was included in the flora survey completed for the Route Options Paper (1993). No comments regarding the composition of the list were made in community responses to the Route Options Paper.

The species are listed below, with discussion of their ecology and risk codes (see Appendix 2), based on Briggs and Leigh, 1988. Some species listed may only occur on the edge of the study area or in the forested lands of the Nightcap Range. Those only recorded as occurring at higher altitudes in the Nightcap Range may be unlikely to occur along the route corridor.

Byron Bay Acronychia (Acronychia baeuerlenii) 3RC-

Byron Bay Acronychia is a small tree which may reach 9 metres in height. It occurs in subtropical and warm temperate rainforest in the Lismore - Byron Bay area, including the Nightcap Range, Emery's Scrub, Brockley and Rotary Park.

This species was not located along the route corridor.

Rusty Plum (Amorphospermum whitei) 3RCa

Rusty Plum is a small to medium tree which occurs in littoral and warm temperate rainforest, north from the upper Macleay River. In the area it occurs in the Nightcap Range and Minyon Falls, outside of the route traversed by the proposed transmission line.

Veiny Lace Flower (Archidendron muellerianum) 3RCa

Veiny Lace Flower is a tree to 20 metres tall which occurs in riverine and subtropical rainforest, north from Alstonville. Recorded locations include the Nightcap Range (Whian Whian State Forest), Coopers Creek, Johnston's Scrub, Morton's Scrub, Glendower, Emery's Scrub, Willowbank, Booyong, Rotary Park, Pearces Creek, near Wollongbar.

Veiny Lace Flower has also been recorded near Boomerang Creek within the route corridor.

Silver Leaf (Argophyllum nullumense) 3RCa

Silver Leaf is a shrub or small tree which grows to 7 metres. It occurs in subtropical and warm temperate rainforest in the Nightcap, Tweed and McPherson Ranges. It has recently been recorded in rainforest along the Wilsons River at Federal. This species was not found along the route corridor.

Pink Cherry (Austrobuxus swainii) 3RCa

Pink Cherry is a tree to 40 metres in height which occurs in rainforest or wet sclerophyll forest, north from the Bellinger River. In and near the study area it has been recorded in the Nightcap Ranges, at Terania Creek, Big Scrub Flora Reserve, Minyon Falls and near Nashua. No specimens of this species were observed within the route corridor.

Small-leaved Myrtle (Austromyrtus fragrantissima) 3EC-

Small-leaved Myrtle is a shrub or small tree which reaches 7 metres in height. It grows in subtropical rainforest north from Lismore. Records of the species have been made at Boatharbour Nature Reserve, Booyong and Rotary and Wilson Parks at Lismore. None of these sites are within the route corridor.

Clematis fawcettii 3VC-

Clematis fawcettii is a weak climbing plant with stems 1 to 2 metres long. It is found close to streams in dry rainforest, north from the Richmond River. Recorded locations include Rotary and Wilson Parks at Lismore. No areas of dry rainforest were identified along the route corridor.

Corchorus cunninghamii 3E

Corchorus cunninghamii is an annual or perennial herb to 150 centimetres tall. Harden (1990) records it as being chiefly collected in the Lismore district last century and that it is now rare. NPWS records do not reveal any collections of this plant in the study area since 1894.

Corokia (Corokia whiteana) 2VCi

Corokia is a shrub to 4 metres high which grows in warm temperate rainforest. It is known only from the Nightcap Ranges including Big Scrub Flora Reserve, to the north of the route corridor.

Cupaniopsis newmannii -

Cupaniopsis newmannii is a shrub or small tree. It grows on rainforest margins and in subtropical rainforest. Whilst Harden (1991) records its southern limit as Mullumbimby, there are records for Minyon Falls and Federal (Lott and Duggin 1993). This species was not found along the route corridor.

Cyperus rupicolus 2RC-

Cyperus rupicolus is a perennial tussock forming sedge to 100 centimetres high. It is only recorded for Mount Warning and the Nightcap Range, where it has been found in Whian Whian State Forest, to the north of the route corridor.

Smooth Davidsonia (Davidsonia sp.A) 2E

Smooth Davidsonia is a bushy tree to 12 metres high. It occurs in disturbed subtropical rainforest and wet sclerophyll forest margins. It has been found near Mullumbimby, Nullum State Forest and the Nightcap Ranges. This species was not observed along the route corridor.

Thorny Pea (Desmodium acanthocladum) 2V

Thorny Pea is a small shrub to 1 metre tall. It is most commonly located along rivers. Its range extends from Lismore to Grafton. Records include the Wilson River (south of Mullumbimby), Rocky Creek Dam, Coopers Creek, Johnston's Scrub, Morton's Scrub, Booyong, Federal, Boatharbour Nature Reserve, Wilson and Rotary Parks and Alstonville. This species was not found along the route corridor, however its presence in several rainforest remnants in the Big Scrub indicates plants may have been overlooked during the survey.

Small-leaved Tamarind (Diploglottis campbellii) 2E

Small-leaved Tamarind is a small to medium sized rainforest tree which grows to 20 metres in height. It is generally found in riverine rainforest north from the Richmond River. The only record on the NPWS data base is from the Boomerang Creek area. This species was not collected from the route corridor in the present survey.

Diplosora (Diplosora cameronii) 3VC-

Diplosora is a small tree to 6 metres in height. It occurs in dry rainforest and the only recorded location in New South Wales is at Lismore. It was not found along the route corridor.

Velvet Laurel (Endiandra hayesii) 3VC-

Velvet Laurel is a medium-sized rainforest tree which occurs in subtropical rainforest stands on sedimentary or alluvial soils. It has been recorded in the Nightcap Ranges, Wilsons River, Whain Whian State Forest, Big Scrub Flora Reserve, Minyon Falls and south of Mullumbimby Power Station, to the east of the proposed tranmission line route.

Ball Nut (Floydia praealta) 3VC-

Ball Nut is a small to medium-sized tree which may reach 30 metres. It occurs in subtropical and riverine rainforest north from the Clarence River. It has been recorded from Johnston's Scrub, Emery's Scrub, Brockley, Federal, Boatharbour Nature Reserve, Booyong, Rotary Park and the Wollongbar area. This species was not found during the field survey.

Fontainea oraria 2E

Fontainea oraria is a shrub or small tree to 5 metres tall which occurs in dry rainforest. It is known from a few plants at Lennox Head. NPWS records indicate it was located in the Nightcap Ranges. No specimens were located along the route corridor.

Gahnia insignis 3RCa

Gahnia insignis is a sedge or cutting grass to 2 metres tall. It occurs in rock crevices on slopes and heath and in sclerophyll forest communities. Locations where it has been recorded include the Nightcap Ranges, Coopers Creek and the Big Scrub Flora Reserve. It was not found along the route corridor during the present survey.

Stream Lily (Helmholtzia glaberrima) 2RCa

Stream Lily is a tall tufted lily which prefers wet habitats such as streambanks in rainforests. Stems may reach 150 centimetres in height. It is recorded from the Nightcap Ranges, Terania Creek, Minyon Falls and Federal. This species was not found to occur along the route corridor.

Hibbertia hexandra 3RC-

Hibbertia hexandra is a tall shrub or small tree which occurs in heath, open forest or rainforest. It occurs at Wauchope and Mount Warniing. In the area it is recorded from Whian Whian State Forest and Wilsons River near Nashua. No populations of this species were found during the field survey.

Rough-leaved Macadamia (Macadamia tetraphylla) 2VC-

Rough-leaved Macadamia is a small to medium-sized tree which may reach 15 metres high. It occurs in subtropical rainforest north from the Clarence River, into Queensland. It has been recorded from the Nightcap Range, Wilsons River near Eltham, Willowbank, Booyong, Federal, Minyon Falls and Pearces Creek.

During the field survey populations of Rough-leaved Macadamia were located in the rainforest stand along the Wilson River near Donaghys Bridge, in a gully east of Goonengerry and near Byrongerry Creek.

Blunt Wisteria (Milletia australis) 3VC-

Blunt Wisteria is a tall woody climber which grows in subtropical rainforest, north from Port Macquarie. It has been recorded from Rocky Creek near The Channon and Johnston's Scrub. No examples of this species were found along the route corridor.

Southern Ochrosia (Ochrosia moorei) 2RC-

Southern Ochrosia is shrub or small tree which may reach 9 metres in height. It occurs in subtropical rainforest in the Richmond and Tweed River valleys. Records include the Nightcap Range, Big Scrub Flora Reserve, Johnston's Scrub, Emery's Scrub, Booyong Recreation Reserve, Boatharbour Nature Reserve, Rotary Park, Wilson Park and Alstonville. Whilst this species was not found during the field survey, its occurrence in several Big Scrub remnants indicates individual plants may have been overlooked.

Olearia heterocarpa 2RCa

Olearia heterocarpa is a shrub to 5 metres high. It is found in wet sclerophyll forest, woodland and mallee communities. The records in the area are for Whian Whian State Forest and the Minyon Falls area, to the north of the route corridor.

Onion Cedar (Owenia cepiodora) 2ECi

Onion Cedar is a tall tree reaching 30 metres in height. It occurs in subtropical and dry rainforest types, north from Bangalow. Records include Terania Creek, Big Scrub Flora Reserve, Boomerang Falls, Elliot Road, Coopers Creek, Morton's Scrub and Glendower. This species was not observed along the route corridor.

Crisped Silkpod (Parsonsia lilacina) 3RC-

Crisped Silkpod is a slender climbing plant. Its favoured habitat is drier subtropical rainforest north from Lismore. It has been recorded from Rotary and Wilson Parks. No areas of dry rainforest were identified along the route corridor.

Southern Quassia (Quassia sp. A) 3RC-

Southern Quassia is a shrub to 2 metres in height. It occurs in subtropical and warm temperate rainforest in the Alstonville and Nightcap Range areas. Locations include Big Scrub Flora Reserve, Boomerang Falls, Glendower, Emery's Scrub, Willowbank, Brockley and Federal. This species was not found along the route corridor.

Spiny Gardenia (Randia moorei) 3EC-

Spiny Gardenia is a tall shrub or small tree which reaches about 8 metres in height. It grows in subtropical rainforest, north from Lismore. There is one record for the species in the area, from Wilson Park. No samples of this species were found to occur along the route corridor.

Smooth Scrub Turpentine (Rhodamnia maideniana) 2RC-

Smooth Scrub Turpentine is a shrub to about 3 metres in height. It occurs in subtropical rainforest north from the Richmond River. Recorded locations in the study area include Willowbank and Federal. This species was not found along the route corridor.

Sarcochilus dilatatus 3RC-

Sarcochilus dilatatus is an epiphytic orchid which is generally found growing on trees in dry rainforest. It extends north from the Richmond River district. An old record (1894) exists for the Lismore area. This species was not found during the field surveys for this report.

Sarcochilus hartmannii 3VC-

Sarcochilus hartmannii is found growing on rocks in moderately exposed sites in wet sclerophyll forests or rainforest margins. Its range extends from the Taree district north into Queensland. It has been recorded in Whian Whian State Forest, to the north of the route corridor.

Schistotylus purpuratus 3RCi

Schistotylus purpuratus is a small epiphytic orchid which grows on tree branches and twigs. NPWS records show it was found at Lismore in 1912. It was not observed during the field survey for this report.

Small-leaved Hazelwood (Symplocus baeuerlenii) 2VC-

Small-leaved Hazelwood is a shrub or small tree which may reach 7 metres in height. It is found in subtropical and warm temperate rainforest, north from the Nightcap

Range. It has been recorded from the Nightcap Range, Nullum State Forest, Terania Creek, Minyon Falls and Boomerang Falls, to the north of the route corridor.

Red Lilly Pilly (Syzygium hodgkinsoniae) 3VC-

Red Lilly Pilly is a small tree which occurs in subtropical or gallery rainforest, north from the Richmond River. Records include Whian Whian State Forest, Minyon Falls, Big Scrub Flora Reserve, Boomerang Falls, Dawes Bush, Emery's Scrub, Brockley, Wollongbar, Booyong, Boatharbour, Federal and Johnstons Scrub.

Red Lilly Pilly was found to occur in the rainforest stand south-west of Repentance Creek Bridge and Byrongerry Creek.

Durobby (Syzygium moorei) 2VCi

Durobby is a medium to large tree with flaky bark. It occurs in lowland subtropical rainforest, north from the Richmond River. The species has been found in the study area in rainforest near Federal. Durobby was not found along the route corridor.

Arrow-head Vine (Tinospora tinosporoides) 3VC-

Arrow-head Vine is a tall woody climber which grows in subtropical rainforest communities. Recorded locations in the area include Minyon Falls, Big Scrub Flora Reserve, Boomerang Falls, Coopers Creek, Johnston's Scrub, Morton's Scrub, Emery's Scrub, Elliot Road, Dawes Bush, Glendower, Willowbank, Brockley, Federal, Wollongbar, Booyong, Boatharbour, Rotary and Wilson Parks, Lismore and Alstonville. This species is widespread in rainforest remnants in the Big Scrub area and was found during the 1987 field survey (Electricity Commission 1987).

Trichosanthes subvelutina 3RC-

Trichosanthes subvelutina is a climber with long hairy stems. It occurs within and on the margins of rainforest and in wet sclerophyll forest. There are several records for the species in the area including Big Scrub Flora Reserve, Rocky Creek, Johnston's Scrub, Dawes Bush, Emery's Scrub, Boatharbour, Federal, Lismore and Alstonville. No plants were found during the field survey for this report.

Tricostularia pauciflora -

Tricostularia pauciflora is a perennial sedge to 30 centimetres tall. It occurs in sandy moist soils in dry sclerophyll woodland or heath. Locations within the area include Rocky Creek and near Eureka. These vegetation types were not found to occur along the proposed route of the transmission line.

Peach Myrtle (Uromyrtus australis) 2ECi

Peach Myrtle is a shrub to small tree which may reach 12 metres in height. It occurs in warm temperate rainforest. It has been recorded in the Nightcap Ranges, in Nullum State Forest, Whian Whian State Forest and Terania Creek, to the north of the route corridor.

Westringia blakeana 2RCa

Westringia blakeana is a small to medium shrub which may reach 4 metres in height. It occurs in wet sclerophyll forest and rainforest often on creek banks, north from Lismore. Recorded locations include Whian Whian State Forest, Minyon Falls, Boomerang Falls and the Big Scrub Flora Reserve, to the north of the route corridor.

5.0 Likely Impacts of the Proposed Transmission Line

The proposed transmission line traverses a variety of vegetation map units, with the most prevalent units traversed being Cleared Land, Horticulture and White Booyong Sub-tropical Rainforest. The other native plant communities which may be directly or indirectly affected include Black Bean - Red Bean Sub-tropical Rainforest, Sub-tropical Rainforest with Brush Box Emergents, Brush Box Open-forest and Sydney Blue Gum Open-forest.

The existing 66kV transmission line has had an impact on the vegetation of the route corridor. Clearing and use of herbicides to maintain clearance along the line has damaged forest stands along the route and encouraged the spread of weed species such as Lantana, Mistflower and Boneseed. The clearance work has apparently been conducted without thought of the consequences on any significant vegetation or rare species which may occur in proximity to the line.

The 132kV transmission line will require vegetation clearance along part of the route to maintain a safe distance between the line and overhanging branches. In areas where the line spans gullies clearance under the line will not be necessary. The extent of clearance will not be significantly greater than that which is required for the 66kV transmission line.

Access tracks to pole structures may require some additional clearance of vegetation, particularly scattered trees in paddocks. Access tracks will generally be located along existing property access roads, avoiding significant forest stands.

The route corridor crosses or passes in close proximity to 5 rainforest areas of high species diversity relative to other forest stands along the route corridor. The locations of these areas are :

- about 1km south-west of the Repentance Creek Bridge

- adjacent to the Wilsons River just south of Donaghys Bridge

- Boomerang Creek (the rare species, Veiny Lace Flower has been recorded in this vicinity)

- Turkey Creek, and,

- the Wilsons River, south of Montecollum Road (this area supports the rare plant species, Rough-leaved Macadamia).

A proposed deviation along a closed road, south of Goonengerry would traverse an area of rainforest supporting trees including Red Cedar (Toona australis), White Booyong (Heritiera trifoliolata), Cudgerie (Flindersia schottiana), Foambark Tree (Jagera pseudorhus), Red Ash (Alphitonia excelsa), Stinging Tree (Dendrocnide excelsa), Black Bean (Castanospermum australe), Blue Quandong (Elaeocarpus grandis) and Red Kamala (Mallotus philippensis).

5.1 Impact on Rare or Threatened Plant Species

Rough-leaved Macadamia was recorded in the vicinity of the route corridor at Byrongerry Creek and near Wilsons River, south of Montecollum Bridge.

Velvet Laurel was recorded in 1987 in a rainforest patch south-east of Mullumbimby Power Station about 250 metres east of the route corridor.

Red Lilly Pilly was found to occur in the rainforest stand south-west of the Repentance Creek Bridge.

Veiny Lace Flower, whilst recorded in the vicinity of Boomerang Creek close to the location traversed by the preferred route, was not observed during the field survey.

Arrow-head Vine is found in many rainforest remnants in the Big Scrub area. It was recorded in Electricity Commission (1987), but has not been confirmed as occurring along the preferred route for the current proposal. It is considered likely that this species does occur along the route, but that it was overlooked during the most recent survey.

The disturbed nature of the vegetation underneath the existing 66kV transmission line generally provides poor habitat for the rare or threatened plant species which occur within the route corridor. However, where forest stands are spanned by the existing line, suitable habitat for these species remains. The current proposal is unlikely to result in significant additional impact, but individual plants of the rare species may be affected by clearing.

6.0 Mitigation of Impacts

The impact of the transmission line on areas of relatively high species diversity can be reduced by constructing the line in a manner which seeks to span across these areas which generally occur in valleys. Additional protection may be able to be achieved by use of higher poles and longer spans in these areas, which include the rainforest stands at Boomerang Creek, Turkey Creek, south-west of Repentance Creek and Wilsons River.

Where impact cannot be avoided by spanning relocation of the line within the bandwidth may improve viability of rainforest stands. This should only be undertaken where there is some commitment by landowners to protection of the particular rainforest stands. Without such commitment it would be preferable to direct any funds available for impact mitigation towards existing rainforest regeneration programs.

In areas, including Boomerang Creek and south-west of Repentance Creek, where rare plants occur in the vicinity of the proposed line, fine tuning of the route at the time of construction may be necessary to avoid direct impact. Where such impact cannot be avoided due to other constraints any regeneration programs in the vicinity should include propagation of the rare species involved.

Weed control will be necessary to prevent the spread of weeds in any cleared areas underneath the transmission line. This may be achieved by contracting of weed control to local land holders or rainforest regeneration teams.

The proposed development may have direct and indirect impacts on rainforest stands of high conservation significance and individuals of rare or threatened plant species. Implementation of the mitigation measures recommended in this report will avoid significant impact on these rainforest stands and limit impact on the rare or threatened plant species known from the route.

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Figure 1 - FLORA SURVEY SITES

APPENDIX 1

LISMORE TO MULLUMBIMBY 132KV TRANMISSION LINE

FLORISTIC LIST

	PLANT COMMUNITIES IN TEXT				
<u>FERNS</u>					
ADIANTACEAE					
Adiantum formosum	1				
Adiantum hispidulum	1	7	13		
ASPIDIACEAE					
Lastreopsis acuminata	1	7			
Lastreopsis decomposita	1				
ASPLENIACEAE					
Asplenium australasicum	1	3	6		
ATHYRIACEAE					
Diplazium dilatatum	1				
BLECHNACEAE					
Blechnum patersonii	#				
Doodia aspera	1	6	7	12	13
CYATHEACEAE					
Cyathea australis	1				
Cyathea cooperi	1				
Cyathea leichhardtiana	1				
DAVALLIACEAE					
Arthropteris tenella	#				
Davallia pyxidata	1	3			
DENNSTAEDTIACEAE					
Histiopteris incisa	1				
Hypolepis muelleri	1				
Pteridium esculentum	7	10	12	13	
DICKSONIACEAE					
Dicksonia youngiae	#				
OSMUNDACEAE					
Todea barbara	#				
POLYPODIACEAE					
Microsorum diversifolium	1				
Platycerium bifurcatum	1				
Platycerium superbum	1	6			
Pyrrosia confluens	1	6			
Pyrrosia rupestris	1	3	6		

PTERIDACEAE					
Pteris tremula	1				
Pteris umbrosa	1	7			
SCHIZAEACEAE					
Lygodium microphyllum	#				
SINOPTERIDACEAE					
Cheilanthes austrotenuifolia	12				
Cheilanthes distans	11				
Cheilanthes sieberi	7	13			
Pellaea paradoxa	1				
THELYPTERIDACEAE					
Christella dentata	1				
GYMNOSPERMS					
ARAUCARIACEAE					
Araucaria cunninghamii	1	2	10	11	13
CUPRESSACEAE					
Callitris macleayana	#				
PODOCARPACEAE					
Podocarpus elatus	#				
ZAMIACEAE					
Lepidozamia peroffskyana	#				
ANGIOSPERMS					
Dicotyledons					
ACANTHACEAE					
Pseuderanthemum variabile	7	10			
AKANIACEAE					
Akania lucens	1				
ALANGIACEAE					
Allangium villosum ssp. polyosmoides	1				
AMARANTHACEAE					
Alternanthera denticulata	1				
Deeringia arborescens	#				
Nyssanthes diffusa	1				
ANACARDIACEAE					
Euroschinus falcata	#				

	Rhodosphaera rhodanthema	#				
	ANNONACEAE					
	Fissistigma stenopetala	#				
	Rauwenhoffia leichhardtii	1				
	APIACEAE					
	Centella asiatica	7	11	12	13	
	APOCYNACEAE					
	Alyxia ruscifolia	#				
	Carissa ovata	1				
	Ervatamia angustisepala	1				
	Melodinus australis	1				
	Neisosperma poweri	#				
	Ochrosia moorei	#				
	Parsonsia fulva	#				
	Parsonsia induplicata	#				
	Parsonsia latifolia	#				
	Parsonsia lilacina	#				
	Parsonsia rostrata	#				
	Parsonsia straminea	1				
	Parsonsia velutina	1				
	Parsonsia ventricosa	1				
	Tabernaemontana pandacaqui	#				
	ARALIACEAE					
	Cephalaralia cephalobotrys	#				
	Polyscias elegans	1				
	Polyscias murrayi	1				
	ARISTOLOCHIACEAE					
	Aristolochia praevenosa	1				
	ASCLEPIADACEAE					
*	Gomphocarpus fruticosus	11				
	Hoya australis	#				
	Marsdenia flavescens	#				
	Marsdenia rostrata	1				
	Secamone elliptica	#				
	Thozetia racemosa	#				
	Tylophora crebriflora	#				
	Tylophora paniculata	#				
	ASTERACEAE					
*	Achillea millefolium	11				
*	Ageratina adenophora	1	11	12		
*	Ageratina riparia	1	6	7	11	13
*	Ageratum houstonianum	1	13			
*	Bidens pilosa	1	11	12	13	
*	Chrysanthemoides monilifera	1	7			

	Gnaphalium sphaericum	12			
*	Hypochaeris radicata	1	13		
	Ozothamnus diosmifolius	1	6		
*	Senecio madagascariensis	1	7	11	12
*	Senecio mikanioides	1			
	Sigesbeckia orientalis	7	10	12	13
	ATHEROSPERMATACEAE				
	Doryphora sassafras	1			
	BASELLACEAE				
*	Anredera cordifolia	1			
	BIGNONIACEAE				
	Pandorea jasminoides	1			
	Pandorea pandorana	1	3	12	
	BORAGINACEAE				
	Ehretia acuminata	1	12		
	BURSERACEAE				
	Canarium australasicum	#			
	CAMPANULACEAE				
	Wahlenbergia gracilis	7			
	CAPPARIDACEAE				
	Capparis arborea	1			
	CAPRIFOLIACEAE				
	Sambucus australasica	1			
	CARYOPHYLLACEAE				
*	Stellaria media	1			
	CASUARINACEAE				
	Casuarina glauca	#			
	Allocasuarina torulosa	11	12		
	CELASTRACEAE				
	Cassine australis	1			
	Celastrus australis	#			
	Celastrus subspicatus	1			
	Denhamia celastroides	#			
	Hedraianthera porphyropetala	#			
	Loeseneriella barbata	#			
	Siphonodon australe	#			
	CHENOPODIACEAE				
	Einadia hastata	7			

CONVOLVULACEAE				
Dichondra repens	7	11	12	13
CUCURBITACEAE				
Diplocyclos palmatus	#			
Sicyos australis	#			
Trichosanthes subvelutina	#			
Zeyneria cunninghamii	#			
CUNONIACEAE				
Aphanopetalum resinosum	1			
Caldcluvia paniculosa	#			
Geissois benthamiana	1			
Pseudoweinmannia lachnocarpa	#			
Schizomeria ovata	1			
DILLENIACEAE				
Hibbertia dentata	#			
Hibbertia scandens	3	6		
EBENACEAE				
Diospyros australis	#			
Diospyros fasciculosa	#			
Diospyros pentamera	1			
ELAEOCARPACEAE				
Elaeocarpus eumundi	#			
Elaeocarpus grandis	1			
Elaeocarpus kirtonii	1			
Elaeocarpus obovatus	1			
Elaeocarpus reticulatus	#			
Sloanea australis	1	3		
Sloanea woollsii	1			
EPACRIDACEAE				
Trochocarpa laurina	#			
ESCALLONIACEAE				
Abrophyllum ornans	#			
Anopterus macleayanus	#			
Corokia whiteana	#			
Cuttsia viburnea	#			
Polyosma cunninghamii	1			
Quintinia verdonii	#			
EUPHORBIACEAE				
Acalypha capillipes	#			
Actephila lindleyi	1			
Austrobuxus swainii	#			
Baloghia inophylla	1			
Baloghia marmorata	#			

	Breynia oblongifolia	7 12
	Bridelia exaltata	3
	Claoxylon australe	1
	Cleistanthus cunninghamii	1
	Coelebogyne ilicifolia	3
	Croton acronychioides	#
	Croton stigmatosus	#
	Croton verreauxii	#
	Drypetes lasiogyna	#
	Glochidion ferdinandi	1 3
	Glochidion sumatranum	#
	Macaranga tanarius	1 6 11 12 13
	Mallotus claoxyloides	#
	Mallotus discolor	1
	Mallotus philippensis	1 3 6 7 10 11 12 13
	Omalanthus populifolius	1
*	Ricinus communis	11 13
	EUPOMATIACEAE	
	Eupomatia bennettii	1
	Eupomatia laurina	1
	FABACEAE	
	Acacia floribunda	13
	Acacia implexa	1 6 12 13
	Acacia irrorata	1 6
	Acacia melanoxylon	1 3 6 11 12 13
	Archidendrom grandiflorum	#
	Archidendron hendersonii	#
	Archidendron muellerianum	#
	Austrosteensia blackii	#
	Caesalpinia scortechinii	3
	Caesalpinia subtropica	1 6 13
	Castanospermum australe	1 3
	Derris involuta	1
	Desmodium acanthocladum	#
	Desmodium varians	7 10
	Glycine clandestina	1 7 11 12
	Glycine tabacina	7 12
	Goodia lotifolia	#
	Kennedia rubicunda	1 7 11 12 13
	Millettia megasperma	1
	Pararchidendron pruinosum	1
*	Senna X floribunda	1 3 6 13
	FLACOURTIACEAE	
	Casearia multinervosa	#
	Scolopia braunii	1
	Streptothamnus moorei	#
	Xylosma terrareginae	#

GERANIACEAE	
Geranium sp.	7 11 12
ICACINACEAE	
Citronella moorei	#
Pennantia cunninghamii	#
LAURACEAE	
Beilschmiedia elliptica	1
Beilschmiedia obtusifolia	#
* Cinnamomum camphora	1 3 7 11 12
Cinnamomum oliveri	1
Cinnamomum virens	1
Cryptocarya bidwillii	#
Cryptocarya bowiei	#
Cryptocarya erythroxylon	1
Cryptocarya foetida	#
Cryptocarya glaucescens	#
Cryptocarya microneura	#
Cryptocarya obovata	1
Cryptocarya rigida	#
Cryptocarya triplinervis	1
Endiandra compressa	#
Endiandra discolor	#
Endiandra hayesii	#
Endiandra muelleri	1
Endiandra pubens	1
Endiandra sieberi	1
Endiandra virens	#
Litsea leefeana	1
Litsea reticulata	#
Neolitsea australiensis	1
Neolitsea dealbata	1
LAMIACEAE	
Plectranthus sp.	1
LOBELIACEAE	
Pratia purpurascens	7 12
LORANTHACEAE	
Amyema scandens	1
MALVACEAE	
Hisbiscus heterophyllus	1 6 12 13
* Sida rhombifolia	7 11
MELIACEAE	
Dysoxylum fraserianum	3
Dysoxylum muelleri	3
Dysoxylum rufum	1 3

Melia azedarach	#			
Owenia cepiodora	#			
Synoum glanulosum	1	3	6	
Toona australis	1	3	6	13
MENISPERMACEAE				
Carronia multisepala	1			
Legnephora moorei	1			
Sarcopetalum harveyanum	1			
Stephania aculeata	1			
Stephania japonica	1	3	12	13
Tinospora tinosporoides	1			
MONIMIACEAE				
Daphnandra ?sp. D	1			
Daphnandra tenuipes	#			
Palmeria scandens	#			
Wilkiea austroqueenslandica	3			
Wilkiea huegeliana	1	6		
Wilkiea macrophylla	1			
MORACEAE				
Ficus coronata	1	6		
Ficus fraseri	1			
Ficus macrophylla	1	3	13	
Ficus obliqua	1			
Ficus rubiginosa	#			
Ficus superba	#			
Ficus virens	#			
Ficus watkinsiana	1	3	6	
Maclura cochinchinensis	1	3		
Malaisia scandens	1			
Streblus brunonianus	#			
MYRSINACEAE				
Embelia australiana	1			
Rapanea howittiana	#			
Rapanea subsessilis	1			
Rapanea variabilis	#			
Tapeinosperma pseudojambosa	#			
MYRTACEAE				
Acmena brachyandra	1			
Acmena hemilampra	1			
Acmena smithii	1	3		
Archirhodomyrtus beckleri	1			
Austromyrtus bidwillii	1			
Austromyrtus fragrantissima	#			
Austromyrtus hillii	#			
Backhousia myrtifolia	1			
Callistemon salignus	1	11		

	Decaspermum humile	#
	Eucalyptus acmenoides	7 12 13
*	Eucalyptus citriodora	13
	Eucalyptus grandis	6 8
	Eucalyptus intermedia	11 12 13
	Eucalyptus microcorys	6 7 8 10 12
	Eucalyptus pilularis	9
	Eucalyptus propinqua	7 12 13
	Eucalyptus saligna	6 8 10 11
	Eucalyptus tereticornis	11 12
	Lophostemon confertus	1 6 7 11 12 13
	Lophostemon suaveolens	11
	Pilidiostigma glabrum	1
*	Psidium guajava	1 13
	Rhodamnia argentea	1
	Rhodamnia maideniana	1
	Rhodamnia rubescens	1 6 7 10
	Rhodomyrtus psidioides	1
	Syncarpia glomulifera	6
	Syzygium australe	3
	Syzygium corynanthum	1
	Syzygium crebrinerve	1
	Syzygium francisii	1
	Syzygium hodgkinsoniae	1
	Syzygium luehmannii	#
	Syzygium moorei	#
	Syzygium oleosum	1
	Tristaniopsis laurina	1
	OLEACEAE	
	Jasminum singuliflorum	#
*	Ligustrum lucidum	1 12
*	Ligustrum sinense	1
	Notelaea johnsonii	1
	Notelaea longifolia	7 13
	Olea paniculata	#
	OXALIDACEAE	
	Oxalis corniculata	7 13
	PASSIFLORACEAE	
*	Passiflora edulis	1 3
	Passiflora herbertiana	1 6 7 12 13
*	Passiflora subpeltata	1
	PEPEROMIACEAE	
	Peperomia tetraphylla	1 3 6
	PHYTOLACCACEAE	
*	Phytolacca octandra	1

PIPERACEAE					
Piper novae-hollandiae	1				
PITTOSPORACEAE					
Citriobatus pauciflorus	1	6	7	10	12
Hymenophyllum flavum	1	6			
Pittosporum revolutum	1				
Pittosporum rhombifolium	#				
Pittosporum undulatum	1	3	6	7	
PROTEACEAE					
Floydia praealta	#				
Grevillea robusta	1				
Helicia ferruginea	#				
Helicia glabriflora	1				
Hicksbeachia pinnatifolia	1				
Macadamia tetraphylla	1	3			
Orites excelsa	#				
Stenocarpus salignus	#				
Stenocarpus sinuatus	1				
Triunia youngiana	3				
RANUNCULACEAE					
Clematis aristata	#				
Clematis glycinoides	#				
RHAMNACEAE					
Alphitonia excelsa	1	3	6	13	
Emmenosperma alphitonioides	#				
ROSACEAE					
Rubus hillii	7				
Rubus moorei	#				
Rubus parvifolius	13				
Rubus rosifolius	1	7	10		
RUBIACEAE					
Canthium coprosmoides	1				
Hodgkinsonia ovatifolia	#				
Morinda jasminoides	1				
Psychotria daphnoides	#				
Psychotria loniceroides	#				
Randia benthamiana	#				
Randia chartacea	#				
RUTACEAE					
Acradenia euodiiformis	#				
Acronychia bauerlenii	1				
Acronychia oblongifolia	#				
Acronychia pauciflora	#				
Acronychia pubescens	1				

Acronychia wilcoxiana	#				
Bosistoa pentacocca	#				
Bouchardatia neurococca	#				
Flindersia australis	1				
Flindersia bennettiana	1	3			
Flindersia schottiana	1	13			
Flindersia xanthoxyla	1	13			
Geijera paniculata	#				
Geijera salicifolia	#				
Halfordia kendack	#				
Melicope elleryana	#				
Melicope erythrococca	#				
Melicope micrococca	1				
Melicope octandra	#				
Microcitrus australasica	1				
Pentaceras australe	1				
Sarcomelicope simplicifolia	1				
Zanthoxylum brachyacanthum	#				
Zieria smithii	7				
SALICACEAE					
* Salix babylonica	11				
SAPINDACEAE					
Alectryon subcinereus	1				
Arytera distylis	1				
Arytera divaricata	#				
Atalaya multiflora	#				
Castanospora alphandii	1				
Cupaniopsis flagelliformis	1				
Cupaniopsis parvifolia	#				
Diploglottis australis	1	3	7		
Elattostachys nervosa	1				
Guioa semiglauca	1	3	6	7	12
Harpullia alata	1				
Harpullia hillii	1				
Harpullia pendula	#				
Jagera pseudorhus	1	6	11	12	13
Mischocarpus australis	#				
Mischocarpus pyriformis	1				
Rhysotoechia bifoliolata	#				
Sarcopteryx stipitata	1				
Toechima dasyrrhache	#				
SAPOTACEAE					
Amorphospermum whitei	#				
Planchonella australis	1				
Planchonella chartacea	#				
Planchonella laurifolia	#				
Planchonella myrsinoides	#				

	SCROPHULARIACEAE				
	Veronica calycina	1			
	SIMAROUBACEAE				
	Guilfoylia monostylis	1			
	Quassia sp. A	#			
	SOLANACEAE				
	Duboisia myoporoides	1			
*	Solanum mauritianum	1	11	13	
	STERCULIACEAE				
	Brachychiton acerifolius	1			
	Brachychiton discolor	1			
	Commersonia bartramia	1	6	13	
	Heritiera actinophylla	1			
	Heritiera trifoliolata	1	3		
	Sterculia quadrifida	#			
	SYMPLOCACEAE				
	Symplocus bauerlenii	#			
	Symplocus stawellii	#			
	Symplocus thwaitesii	1			
	THYMELAEACEAE				
	Pimelea linifolia	7			
	THYMELEACEAE				
	Pimelea ligustrina	7	13		
	Wikstroemia indica	#			
	ULMACEAE				
	Aphananthe philippinensis	1			
	Celtis paniculata	#			
	Trema aspera	1	6		
	URTICACEAE				
	Dendrocnide excelsa	1			
	Dendrocnide photinophylla	#			
	VERBENACEAE				
	Clerodendrum floribundum	#			
	Clerodendrum tomentosum	1			
	Gmelina leichhardtii	#			
*	Lantana camara	1	11	12	13
*	Verbena bonariensis	11	12	13	
	VITACEAE				
	Cayratia acris	#			
	Cayratia clematidea	1			
	Cayratia eurynema	#			

	Cissus antarctica	1	6	12
	Cissus hypoglauca	1		
	Cissus sterculifolia	1		
	Tetrastigma nitens	#		
	WINTERACEAE			
	Tasmannia insipida	#		
	Monocotyledons			
	AGAVACEAE			
	Cordyline petiolaris	1		
	Cordyline rubra	1	3	6
	ARACEAE			
	Alocasia macrorrhizos	1		
	Gymnostachys anceps	1	7	
	Pothos longipes	1		
	ARECACEAE			
	Archonotophoenix cunninghamiana	1		
	Calamus muelleri	1	3	
	Linospadix monostachyus	#		
*	Phoenix canariensis	11		
	COMMELINACEAE			
	Commelina cyanea	1	12	
	Pollia crispata	1		
*	Tradescantia albiflora	1		
	CYPERACEAE			
	Carex sp.	1		
	Fimbristylis dichotoma	7		
	Gahnia sp.	12		
	Lepidosperma laterale	12		
	DIOSCOREACEAE			
	Dioscorea transversa	1	10	
	FLAGELLARIACEAE			
	Flagellaria indica	3	6	
	JUNCACEAE			
	Juncus usitatus	11		
	LILIACEAE			
*	Asparagus setaceus	1	12	
	Dianella caerulea	1	7	
	Schelhammera undulata	1	6	

LOMANDRACEAE							
Lomandra longifolia	1	7	12				
Lomandra spicata	1						
PHILESIACEAE							
Eustrephus latifolius	1	6	7	10	12	13	
Geitonoplesium cymosum	1	6	12				
POACEAE							
* Axonopus affinis	7	11					
Bothriochloa macra	12						
* Chloris gayana	11	12					
Chloris truncata	12	13					
Cymbopogon refractus	7	11	12				
Cynodon dactylon	11	12					
Digitaria parviflora	7	12					
Echinopogon ovatus	7	10	13				
Entolasia marginata	10						
Imperata cylindrica	10	11	12				
Microlaena stipoides	1	6	7	10	11	12	13
Oplismenus aemulus	1	7					
Oplismenus imbecillis	1	3	7	12			
Panicum effusum	7	8	11	13			
Panicum simile	7						
* Paspalum dilatatum	11	13					
* Pennisetum clandestinum	7	11	13				
Poa affinis	13						
* Rhynchelytrum repens	11						
* Setaria palmifolia	13						
Themeda australis	7	11					
SMILACACEAE							
Ripogonum album	6						
Ripogonum discolor	#						
Ripogonum elseyanum	#						
Smilax australis	1	7	12	13			
TYPHACEAE							
Typha sp.	11						
ZINGIBERACEAE							
Alpinia caerulea	6						

Notes

* Introduced Species or Native Species not Indigenous to Area

? Uncertain Identification

Species recorded in previous surveys of Big Scrub rainforests and likely to occur in study area, based on list presented in Lott and Duggin (1993)

Appendix 2

Rare or Threatened Plants Risk Code

1 Species only known from type collection
2 Species with a restricted distribution in Australia (range < 100km)
3 Species with a range of greater than 100km but occurring in small populations and specific habitats

X Presumed Extinct
E Endangered - species at risk of extinction within 20 years
V Vulnerable - species at risk of extinction in 20 to 50 years
R Rare - species which are rare but not currently under threat
K Poorly Known - species for which insuffucient data exists to accurately determine risk status

C Species represented in at least one conservation reserve
a Species with over 1000 plants in conservation reserves
i Species with a known population of less than 1000 in conservation reserves
t Species whose total population lies within conservation reserves
- Species whose population within reserves is unknown

after Briggs and Leigh (1988)

H

Appendix H
Fauna Report

LISMORE TO MULLUMBIMBY TRANSMISSION LINE

AN INVESTIGATION OF THE NATIVE FAUNA & FAUNA HABITATS

SEPTEMBER 1994

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LISMORE TO MULLUMBIMBY TRANSMISSION LINE

AN INVESTIGATION OF THE NATIVE FAUNA AND FAUNA HABITATS

F Dominic Fanning

September 1994

1 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Pacific Power proposes to construct a 132kV transmission line between Lismore and Mullumbimby in northern NSW. Earlier environmental studies and documentation have dealt with a number of potential options for the route of the proposed transmission line, including the preparation of an earlier EIS (SKP 1987), and a recent Route Options Paper (SK 1993). The 1993 study of potential route options resulted in Pacific Power selecting the option of reconstructing the existing 66kV line between Lismore and Mullumbimby as the Preferred Route Option.

This report provides details of the fauna and fauna habitats which are present through the general area, and specifically along the preferred transmission line corridor. A combination of access to existing databases, review of information and reports from the general area, and the conduct of specific and detailed fauna surveys along the proposed corridor for the transmission line have contributed to this report. The investigation focuses on assessment of the nature and condition of fauna communities and habitats, and assessment of the potential impacts from the proposed transmission line rebuilding on native species and their habitats along the corridor.

The objectives of this fauna investigation and report are:

- to describe the fauna and fauna habitats along the preferred transmission route and in the vicinity, and to assess the condition of natural communities and the potential for adverse impacts on species of fauna or on their habitats. This investigation will address Section 4A of the Environmental Planning & Assessment Act 1979;

- to review the transmission corridor options (documented in the Route Options Paper - SK 1993), and responses to the ROP, and to assess the relative impacts on native fauna of the transmission line installation along the various route options;

- to delineate possible impact amelioration measures which may be implemented both to limit the effects of the proposed transmission line construction on native fauna and their habitats and to enhance the local environment for native fauna conservation wherever possible; and

- to contribute to the preparation of a Fauna Impact Statement which satisfies the National Parks & Wildlife Service and the Endangered Fauna (Interim Protection) Act 1991.

These objectives are to be realised by a combination of the review of prior information, previous reports and other studies in the general vicinity, as well as specific targeted field surveys to investigate native fauna and their habitats along the preferred route option.

1.2 THE ROUTE OPTIONS PAPER

The 1993 Route Options Paper (SK 1993) involved a revisitation of the route determination process for the proposed transmission line between Lismore and Mullumbimby (undertaken in 1986-87). The approach adopted in 1993 again involved community consultation, preparation of specialist's reports concerning individual features of the environment, and the consideration of a series of potential routes between Lismore and Mullumbimby. With respect to native fauna, a series of constraints were derived which determined suitability of the various possible routes (Fanning 1993). These were applied in conjunction with a number of other sets of constraints (for vegetation, agriculture, economic and the physical environment), to the various route options. In conjunction with community concerns, these constraints were used to determine the route which imposed the least adverse impacts on the environment (both social and physical).

The criteria for assessing the potential implications for fauna and fauna habitats through the study area were applied at the broad landscape level, and anticipated further detailed fauna surveys. Three levels of fauna constraint were defined and described in the ROP for determining the preferred transmission line route between Lismore and Mullumbimby. These constraints were assessed on the basis of published information regarding 'Big Scrub' remnants, known distributional and habitat data for native fauna (particularly species of conservation significance or those restricted to rainforest habitats), and as a result of discussions with researchers and the National Parks & Wildlife Service (NP&WS) in the Lismore/Mullumbimby region.

Primary fauna constraints involved sites of high fauna conservation value, likely to support habitat-restricted fauna species (for example, species restricted to rainforest or to watercourses). All primary constraint habitats were considered to provide special or restricted resources for such fauna species. Primary constraints included vegetation communities and habitat patches which were of moderate to large size and located in close proximity to other natural habitats (thus enabling fauna to move into or out of these sites). Of particular value were 'Big Scrub' remnants (as defined by Lott & Duggin 1993 and by the NP&WS - Alstonville office). Rainforest patches in good condition and riparian vegetation (particularly where continuous and well-developed) were also considered primary fauna constraints, along with natural wetlands and swamp forest (very rare along the potential transmission line corridor options). Primary fauna constraints are to be avoided by the proposed transmission line wherever possible. Where the transmission line must cross such habitats, special ameliorative measures will be required to avoid or minimise adverse impacts.

Secondary fauna constraints included vegetation patches of moderate conservation value or which were considered to have a high potential to provide significant future habitat. In this regard, regenerating rainforest or eucalypt forest in relatively large patches, where close to other natural vegetation or where forming possible future corridors for native fauna, were considered of particular value, especially where weed infestation is only moderate. Continuous riparian vegetation corridors or narrow stands of riparian vegetation along major waterways were also included as secondary constraints. These features and sites are considered of sufficient value to require avoidance where possible during construction of the transmission line and were used to determine the preferred option.

The third level of fauna constraint involved patches of vegetation and potential fauna habitat which were of relatively low or limited conservation value, but which were considered possible for future rehabilitation to provide additional fauna habitat in the general region. These sites may be of local conservation value, particularly where surrounding lands have been alienated for agricultural purposes. Some larger patches of disturbed vegetation were characterised by introduced weed species, such as Camphor Laurel, with a regenerating rainforest undergrowth. However, this habitat type is regarded as of relatively low conservation value for native fauna in its current state.

The fauna constraints described above were utilised to assess the potential transmission line corridors between Lismore and Mullumbimby in the Route Options Paper (SK 1993). The preferred option from the potential corridors available involves rebuilding the existing 66kV line between Lismore and Mullumbimby.

1.3 BACKGROUND

The area between Lismore and Mullumbimby occupies a broad gentle plateau which was originally covered by the largest single tract of rainforest in NSW, an area known as the 'Big Scrub'. The rainforest of the 'Big Scrub' was a heterogeneous environment, comprising a range of rainforest and moist forest types. The remnants of the 'Big Scrub' represent at least four different vegetation associations, but do not include many associations which would have been present originally (Floyd 1990, in Lot & Duggin 1993). Substantial clearing during the late 1800's (primarily for timber and agricultural pursuits) reduced the 'Big Scrub' by the early 1900's to a network of small remnants scattered through a substantially cleared landscape (Lot & Duggin 1993). This situation is essentially that which prevails today.

A number of previous investigations have been conducted on 'Big Scrub' remnants, on specific features of the 'Big Scrub' or on native fauna which inhabit the Lismore/Mullumbimby area. A survey of east Australian rainforests by the Australian Museum (Broadbent & Clarke 1976) included a few sites on the Lismore Plateau, and these have been accessed for this investigation. Other detailed studies within the Lismore/Mullumbimby area include a survey of birds from the 'Big Scrub' by Holmes (1987) and a review of rainforest remnants (Lot & Duggin 1993). Other specific investigations involving 'Big Scrub' remnants or native fauna which rely on them include the investigations and reports on rainforest pigeons in northern NSW (Date & Recher 1990; Date *et al* 1991), and a number of undergraduate and postgraduate reports by students of Southern Cross University (in particular those associated with Dr Peter Baverstock of the Graduate Research College at Lismore). Reports of particular value in this regard include consideration of amphibians in 'Big Scrub' remnants (Arens 1992), reptiles (Bohm 1991), Camphor Laurel (Deegan 1993), microchiropteran bats (Priestley 1992), the use of GIS (Johnson 1992) and the biology and management of the Black-necked Stork (Purcell 1993). Other information was also provided through discussions with the local National Parks & Wildlife Service officers, and other students and researchers at Southern Cross University and other universities. Consequently, there is a moderate body of data available on fauna and habitats in the Lismore/Mullumbimby area. This investigation also involves detailed studies of rainforest and 'Big Scrub' remnants, specifically along the proposed transmission line corridor.

2 METHODS

A substantial proportion of the existing transmission line corridor and proposed new facility consists of grazing lands or areas used for agricultural pursuits such as macadamia nut farms. These features are widespread throughout the region and are generally considered of relatively low significance for the conservation of native fauna. Few species are reliant upon such habitats, and those present are generally common to abundant or widespread species, or species which are tolerant of disturbance. Consequently, detailed field surveys were not conducted through areas which had been substantially cleared or disturbed for agricultural purposes. The fauna surveys conducted for the Environmental Impact Statement (detailed in this report) include detailed field studies in areas of native or semi-natural habitats along the existing transmission line and at sites adjacent to it.

Detailed aerial photography and topographic maps were used to locate areas of natural or regenerating forest along the transmission line corridor. As was evident from the aerial photography, a broad range of conditions pertained to patches and tracts of vegetation along the route, ranging from areas which had previously been grazed but in which stock had been removed and natural regeneration was occurring through to more substantial sites (such as around Boomerang Creek), where substantial remnants of 'Big Scrub' vegetation appear to have been retained over a long period.

Areas identified from the topographic maps and aerial photographs were subsequently reviewed in the field and ground-truthed for their nature and condition. An initial assessment was conducted by driving along roads and tracks, and by determining the size and nature of patches of vegetation, essentially by observation from the road. Subsequently, patches of vegetation were investigated on foot, and a final assessment made in the field regarding the suitability of individual patches as survey locations for the proposed transmission line corridor. Details of the fauna survey sites are provided in Appendices 1 and 1A of this report.

In addition to the size, condition and nature of vegetation communities and patches scattered throughout the transmission line corridor, the accessibility of sites for trapping surveys was also a condition for executing field-based studies at individual locations. In some instances, access was physically extremely difficult, and in several instances, sites were surveyed primarily by observations on foot (but were not trapped). At other locations, access to tracts of forest or natural vegetation was restricted by landowners, and consequently a few sites were not able to be surveyed by detailed trapping or bat detection and spotlighting surveys. On some occasions, however, observations from adjoining accessible land enabled at least a preliminary fauna assemblage to be acquired for some of these sites.

Standard biological survey techniques were adopted for the conduct of fauna surveys in the field along the proposed transmission line corridor. A variety of trapping techniques were employed, as well as methods for indirectly determining the presence of species, along with general observations and habitat searches.

Trapping techniques involved the deployment of Elliott small mammal traps, cage traps and the installation of pit traps with drift fences in some locations. Trap numbers varied from site to site, primarily dependent on the size of the habitat patch being surveyed and the nature of the environments present. Thus in large areas such as Boomerang Creek, up to 50 Elliotts were deployed, whereas some of the smaller habitat patches were only large enough for the use of 15-20 Elliotts. Similarly, the number of cage traps deployed at various locations was related both to habitat condition and size, and to accessibility. Pit traps with drift fences were installed in the larger tracts of forest and regenerating native habitat along the transmission line corridor. Pit trap installation again was in part dependent on accessibility and also on the nature of the ground. Extremely rocky substrates do not provide for the installation of pit traps. Appendix 2 provides details of the trapping activities conducted at each of the specific survey sites. Traps were baited with a standard mixture of peanut butter, rolled oats and honey and were set for a minimum of four nights at each locality.

Spotlighting surveys were conducted through all major survey locations using hand-held battery operated spotlights. Surveys were conducted in the evenings (between 1900 and 2300), and generally comprised walked transects along tracks and through open areas of rainforest and forest vegetation. In some instances, where roads or farm tracks passed through forested areas which were being surveyed, a road-based transect was also conducted. Table 2 indicates the frequency of spotlighting surveys at different locations along the transmission line corridor, and provides approximate person-hours dedicated at each location. A total of approximately 100 person hours of spotlighting have been conducted along the transmission line corridor for the purposes of this investigation.

Detailed surveys were also conducted for the microchiropteran bats. These animals are nocturnal, foraging through the forest canopy or understorey for the insects and small vertebrates upon which they feed. Two survey techniques were adopted to determine the presence of species of microchiropteran bats along the transmission line corridor. The first involved the use of mist nets and harp-type bat traps to capture individuals for identification at various locations along the transmission line corridor. The deployment of bat traps and mist nets requires the presence of suitable flying pathways or corridors through the vegetation, so that the traps can be appropriately placed to capture bats moving through the area or foraging in it. This technique was applied at a number of the survey sites along the transmission line corridor, with mist nets being the most frequently deployed trapping method in the Lismore/Mullumbimby area (Appendix 2).

The second technique for determining the presence of microchiropteran bats involves the recording of their echolocation calls and subsequent analysis by comparison with a library of calls to identify individual species present at any one locality. Microchiropteran bat calls are recorded using an Anabat II detector and a small portable cassette recorder. The detector collects the ultrasonic calls of the microchiropteran bats and converts them into a frequency which can be recorded on standard cassette tapes. Calls are subsequently analysed by comparison with computer-based call frequencies, to enable identification of the individual bat species present. Ultrasonic detection of microchiropteran bats was employed at most of the survey sites investigated along the transmission line corridor, with a total of 30 hours of bat recordings collected and analysed. Table 2 indicates the deployment intensities for the Anabat recorder and for mist nets and harp-type bat traps along the Lismore/Mullumbimby transmission line.

Other survey methods employed along the transmission line corridor involved specific surveys for birds in each of the locations and habitats investigated, and habitat searches (particularly targetted at reptiles and amphibians and conducted by the movement of logs, rocks and other debris or potential cover). Searches were also conducted through forest litter, and spotlight searches were conducted at night along tracks, waterways and around ponds. Specific searches of relevant eucalypts for Koala scratches and on the ground beneath them for Koala droppings were included at appropriate locations. As for other survey methods, the time dedicated to habitat searches and bird surveys was dependent substantially on the size and condition of the habitat patch being investigated. Additionally, accessibility dictated variable times for habitat searches and specific bird surveys.

Because of the nature of the proposal, the condition of the general landscape through which the proposed transmission line passes, and the scattered and patchy nature of native habitats, it was not considered appropriate to restrict investigations to particular endangered species. For example, it was not considered of benefit to specifically search for rainforest pigeons. The intensity and detail of investigations in the various habitats surveyed for this proposed transmission line has included suitable periods of observation and appropriate methods and search patterns to detect the presence of endangered fauna species in the rainforest patches and other habitats surveyed.

Several wildlife databases were accessed for information regarding native fauna records from the Lismore to Mullumbimby transmission line corridor and through the general area (Appendix 2b). The wildlife atlas of the NSW National Parks & Wildlife Service provided information on the locations of native vertebrate animals recorded from a substantial area of the Lismore plateau. Atlases which were searched for native birds include those retained by the Royal Australasian Ornithologists Union and the NSW Bird Atlasers Inc. Both groups provide bird information based on 10' blocks.

Other information was sought from a number of sources, and included discussions with the Alstonville office of the NSW NP&WS (Mr D Charley and Mr G Holloway), as well as with Dr P Baverstock of Southern Cross University, Dr E Date of the University of New England, and Mr D Milledge and Mr S Gilmore (residents and naturalists in the region). In addition, a number of reports and studies which have been conducted through the Lismore/Mullumbimby area generally, particularly associated with consideration of the 'Big Scrub' remnants, were reviewed, and data incorporated into this report where relevant.

Investigations have included surveys of birds from the 'Big Scrub' area (Holmes 1987) and a substantial review of rainforest remnants of the 'Big Scrub' (Lott & Duggin 1993). A number of other student reports from Southern Cross University were also reviewed (see Section 1.3 of this report), as well as the specific investigations of rainforest pigeons by Dr E Date of the University of New England.

3 FAUNA HABITATS

The fauna habitats along the Lismore/Mullumbimby transmission line corridor are defined principally in terms of the vegetation communities described by R Lembit (for this EIS). The fine scale divisions between vegetation communities are generally of less relevance for fauna, with animals tending to occur through broader landscape units and utilising resources distributed through a range of vegetation communities.

The principal vegetation associations present through the study area which are of relevance to native fauna are those based on Rainforest communities (including where dominated by Camphor Laurel), and those characterised by eucalypts or Brush Box in the canopy (with or without a Rainforest understorey). The other major Fauna Habitat Unit involves disturbed and agricultural lands, which predominate along the transmission line corridor and through the landscape generally. Wetlands and swamps also occur in the region, but are not represented along the corridor, although farm dams and small creeks and watercourses are present. The latter are not included as a separate Fauna Habitat Unit because few species are reliant solely on them, because impacts in these habitats are likely to be minimal, and because fauna using these habitats have been included in inventories for the surrounding vegetation communities.

FAUNA HABITAT UNITS

Five major Fauna Habitat Units (FHUs) are described for the Lismore/Mullumbimby transmission line, of which the first two (Rainforest and Eucalypt/Brush Box Forest sites) are subdivided on the basis of the levels of disturbance, and the presence of a rainforest understorey, respectively. Details of the habitat attributes and vegetation associations at the 18 fauna survey sites, and the corresponding vegetation categories of Lembit, are included in Appendix 1A.

FHU 1 Rainforest

- Generally in good condition, and often patches of reasonable or moderate size;
- includes a range of specific vegetation associations, including White Booyong, Pepperberry Tree/Stinging Tree, Black Bean/Red Bean, and Palm Subtropical Rainforest communities (Lembit #1, #2, #3 and #5), and Hoop Pine Dry Rainforest (#4);
- the majority of remnants investigated in fauna surveys along the transmission line corridor (12 of the 18) were entirely or partially composed of FHU 1 (4 sites consist exclusively of this FHU).

FHU 1a Disturbed Rainforest

- Rainforest which has been significantly disturbed or is naturally regenerating from previous agricultural activities;
- generally dominated by a canopy of Camphor Laurel and/or Privet with a rainforest understorey;
- consists of the 'White Booyong Subtropical Rainforest - Significant Disturbance' category of Lembit (#1A), with other possible Rainforest associations;
- present in 8 of the 18 fauna survey sites, and characteristic of 3 sites;
- 10 of the 18 sites consist entirely of FHU 1 and FHU 1a.

FHU 2 Eucalypt Forest

- Includes Eucalypt Forest retained from earlier clearing or regenerating naturally;
- excludes sites with a rainforest understorey;
- includes a range of dominant eucalypts, including Sydney Blue Gum, Blackbutt, Tallowood, Forest Red Gum, and Pink Bloodwood/Grey Gum/White Mahogany Open Forest communities (Lembit's vegetation mapping units #8, #9, #10, #11 and #12 respectively). Also includes Brush Box Open Forest (Lembit #7), where rainforest is not present as an understorey;
- present at only 2 of the 18 fauna survey sites, although is scattered along the corridor (usually in small isolated pockets or adjacent to Rainforest).

FHU 2a Eucalypt or Brush Box Forest

- Eucalypt or Brush Box Forest with a rainforest understorey;
- includes a variety of dominant eucalypts, usually Sydney Blue Gum or Tallowood, or the Brush Box Open Forest community (Lembit's vegetation mapping unit #6);
- present at 3 of the 18 fauna survey sites, although is often characteristic of the margins of the Rainforest communities.

FHU 3 Revegetation

- Rainforest or Eucalypt Forest plantations or revegetation patches;
- actively encouraged or nurtured by local landholders or rainforest rehabilitation groups (eg Greening Australia);
- comprises Lembit's Forest Plantation/Rainforest Regeneration category (#15);
- present at 2 of the 18 fauna survey sites, with a small representation at one other.

FHU 4 Cleared/Open Lands

- Lands which have been cleared of native vegetation for agricultural activities;
- characterised as grazing lands dominated by introduced grasses;
- the Cleared category of Lembit (C);
- characteristic of one survey site, and part-dominant at a second;
- most survey sites are surrounded by this FHU, or horticultural lands.

FHU 5 Horticultural Lands

- Lands which have been cleared of native vegetation and subjected to intensive horticultural activities (particularly the planting of Macadamia trees or other orchards, with some cropping);
- the Horticultural/Plantation category of Lembit (#14);
- not characteristic of any of the sites surveyed, although present in the vicinity of or adjacent to several of the fauna survey sites.

4 FAUNA RECORDS

4.1 INTRODUCTION

The native fauna considered for the proposed Lismore to Mullumbimby transmission line corridor include species recorded during the field investigations for this Environmental Impact Statement, as well as a number of additional species which have been recorded by other researchers in the general area and in databases maintained by ornithological groups and the National Parks & Wildlife Service. Records from other sources include species and sites located at some distance from the proposed transmission line, boosting the number of species considered, and including many species unlikely to be present along the corridor.

Species lists were obtained from Lott & Duggin (1993), Holmes (1987), Date & Recher (1990), Priestley (1992), Arens (1992) and Bohm (1991). In addition, the ornithological and NP&WS databases have provided additional records for the general region, although these include data from a substantially larger area than the transmission line corridor. A similar situation exists for the NP&WS wildlife atlas data. By virtue of the wide range of the reference material accessed, and the large areas which had been surveyed for these studies, some of the native fauna species recorded are unlikely to occur along the specific route of the proposed transmission line. Nevertheless, it is possible for most of these species to occur occasionally or on a seasonal basis at some locations along the transmission line corridor.

Many of the species which are included in the comprehensive lists provided in this report rely either on habitat types which are disturbed or which are widespread and common throughout the general landscape. Other species listed are dependent on habitat types which are not characteristic of the proposed transmission line corridor. Species which inhabit open grassland and grazing country, or which are tolerant of agricultural practices such as orchards, are likely to be widespread throughout the Lismore/Mullumbimby landscape, and are not restricted to the transmission line corridor. Similarly, species dependent on particular habitats (such as swamps and wetlands) are unlikely to be characteristic of the Lismore to Mullumbimby transmission line corridor, as these habitats are either extremely small or non-existent in this particular area. Consequently, many of the wetland species which have been recorded by other investigators or which are included on the species lists compiled for the area are unlikely to be present, other than as occasional vagrants. Additionally, these particular habitats are unlikely to be adversely affected by the proposed transmission line development, as ground construction will be restricted to small isolated sites along the corridor.

The following discussion considers the four main groups of vertebrate native fauna known or likely to occur through the forest remnants and habitats along the transmission line corridor between Lismore and Mullumbimby. With each group, the species recorded during surveys along the corridor are considered, as well as those which may be present based on previous studies in the area or on data from the databases accessed.

4.2 AVIFAUNA

One hundred and four bird species have been recorded from the 18 survey sites which were investigated along the Lismore/Mullumbimby transmission line (Appendix 3). Additional avian species were included on databases which were searched for this investigation, including the RAOU, NP&WS and NSWBA lists (Appendix 4). Due to the extended area covered by those databases, a substantial number of these species are considered of no relevance (eg the marine birds), or are unlikely to be present within the habitats along the proposed transmission line corridor, or to be solely dependent upon them. Additionally, most of the species recorded during this survey and listed in the various databases are relatively widespread and common to abundant, and are likely to be present throughout the general landscape.

Of the avian species specifically recorded along the transmission line corridor, four endangered birds were identified. Three of these are rainforest pigeons (the Superb, Rose-crowned and Wompoo Fruit-doves) and the fourth is the Marbled Frogmouth. All of these species are dependent upon rainforest habitats and are consequently unlikely to be broadly scattered throughout the landscape, but will be concentrated in the 'Big Scrub' remnants.

A number of other endangered bird species are either known from the general 'Big Scrub' area or may be expected to occur in the region. Several were considered by Lott & Duggin (1993) as likely to be present, including species such as the Yellow-eyed Cuckoo-shrike, White-eared Monarch, Alberts Lyrebird and the Sooty Owl (Table 4.1).

The other databases searched during this investigation indicated the presence of a number of other endangered bird species from the region, such as the Black Bittern, Black-necked Stork, Osprey, Bush Hen, Brolga, the Glossy Black and Red-tailed Black Cockatoos and a number of aquatic and wetland birds. Some of these species are unlikely to be present along the proposed transmission line corridor due to the absence of suitable habitat. Thus, the Black Bittern, Osprey, Brolga, Comb-crested Jacana, Pied Oystercatcher, Sanderling, Little Tern and Rufous Scrub-bird are not considered in detail.

A number of the birds included in Appendix 4 are inhabitants of open grassland or disturbed habitats. Species which are tolerant of disturbance and which regularly occur in agricultural lands or grassland environments will be typical of the majority of the transmission line corridor, and generally are widespread and common to abundant. Regularly and widely sighted species, such as the Australian Magpie, Magpie-lark, Australian Raven, Masked Lapwing, Willie Wagtail, Australian Kestrel and Richards Pipit, are typically associated with open environments. No species of conservation significance were recorded in these environments during this investigation, although a few species (such as the Brolga) have been recorded in the general region (RAOU database).

The second guild of birds recorded during surveys along the Lismore/Mullumbimby transmission line involve those associated with wetlands and aquatic habitats. Most of these features along the proposed corridor consist of small farm dams or small watercourses, either through open grassland or with some remnant riparian vegetation. No natural wetlands or swamps of any significance occur along the transmission line corridor, and the largest water body present is a substantial farm dam east of Dunoon. As for the grassland and open field birds, most of the species associated with the aquatic environments and wetlands are widespread and common to abundant. Species such as the White-faced Heron, Sacred and Straw-necked Ibises, Pacific Black Duck, Dusky Moorhen, Purple Swamphen and Little Pied Cormorant were regularly sighted along any small to moderate sized watercourse.

TABLE 4.1 Rainforest-dependent vertebrates that are known from or could be expected to occur in the 'Big Scrub' region of northern NSW (modified from Lott & Duggin 1993).

COMMON NAME	SCIENTIFIC NAME
AMPHIBIANS	
★Pouched Frog	*Assa darlingtoni*
Fletchers Frog	*Lechriodus fletcheri*
★Loveridges Frog	*Philoria loveridgei*
REPTILES	
Southern Angle-headed Dragon	*Hypsilurus spinipes*
Blue-speckled Forest Skink	*Eulamprus murrayi*
Leaf-tailed Gecko	*Phyllurus cornutus*
★Three-toed Snake-tooth Skink	*Coeranoscincus reticulatus*
Rainforest Cool-skink	*Pseudemoia zia*
Dwarf-crowned Snake	*Cacophis krefftii*
MAMMALS	
Mountain Brushtail Possum	*Trichosurus caninus*
Red-necked Pademelon	*Thylogale thetis*
★Red-legged Pademelon	*Thylogale stigmatica*
Fawn-footed Melomys	*Melomys cervinipes*
BIRDS	
Australian Brush Turkey	*Alectura lathami*
★Superb Fruit-dove	*Ptilinopus superbus*
★Rose-crowned Fruit-dove	*Ptilinopus regina*
★Wompoo Fruit-dove	*Ptilinopus magnificus*
Topknot Pigeon	*Lopholaimus antarcticus*
White-headed Pigeon	*Columba leucomela*
★Sooty Owl	*Tyto tenebricosa*
★Marbled Frogmouth	*Podargus ocellatus*
Noisy Pitta	*Pitta versicolor*
★Albert's Lyrebird	*Menura alberti*
Russet Thrush	*Zoothera heinei*
Pale Yellow Robin	*Tregellasia capito*
Black-faced Monarch	*Monarcha melanopsis*
Spectacled Monarch	*Monarcha trivirgatus*
★White-eared Monarch	*Monarcha leucotis*
Logrunner	*Orthonyx temminikii*
Large-billed Scrubwren	*Sericornis magnirostris*
Yellow-throated Scrubwren	*Sericornis citreogularis*
Brown Warbler	*Gerygone mouki*
Spangled Drongo	*Dicrurus hottentottus*
Regent Bowerbird	*Sericulus chrysocephalus*
Green Catbird	*Ailuroedus crassirostris*
Paradise Riflebird	*Ptiloris paradiseus*
★Yellow-eyed Cuckoo-shrike	*Coracina lineata*

★ Schedule 12 (NP&W Act 1974): Part II Vulnerable & Rare fauna.

Other species which are also commonly located throughout the Australian landscape include the Australasian Grebe, Pacific Heron, Intermediate Egret, Coot and the Australian Crake. The Comb-crested Jacana could be present, but suitable habitat is sparse.

One species of native Australian bird of conservation significance which is associated with wetlands and is known from the Lismore region is the Black-necked Stork. This species was not recorded during these surveys, and the only record in the general Lismore/Mullumbimby area is a sighting north of Federal (Purcell 1993), towards the northern end of the proposed transmission line corridor. However, the transmission line is not intended to pass in close proximity to that location. It is not considered likely that the Black-necked Stork will occur specifically along the existing corridor, as there are no habitats of high relevance to this species along the route. However, some consideration is given in later sections of this report to the potential impacts of the line on the Black-necked Stork.

The majority of avifauna recorded during the surveys along the proposed transmission line corridor, and the majority of those included on other databases and in other reports, are birds associated with forest communities. These may be divided into two groups, those more regularly associated with drier eucalypt forests (although many of these also occur regularly in rainforest environments), and birds predominantly associated with rainforests (which may also forage in eucalypt forest). However, most of the species considered as rainforest birds are dependent primarily on the existence of rainforest habitats for their continued survival.

Most of the forest birds recorded during the site surveys through the Lismore to Mullumbimby area are relatively common to abundant and widespread. Most of the pigeons, cuckoos, kingfishers and parrots are regular inhabitants of forest environments, along with common species such as the Black-faced Cuckoo-shrike, Varied Triller, the robins, Grey Fantail, Willy Wagtail, shrike-thrushes, thornbills, treecreepers, and the Pied Currawong. Many of these species were recorded at every survey site investigated (Appendix 3), indicating their widespread distribution and abundant status.

Endangered species which are known from the general region (as included on the RAOU and NSWBA data lists) and which generally inhabit open eucalypt forest communities include the Red-tailed and Glossy Black-Cockatoos. However, neither of these species is considered likely to be dependent on the habitats scattered along the proposed transmission line, and neither is particularly likely to occur along the line to any relevant extent.

The avifauna of most conservation interest with regard to the proposed transmission line corridor are those birds associated with rainforest habitats. Several of the avian species considered by Lott & Duggin (1993) to be rainforest-dependent were recorded during the surveys along the transmission line corridor. Some of these species were frequently recorded, including the Australian Brush Turkey, Topknot Pigeon, White-headed Pigeon and Green Catbird (Appendix 3). Other species were seen in up to half of the survey sites, including the Spangled Drongo and Rose-crowned Fruit-dove. Less commonly sighted rainforest-dependent birds included the Superb Fruit-dove, Wompoo Fruit-dove, Marbled Frogmouth, Noisy Pitta, Pale Yellow Robin, Yellow-throated Scrubwren and Regent Bowerbird. These species were located in only between one and five survey sites of the 18 investigated. The Superb Fruit-dove was located in only two 'Big Scrub' remnants along the proposed corridor (P7 & P14). The Rose-crowned Fruit-dove is noted by Lott & Duggin (1993) as a "widespread" rainforest species (it was recorded at 23 out of the 32 sites listed in their report), and the Wompoo Fruit-dove was listed as a "common" rainforest species, occurring in 14 of the 32 sites.

Four endangered Australian bird species were recorded from the rainforest remnants investigated along the transmission line corridor, including the three Fruit-doves and the Marbled Frogmouth. Other endangered species considered by Lott & Duggin (1993) to be dependent on rainforest habitats and which are known from the general region include the Sooty Owl, Alberts Lyrebird, White-eared Monarch and Yellow-eyed Cuckoo-shrike. Of these the Sooty Owl, Alberts Lyrebird and White-eared Monarch have been recorded in 'Big Scrub' rainforest remnants (Holmes 1987). However, none of the survey sites inspected by Holmes were located along the proposed transmission line corridor. The Sooty Owl was located in a remnant close to the Nightcap Range and is considered most likely to occur in such areas of extensive forest. The White-eared Monarch was located at several survey sites in Holmes' study, and Alberts Lyrebird was only associated with rainforest remnants close to larger tracts of forest, such as near the Blackwall and Nightcap Ranges.

The diversity and abundance of bird species appear to be related primarily to the size of the rainforest patches and to their degree of isolation from major areas of native forest (such as the Nightcap or Blackwall Ranges). Holmes (1987) and Lott & Duggin (1993) noted that the area occupied by rainforest remnants was a reliable predictor of bird species diversity, but that this phenomenon was complicated by proximity to large areas of continuous forest. Thus, some small areas of 'Big Scrub' remnant close to the Blackwall and Nightcap ranges supported a greater species diversity of rainforest-dependent birds than larger areas at some distance (for example Boatharbour, Rotary Park and Wollongbar). This situation is suggested by Holmes (1987) as most probably the result of disturbance by humans and cattle, as well as the likely effects of adjacent roads. Lott & Duggin (1993) also note that sites with moderate numbers of bird species tended to be sites with high tree and shrub species diversities. Lott & Duggin further note that the proportion of rainforest-dependent avifauna is related to remnant size and isolation from continuous forest. They indicate that "*the number and proportion of rainforest-dependent species declines with total number of bird species, remnant size and isolation*".

One of the most significant features of the 'Big Scrub' remnants scattered through the Lismore region is their use as 'stepping stones' by rainforest-dependent pigeons. Date *et al* (1991) indicated that rainforest pigeons moved between the larger tracts of rainforest and other forest habitats on the north coast of NSW using the small remnants of the 'Big Scrub' as islands to enable them to move across areas of otherwise cleared agricultural land. Furthermore, Holmes (1987) indicated that fewer than 50% of the bird species he recorded in remnant patches of the 'Big Scrub' were likely to reside permanently in those sites, in part because of the small size and limited resources present in each one. Therefore, it is likely that a number of remnants would be required in any one area to provide sufficient resources, particularly for birds such as rainforest pigeons. The conclusions of Holmes (1987), Date *et al* (1991) and Lott & Duggin (1993) are that maintenance of all remaining 'Big Scrub' patches is important to ensure the continued survival of rainforest-dependent species, particularly for mobile groups such as the pigeons.

4.3 MAMMALS

A total of fourteen native mammal species were recorded from the sites surveyed along the proposed transmission line corridor between Lismore and Mullumbimby. Of these, four are microchiropteran bats (discussed below), and one megachiropteran bat, the Grey-headed Flying Fox, has also been recorded. The remainder include the Short-beaked Echidna, the Northern Brown and Long-nosed Bandicoots, the Brown Antechinus, Bush Rat, Koala, Common Ringtail Possum, and the Mountain and Common Brushtail Possums. Of these species, only the Mountain Brushtail Possum is considered rainforest-dependent or rainforest-obligate (Smith *et al* 1989), although it has been recorded in other moist forest habitats in NSW (D Fanning *pers obs*).

Of the terrestrial mammals, the Bush Rat *Rattus fuscipes* was recorded in nine of the eighteen rainforest remnants surveyed for the transmission line corridor. The Short-beaked Echidna and Brown Antechinus were located in only four survey sites, the Northern Brown Bandicoot in 3 or 4 (1 record is uncertain), and the Long-nosed Bandicoot in 1 or 2 (Appendix 5). The smaller terrestrial mammals (the Brown Antechinus and Bush Rat) were mostly located at sites which contained a substantial area of surface rock, providing shelter for these species from predators. Neither of the bandicoots are rainforest-obligate species, and both require dense understorey (at least in patches) to provide shelter. Consequently, many of the sites surveyed did not provide suitable habitat for these species. No endangered terrestrial mammals were recorded during this investigation.

Other terrestrial mammals have been recorded from rainforest remnants of the 'Big Scrub', particularly from the Big Scrub Flora Reserve (FR) and other large scrub remnants. The Swamp Rat *Rattus lutreolus*, which is not a rainforest-obligate species, has been recorded in Booyong Nature Reserve (NR). Other species recorded in various 'Big Scrub' remnants include the Fawn-footed Melomys, Tiger Quoll, Long-nosed Potoroo, Red-legged Pademelon and Red-necked Pademelon. Lott & Duggin (1993) note that all of these species have been recorded in the Big Scrub FR, which is adjacent to the Nightcap Range and therefore contiguous with extensive tracts of forest. However, the occurrence of terrestrial mammals in other remnants depends on their size and location. Generally, the smaller and more isolated rainforest remnants are capable of supporting few or none of the small terrestrial mammals which might otherwise be present in these habitats.

Several of the terrestrial species reported from the 'Big Scrub' remnants by Lott & Duggin (1993) are endangered (listed on Schedule 12 of the NP&W Act), as indicated in Table 5.1. The Tiger Quoll *Dasyurus maculatus* had been recorded at the Big Scrub FR in 1976, but has not been seen in more recent times in that locality (Gilmore 1987, in Lott & Duggin 1993). It has more recently been recorded at Federal (Millgate *et al* 1992 in Lott & Duggin 1993). The Common Planigale *Planigale maculata* was recorded in the 'Allansby' rainforest remnant by Campbell in 1992 (*pers comm*), although this species was not recorded during the current investigations along the proposed transmission line corridor, despite the use of pit traps. It has also been recorded at Eureka (Bohm 1991), which is located near Federal, and thus occurs in the general area through which the transmission line passes (although not directly on it).

Macropods were not recorded in any remnant during this investigation, and appear to be only rarely encountered in 'Big Scrub' remnants. The Potoroo *Potorous tridactylus* was recorded in the Big Scrub FR (in 1980), at Victoria Park (in 1981) and Boatharbour (in 1971). Lott & Duggin (1993) suggest that "long term survival of this species [at Victoria Park] .... is dubious", and it is no longer likely to occur at Boatharbour. Other macropods are also rare, with the Red-necked Pademelon recorded only at Big Scrub FR, Dawes Scrub and Victoria Park, and the Red-legged Pademelon only at Big Scrub FR (Lott & Duggin 1993). The Swamp Wallaby has also been recorded (at Federal), but macropods clearly are sparse throughout the 'Big Scrub' remnants on the Lismore Plateau.

Generally speaking, the 'Big Scrub' remnants in the Lismore region appear to be depauperate in terms of terrestrial mammal fauna, usually as a result of their small size, mostly isolated nature, levels of disturbance and lack of shelter for small terrestrial mammals, and to the impacts of human and animal interference. Campbell (*pers comm*) notes that the Fawn-footed Melomys *Melomys cervinipes* was not collected in any of the six remnants which he intensively studied.

With respect to the arboreal mammals, four species were recorded during the intensive surveys conducted along the proposed transmission line corridor between Lismore and Mullumbimby (Appendix 5). Of these, the Mountain Brushtail Possum is regarded by Smith *et al* (1989) as a rainforest-obligate species, although it is regularly recorded in moist sclerophyll forest as well, and is not specifically restricted to rainforest (D Fanning *pers obs*). This species was located in a number of the remnants scattered along the proposed transmission line corridor (7 of the 18 plots surveyed). All of these were dominated by a rainforest understorey, but in several instances supported a Camphor Laurel or eucalypt overstorey. The Common Brushtail Possum, on the other hand, is a species of eucalypt forest, but is capable of utilising a range of vegetation communities and developed environments.

Lott & Duggin (1993) note that the Common Ringtail Possum *Pseudocheirus peregrinus* has been recorded in rainforests of the 'Big Scrub' and northeastern NSW. This species was recorded in only one 'Big Scrub' remnant during surveys along the proposed transmission line, and is likely to be more common in larger areas of contiguous forest (such as in the Big Scrub FR and other reserves adjacent to the Nightcap Range).

The final arboreal species, the Koala *Phascolarctus cinereus* was recorded at several locations during this investigation, with evidence for its presence (including scratches on trees and droppings) located at five of the survey sites (Appendix 5). Similar evidence was found on other trees not included on the survey sites, and the Koala is clearly scattered throughout the Lismore region, particularly in the Dunoon area and around Goonengerry. The Koala is not a rainforest species, and in fact generally avoids such moist habitats. It is dependent on woodland and open dry forest communities, and the distribution of these resources through the open grazing lands of the Lismore region are clearly suitable for this species. A more detailed discussion of the Koala is included in Section 5 of this report.

Two other native mammal species have been recorded in the Lismore/Mullumbimby area, and may occasionally be associated with rainforest remnants. They may also occur in the streams which are crossed by the proposed transmission line corridor. The Australian Water Rat and the Platypus, both of which are recorded occasionally throughout the region, are associated primarily or entirely with waterways. In particular, the Platypus is dependent on freshwater habitats, obtaining all its food in the water. Neither species is considered likely to occur in substantial numbers in the area to be affected by the proposed transmission line corridor, although both may occur on occasions.

The final group of native mammals which is relevant to the proposed transmission line corridor and the remnants of 'Big Scrub' vegetation scattered throughout the Lismore area are the bats. Bats are divided into two groups, the flying foxes or megachiropteran bats (which feed on pollen, nectar and fruit), and the microchiropteran bats (which principally eat small vertebrates and insects).

Two megachiropteran bats are commonly recorded in the Lismore region, the Grey-headed Flying Fox *Pteropus poliocephalus* and the Black Flying Fox *Pteropus alecto*. Flying Foxes were recorded at many of the survey sites, but the species involved was generally not able to be identified as the animals were flying overhead and did not alight (although one Grey-headed Flying Fox was captured in a mist net at site P7). However, as noted by Lott & Duggin (1993), both species are likely to feed in any remnant rainforest vegetation throughout the region during the fruiting season. The Grey-headed and Black Flying Foxes are widespread species, capable of travelling substantial distances in an evening to fruiting and flowering trees.

One other species, the Little Red Flying Fox *Pteropus scapulatus*, may also be expected occasionally in rainforest or in eucalypt forest remnants throughout the region. This species feeds on nectar and pollen and would be likely to occur where dense flowering of eucalypts occurs on a seasonal basis.

Roost sites for the Black and Grey-headed Flying Foxes are known from several reserves and rainforest remnants through the Lismore region, including Booyong, Currie Park and Boatharbour Reserves. As noted by Lott & Duggin (1993), Flying Foxes generally roost in large camps involving hundreds to thousands of animals, but may also occasionally roost in small numbers in isolated patches of rainforest.

One other megachiropteran bat has been recorded from the Lismore region, notably from 'Big Scrub' remnants (Lott & Duggin 1993). The Queensland Tube-nosed Bat is known from the Snows Gully Reserve and possibly the Boomerang Falls Reserve. Both sites are contiguous with the extensive forests of the Nightcap Range, and the species has not been recorded from isolated remnants.

Microchiropteran bats are small animals which forage at night through a range of habitats and altitudes for insects or for small vertebrates such as lizards and fish. Lott & Duggin (1993) indicate that 10 species of microchiropteran bats are recorded for the 'Big Scrub' area, all of which were recorded in the Big Scrub FR (which is contiguous with the Nightcap Range forests). Only three microchiropteran bat species were recorded from 'Big Scrub' remnants beyond that location (the Northern and Gould's Long-eared Bats and the Pumilus).

Intensive surveys for microchiropteran bats during this investigation along the proposed transmission line corridor between Lismore and Mullumbimby revealed the presence of four species, the White-striped Mastiff-bat, Little Bent-wing Bat, Gould's Wattled Bat and Large-footed Myotis. All species occurred at a relatively small number of sites (between one and four survey sites investigated).

In the only other detailed investigation for microchiropteran bats in the 'Big Scrub' remnants, Priestley (1992) also recorded four species, which include an additional three beyond those obtained during this investigation. Three of the four sites at which Priestley surveyed are at a considerable distance from the proposed transmission line corridor, but the fourth (the 'Allansby' rainforest remnant) is located in the vicinity of the Johnstone scrub remnants (near Federal), and although not directly on the transmission line corridor is in the general vicinity. Trapping activities at 'Allansby' revealed the presence of Gould's Long-eared Bat *Nyctophilus gouldii*, represented by one individual. The other survey sites contained one to three species, with substantial numbers of the Large-footed Myotis being recorded at Brockley, and smaller numbers of the other species at the Victoria Park and Booyong Reserve sites.

The widely distributed and relatively common Gould's Long-eared Bat recorded at 'Allansby' utilises a wide range of habitats and is not regarded as a rainforest-obligate species. Similarly, the White-striped Mastiff-bat (collected at four locations) and Gould's Wattled Bat (collected at one) are relatively widespread and common species, not restricted to rainforest habitats.
Three of the microchiropteran bats which have been recorded from rainforest remnants in the Lismore region are included on the endangered species list of NSW fauna (Schedule 12 of the NP&W Act). The Northern Long Eared Bat *Nyctophilus bifax* was collected by Priestley

(1992) in Booyong Recreation Reserve (13 hectares) and at Victoria Park NR (8ha). Neither reserve is close to the proposed transmission line corridor. *Nyctophilus bifax* has also been recorded at Macquires Creek (Milledge in Lott & Duggin 1993 and Big Scrub FR (Parnaby in Lott & Duggin 1993). The former site is distant from the corridor, and the latter site is contiguous with the forests of the Nightcap Range. The Northern Long-eared Bat was not recorded during investigations along the corridor.

The Little Bent Wing Bat *Miniopterus australis* was recorded at three locations during surveys for the proposed transmission line corridor (Appendix 5), although no substantial caves which might function as maternity roosts were located. The Little Bent-wing Bat is a "*localised and common*" species (Parnaby 1992), which is considered of conservation concern primarily because of its restricted maternity roosting requirements. The Common Bent-wing Bat *Miniopterus shreibersii* has been recorded at the Big Scrub FR (Parnaby in Lott & Duggin 1993), but has not been located in any other rainforest remnant or other site in the Lismore/Mullumbimby region. This is regarded by Parnaby (1992) as a "*common cave-dwelling species*", although it is included on Schedule 12 of the NP&W Act.

The Large-footed Myotis *Myotis adversus* was located at three sites during this investigation of the transmission line corridor, and was recorded by Priestley (1992) in relatively large numbers at the Brockley site (a substantial distance south of the corridor). One of the locations surveyed near the Mullumbimby Power Station during this investigation (Site P14) also supported substantial numbers of *Myotis adversus*. This site was characterised by a large pool in the Wilson River, which flows through a rainforest remnant.

An unconfirmed record for the Eastern Horseshoe Bat *Rhinolophus megaphyllus* in Boatharbour NR (Milledge in Lott & Duggin 1993) is the only other microchiropteran bat record available for sites which are not immediately adjacent to the Nightcap Range. *Rhinolophus megaphyllus* is also an endangered species, but is not rainforest-obligate as it occurs in a range of eucalypt forest habitats as well as rainforest. Whilst several other species noted by Lott & Duggin (1993) as occurring in the Big Scrub FR may also occur more widely throughout the region, it is considered (given the intensity of surveys conducted in the region) unlikely that significant populations of these species occur along the transmission line corridor.

4.4 REPTILES

A total of thirteen reptiles have been recorded during the field investigations along the proposed transmission line corridor. Several of these were located in a substantial number of the sites surveyed, including the Eastern Snake-necked Turtle (which was located in virtually all water bodies investigated), the Eastern Water Dragon (located adjacent to most watercourses), the Dark-flecked Garden Sun-skink (which is an extremely widespread and abundant species), and the Carpet Python (which was located in 9 of the 17 sites surveyed). Other species were less frequently recorded, appearing in between 1 and 6 of the sites investigated. None of the species recorded during this investigation are considered threatened or endangered (per Schedule 12 of the NP&W Act). Furthermore, none of the species which were located during this investigation are considered rainforest-obligate, although the Land Mullet *Egernia major* tends to occur most frequently in such habitats.

Lott & Duggin (1993) discuss a number of other reptile species which have been recorded during various investigations in rainforest remnants in the 'Big Scrub' area. Included amongst these are several species considered rainforest-obligate, such as the Southern Angle-headed Dragon *Hypsilurus spinipes*, the Blue-speckled Forest Skink *Eulamprus murrayi* and the Dwarf Crowned Snake *Cacophis krefftii* (Table 4.1). These species have been recorded in the Big Scrub FR, but also in smaller remnants throughout the Lismore area. Records for the Southern Angle-headed Dragon and Dwarf Crowned Snake were obtained from the 'Federal' remnant, which is close to the proposed transmission line corridor. The Southern Angle-headed Dragon was also recorded from the 'Allansby' remnant which is near Federal. Several additional species are listed in Lott & Duggin (1993) as having been recorded from 'Big Scrub' rainforest remnants in the Lismore region (including *Varanus varius*, *Lampropholis delicata*, *Ophioscincus truncatus*, *Saproscincus challengeri*, *Morelia spilota*, *Tropidechis carinatus* and *Tiliqua gerrardii*). However, none of these additional species are included on Schedule 12 of the National Parks & Wildlife Act, and none were recorded during the field surveys for the proposed transmission line.

Bohm (1991) conducted pitfall trapping surveys for reptiles in six 'Big Scrub' remnants in the Lismore region. Of the sites investigated by Bohm, the 'Eureka' remnant (near Federal) is close to the corridor, although it is not precisely on the proposed transmission line corridor. Species recorded by Bohm at 'Eureka' include the Southern Angle-headed Dragon, Challengers Skink, the Garden and Grass Skinks (*Lampropholis delicata* and *L guichenoti*), the Land Mullet, and the Dwarf Crowned Snake (which is considered a rainforest-obligate species).

Bohm (1991) recorded a total of 20 reptile species from his six study sites in 'Big Scrub' rainforest remnants, of which six were also recorded during the current investigations along the transmission line corridor. Fourteen additional species were recorded by Bohm, including the Southern Angle-headed Dragon (recorded in three of his six sites), the Land Mullet (recorded at five sites), the Blue-speckled Forest Skink (recorded at two) and several snakes (including the Green Tree Snake, Common Brown and Eastern Small-eyed Snakes). The Dwarf-crowned Snake was also recorded at Boatharbour NR.

Bohm (1991) notes that the numbers of reptile species recorded in the scattered rainforest remnants of the 'Big Scrub' studied "*generally represent a sub-set of those recorded in the larger tracts of rainforest to the north and west*". Bohm also notes that reptile species diversity in rainforest remnants is dependent primarily on remnant size (as is the case for other fauna groups). Because of the intervening areas of unsuitable habitat, particularly agricultural and grazing lands, many of the reptile species recorded in rainforest remnants are regarded as 'remnant-obligate' (Bohm 1991). Rainforest-obligate species may thus be restricted to a single remnant, and may be incapable of migrating to other remnants without intervening areas of connecting habitat.

The 'Big Scrub' rainforest remnants surveyed during the current investigation for the proposed transmission line corridor support a relatively modest to depauperate reptile assemblage. Most sites contained between 1 and 4 species (Appendix 6), with only 4 of the 18 survey sites supporting more than 4 reptile species. The three sites in this study (P7, P11 and P15) which supported 9 or 10 species were the largest remnants investigated. By comparision, 5 of Bohm's 6 sites supported 7 reptile species or more, with Boatharbour NR containing 15 species, and the 'Eureka' site (of 1.5 to 2ha) supported 7 species.

4.5 AMPHIBIANS

Five native and one introduced amphibian species were recorded during the field investigations for the proposed transmission line corridor between Lismore and Mullumbimby. Of these, the Green Tree Frog *Litoria caerulea* and Eastern Dwarf Tree Frog *Litoria fallax* are common and widespread, and were located in most of the sites surveyed. The Brown Striped Frog *Limnodynastes peronii* was located in approximately half of the survey sites, whilst the Spotted Grass Frog *Limnodynastes tasmaniensis* and Lesueur's Frog *Litoria lesueurii* were recorded in fewer sites (1 and 3 sites respectively). The introduced pest, the Cane Toad *Bufo marinus* was located in two sites near Lismore. None of the species recorded during this investigation are threatened or endangered.

Arens (1992) conducted a review of the global frog decline phenomenon and a survey of amphibians in 'Big Scrub' rainforest remnants, as well as along the northern coast of NSW. Arens located no amphibians in the three sites that she surveyed, which included Wilson Park, Rotary Park, and the Johnstone Scrub group of rainforest remnants (the latter group is in the general vicinity of the transmission corridor). However, two species were located adjacent to the Wilson Park study site, these been *Litoria fallax* and *Litoria caerulea*. Both species were recorded during the investigations along the potential transmission line corridor between Lismore and Mullumbimby (this report), and both are common to widespread.

Lott & Duggin (1993) compiled records for 'Big Scrub' remnants in the Lismore region, and located several rainforest-obligate or endangered amphibian species in rainforest remnants (Tables 4.1 and 5.1). Three rainforest-obligate species were listed from several sources, including the Pouched Frog *Assa darlingtoni*, Fletcher's Frog *Lechriodus fletcheri* and Loveridge's Frog *Philoria loveridgei*. The former of these was located only in the Big Scrub FR, adjacent to the Nightcap Range, whilst the latter two species were located at Federal (near the transmission line corridor), as well as at Snows Gully (another 'Nightcap Range' site). The 'Federal' site is not on the transmission line corridor, but is in the general region, and it is possible that Fletcher's and Loveridge's Frogs could occur along the corridor. None of these species were recorded during the field surveys conducted for this report.

Eight additional amphibians are noted by Lott & Duggin (1993) from 'Big Scrub' remnants, including *Litoria barringtonensis*, which was located only in the Big Scrub FR along with *Litoria lesueuri*. This latter species was also recorded during the investigation along the proposed transmission line corridor. Other species listed by Lott & Duggin (1993) include *Litoria pearsoniana*, *Litoria chloris* and *Litoria caerulea*, the latter of which was recorded regularly during the transmission line study. *Litoria pearsoniana* has also been recorded at the 'Federal' site (Lott & Duggin 1993), but was not located during surveys for the transmission line.

Relevant amphibian species which are considered of conservation concern are discussed in further detail in Section 5 of this report. Whilst several additional species could be present along the proposed transmission line corridor, it is considered unlikely that the proposed development (being rebuilding of the existing transmission line) will have an adverse impact on the habitats or features of significance for these species.

5 ENDANGERED SPECIES

Endangered fauna species are defined as those listed on Schedule 12 of the National Parks & Wildlife Act 1974, as amended subject to the Endangered Fauna (Interim Protection) Act 1991. This Schedule lists species which are considered of conservation concern because of restricted distributions or habitat requirements, or because of significant population or distributional range declines and where threats to species' survival still prevail. Schedule 12 has been revised and assessed by a scientific committee using information from experts on individual species and groups, and most of the native fauna currently listed on Schedule 12 may be considered genuinely threatened or vulnerable. For some species, however, current information is not sufficient to enable a satisfactory assessment of true conservation status.

A number of endangered native fauna species are known to or could possibly occur in the Lismore/Mullumbimby region (Table 5.1), and doubtless a considerable number of now threatened species would have been common in the 'Big Scrub' prior to its substantial disturbance during the second half of the nineteenth century. Table 5.1 is derived from distributional maps and databases and many of the species included have not been recorded from the vicinity of the transmission line corridor.

Of the species listed in Table 5.1, only seven were recorded during the field investigations along the proposed transmission line corridor, and an additional 19 have been recorded in habitats through the Lismore/Mullumbimby area or in rainforest remnants scattered throughout the original 'Big Scrub' area (as mapped in Lott & Duggin 1993). Of these additional species, however, ten have only been recorded in the 'Big Scrub' remnants which are adjacent to the contiguous forests of the Nightcap Range, and one (the Red-tailed Black-Cockatoo) is considered extinct. These species are considered unlikely to occur in the smaller isolated remnants on other than an occasional 'non-viable basis. Additionally, one species (Alberts Lyrebird), was recorded only from remnants adjacent to the Nightcap and Blackwall Ranges. This species is also not likely to be present in the smaller or more isolated tracts of remnant rainforest vegetation. Only six extra endangered rainforest species, and the Black-necked Stork, are considered of potential relevance to the proposed transmission line.

Species profiles have been compiled for each of the endangered species which were recorded during these investigations along the proposed transmission line corridor, and for other species known from remnants in the general region and which could possibly occur along the corridor. Species which are considered of little relevance to the proposed transmission line corridor, or which if present are considered likely not to be affected by the proposed development, are not discussed in detail below.

TABLE 5.1 Vulnerable & Rare Fauna of the 'Big Scrub' region, including the Lismore to Mullumbimby area (modified from Lott & Duggin 1993), with additional known records included).

COMMON NAME	SCIENTIFIC NAME	KNOWN SITE	THIS STUDY
AMPHIBIANS			
# Pouched Frog	*Assa darlingtoni*	1,SG	
Loveridge's Frog	*Philoria loveridgei*	19,21,26,SG, **F**	
MAMMALS			
Koala	*Phascolarctos cinereus*		●
# Long-nosed Potoroo	*Potorous tridactylus*	1,21?,30?	
# Red-legged Pademelon	*Thylogale stigmatica*	1,SG	
Tiger Quoll	*Dasyurus maculatus*	1?, **F**	
Common Planigale	*Planigale maculata*	**33, 38 or 39**	
# Queensland Tube-nosed Bat	*Nyctimene robinsoni*	2?,SG	
Black Flying-fox	*Pteropus alecto*	2,13,19,26,27,30?, 35,SG,**F**	
# Queensland Blossom Bat	*Syconycterus australis*	30,SG	
# Common Bent-wing Bat	*Miniopterus schreibersii*	1	
Little Bent-wing Bat	*Miniopterus australis*	1,SG	●
# Large Pied Bat	*Chalinolobus dwyeri*	1	
Large-footed Myotis	*Myotis adversus*	1,16	●
Northern Long-eared Bat	*Nyctophilus bifax*	1,13,21,26,30,SG	
BIRDS			
Osprey	*Pandion haliaetus*	27	
# Bush Hen	*Gallinula olivacea*	SG	
Superb Fruit-dove	*Ptilinopus superbus*	1,2,SG	●
Rose-crowned Fruit-dove	*Ptilinopus regina*		●
Wompoo Fruit-dove	*Ptilinopus magnificus*		●
# Red-tailed Black-Cockatoo	*Calyptorhynchus magnificus*	extinct?	
# Glossy Black-Cockatoo	*Calyptorhynchus lathami*	SG	
Sooty Owl	*Tyto tenebricosa*	2,3,SG,**F**	
Marbled Frogmouth	*Podargus ocellatus*	1,2,3,24,SG,**F**	●
# Yellow-eyed Cuckoo-shrike	*Coracina lineata*	SG	
Albert's Lyrebird	*Menura alberti*	1,2,3,28,29,SG	
White-eared Monarch	*Monarcha leucotis*	1,3,23,28,SG,**F**	
Black-necked Stork	*Ephippiorhynchus asiaticus*		*

The 'known sites' are those described by Lott & Duggin (1993), and other records (Preistley 1992; Arens 1992; Bohm 1991; Purcell 1993). Those in bold are on or close to the proposed transmission line.

● 'THIS STUDY' includes records obtained during specific field surveys along the proposed transmission line corridor.

* recorded from a site near Federal (Purcell 1993).

\# Species recorded only from remnants adjacent to the Nightcap Range within the 'Big Scrub'.

Common Planigale ***Planigale maculata***

The Common Planigale is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species on the basis of "*population and distribution suspected to be reduced; threatening processes moderate; ecological specialist*" (NP&WS 1993). This species is noted by Strahan (1992) to be nationally "*common*" and "*secure*", with a total range of 300000 to 1 million sq.km. It is distributed through the northeastern and northern coastal areas of Australia, with few specimens recorded south of 30° latitude (Denny 1982).

Like most Planigales this species is commonly found in areas associated with either permanent water or in those which are periodically flooded (Denny 1982). It has been recorded in flooded marsh, coast swamp fringes, rocky areas, and in wet soil near creeks (Redhead 1991), and is generally found "*in or near wet swampy areas with a vegetation cover of trees, scrub, sedge and or grass*" (Denny 1982). Individuals have been recorded in rainforest, sclerophyll forest, grassland and marshland habitats (Redhead 1989), tall woodland, wattle scrub and pine plantations (Denny 1982). Nests are built under rocks or in or under fallen timber (Strahan 1992), and the animals may be "*communal with individuals of their own or other species*".

The Common Planigale has been recorded at 2 locations in the Lismore/Mullumbimby area, in the 'Allansby' (Campbell *pers comm*) and 'Eureka' (Bohm 1991) remnants. Neither site is on the proposed transmisssion line corridor, but both are in the general vicinity, and the Common Planigale could be present in one or a few of the rainforest remnants along the route.

The Koala ***Phascolarctos cinereus***

The Koala is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species because of its rather precarious situation in NSW, and on the basis of "*population and distribution severely reduced; poor recovery potential; threatening processes severe; ecological specialist*". Conversely, Martin (1989) has indicated that one of the significant problems with Koalas, particularly in Victoria, is the rapid rate of population increase, and the difficulties associated with finding sufficient suitable habitat.

The Koala is considered by Strahan (1992) as "*very sparse*" in abundance but "*probably secure*", covering a total distribution of 300000 to 1 million sq.km. The Koala occurs throughout eastern Australia, from the western side of Victoria to the base of Cape York, in a series of large but disjunct population groups, with the main concentrations of the species in southeastern Queensland and northeastern NSW, as well as in Victoria (Phillips 1990). Whilst the historical geographic range of the species has been largely maintained, the animals appear to be abundant in only a few localities. Reed *et al* (1991) note that Koalas were generally uncommon in the majority of locations in NSW from which records were obtained, and that they occur primarily on private and agricultural lands, rather than within the state reserve system or within State Forests.

The history of Koalas in Australia over the last 200 years has involved significant fluctuations in population sizes, with periods of hunting of the animals and associated population declines occurring into the early 1900s. There have also been intermittent periods of apparent population increases and a considerable history throughout eastern Australia of substantial habitat modification and degradation (Phillips 1990; Reed *et al* 1991). The Koala in NSW appears to be declining on the northern and western fringes of its range (Phillips 1990), due particularly to habitat clearing. In northern NSW, the Koala is likely to be at most risk along the northern coastal area, where pressures due to rapid urbanisation and human population increase, and subsequent habitat fragmentation, are intense.

The Koala primarily inhabits eucalypt woodland and open forest, and is rarely recorded within rainforest or closed eucalypt forest. It is able to cross large areas of open ground and is consequently not restricted to locations where trees are dense (Martin 1989).

Whilst having the reputation as being a fastidious eater, reputedly dining on the leaves of only a few eucalypt species and no other trees, the Koala in fact has a somewhat more catholic diet. Koalas have been recorded feeding or resting in a total of 120 species of eucalypt, as well as 40 other tree species (Reed *et al* 1990; Phillips 1990; Lee & Martin 1988). At any one point across its range, the Koala may feed on a variety of preferred eucalypt species or may be subsisting on a number of other less favoured tree species. Of the eucalypts present in the study area, the species of greatest relevance for the Koala include *E pilularis*, *E robusta*, *E tereticornis*, *E maculata* and *E punctata* (Lee & Martin 1988; Pahl *et al* 1991; Reed *et al* 1990).

Koalas were recorded at several of the study sites along the transmission line corridor (Appendix 5), with apparent foci of Koala activity at Goonengerry and Dunoon. The proposed line rebuilding may involve the removal of some trees known to be browsed by Koalas (as indicated by recent signs), although such impacts will be limited in extent.

Little Bent-wing Bat ***Miniopterus australis***

This species is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species on the basis of "*population reduced, but expected to be stable; concentrates; threatening processes severe; ecological specialist*" (NP&WS 1993). It is noted by Parnaby (1992) as "*localised and common*", by Dwyer (1989) as abundant and by Strahan (1992) as "*abundant*" and "*secure*". Its range comprises a strip along northeastern Australia, from Cape York down into northern NSW, with a distribution of 300000 to 1 million sq.km (Strahan 1992).

The Little Bent-wing Bat roosts in caves and tunnels, and forages above the tree canopy in well timbered valleys throughout its habitat (Dwyer 1989). It is known to congregate in very large nursing colonies in cave systems, with up to a hundred thousand bats reported from Mount Etna in Queensland (Dwyer 1989). Disturbance to these caves for activities such as mining are considered serious potential threats to the species' conservation (Dwyer 1989).

The Little Bent-wing Bat was recorded at 4 survey sites during investigations along the transmission line corridor. Habitats at these sites included rainforest regeneration, eucalypt plantations, weed infested riparian vegetation and small patches of intact rainforest. No caves or tunnels were located in the sites surveyed, and the areas along the corridor are principally foraging habitat, rather than major roosting areas.

Common Bent-wing Bat ***Miniopterus schreibersii***

The Common Bent-wing Bat is included on Schedule 12 of the NP&W Act as Vulnerable & Rare on the basis of "*population reduced, but suspected to be stable; concentrates; threatening processes severe; ecological specialist*" (NP&WS 1993). Although listed on Schedule 12, the Common Bent-wing Bat is considered by Dwyer (1989) as abundant, by Parnaby (1992) as "*a common cave-dwelling species*" and by Strahan (1992) as both "*abundant*" and "*secure*". It is, in fact, recorded regularly in comprehensive microchiropteran bat surveys in eastern NSW.

This species roosts in caves, mines, old buildings and stormwater channels, and like the Little Bent-wing Bat occupies large breeding caves during the breeding season. It is a fast-flying species, which generally forages above the tree canopy on small insects, and is typically "*found in well timbered valleys*" (Dwyer 1989), in "*tropical to cool-temperate wet and dry sclerophyll forest*" (Strahan 1992).

The species is regarded with concern because of its reliance on large communal nursery caves, which are thought to contain a large proportion of the species' population during the breeding season. No breeding caves are known from the transmission line corridor, and the Common Bent-wing Bat was not recorded during this survey. It has been recorded at the 'Big Scrub' FR (Parnaby in Lott & Duggin 1993), but not in any other rainforest remnant.

Large-footed Myotis ***Myotis adversus***

The Large-footed Myotis is considered comparatively rare by Richards (1989) and "*very sparse*" but "*probably secure*" by Strahan (1992). It is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species on the basis of "*population and distribution suspected to be reduced; threatening processes severe; ecological specialist*" (NP&WS 1993). This species has a wide distributional range of 300000 to 1 million sq.km, ranging from the Kimberley region around coastal Australia, through Queensland and NSW and into South Australia.

The Large-footed Myotis roosts in caves, tunnels, mines and under bridges, nesting in colonies of up to several hundred. It has also been recorded roosting in dense rainforest foliage (Strahan 1992). This species feeds by flying over open bodies of water, such as pools, dams and ponds in streams, raking the water surface with its hind feet and catching small fish and insects.

The Large-footed Myotis was recorded at 4 survey sites along the transmission line corridor, and has also been recorded at some distance from the corridor (Priestley 1992). At site P14, located on Byrangery Creek, a high density of Myotis were observed, indicating a habitat of particularly high value for this species. The existing power line passes directly over the study site, indicating that the power line does not currently pose a threat for the bat at this location.

Northern Long-eared Bat ***Nyctophilus bifax***

The Northern Long-eared Bat is included on Schedule 12 of the NP&W Act (1974) on the basis of "*population and distribution reduced; threatening processes severe; ecological specialist*" (NP&WS 1993). This species is considered "*common but localised*" by Parnaby (1992), "*common*" and "*probably secure*" by Strahan (1992) and "*common*" by Allison (1989). The total distribution of the species is noted as greater than 1 million sq.km (Strahan 1992).

The Northern Long-eared Bat is a slow-flying species which manouevres in relatively dense foliage, foraging for insects. It is apparently able to hover, while gleaning insects from surfaces, and also feeds on the ground (Allison 1989). It is predominantly a tree-roosting species recorded in forest habitats ranging from rainforest to dry sclerophyll forest and woodland.

Strahan (1992) and Allison (1989) suggest a distribution limited to the northern parts of Australia for this species, but Parnaby (1992) indicates that it is present in coastal Queensland and northeastern NSW. The Northern Long-eared Bat has been recorded at several sites through the Lismore/Mullumbimby region (including the Big Scrub FR, Booyong NR and in the MacGuires Creek and Victoria Park remnants), none of which are in the immediate vicinity of the transmission line corridor (Lott & Duggin 1993). It was not recorded during this investigation, despite intensive bat surveys, although it may be present at some localities.

Black Flying-fox ***Pteropus alecto***

The Black Flying-fox is considered "*common*" by Richards (1991) and "*abundant*" and "*secure*" by Strahan (1992). It is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species on the basis of "*population suspected to be reduced; distribution severely reduced; concentrates; threatening processes severe; ecological specialist*" (NP&WS 1993). This species has a distributional range of 300000 to 1 million sq.km (Strahan 1992).

The Black Flying-fox is "*more restricted to well-watered forest*" than other species of the same genus, and inhabits tropical and subtropical rainforest, monsoon forest, wet sclerophyll forest and mangroves, in coastal areas of northern Australia (Strahan 1992). Individuals congregate in 'camps' located on mangrove islands in the estuaries of northern rivers, paperbark swamps or patches of rainforest (Richards 1991). It roosts in high dense foliage and is capable of travelling great distances (up to 50km) from diurnal roosts to nocturnal feeding areas (Strahan 1992), where it feeds on the blossoms of eucalypts, turpentines and paperbarks, and other native and introduced blossoms and fruits, including mangoes (Richards 1991).

The Black Flying-fox was not recorded during this investigation along the transmission line corridor, but has previously been located in several of the 'Big Scrub' remnants (Lott & Duggin 1993), including Booyong and Boatharbour Nature Reserves, and MacGuires Creek, Currie Park and Davis Scrub. Currie Park is on the northern outskirts of Lismore, although it is not traversed by the transmission line.

Tiger Quoll ***Dasyurus maculatus***

The Tiger Quoll is the largest of the native carnivores on the mainland of Australia. It has been included on Schedule 12 of the NP&W Act (1974) on the basis of "*population severely reduced; distribution reduced; threatening processes severe; ecological specialist*" (NP&WS 1993). It has been noted by Edgar (1989) as common to sparse throughout its range, and by Strahan (1992) as "*sparse*" but "*probably secure*". Mansergh (1983) notes that the Tiger Quoll was not common even during the first century of European settlement, and also that it is more common in the north of NSW than elsewhere in the state.

The Tiger Quoll occurs through eastern Australia from Cape York to Tasmania, in several disjunct populations. The species appears to have declined substantially over the last 200 years, as have many of its close relatives (Edgar 1989). Land clearance has removed much suitable habitat for the species, but it is also believed than an epidemic adversely effected populations of all of the Quoll species in eastern Australia in the early 1900s (Edgar 1989). Additionally, threats and competition from feral cats and foxes are considered a significant threat to the species.

The Tiger Quoll inhabits a range of forest communities, including wet and dry sclerophyll forest and rainforest (Mansergh 1983; Edgar 1989; Strahan 1992). It is generally considered to be more abundant in areas of high understorey and shrub layer density, which provide cover and tend to focus prey items. This species preys upon a range of native mammals, birds and reptiles, and being partially arboreal, includes gliders and small possums in its diet. By day, the Tiger Quoll rests in hollow logs or rock crevices, or alternatively in low tree-hollows, but it is not generally considered an arboreal mammal.

Tiger Quolls were not recorded during this investigation, but have previously been located in the Big Scrub FR (Gilmore 1987), although apparently not since 1976. A recent record of the Quoll is noted from the 'Federal' remnant (Millgate *et al* in Lott & Duggin 1993). The Boomerang Creek area, being a relatively large remnant, also has potential to provide suitable habitat for the Tiger Quoll, but no records exist for this site.

Wompoo Fruit-dove ***Ptilinopus magnificus***

The Wompoo Fruit-dove is included on Schedule 12 of the NP&W Act 1974 as a Vulnerable & Rare species, on the basis of "*population reduced, but stable; distribution reduced; poor recovery potential; threatening processes moderate; ecological specialist*" (NP&WS 1993). It is noted by Lindsey (1992) as "*sparse*" and "*vulnerable*", over a range of 100000 to 300000 sq.km.

The Wompoo Fruit-dove occurs in New Guinea and northeastern Australia, and is regarded by Slater *et al* (1989) as a common to rare resident in rainforest and contiguous forest from Cape York to the Hunter River in NSW. It is apparently less common in the highlands than in coastal lowlands (Lindsey 1992), and seems to be disappearing from the southern end of its range (Blakers *et al* 1984; Slater 1989; Lindsey 1992). However, Date *et al* (1991) suggest that populations of the Wompoo Fruit-dove are stable in NSW, and that concern over their conservation status can be moderated.

The principal habitat requirement of the Wompoo Fruit-dove is rainforest. Strictly arboreal and locally nomadic, this species favours the upper canopy, feeding on a wide variety of fruits in tall rainforest trees, with some local movement noted in response to abundances of fruiting trees (Blakers *et al* 1984). It nests in the outer foliage of rainforest trees, high in the canopy (Lindsey 1992), and also utilises introduced plants, feeding on the fruit of the abundant Camphor Laurel (Date *et al* 1991).

The Wompoo Fruit-dove was recorded at 5 of the survey sites along the transmission line corridor, and has been located in several other remnants in the region (Date *et al* 1991). Lott & Duggin (1993) regard the Wompoo Fruit-dove as "*common*", being recorded in 14 of 32 rainforest remnants considered in their report.

Rose-crowned Fruit-dove ***Ptilinopus regina***

This species is listed on Schedule 12 of the NP&W Act 1974 as a Vulnerable & Rare species, on the basis of "*population reduced, but stable; distribution severely reduced; moderate* *recovery potential; ecological specialist*" (NP&WS 1993). It is noted by Lindsey (1992) as "*sparse*" and "*vulnerable*" over a range of 100000 to 300000 sq.km, occurring in Indonesia and northern and eastern Australia. Slater *et al* (1989) regard this species as "*common*" to "*rare*" in rainforest, forest, mangroves and melaleuca forest from the Kimberly Region in Western Australia to about Newcastle in NSW, but a "*rare vagrant*" further south.

The Rose-crowned Fruit-dove generally lives in rainforest (Blakers *et al* 1984), but also inhabits mangroves, adjacent eucalypt forest with rainforest shrubs, beachside scrub and riverine forest (Lindsey 1992). It feeds primarily on a wide variety of fruits from tall rainforest trees, and nests in trees, bushes or vine tangles nearby. This species is locally nomadic in response to the abundance of fruiting trees and appears to be partially migratory, with a large part of the population moving to tropical rainforest in northern Queensland during winter (Blakers *et al* 1984).

Within the Lismore/Mullumbimby study area, the Rose-crowned Fruit-dove was recorded at 6 of the 18 survey sites, and is considered a "*widespread*" rainforest species by Lott & Duggin (1993), being recorded in 23 out of 32 sites.

Superb Fruit-dove ***Ptilinopus superbus***

This species is listed on Schedule 12 of the NP&W Act (1974) as Vulnerable & Rare, on the basis of "*population and distribution severely reduced; poor recovery potential; ecological specialist*" (NP&WS 1993). It is noted in Lindsey (1992) as "*sparse to common*" and "*vulnerable*", over a range of 100000 to 300000 sq.km. Slater *et al* (1989) regard the species as common in the northeastern rainforests of Queensland, but an "*uncommon nomad or a rare vagrant further south*". The Atlas of Australian Birds (Blakers *et al* 1984) also notes that the species is predominantly located in the northern part of Queensland in coastal rainforest and lowland rainforest, and is only infrequently recorded south of Brisbane. The Superb Fruit-dove also occurs in Indonesia and New Guinea, and is common in secondary growth as well as rainforest (Blakers *et al* 1984).

The prefered habitat of the Superb Fruit-dove is rainforest, although it also feeds in adjacent moist eucalypt forest and occasionally in mangroves (Blakers *et al* 1984). It feeds primarily on the fruit of tall rainforest trees and on the fruit of lower rainforest and moist vegetation, and nests in small bushy trees to tall trees in similar habitat. In the 'Big Scrub' area, Camphor Laurel also provides an important food resource (Date *et al* 1991).

The Superb Fruit-dove was recorded infrequently during this investigation along the transmission line corridor, being located in only two survey sites (P7 and P14). The former of these is the largest rainforest remnant along the corridor (at Boomerang Creek) and the latter involves another significant remnant (at Byrangery Creek). Other localities for this species include three of the remnants of the 'Big Scrub' adjacent to the Nightcap Range (Lott & Duggin 1993). Thus, the Superb Fruit-dove appears reliant on larger, more intact rainforest than the other rainforest-dependent pigeons.

Sooty Owl ***Tyto tenebricosa***

The Sooty Owl is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species, on the basis of "*population severely reduced; poor recovery potential; threatening processes severe; ecological specialist*" (NP&WS 1993). This species is also noted in Lindsey (1992) as "*sparse*" but "*probably secure*", with a total range of 100000 to 300000 sq.km, and "*rare*" by Garnett (1992b).

The Sooty Owl is distributed along the east coast of Australia from the Dandenong and Strzelecki Ranges near Melbourne to the Connondale and Blackall Ranges in southeastern Qld (Garnett 1992b), and inland to the Great Dividing Range. Within its preferred habitat, the Sooty Owl is a sedentary species, with breeding pairs remaining in one area for long periods, and possessing large home ranges to satisfy food requirements (Shodde & Mason 1980). Home ranges are in the vicinity of 200 to 800 hectares, depending on forest type (Blakers *et al* 1984).

The specific habitat requirements of the Sooty Owl are rainforest and moist hardwood forest, "*tall wet old-growth forest on fertile soils with a dense understorey and emergent tall eucalypts*" (Garnett 1992b), with large tree-hollows for nesting and an abundant supply of arboreal mammals as food. Nest sites are located high in large eucalypts and consist of very large tree-hollows. The Sooty Owl apparently displays strong site fidelity, with breeding pairs using a single nest site over several years (R Jordan *pers comm*).

The Sooty Owl is considered dependent upon 'old-growth' forest (Loyn 1985; Smith *et al* 1992), although Milledge *et al* (1991) reported similar rates of occurrence of Sooty Owls in forest which had been logged 50 to 80 years previously and in forests older than 165 years.

The Sooty Owl feeds on a number of arboreal mammals, including Ringtail Possums, Sugar Gliders and Greater Gliders, as well as on semi-arboreal species such as Bush Rats and the Brown Antechinus. Consequently, it is dependent upon moderate to high densities of these prey species throughout its home range.

The Sooty Owl was not recorded during this investigation along the transmission line corridor, although it has been located at the 'Federal' remnant (Lott & Duggin 1993). All other records are from remnants adjacent to the Nightcap Range forests.

Osprey **Pandion haliaetus**

The Osprey is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare Species, on the basis of "*population critical, but suspected to be stable; poor recovery potential; threatening processes severe; ecological specialist*" (NP&WS 1993). It is noted by Lindsey (1992) to be nationally "*common*" but "*probably secure*", with a total range of 300000 to 1 million sq.km. Garnett (1992a) considers the species "*vulnerable*" in NSW, but "*secure*" on a national basis.

The distribution of the Osprey is almost worldwide (Lindsey 1992). In Australia it has a predominantly coastal distribution (Marchant & Higgins 1990), although it does occur along the larger northern rivers and the Murray River (Blakers *et al* 1984). It is more common in the north of Australia than the south, and rare in Tasmania. It has been recorded in Boatharbour NR, but is considered unlikely to be present in remnants along the proposed transmission line.

Marbled Frogmouth ***Podargus ocellatus***

The Marbled Frogmouth is included on Schedule 12 of the NP&W Act 1974 as a Vulnerable & Rare species on the basis of "*population and distribution severely reduced; threatening processes severe; ecological specialist*" (NP&WS 1993). It is noted in Lindsey (1992) as "*rare to sparse*" and "*possibly endangered*", over a range 30000 to 100000 sq.km, and is considered rare by Garnett (1992a,b).

The Marbled Frogmouth inhabits "*subtropical rainforest and tall wet eucalypt forests*" (Garnett 1992b), including areas with a rainforest understorey beneath an emergent eucalypt canopy (Blakers *et al* 1984). These forests have been extensively cleared for agriculture in the 'Big Scrub' region, and suitable habitat has therefore significantly declined.

The Marbled Frogmouth was recorded during field investigations along the corridor at site P7, which is one of the largest rainforest stands along the corridor (at Boomerang Creek). It has also been recorded at the 'Federal' site and several of the Nightcap Range sites (Lott & Duggin 1993).

Black-necked Stork ***Ephippiorhynchus asiaticus***

The Black-necked Stork is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare Species, on the basis of "*population at a critical level, but suspected to be stable; distribution reduced; threatening processes severe; ecological specialist*" (NP&WS 1993). It is noted by Lindsey (1992) to be nationally "*very sparse*" but "*probably secure*", with a total range of over 1 million sq.km. Garnett (1992a) considers the species "*vulnerable*" in NSW, but "*secure*" on a national basis.

The distribution of the Black-necked Stork ranges through Pakistan, India, Southeast Asia, New Guinea and Australia (Marchant & Higgins 1990). In Australia, it is common in the tropical north and occurs at low densities from northwestern Australia to northern Queensland, with numbers declining in the southeast of its range (Marchant & Higgins 1990). Purcell (1993) describes the Black-necked Stork as "*widespread and mostly coastal to as far south as Nowra in NSW*". However, its occurrence south of the Clarence River in NSW is erratic (Lindsey 1992).

The preferred habitat of the Black-necked Stork comprises tropical and warm terrestrial wetlands, littoral habitats and occasionally wooded or grassland habitats (Marchant & Higgins 1990). Purcell (1993) found prime foraging habitat in the Richmond River Catchment of NSW to consist of "*open and shallow freshwater swamps with short emergent vegetation and abundant aquatic flora*". Melaleuca swamps, watercourses and farm dams also provide important foraging habitat for this species (Marchant & Higgins 1990). The Black-necked Stork feeds on fish, frogs, insects, snakes and crustaceans.

The Black-necked Stork is largely sedentary, although juveniles may move large distances outside of the species' normal range (Marchant & Higgins 1990). There is no evidence for any large scale migratory movements in Australia (Blakers *et al* 1984), and apparent fluctuations in numbers in NSW are suggested as possibly reflecting movements within large home ranges (Marchant & Higgins 1990).

Breeding sites are solitary and situated adjacent to or in freshwater swamps. Nests are constructed at the top of tall trees which command an 'all-round view', and are often used repeatedly over long periods (Purcell 1993).

Much of the Black-necked Stork's favoured breeding and feeding habitats in natural freshwater wetlands have been lost through drainage for agriculture (Garnett 1992a; Marchant & Higgins 1990). Such habitat loss is considered the most important threat to this species continued survival (Purcell 1993). Wetlands and appropriate feeding sites for the Black-neck Stork are not a feature of the proposed transmission line corridor, and this development does not impose a novel threat on the species. There is, however, the potential for storks to strike the powerlines, resulting in serious injury or death (Purcell 1993). This possible impact is discussed in detail below, but already exists as a function of the current line.

Bush Hen ***Gallinula olivacea***

The Bush Hen is included on Schedule 12 of the NP&W Act (1974) as a Vulnerable & Rare species, on the basis of "*population severely reduced; ecological specialist*" (NP&WS 1993). This species is noted in Lindsey (1992) as "*sparse*" but "*probably secure*", with a total range of 100000 to 300000 sq.km, and "*rare*" by Garnett (1992b).

The Bush Hen occurs through southeastern Asia, New Guinea and Australia (Marchant & Higgins 1992). In Australia, it is distributed through northern Australia, eastern Queensland and northeastern NSW south to Ballina (Lindsey 1992). Within its range, the Bush Hen is considered possibly nomadic, moving into regions with the onset of rain, and retreating to areas of permanent freshwater during drier periods (Lindsey 1992; Marchant & Higgins 1992).

The Bush Hen generally occurs within rainforest (often near its margins), rainforest remnants, secondary growth forest or pasture and grassland abutting forested areas (Marchant & Higgins 1992). It requires thick undergrowth and permanent fresh water, and is often recorded in tall rank grass or dense thickets of Lantana on the margins of rivers, creeks, billabongs and dams (Marchant & Higgins 1992). This is a predominantly nocturnal species, and forages on the ground for seeds, plant material, insects and sometimes frogs (Marchant & Higgins 1992).

The Bush Hen was not recorded during this investigation, and although it has been recorded in the region, there are no records from the vicinity of the transmission line corridor (Lott & Duggin 1993). The closest record to the corridor is at Snows Gully, adjacent to the Nightcap Range.

Loveridge's Frog ***Philoria loveridgei***

This species is also included on Schedule 12 of the NP&W Act 1974, as a Vulnerable & Rare species on the basis of "*population severely reduced; threatening processes severe; ecological specialist*" (NP&WS 1993). Loveridge's Frog is noted in Tyler (1992) as "*very sparse*" but "*probably secure*". This classification indicates that the species is "*infrequently located usually after considerable effort; apparently absent from many appropriate habitats*". However, it is considered probably secure as there appears to be "*no existing or foreseeable threat to continuance of the species*" (Tyler 1992), although there is insufficient data currently available to be certain of the species' survival status .

Loveridge's frog is restricted in its distribution to the Northern Tablelands of NSW and the highlands on the border of NSW and southern Queensland. It is noted by Tyler (1992) as having a distribution in the range of 10000 to 30000 sq.km, which places it in the second smallest of Tyler's categories for distribution scores of Australian frogs. This scoring classification needs to be treated with caution, however, as suitable habitat for Loveridge's Frog is likely to occupy only a small proportion of that total distributional range.

Loveridge's Frog inhabits Antarctic Beech forests, rainforest and wet forest, generally above about 750 metres in altitude (Cogger 1992). It is usually found along waterways in these habitats and appears to depend on mossy wet soil for burrowing, both for refuge and for breeding. It often sits in mossy cavities beside streams in these wet habitats (Tyler 1992). Areas preferred for breeding by Loveridge's Frog appear to focus on moist seepages at the upper ends of stream catchments in the Glen Innes region (Smith *et al* 1992), generally in rainforest and Antarctic Beech forests.

Loveridge's Frog was not recorded during this investigation along the transmission line corridor, but has been located at Snows Gully (adjacent to the Nightcap Range forests) and at the 'Federal' remnant (Lott & Duggin 1993). It could therefore be present in a few sites along the corridor.

6 POTENTIAL IMPACTS

The proposed Lismore to Mullumbimby transmission line has the potential (at least theoretically) to impose adverse impacts on native fauna or their habitats through the landscape over which it will pass (if inappropriately located or insensitively constructed). The preferred transmission line corridor has been selected from a range of potential routes through the Lismore to Mullumbimby region, and will comprise a rebuilding of the existing transmission line. In some localities along the existing transmission line corridor, deviations from the present line will occur.

As a consequence of the assessment process described in Section 2, and the selection of the existing transmission line as the preferred route, the potential for adverse impacts on native fauna and their habitats has already been addressed in some detail. Installation of the transmission line along a new or undisturbed route would doubtless have the potential for imposing significant adverse impacts on native fauna and their habitats. Selection of the existing corridor for the proposed new line has substantially reduced the potential for significant impacts on native fauna and fauna habitats. This proposal involves the modest intensification of an existing activity and disturbance, rather than the imposition of a novel one.

There are essentially two features of the transmission line and its installation which have the potential for imposing adverse impacts on native fauna or their habitats. The first of these involves the clearing or disturbance of native vegetation and fauna habitats, particularly areas of undisturbed or relatively intact rainforest, eucalypt forest and riparian vegetation. [It should be noted, however, that substantial tracts of relatively undisturbed vegetation communities or fauna habitats are rare along the existing transmission line route]. The second feature involves the possibility of birds and megachiropteran bats striking the actual transmission lines, or being electrocuted. Again, given the existence of the current 66kV transmission line along the proposed corridor, this would involve the modest intensification of an existing impact rather than the imposition of a novel one.

The most significant potential impact of the proposed transmission line between Lismore and Mullumbimby would involve the possible clearing of vegetation and fauna habitats along the specific route (if that was to occur). Given the substantial extent of previous rainforest clearing through the region (in the 19th century and early parts of the 20th century), any further clearing of native vegetation has the potential to impose adverse impacts if it involves removing a significant proportion of the remaining native vegetation communities.

Doubtless, the vegetation communities and fauna habitats which are considered of greatest significance in the Lismore to Mullumbimby area are the rainforest remnants of the 'Big Scrub'. Small remnants of this once extensive rainforest are scattered throughout the Lismore Plateau, including along the proposed transmission line corridor. However, in most instances the transmission line avoids the larger patches of remnant rainforest, and most of the sites which were surveyed in detail are adjacent to, rather than beneath, the existing transmission line. This discussion considers the potential impacts of clearing of rainforest and other vegetation communities in principle, rather than concentrating on any individual patches of rainforest or other fauna habitats.

The significance of the potential impacts on rainforest which would be imposed by clearing for installation of a transmission line is dependent on several features of the vegetation been cleared. Large tracts of remnant rainforest are recognised as being of greater relevance for the conservation of the rainforest-dependent fauna than smaller tracts of vegetation. Investigations by Priestley (1992), Bohm (1991), Lott & Duggin (1993), Holmes (1987) and others indicate clearly that the diversity of rainforest-dependent fauna species is related substantially to the size of the forest remnant. Thus, large tracts of rainforest have proportionately larger numbers of species and a greater abundance of individuals than smaller tracts of rainforest. Consequently, activities which would involve the clearing of large areas of rainforest or clearing through larger tracts of rainforest involve potentially more significant impacts than similar operations in small remnants, which are already likely to support a depauperate or limited rainforest fauna. In this regard, the most significant rainforest remnants along the transmission line corridor are those associated with the Boomerang, Byrangery and Turkey Creeks, and the Wilsons River.

Several other features of the rainforest remnants in the Lismore/Mullumbimby area are significant, however, with respect to their value for the conservation of rainforest-dependent native fauna in the region. As noted by Holmes (1987), Milledge (in Lott & Duggin 1993) and Lott & Duggin (1993), the 'connectedness' of a tract of rainforest to other similar vegetation communities or other forest habitats is relevant in assessing the conservation value of each site. Rainforest patches which are close to larger tracts of vegetation, such as the Nightcap Range, tend to support somewhat greater species diversity than similar sized patches at greater distances. Corridors of natural vegetation or regenerating forest, particularly regenerating rainforest, between areas of remnant rainforest are of relevance in providing migration paths for many native fauna species. The significance of potential adverse impacts as a result of clearing or disturbance to forest communities along any proposed transmission line corridor is related in part to the connectedness of those patches to be disturbed, and also to the potential for adversely affecting existing or possible future corridors of native vegetation and habitats between tracts of remnant rainforest and other forest communities.

Finally, the extent of clearing involved is of relevance in determining the significance of any potential adverse impacts. Where clearing which involves the total removal of all native vegetation and its replacement by grass or other exotic communities is required, or where the installation of maintenance tracks through native vegetation is necessary, the potential for adverse impacts on native fauna and their habitats is substantially greater than at locations which require less intensive clearing (for instance, by retention of the midstorey and lower shrub layers or groundcover vegetation).

Significant clearing, if permitted, could impose adverse impacts on the native fauna dependent on rainforest patches along the preferred transmission line corridor. However, use of the existing transmission line route and the avoidance, where possible, of substantial tracts of rainforest vegetation, as well as the use of sensitive installation procedures, should enable potential adverse effects to be minimised or avoided altogether. Given this approach, it is considered unlikely that the proposed transmission line will impose a significant adverse impact on native fauna or their habitats.

Another habitat which is considered of significance for native fauna is riparian vegetation. As with rainforest through the Lismore Plateau, most of the riparian vegetation communities have been cleared or significantly disturbed as a result of agricultural activities. Consequently, remaining riparian communities are of potentially high value for native fauna, by providing microhabitat features and special resources for species (such as the Australian Water Rat, kingfishers, some reptiles and microchiropteran bats). Riparian corridors may also provide movement corridors between other tracts of vegetation, for example between stands of remnant rainforest. The remaining riparian corridors in the Lismore/Mullumbimby area are regarded as of particular relevance, and their value as fauna habitat was recognised in the ROP (SK 1993).

With respect to the potential impacts of the proposed transmission line between Lismore and Mullumbimby on riparian vegetation, similar considerations apply as are relevant for the rainforest vegetation communities. Thus, those riparian corridors which are of substantial size or which are relatively undisturbed are considered of proportionately greater value than smaller or more disturbed areas. As for the rainforest communities, clearing or disturbance for the installation of the proposed transmission line could adversely impact on the riparian habitats present and the native fauna which inhabit them. Many species of native fauna are not capable of crossing extensive areas of open ground, or may be restricted to complex vegetation communities. The transmission line corridor could disrupt movement corridors for native fauna, or remove potential habitat for some species, if substantial clearing were to occur.

As the preferred option involves reconstruction of the existing line which will enable sensitive vegetation communities to be spanned, extensive clearing of native vegetation will not be required. On this basis, it is considered possible to avoid or minimise the potential for adverse impacts by appropriate installation techniques.

Clearing of or disturbance to regenerating vegetation, particularly rainforest communities, on the Lismore Plateau would also be considered likely to impose some adverse impact upon native fauna. These communities generally are dominated by Camphor Laurel and other introduced weeds, which provide cover and protection for regenerating rainforest. Furthermore, Camphor Laurel is an abundantly fruiting plant, which provides food resources for several species of native fauna (particularly for the rainforest pigeons - the Rose-crowned, Superb and Wompoo Fruit-doves). These birds also utilise patches of Camphor Laurel as 'stepping stones' between larger tracts of rainforest vegetation in the region, including for seasonal migration between high and low elevation forest (Date & Recher 1990; Date *et al* 1991). Consequently, whilst already disturbed and dominated by non-native species, these regenerating patches may be of considerable value for native fauna.

As for rainforest, the proposed transmission line has the potential to impose an adverse impact on regenerating forest communities, by clearing or disturbance. However, (as also noted for the rainforest patches) the transmission line can be located and designed to minimise or avoid impacts upon these Camphor Laurel-dominated vegetation communities (see Section 6).

Naturally occurring or regenerating patches of eucalypt forest, often associated with rainforest are another potentially significant vegetation community. The preferred transmission line corridor does not significantly affect any substantial tracts of eucalypt forest vegetation. However, there are some sites at which eucalypt forest or small stands are present on or adjacent to the existing transmission line, and the removal of some trees may be necessary for the proposed transmission line rebuilding.

Koalas are known to occur throughout the Lismore region, and were recorded at 5 of the survey sites studied for the proposed transmission line. They were also located outside the study sites, and are clearly widely distributed, although not appearing abundant in the area. As some eucalypts may be removed for the proposed transmission line, there is clearly some potential for an adverse impact upon Koalas and other fauna which may utilise the eucalypts present. Impact amelioration and minimisation measures are discussed below.

The second potential impact of the proposed transmission line between Lismore and Mullumbimby involves the possibility of bird strike and bat strike on the transmission lines themselves. In this regard, the existing transmission line clearly already presents the potential for such phenomena, although no specific incidences of bird and bat strike have been recorded along the existing line (J Purcell, D Charley *pers comm*).

For most aerial fauna, the striking of power lines is unknown or is uncommon. This phenomenon is considered unlikely to impose any adverse impact on the vast majority of native fauna present through the Lismore/Mullumbimby area. However, for a few species there is some potential for adverse impact. Megachiropteran bats (the flying-foxes) are often electrocuted by powerlines, and probably also strike the lines on occasions (D Charley *pers comm*). The proposed transmission line may present some limited hazard to a relatively small number of the large megachiropteran bats, but the potential impacts of such a phenomenon are considered of no significance.

Large birds, particularly wading or aquatic species, are known to be susceptible to 'power line strike'. Species which have been recorded as having died from this phenomenon include the Grey Teal, Black-necked Stork, Pelican, Black Swan and egrets (ELCOM 1988, Appendix 2; G Clancy *pers comm*). Magpie Geese have also been recorded striking transmission lines (SWC 1993). The susceptibility of these species to 'power line strike' appears to be related largely to their size and relative inability to quickly avoid obstacles while flying.

The significance of bird strike on transmission lines is also partly related to their proximity to important bird habitats, particularly wetlands. In this regard, it was recommended that the Coffs Harbour/Grafton transmission line be located as far as possible from important wetlands along its route (ELCOM 1988). Similarly, the Waratah West transmission line is considered likely to adversely affect large avifauna, especially the Magpie Goose, and re-routing of the line was suggested (SWC 1993). However, that report also noted that the impacts of the line "*on the Magpie Goose, and other waterbird species, is considered likely to be minor* ..". The Gibbs Inquiry (1991) concluded that whilst some potential existed for bird strike as a result of the proposed Coffs Harbour/Grafton transmission line, this impact would not be "ecologically significant".

The most significant species known from the Lismore/Mullumbimby area which could potentially be adversely affected by transmission line strike is the Jabiru or Black-necked Stork *Ephippiorynchus asiaticus*. This is an endangered species, which is present in the Richmond River catchment in only small numbers (Purcell 1993). Wetlands and appropriate foraging sites for the Black-necked Stork do not occur along the transmission line corridor, but the species has been recorded in the vicinity of Federal (Purcell 1993), and could possibly utilise some of the farm dams along the transmission line route. Consequently, there is some slight potential for the Black-necked Stork to be affected by the proposed transmission line corridor.

Whilst habitat loss is likely to be the most important threat to the Black-necked Stork, both in the region and generally (Purcell 1993), powerline strike is also considered a potential threat to the animals. However, there are no records of Black-necked Storks striking transmission lines in the Lismore/Mullumbimby area (D Charley NP&WS *pers comm*). Furthermore the proposed transmission line does not impose a novel threat to the birds, and is considered unlikely to substantially increase any existing impact. Given the low incidence of the relevant bird species along the corridor, the absence of significant wetlands, and the selection of the existing power line for the transmission line route, the likely impacts of the proposal with respect to bird strike are considered minimal.

The proposed transmission line corridor between Lismore and Mullumbimby involves a rebuilding of the existing facility, rather than the imposition of a novel impact. It is not considered likely that the proposal will impose a significantly increased adverse impact upon the natural environment or fauna habitats along the route. Whilst there is some potential for adverse impact, particularly during installation of the transmission line, amelioration measures (discussed below in Section 6) are considered capable of limiting any adverse impact to an insignificant level.

Installation of the proposed transmission line may impose several smaller, transient and essentially local impacts along the corridor. Disturbance of animals at the sites of active works (support pole installation locations etc) will doubtless affect a few individuals of a few animals on occasions. The exposure of soil, potential for weed invasion, alterations to vegetative cover, and possibility of local site contamination or the discharge of excess sediment or contaminants into adjacent water ways, could all involve adverse impacts on native fauna and their habitats. These phenomena are, however, temporary in nature, and readily managed to avoid significant impacts.

Specific details of potential impacts at particular sites or localities along the proposed transmission line corridor cannot be determined until the final precise route is determined. Clearly, where the transmission line will simply replace the existing structure, the imposition of significant adverse impacts must be considered minimal (provided appropriate protocols are implemented). Conversely, where an alternative route is chosen, there is the potential for the imposition of significant impacts if clearing of or disturbance to natural vegetation communities occurs. However, the avoidance or minimisation of adverse impacts is considered readily achievable in this case.

7 IMPACT AMELIORATION

Minimisation of the potential impacts which may be imposed by the proposed Lismore to Mullumbimby transmission line has been achieved in substantial measure by the approach adopted to this project, involving review of the various potential route options and the selection of the existing transmission line as the 'preferred route' for the proposed new line. The identification of potential transmission line corridors between Lismore and Mullumbimby, and the selection of the 'preferred route' was examined in the Route Options Paper (SK 1993). As a result of this process, the 'preferred route' which was chosen (ie rebuilding the existing power line) has been selected in part on the basis of minimising impacts on native fauna and their habitats. Consequently, a substantial level of impact amelioration has already been applied to the proposed Lismore to Mullumbimby transmission line. Whist the project involves the intensification of an existing impact, this will occur to a relatively minor degree, and is preferable to the imposition of a novel impact on previously undisturbed habitats.

Notwithstanding the above comments, a number of measures are proposed for the installation of the new 132kV line in order to further minimise the potential for adverse impacts on native fauna and their habitats.

In the first instance, the specific location of the transmission line within the corridor between Lismore and Mullumbimby should involve minimal clearing, wherever possible. The new transmission line will deviate slightly from the existing 66kV line at a few sites, but most of the relevant land has already been significantly disturbed. At all locations along the corridor, the clearing of vegetation (especially remnant rainforest or intact riparian vegetation, but also including regrowth forests and eucalypt forest) should be limited to a minimum.

Sites for location of the new transmission line poles and support structures should also be chosen with respect to the maintenance of native vegetative cover. Thus, wherever possible, the localities for new power poles should be in open land and should not involve the clearing of native or regenerating vegetation. In some instances, where the existing power line traverses 'extensive' tracts of rainforest or other native vegetation, it is preferable to use the existing disturbed corridor for the location of new power poles. Alternatively, re-routing of the power line to avoid native vegetation altogether would be preferable, with power poles and support structures sited in cleared paddocks or patches abutting such tracts of native forest.

One of the features of the rainforest remnants through much of the Lismore Plateau area is their location in sheltered gullies. This feature is a result of past clearing patterns, but is also a consequence of the microclimates which encourage rainforest survival in the more sheltered sites. The location of many of the rainforest remnants and other forested vegetation in gullies provides some additional potential for impact amelioration. By siting support structures on higher ground, it will be possible in many instances to span the rainforest remnants in the gullies. Providing Suitable installation procedures, such as the use of helicopters to install cables across gullies, will avoid the necessity for driving cables across rainforest patches.

Similar considerations apply for riparian vegetation. Specific protocols for implementing this measure will need to be considered at each point along the transmission line, once the precise route is determined or as construction activities proceed.

The use of existing roads and farm tracks for access to the transmission line, both for construction purposes and for subsequent maintenance, are considered preferable to the installation of new and extended tracks, which may involve significant clearing of native vegetation. Similarly, a 'minimalist' approach is considered appropriate for the clearing of vegetation for safety and fire hazard purposes. Installation of the transmission line between hilltops, spanning rainforest or other remnant vegetation in gullies, is of value in permitting the existing canopy to remain intact. This approach is of particular significance with respect to rainforest, where canopy clearing usually constitutes a significant adverse impact.

Where it is necessary to clear vegetation beneath the transmission line for access or maintenance purposes, it is proposed that such clearing be limited in extent and intensity, and that native vegetation communities below the transmission line not be replaced by open grassland (wherever possible). Where it is necessary to remove forest vegetation, the lower vegetative strata should be retained where possible. Maintenance of a native vegetation community comprising a 1 to 2-metre high shrub layer connecting forest patches on each side of the line would permit the continued movement of many native species from one to the other. Conversely, the creation of open grassland between two previously connected patches of forest could potentially prevent many species from moving between them, and could thus reduce the population viability of fauna communities at both locations.

Where possible, Pacific Power should encourage the regeneration of native vegetation communities beneath the transmission line or adjacent to it. The use of portions of the corridor to re-create links of native vegetation between previously separated rainforest or riparian habitats should be considered, where landholders are amenable. Local conservation or community groups should be encouraged to implement bush regeneration programs at appropriate locations, and efforts made to ensure that the line installation and subsequent safety and maintenance requirements do not conflict with habitat re-creation.

It is likely that some Koala food trees may have to be removed at a few locations along the transmission line corridor. Impact amelioration measures should involve removal of the minimum number of Koala trees possible, as well as a supplementary planting program at any available and suitable location along the transmission line corridor, where property owners are agreeable. The supplementary planting program would involve the planting of eucalypts specifically for use by Koalas, particularly Tallowood, Flooded Gum, Blackbutt and Sydney Blue Gum.

One additional feature with respect to Koalas should be the development of a protocol to deal with any animals located during construction activities. A program of checking eucalypts prior to their removal, and of temporarily leaving trees which contain animals is required (the animals will probably abandon trees near disturbance overnight). Close contact with the NP&WS and local WIRES groups should be maintained to deal with any displaced or injured animals. A similar protocol should be implemented for other native fauna along the route.

If a significant incidence of bird strike on the transmission line is subsequently identified at any points along it, a monitoring program should be implemented, and measures could be adopted where necessary to reduce the rate of bird strike (such as the installation of coloured balls on the transmission cables). However, it is considered unlikely that this phenomenon will arise or that these measures will be required.

Other measures which are appropriate for ameliorating the potential adverse impacts of the proposed transmission line on fauna and fauna habitats would involve weed control and the management of silt and sediment, as well as appropriate protocols for the management of wastes or other possible contaminants during construction.

A weed control program should be installed at every location which is disturbed by the activities associated with the transmission line. In open paddocks where grazing is to continue, weed control is not likely to be of particular significance, although the potential for introducing new weeds should be addressed. Where support structures are to be located adjacent to or in native vegetation communities, there is a greater potential for the introduction of weeds as a result of the clearing of native vegetation. Where access through native communities requires disturbance or where support structure installation involves temporary disturbance to a native community, it is suggested that a replanting program be initiated, involving the mulching of bare ground, planting of native shrubs, broadcasting of native seed, and a monitoring program over the ensuing one to two years to minimise the invasion of weed species. Where substantial areas require clearing, the use of hydro-mulching techniques or fibre matting to protect the soil surface and to limit weed growth are proposed as suitable weed control protocols.

Silt traps and erosion control measures will also be required at some localities along the transmission line corridor, where disturbance to the soil surface and vegetation is required. Where slopes are steep, cleared areas will need to be rapidly mulched or protected by fibre matting (as noted above). This approach can be used both to reduce soil erosion and consequent sediment transport into adjacent streams, and to suppress weed growth whilst permitting the regrowth of native plants.

Other relevant measures for the management of erosion and sediment discharge from sites disturbed by the installation of the transmission line may involve the use of silt fences and other sediment control structures. In locations where disturbance is to be temporary, the mulching and covering of exposed soil surfaces as rapidly as possible will be required. Where longer term disturbance to the soil surface is likely to occur, permanent silt traps or settlement ponds may be necessary. Wherever possible, mulching, the use of fibre matting and the regeneration of native vegetation or grazing pasture on disturbed soil surfaces should be a high priority, and should occur as rapidly as possible.

The final element of the proposed impact amelioration measures for the transmission line will involve the control of potential contaminants arising from construction activities. Protocols are required to prevent the discharge of oils, paints, timber preservatives and other possible contaminants from vehicles and construction sites. Similarly, any stockpile sites or construction camps should be appropriately bunded and managed to avoid the potential for discharge of contaminants, including human waste and rubbish, into native habitats.

8 ASSESSMENT OF SIGNIFICANCE OF IMPACTS

The potential impacts of the proposal on the native fauna of the vicinity are assessed using the criteria established under Section 4A of the Environmental Planning & Assessment Act, as documented in the Endangered Fauna (Interim Protection) Act 1991. These criteria are designed to determine "whether there is likely to be a significant effect on the environment of protected fauna", and consequently whether there will be a significant impact on native animals.

If 'endangered' fauna or their habitats are to be affected by the proposal, a licence is required under Section 120 of the NP&W Act 1974, as amended by the EF(IP) Act 1991, to "take or kill" endangered species. "Take" is defined as:

> "hunt, shoot, poison, net, snare, spear, pursue, capture, disturb, lure or injure, and without limiting the foregoing also includes significant modification of the habitat of the fauna which is likely to adversely affect its essential behaviour patterns".

The NSW National Parks & Wildlife Service' "Draft General Guidelines for Fauna Impact Statements" state:

> "Under the provisions of the Endangered Fauna (Interim Protection) Act, 1991, as amended by the Timber Industry (Interim Protection) Act, 1992, there are two scenarios which require the preparation of Fauna Impact Statements:
>
> NATIONAL PARKS AND WILDLIFE ACT, 1974
>
> The National Parks and Wildlife Act, 1974 (NP & W Act) requires a Fauna Impact Statement to be prepared where an action is likely to take or kill **endangered** fauna.
>
> **Endangered fauna** are those species named in the revised (interim) Schedule 12 as Threatened or Vulnerable and Rare, published on 28 February 1992.
>
> A Fauna Impact Statement is a requirement for obtaining a general licence from the National Parks and Wildlife Service to take or kill endangered fauna after 27 February, 1992.

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979

The Environmental Planning and Assessment Act, 1979 requires a Fauna Impact Statement to be prepared where a development or activity is likely to **significantly** affect the environment of endangered fauna."

As noted, an FIS is required "where an action is likely to take or kill **endangered** fauna". Additionally, endangered fauna are defined in the NP&WS document as "those species named in the revised (interim) Schedule 12 as Threatened or Vulnerable and Rare".

(a) the extent of modification or removal of habitat, in relation to the same habitat type in the locality

The proposed transmission line between Lismore and Mullumbimby involves the reconstruction of an existing 66kV line between these locations. Much of the proposed new transmission line will be located immediately adjacent to or along the existing power line route except at 3 locations. As a consequence of using the existing route, the area of native vegetation and fauna habitat which will require removal will be minimal. Whilst specific areas and locations are not known at this stage (until the precise line location has been identified), the proposal will mostly involve replacement of the existing 66kV line structure with a 132kV line.

Some modification of existing fauna habitat will occur as a result of installing the new transmission line or for safety and maintenance requirements. Thus, the construction activity itself will involve the disturbance of some native vegetation, and some areas of rainforest or other native vegetation may need to be modified or cleared to maintain safety clearances and access to the transmission line and support structures. In some locations, it is likely that removal of canopy trees will be necessary for installation or safety reasons.

However, most of the transmission line corridor involves previously cleared grazing and agricultural lands, or horticultural features such as macadamia nut farms. These landscape elements, whilst providing some resources for a few native fauna species, are neither natural nor considered significant in terms of the conservation of native fauna.

The selection of the preferred route for the proposed transmission line between Lismore and Mullumbimby has been specifically intended to reduce the potential for adverse impacts on the natural and cultural environment. Whilst there will doubtless be some disturbance or 'modification or removal' of fauna habitat along the transmission line corridor, the extent of this will be minimal due to the use of existing disturbed areas and the avoidance (wherever possible) of intact native vegetation.

By avoiding the most significant tracts of rainforest, by employing appropriate construction methods (including the use of helicopters), and by the spanning of significant patches of rainforest and gullies where possible, it is considered unlikely that any significant 'extent' of rainforest vegetation or other fauna habitat will be modified or removed by the proposed transmission line installation.

With respect to Koalas, it is possible in some localities that a proportion of the existing food trees present will need to be removed for the installation of the proposed transmission line. Given the nature of the development (that is, a linear construction rather than one covering a broad area), it is likely that the number of Koala trees which would be affected by the proposal will be small. Consequently, in terms of the total resource for Koalas in the region, the effect of the proposed transmission line will be relatively limited. Nevertheless, there is some potential for a significant reduction of this resource for a few individual animals at a few locations along the transmission line corridor. Ameliorative measures (including specific tree planting) are discussed above and in later sections of this report.

(b) the sensitivity of the species of fauna to removal or modification of its habitat

In essence, all species of fauna are sensitive "to removal or modification" of their habitat. Relatively few native species are considered likely to benefit from alterations to native habitats or ecosystems, although those species which prefer open environments and grasslands may benefit from the clearing of native forest.

Given the approach to be adopted for this proposed transmission line (involving the use of the existing 66kV line route) relatively little undisturbed native fauna habitat is likely to be affected. Consequently, with respect to the "sensitivity of ... species of fauna" to the proposed activity, the relevant concepts are the total extent of clearing or disturbance to native habitat which will arise as a result of the proposed development, and the significance of the habitat which is to be removed or disturbed.

Use of the existing disturbed 66kV corridor for the proposed new transmission line means that the area of native habitat which will need to be removed or modified has been minimised. In this regard, it is considered that the proposed development will not impose adverse impacts on the 'sensitivity' of native fauna along the corridor.

Any removal of natural vegetation communities or fauna habitats will doubtless have some adverse impact on those individual animals which reside in it or which may rely on the resources present. Although some individual animals of some species may perish as a result of the limited amount of disturbance proposed for the transmission line corridor, no populations of any native species would be expected to disappear from the general area as a result of the proposed activity. This result will be substantially achieved by the ameliorative processes discussed in Section 6 of this report. In particular, it is intended that sensitive and significant fauna habitats throughout the general transmission line corridor will be avoided or will be disturbed to the absolute minimum necessary for the proposed development.

For endangered fauna, the removal of any remaining habitat has the potential to impose an adverse impact, and therefore these species may be considered more sensitive "to removal or modification" of habitat than the general fauna assemblage. Of the endangered fauna species which could potentially be present in the Lismore Plateau area, only a few are considered likely to be potentially disturbed by the activities associated with the proposed transmission line. The endangered fauna considered of relevance in this regard include microchiropteran bats (several of which have been recorded from along the proposed transmission line corridor), rainforest birds (in particular the rainforest pigeons), and the Koala.

For the microchiropteran bats, the proposed transmission line installation between Lismore and Mullumbimby is considered unlikely to impinge on their "sensitivity" to habitat "removal or modification". This conclusion arises principally because the area of native habitat which will be removed for the proposed transmission line will be limited. Use of the existing transmission line route and avoidance of significant patches of native forest (especially rainforest) will involve the removal of only very small amounts of potential habitat for microchiropteran bats. In addition, these animals are highly mobile and cover large areas each evening for foraging and roosting. Consequently, it is considered unlikely that the microchiropteran bats will be significantly adversely affected.

For the rainforest pigeons which are dependent upon the patches of rainforest through the Lismore Plateau area (either as food resources or as 'stepping stones' between larger tracts of forest), the removal of substantial areas of forest could impose significant adverse impacts. These species are likely to be sensitive to significant habitat "removal or modification", given the limited areas of rainforest vegetation remaining on the Lismore plateau. Conversely, as noted elsewhere in this report, the location and construction of the proposed transmission line are designed to avoid or minimise the clearing or modification of natural environments and fauna habitats. Consequently, provided the ameliorative protocols discussed above and below are implemented for this project, it is considered unlikely that the "sensitivity" of the endangered rainforest pigeons will be adversely affected by the proposed construction.

For the Koala, the removal of food resources (in particular preferred eucalypts) could potentially constitute a serious impact at a local level, as this species is highly sensitive to reductions in its food resource. Again, however, the proposed transmission line is intended to avoid removing other than a limited number of potential Koala food trees, and the "sensitivity" of this species to resource removal will be ameliorated by careful management and minimal clearing. Additionally, it is proposed to provide supplementary plantings of the appropriate eucalypts to increase the food resource for Koalas in the Lismore area, and to locate plantings at appropriate sites in order to reduce the potential for adverse impacts on the species. Consequently, whilst the Koala is potentially sensitive to the removal of habitat and the reduction in food resources in the general area, the proposed development has been designed in such a way as to limit or avoid adverse impacts on this species, and has the potential to increase resources for the Koala.

(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

The proposed transmission line between Lismore and Mullumbimby has been sited and designed to minimise the removal or modification of fauna habitat in general. In particular, it is intended wherever possible to avoid impacts on "critical habitat" for any of the native fauna present in the region. In some instances, however, it will be necessary to affect some resources or "critical habitat" for a few species. For example, some Koala food trees will need to be removed at a few locations, and in a few other sites small areas of rainforest may need to be trimmed or altered.

Where habitat removal and modification is unavoidable, areas of suitable adjacent or nearby land could be regenerated or planted to provide replacement resources for native fauna which may be affected. This proposal would require the co-operation of local land holders, and is particularly relevant for the Koala.

Total re-creation of "critical habitat" would require perhaps a century or more. Large eucalypts, which are often favoured by Koalas, may take fifty to one hundred years to grow to substantial size, and rainforest would take at least one hundred years to regenerate from a grassland environment. However, young eucalypts are also used by Koalas as a food resource, and consequently trees which are only ten years old would also provide resources for these animals. Similarly, rainforest at earlier stages of development does provide useful habitat for endangered species, and the rainforest pigeons are noted as regular users of Camphor Laurel-dominated patches of vegetation throughout the Lismore area (Date *et al* 1991). Consequently, the basic precursors and crucial resources of "critical habitat" can be regenerated more rapidly for these species.

For most of the other species considered in this report, the proposed development (which is predicated on the minimal clearing of native habitats and vegetation communities) is intended to prevent significant reductions in "critical habitat". As a consequence, the "time required to regenerate critical habitat" is not considered relevant to the proposed development, as there is unlikely to be a substantial or significant decrease in this feature for most of the endangered species present. It is intended, by a combination of the siting of the transmission line, construction techniques, minimal vegetation clearing and habitat regeneration, to limit any reductions in the total areas of native fauna habitat.

(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

Given the above considerations and the intention to avoid significant clearing of native vegetation and fauna habitats, it is considered unlikely that any native fauna (including endangered species) will be adversely affected in terms of population recovery in the region. Whilst there is some potential for adverse impacts on some species, and for a temporary decline in some resources at restricted localities, the proposal for the transmission line corridor generally involves the minimisation and avoidance of habitat clearing. Consequently, the extent of removal of crucial resources required for the survival of endangered species populations (ie "critical habitat") will be extremely limited, and significant adverse affects "on the ability of the fauna population[s] to recover" are considered unlikely.

Whilst some small areas of rainforest will require disturbance for the proposed transmission line, significant clearing will generally be avoided. Consequently, the 'recovery' potential of fauna populations along the corridor are regarded as unlikely to decline as a result of the proposed development. Additionally, at appropriate locations along the transmission line corridor, linkages of rainforest vegetation could be planted if so desired, to join previously separated rainforest patches. This approach has the potential to improve and enhance fauna conservation, particularly for rainforest-dependent species, rather than being likely to reduce the conservation of these species in the general area. Similarly, areas of the transmission line corridor or suitable lands in the vicinity could be used for the supplementary planting of eucalypt food trees for Koalas, with the co-operation of local land holders.

(e) any proposal to ameliorate the impact

Section 7 of this report outlines in some detail the proposed ameliorative measures intended for the proposed transmission line corridor between Lismore and Mullumbimby. The broad principles involved in ameliorating adverse impacts from this proposed development include the siting of the development along an existing disturbed corridor, the minimal clearing of vegetation and trees at all locations along the transmission line, the containment of sediment and any potential contaminants, and the potential use of the corridor for the enhancement of fauna habitats. Protocols for the treatment and management of fauna along the corridor during the installation phase of the project are also recommended.

(f) whether the land is currently being assessed for wilderness by the Director of National Parks and Wildlife under the Wilderness Act 1987

The subject land does not satisfy the criteria for wilderness under the Act, and therefore cannot be considered for such a land use.

(g) any adverse effect on the survival of that species of protected fauna or of populations of that fauna

Whilst the proposed transmission line between Lismore and Mullumbimby doubtless has the potential to adversely affect some individuals of native fauna species along the corridor, and will certainly involve some disturbance to native habitats and vegetation communities, it is considered that the proposal will not impose any significant "adverse effect on the survival of ... species of protected fauna". This conclusion arises because the proposed transmission line is generally to be located along an existing disturbed corridor, and has been designed to involve a range of measures specifically intended to minimise adverse impacts on native fauna and their habitats. Thus, whilst there will be some impacts in a few localities, the combination of minimising disturbance and vegetation clearing, encouraging native communities to regenerate, and possibly the enhancement of local fauna habitats, are considered sufficient to avoid significant adverse effects on the survival of any species of protected fauna.

With respect to endangered fauna species (which are by definition under rather more threat than the bulk of the protected fauna), there is theoretically some greater potential for adverse impacts on "the survival of that species" by the proposed transmission line. As for protected species, however, the interests of endangered fauna have been considered in both the selection of the proposed transmission line corridor and in the intended manner of its construction and maintenance. Features such as avoiding habitat and vegetation clearing wherever possible, maintenance of existing substantial and intact tracts of rainforest, eucalypt forest and riparian vegetation, the avoidance of a continual maintenance track along the full length of the corridor, supplementary planting, and the regeneration of native vegetation communities, are intended to avoid any significant reduction in survival opportunities for native species along the corridor.

Those species which may be considered more likely to be adversely effected, and which could perhaps be subject to a decline in survival opportunities, are the rainforest-dependent fauna which occur through the Lismore Plateau. The main species group known from the proposed transmission line corridor is the rainforest pigeons. These have been noted by Date *et al* (1991) as capable of using small isolated patches of rainforest, particularly as 'stepping stones' between larger tracts of intact vegetation. The proposed transmission line is intended to not reduce the area of rainforest suitable for rainforest pigeons. Similar considerations apply to other rainforest species in the Lismore to Mullumbimby area which could potentially be affected by the proposed transmission line.

Another group known from the transmission line corridor which could potentially be adversely affected are the microchiropteran bats. However, as discussed elsewhere, the proposed development involves an approach of minimum clearing of vegetation. Wherever possible, hollow-bearing trees (which are necessary for a number of the microchiropteran bats) would be avoided. Given the high mobility and broad area covered by these aerial mammals, it is considered unlikely that the proposed transmission line corridor will reduce the survival opportunities for microchiropteran bats.

The last endangered species of particular relevance with regard to the transmission line corridor is the Koala. As noted above, supplementary plantings of appropriate eucalypts are proposed along the transmission line corridor. Thus, whilst there is likely to be some reduction in the number of trees currently present at a few isolated sites, the proposed increase in planting should substantially enhance this resource for this species.

It is not anticipated that there will be "any adverse effect on the survival of ... populations of that fauna". In other words, no populations of native fauna (whether protected or endangered) are regarded as likely to become non-viable in the vicinity because of the potential impacts of the proposed transmission line. The measures to be adopted in the construction of this feature through the Lismore/Mullumbimby area are intended to ensure that there is no adverse effect on the survival of protected or endangered native fauna, and are designed to enhance the chances of survival of many species and populations.

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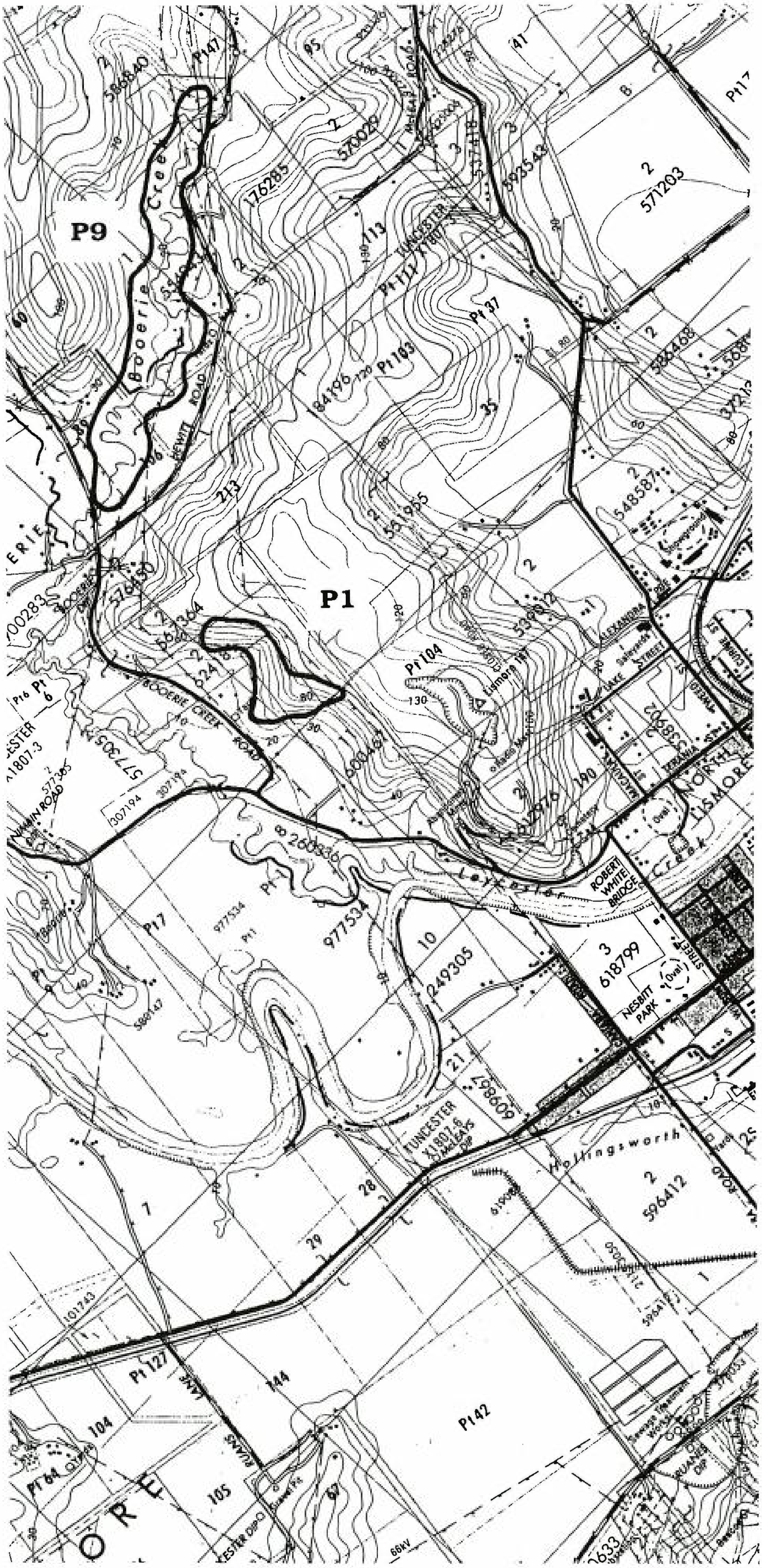

FIGURE 1 Location of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

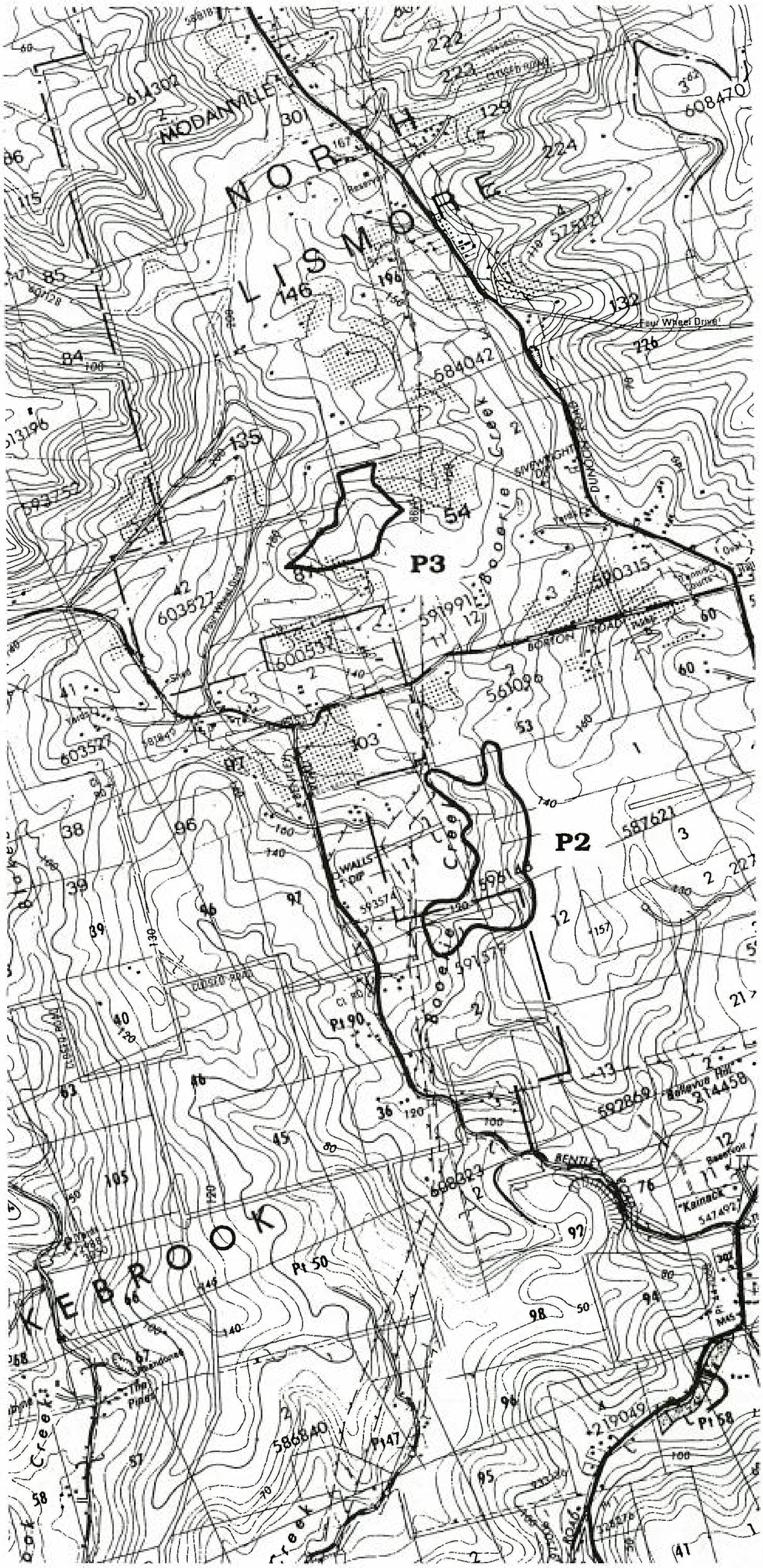

FIGURE 2 Location of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

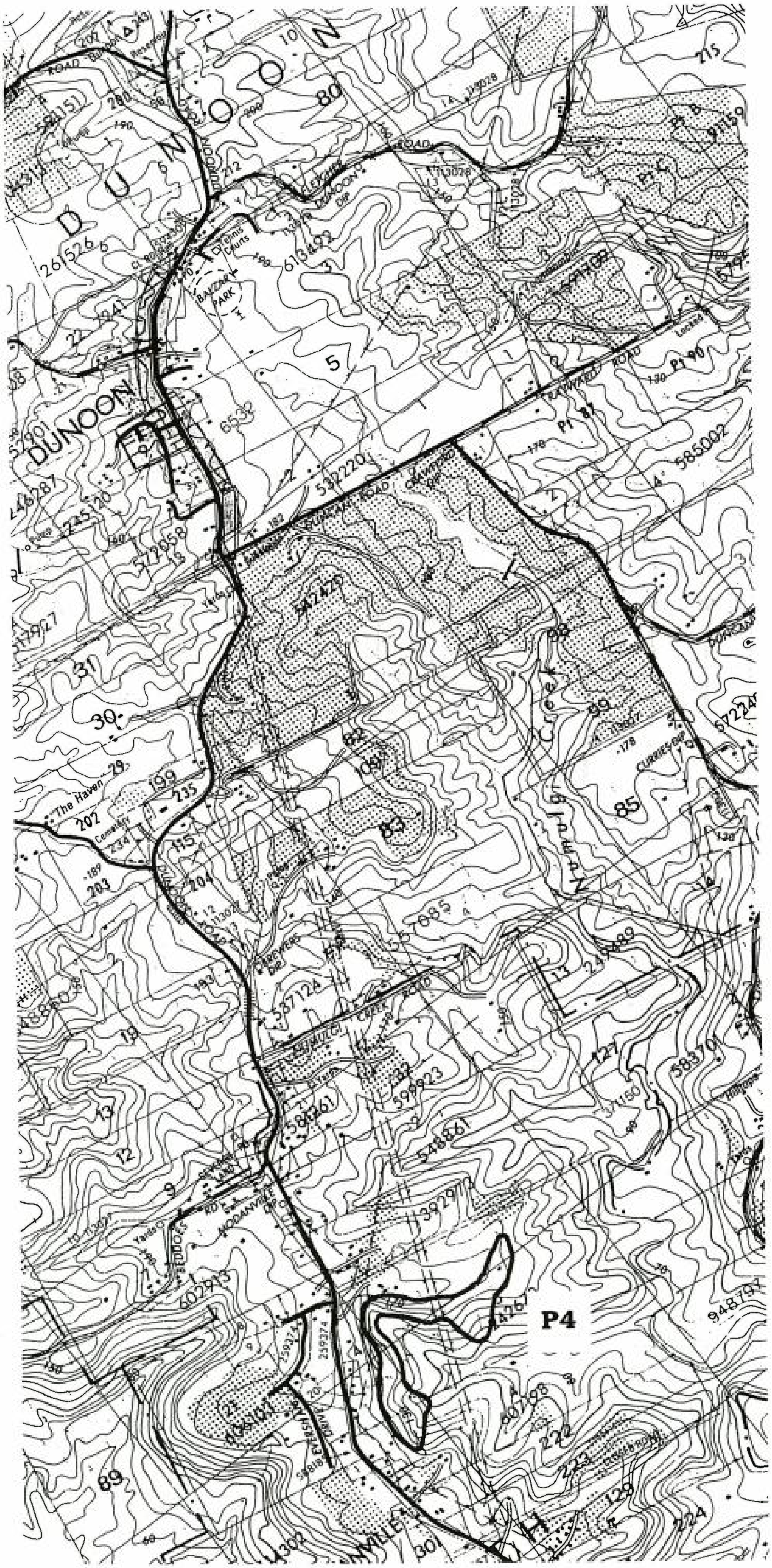

FIGURE 3 Location of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

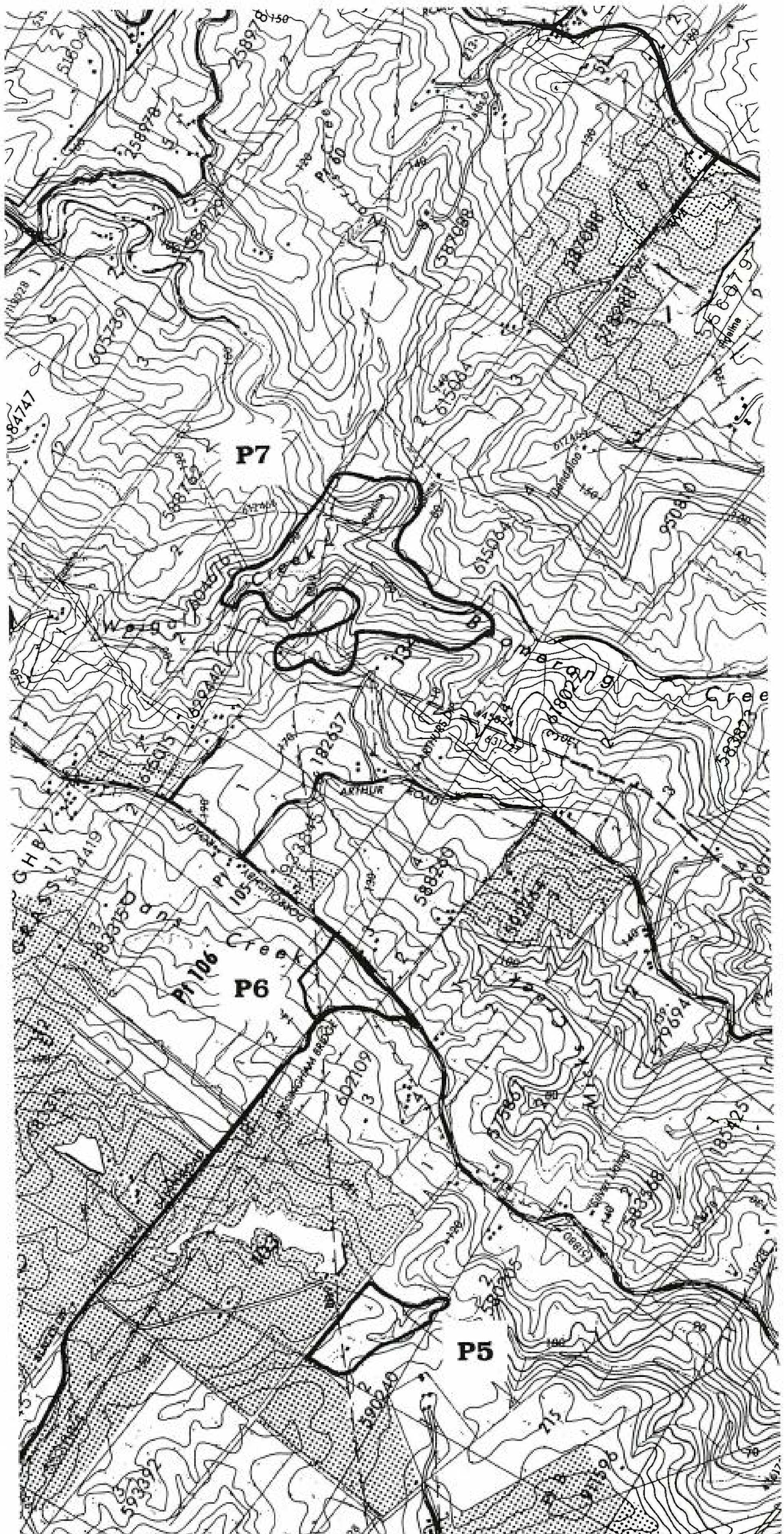

FIGURE 4 Location of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

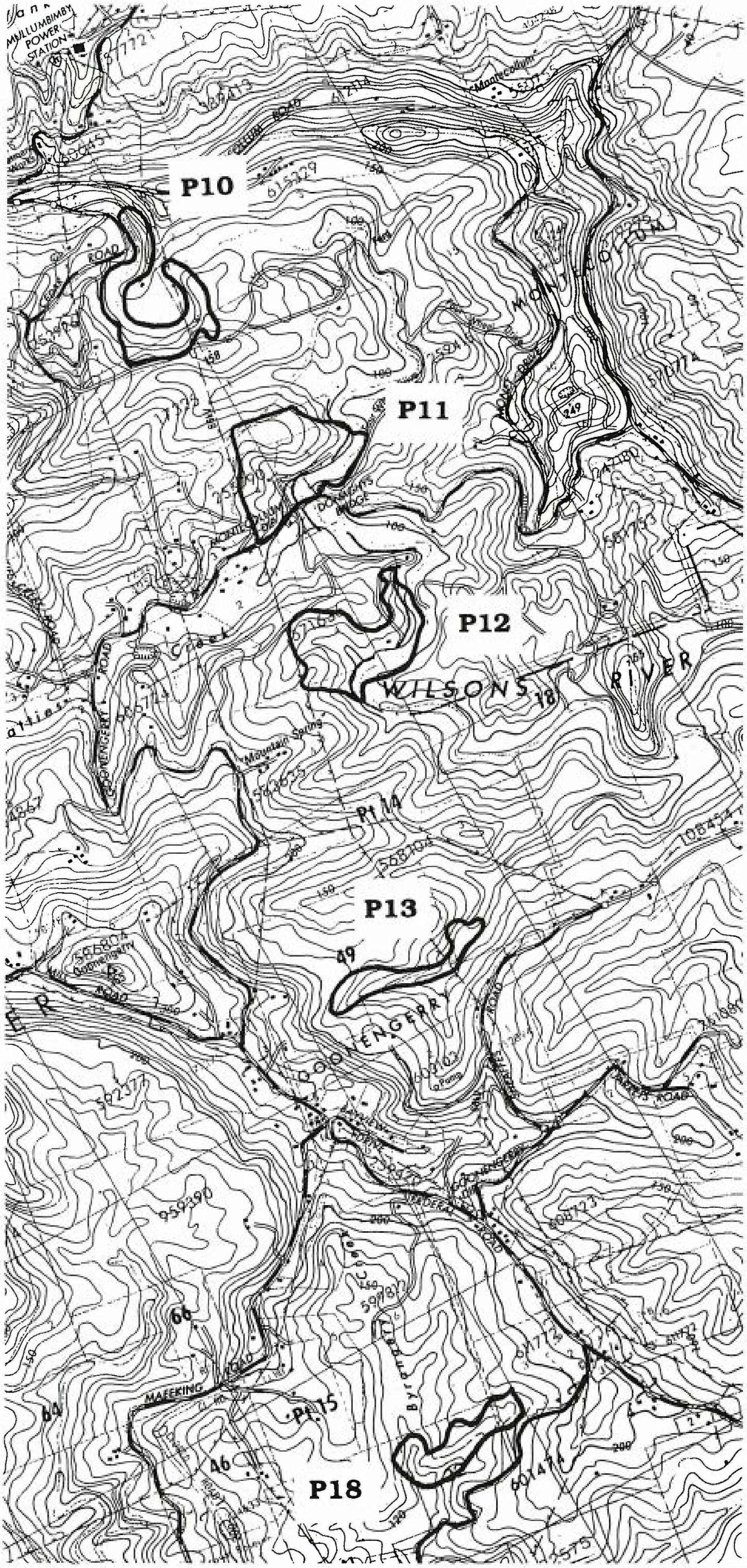

FIGURE 5 Location of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

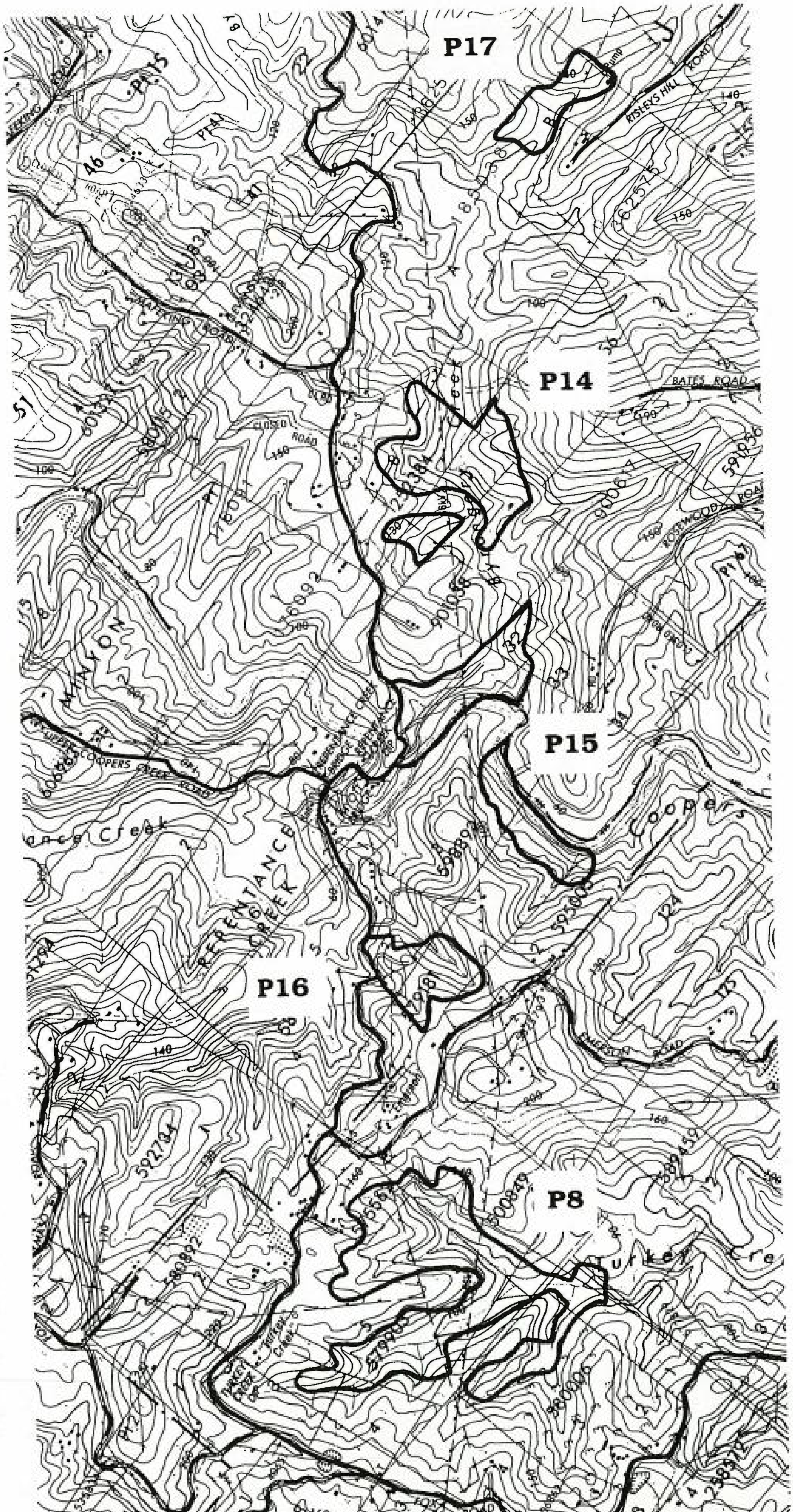

FIGURE 6 Location of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

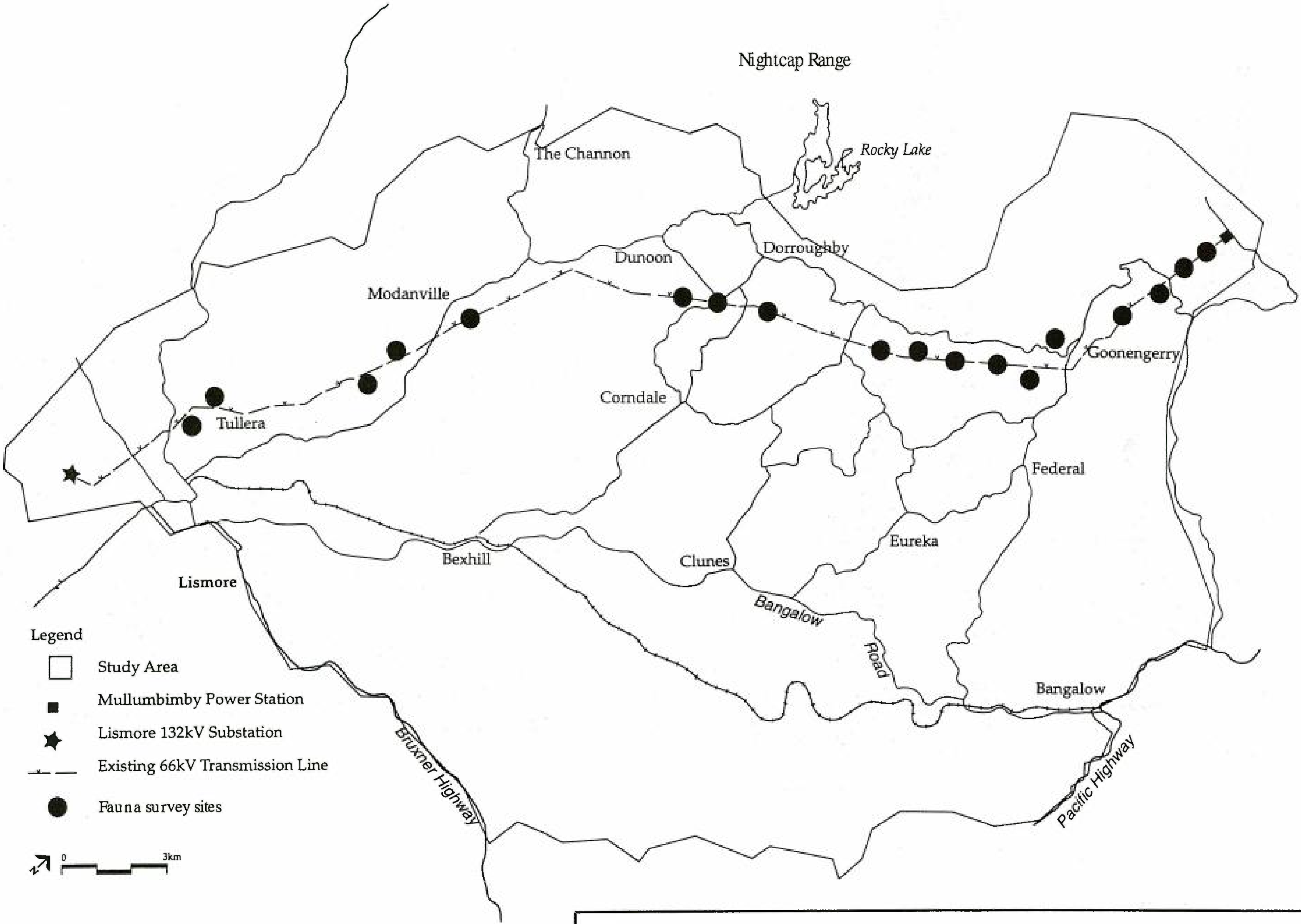

FIGURE 7 Location of fauna survey sites along the existing 66kV transmission line between Lismore and Mullumbimby.

APPENDIX 1 Habitat descriptions of fauna survey sites along the proposed Lismore/Mullumbimby transmission line corridor.

Site P1 **FHU 1a**

Single habitat of degraded secondary rainforest regrowth. The majority of the overstorey is Camphor Laurel *Cinnamomum camphora*, with a few native rainforest species. Understorey is a mixture of various exotic weeds and rainforest species. The site is located on a steep hillside of chocolate soil and is extremely rocky with basalt boulders. Several micro-environments are present, including areas completely covered in sizable boulders with an almost 100% cover of native vegetation in both the understorey and overstorey. Vegetation height 15-25m, FPC 70%.

Site P2 **FHU 1 and FHU 2**

Adjacent to Bently Road, the current powerline passes over rural grazing land. There are numerous highly utilised Koala food trees in the area. Trapping was conducted adjacent to the creek in an area of mature rainforest trees and viney regrowth with an FPC above 70%. The soil is Basaltic Kraznozem and extremely rocky in areas, covered by vegetation.

Site P3 **FHU 1/FHU 2a**

Off Dunoon Road, the current powerline passes over an area of swampy rural grazing land. The trapping site is an area of rainforest regrowth of FPC above 70% and height of 15-25m, with occasional emergent eucalypts. The understorey is dominated by Lantana, with several areas too rocky for plants, supporting epiphytes and lianas. The soil is chocolate brown and extremely rocky, with large basalt outcrops dominant. Eucalypts show heavy usage by Koalas.

Site P4 **FHU 1a**

Off Dunromin Drive. The survey site is an area of rainforest regrowth, with a Camphor Laurel dominant overstory, FPC above 65%, and height of 15m. The current powerline traverses rural grazing land, and bisects the Modanville Estate housing development. A small dam with a well-developed reed cover lies under the current path of the powerline. An area of extensive rainforest regeneration lies adjacent to the existing powerline.

Site P5 **FHU 3 and FHU 1**

The current powerline passes over an area of eucalypt replantings, with evidence of utilisation by Koalas. Adjacent to the powerline is an area of viney rainforest regrowth, with an FPC above 65% and a height of 15m. The powerline also passes directly over a creek with poor vegetative structure, dominated by riparian weeds.

Site P6 **FHU 4 with some FHU 1a**

The area beneath the current powerline is mainly dominated by Camphor Laurel, with a few rainforest trees emergent, including two very large figs at the upper slope of the site. There is little rainforest regrowth at the site. The understorey is dominated by Camphor Laurel seedlings, Privet and Lantana, and the riparian zone is weed-infested. One side of the site borders a Macadamia nut farm, with a eucalypt windbreak along the western edge (with no sign of usage by Koalas).

Site P7 **FHU 1**

Off Armstrong Road, the survey site is directly below the powerline where it crosses Boomerang Creek. Vegetation is a rainforest remnant of FPC above 70%, with a relatively intact and weed-free riparian zone. The water quality of the creek is high, with no evidence of excessive nutrients, and low turbidity. The soil is basaltic in origin and the site is very rocky in some places.

Site P8 **FHU 1**

Off Rosebank Road, the current powerline passes over rural grazing land, with an area of rainforest remnant immediately adjacent to it. The remnant is of high conservation value, with an FPC of above 70% and height of 25m. The site contains a mixture of very mature regrowth with a good diversity of rainforest species. The understorey is of mostly native flora, with rainforest seedlings and lianas, although the riparian zone is heavily infested with weeds. A farm dam adjacent to the remnant lies directly below the powerline.

Site P9 **FHU 4, with a little FHU 1 and FHU 3**

Off Boorie Creek and Hewitt Road. The current powerline runs along Boorie Creek for aproximately 1.5 kilometres at this site, over mostly cleared rural grazing land. The riparian zone includes very few trees and little other than a dense grassland. Towards the end of Hewit Road, the structure of the vegetation becomes more diverse. The current line passes near areas of regeneration planting, and through an area (approximately 150 sq.m) of Hoop Pine-dominated rainforest regrowth (to be avoided). The riparian zone at this end of Hewitt Road shows a dominance of rainforest regrowth species. The soil along the creek is chocolate brown alluvial material.

Site P10 **FHU 2 and FHU 1a**

Off Cedar Road, the area adjacent to the powerline is dominated by eucalypts to 25m in height, with a thick Lantana understory. The riparian zone on this part of Wilsons Creek includes some mature rainforest species, with dominant Camphor Laurel and an FPC of above 75%. The soil is a basaltic origin Kraznozem.

Site P11 **FHU 3 (of FHU 2a and FHU 1)**

This site was divided into two subsites to provide better survey coverage. Site P11a is an area dominated by a re-planting of wet schlerophyl vegetation, with a small area of rainforest regrowth. Trees in the wet schlerophyl zone show evidence of extensive use by Koalas. The small section of rainforest regrowth has an FPC of 80%. Site P11b is an area of rainforest regrowth with large emergent rainforest trees with an FPC of 80%. Extensive regeneration planting has been carried out at this site, and the riparian zone is intact, with minimal weed infestation. The soil is a basaltic origin Kraznozem, and the surface is extremely rocky.

Site P12 **FHU 2a and FHU 1**

Adjacent to the powerline is a narrow area of planted eucalypts to 20 metres in height. The planting is 300 metres in length, supporting some remnant rainforest understorey with an FPC to 80%. The riparian zone is heavily infested with weeds, but rainforest species still dominate. The soils along the creekline are alluvial in origin, and the soils under the rainforest and pasture areas are a basaltic origin Kraznozem. The site is extremely rocky, with a moderate to extreme slope in places.

Site P13 **FHU 1**

This site consists of a small area of rainforest regrowth, occupying the bottom of a valley immediately under the span of the current powerline. The creekline is flowing, and riparian vegetation contains mostly rainforest trees to 25m, with an FPC of 60% and a thick understorey of weeds. The slopes contain a mixture of Camphor Laurel and Lantana, with some colonising rainforest seedlings. There are small areas of rainforest regrowth on either side of Sheaffe's Road. Soil is a Kraznozem with a basaltic substrate.

Site P14 **FHU 1 and FHU 1a**

The current powerline spans Byrangery Creek, with access via Repentance Creek Road. The valley is bordered by Camphor Laurel forest. The riparian zone and its surrounds contain areas of remnant and regrowth rainforest, with substantial areas of rainforest species with a height of 20m and FPC of 60-80%. Undergrowth in the riparian zone is a mixture of epiphytes, lianas and rainforest species with a good diversity. The soil is basaltic Kraznozem, and the surface over most of the site is very rocky.

Site P15 FHU 1a

Off Repentance Creek Road, the current powerline passes over Coopers Creek. Camphor Laurel forest dominates the northern side of the valley, but closer to the creek mature rainforest trees and associated successional regrowth are interspersed with large Camphor Laurels. The riparian zone is weed infested, although some mature rainforest species are present. Soil is chocolate with a basaltic substrate. FPC 60-80%, height 10-25m.

Site P16 FHU 1 and FHU 1a

Access is via Emerson Road. The site contains significant regrowth of rainforest species, with an overstorey approximately 15-25m tall dominated by a good diversity of rainforest species, with an FPC of 65-75%. Understorey is dominated by exotic weeds, including Lantana and Tobacco Bush, with some native seedlings. The creekline in the gully contains more mature trees, and the understorey consists of a complete infestation of Lantana.

Site P17 FHU 1

This site supports only riparian rainforest vegetation. Species diversity is low, and the structure includes an FPC of 70-80% with a height of 20m. Some sections of the riparian zone are highly disturbed, with Camphor Laurel dominating. Undergrowth is dominated by weeds, including Camphor Laurel and Lantana. The soil is a chocolate Kraznozem, with a basaltic substrate.

Site P18 FHU 1

This site is located at the corner of Repentance Creek Road and Federal Road. It supports significant riparian rainforest along a small creek line, and consists of two small pockets of intact rainforest remnants surrounded by secondary scattered forest. Outside the remnant there is highly disturbed pastoral land, with some Camphor Laurel and Lantana.

A small creek flows through the two pockets. The soil is of basaltic origin, and the site is very rocky. Species diversity is moderate, with an FPC of 75% and a height reaching 25m. Undergrowth is poor due to the boulders, but there are some thick lianas.

FHU	DESCRIPTION	VEGETATION COMMUNITIES #
1	Rainforest, generally in good condition.	1A, 2, 3, 4, 5
1a	Rainforest, disturbed, canopy dominated by Camphor Laurel.	1D
2	Eucalypt dominated sites, without rainforest understorey.	7, 8, 9, 10, 11, 12
2a	Eucalypt or Brush Box dominated sites, with rainforest understorey.	6
3	Plantation and regeneration of eucalypts and/or rainforest.	15
4	Cleared/open areas with some trees.	C
5	Horticultural areas.	14

 # R Lembit, this EIS.

APPENDIX 1A Vegetation community characteristics (from Lembit, this EIS) and Fauna Habitat Units of the 18 survey sites for native fauna along the Lismore/Mullumbimby transmission line.

FAUNA SITES	VEGETATION COMMUNITIES	FAUNA HABITAT UNIT
P1	1: White Booyong Subtropical Rainforest.	1a: Rainforest, canopy dominated by Camphor Laurel.
P2 (Booerie Creek)	7 + 6: Brush Box Open Forest, with or without rainforest understorey.	1 + 2: eucalypts plus mature rainforest.
P3	1 (7 + 12): White Booyong Rainforest, with Brush Box and Eucalypt Open Forest.	1 + 2a: Rainforest with emergent eucalypts.
P4	1: White Booyong Rainforest.	1a: Rainforest, canopy dominated by Camphor Laurel.
P5	15 + 1: Forest plantation/rainforest regeneration; Hoop Pine dry rainforest.	3 + 1: Eucalypt replantings and rainforest regeneration.
P6	C: cleared.	4 + 1a: Cleared, and Camphor Laurel with some rainforest elements.
P7 (Boomerang Creek)	1 + 4: White Booyong Rainforest; Hoop Pine dry rainforest.	1: Rainforest generally in good condition.
P8 (Turkey Creek)	1: White Booyong Rainforest.	1: Rainforest generally in good condition.
P9 (Booerie Creek)	C + 1: Cleared; small patch of White Booyong Rainforest.	4 (with a little 1 + 3): mostly cleared, Hoop Pine-dominated Rainforest, riparian zone rainforest regeneration.
P10 (Wilsons River)	1: White Booyong Rainforest.	2 + 1a: Eucalypts, Camphor Laurel-dominated Rainforest in the riparian zone.
P11 (Wilsons River)	15 + 1: Rainforest regeneration and White Booyong Rainforest.	3 (of 2a + 1): Plantation and regeneration of eucalypts and rainforest.
P12 (Wilsons River)	1: White Booyong Rainforest.	2a + 1: eucalypts with rainforest understorey, rainforest-dominated riparian zone.
P13	1: White Booyong Rainforest.	1: rainforest regrowth generally in good condition.
P14 (Byrangery Creek)	1: White Booyong Rainforest.	1 + 1a: Rainforest, rainforest with Camphor Laurel dominated canopy.
P15 (Coopers Creek)	1 + 6: White Booyong Rainforest and Brush Box Open Forest with rainforest subcanopy.	1a: Rainforest, canopy dominated by Camphor Laurel.
P16	1 + 1A: White Booyong Rainforest in good condition.	1 + 1a: Rainforest, weed-infested understorey.
P17	1: White Booyong Rainforest.	1 + 1a: rainforest, rainforest with Camphor Laurel-dominated canopy.
P18	1: White Booyong Rainforest.	1: Significant riparian rainforest.

APPENDIX 2 Details of trapping methods and capture success at each survey site along the proposed Lismore/Mullumbimby transmission line corridor.

SITE	EQUIPMENT	CAPTURE SUCCESS
P1	25 'B' Elliott Traps; 2 'C' Elliott Traps; 2 Cage Traps.	1% 'B' Elliott Traps 0% all other methods
P2	25 'B' Elliott Traps; 2 'C' Elliott Traps; 1 Cage Trap; 1 Harp Trap; 1 Pitfall Line (5 pitfalls); 1 Mist Net (60 ft) over 2 nights.	0% all trapping methods
P3	25 'B' Elliott Traps; 2 'C' Elliott Traps; 2 Cage Traps; 1 Mist Net (40 ft) over 2 nights.	12% 'B' Elliott Traps 0% all other methods
P4	No trapping conducted; bird surveys and habitat searches only.	
P5	1 Mist Net (60 ft) over 2 nights.	0% Mist Net
P6	No trapping conducted; bird surveys and habitat searches only.	
P7	50 'B' Elliott Traps; 4 'C' Elliott Traps; 2 Cage Traps; 1 Pitfall Line (5 pitfalls); 1 Mist Net over 2 nights.	0% all trapping methods
	Second session: 25 'B' Elliott Traps; 1 'C' Elliot Trap; 1 Cage Trap; 1 Mist Net over 2 nights.	17% 'B' Elliott Traps 0% all other methods
P8	25 'B' Elliott Traps; 2 'C' Elliott Traps; 1 Cage Trap; 1 Harp Trap; 1 Mist Net (60 + 20 ft) over 3 nights.	0% all trapping methods
P9	No trapping conducted; bird surveys and habitat searches only.	
P10	25 'B' Elliott Traps; 'C' Elliott Traps; 1 Cage Trap; 1 Mist Net (60 ft) over 2 nights.	2% 'C' Elliott Traps 0% all other methods
P11	25 'B' Elliott Traps; 4 'C' Elliott Traps; 2 Cage Traps; 1 Mist Net (60 ft) over 2 nights.	7% 'B' Elliott Traps 12% 'C' Elliott Traps 0% all other methods
P12	25 'B' Elliott Traps; 2 'C' Elliott Traps; 2 Cage Traps; 1 Harp Trap.	4% 'B' Elliott Traps 0% all other methods
P13	No trapping conducted; bird surveys and habitat searches only.	
P14	25 'B' Elliott Traps; 2 'C' Elliott Traps; 2 Cage Traps; 1 Harp Trap over 2 nights; 1 Pitfall Line (10 pitfalls); 1 Mist Net (30 ft) over 2 nights.	10% 'B' Elliott Traps 0% all other methods
	Second session: 1 Mist Net (40ft) over 2 nights.	1 bat caught in mist net
P15	No trapping conducted; bird surveys and habitat searches only.	
P16	25 'B' Elliott Traps; 2 'C' Elliott Traps; 1 Cage Trap; 1 Harp Trap.	1% 'B' Elliott Traps 0% all other methods
P17	No trapping conducted; bird surveys and habitat searches only.	
P18	25 'B' Elliott Traps; 2 'C' Elliott Traps; 1 Cage Trap; 2 Mist Nets over 3 nights.	3.5% 'B' Elliott Traps 0% all other methods

APPENDIX 2a Details of weather conditions during trapping surveys along the proposed Lismore/Mullumbimby transmission line corridor.

STAGE I	
Dates	3rd - 9th of May 1994
Sites surveyed	P1 P2 P3 P4 P5 P6 P7 P8 P9
Weather	Clear and fairly cool, for 5 of the 6 days, with cold nights. Temperatures ranged from 6 to 25 °C, one night of rain. The moon was full on the third night of the survey.
STAGE II	
Dates	21st - 26th of May 1994
Sites surveyed	P10 P11 P12 P13 P14 P15 P16 P17
Weather	Clear and quite warm for the whole survey; nights were particularly warm for the time of year. Temperatures ranged from 8 to 24°C. The moon was full on the fifth night of the survey.
STAGE III	
Dates	15th - 23rd of August 1994
Sites surveyed	P5 P14 P18
Weather	Mostly dry with the occasional (daily) shower. Temperatures ranged from 12 to 26°C. The nights were warm, with rain recorded on only one night. The moon was full by the end of the survey period.

APPENDIX 2b Details of vertebrate fauna databases accessed for fauna records from the Lismore/Mullumbimby area.

Royal Australasian Ornithologists Union records (RAOU) Data obtained: May '94
10' blocks bounded by 28°45' to 28°55'S & 153°15' to 153°25'E

NSW Bird Atlas records (NSW Bird Atlassers Inc) Data obtained: May '94
10' blocks centred on 28°45' x 153°15', 28°45' x 147°25' & 28°35' x 153°25'.

NSW Wildlife Atlas records (NSW NP&WS) Data obtained: Sept '94
10' blocks bounded by 28°37' to 28°51'S & 153°14 to 153°25'E and 28°34' to 28°51'S & 153°25 to 153°30'E

NP&WS: *"These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions."*

APPENDIX 3 Avifauna species recorded from all survey sites along the Lismore/Mullumbimby transmission line corridor.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Podicipedidae																			
Australasian Grebe	*Tachybaptus novaehollandiae*				●														
Phalacrocoraidae																			
Little Pied Cormorant	*Phalacrocorax melanoleucos*							●	●	●	●		●		●	●			
Ardeidae																			
Pacific Heron	*Ardea pacifica*				●											●			●
White-faced Heron	*Ardea novaehollandiae*	●	●			●				●	●				●	●			
Cattle Egret	*Ardeola ibis*	●	●	●	●		●	●	●	●					●	●			●
Intermediate Egret	*Egretta intermedia*			●															
Plataleidae																			
Sacred Ibis	*Threskiornis aethiopica*	●	●	●	●			●	●	●					●	●			●
Straw-necked Ibis	*Threskiornis spinicollis*		●	●			●		●	●					●	●	●		
Anatidae																			
Pacific Black Duck	*Anas superciliosa*	●	●	●	●			●	●	●	●		●		●	●			●
Accipitridae																			
Black-shouldered Kite	*Elanus notatus*	●		●			●	●	●	●	●		●	●		●			●
Crested Hawk	*Aviceda subcristata*															●			
Whistling Kite	*Haliastur sphenurus*														●	●			
Brown Goshawk	*Accipiter fasciatus*															●			
Little Eagle	*Hieraaetus morphnoides*							●											
Falconidae																			
Australian Kestrel	*Falco cenchroides*	●							●	●	●		●		●				
Megapodiidae																			
Australian Brush-turkey	*Alectura lathami*					●		●	●		●	●	●		●	●	●	●	●
Phasianidae																			
Brown Quail	*Coturnix australis*			●						●	●	●				●			
Rallidae																			
Lewin's Rail	*Rallus pectoralis*												●						
Australian Crake	*Porzana fluminea*				●														
Dusky Moorhen	*Gallinula tenebrosa*		●	●	●			●	●	●	●	●	●			●			
Purple Swamphen	*Porphyrio porphyrio*		●	●	●			●	●	●		●							
Charadriidae																			
Masked Lapwing	*Vanellus miles*	●	●	●	●	●		●	●	●	●	●	●		●	●		●	●

APPENDIX 3 contd. Avifauna species recorded from all survey sites along the Lismore/Mullumbimby transmission line corridor.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Columbidae																			
★Superb Fruit-dove	*Ptilinopus superbus*							●							●				
★Rose-crowned Fruit-dove	*Ptilinopus regina*				●	●		●	●				●		●				
★Wompoo Fruit-dove	*Ptilinopus magnificus*				●			●					●		●				●
Topknot Pigeon	*Lopholaimus antarcticus*	●	●	●	●	●		●	●	●	●	●	●		●	●	●		●
White-headed Pigeon	*Columba leucomela*	●	●	●	●	●		●	●	●	●	●	●		●	●			●
Spotted Turtle-dove	*Streptopelia chinensis*			●						●				●					
Brown Cuckoo-dove	*Macropygia amboinensis*	●	●	●	●			●	●	●	●	●	●		●	●	●	●	●
Peaceful Dove	*Geopelia placida*	●		●				●		●									
Bar-shouldered Dove	*Geopelia humeralis*											●							
Emerald Dove	*Chalcophaps indica*	●	●	●	●			●	●		●	●	●		●	●		●	
Crested Pigeon	*Ocyphaps lophotes*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●
Wonga Pigeon	*Leucosarcia melanoleuca*							●											
Cacatuidae																			
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*								●		●	●			●	●		●	
Sulphur-crested Cockatoo	*Cacatua galerita*	●														●			
Loriidae																			
Rainbow Lorikeet	*Trichoglossus haematodus*	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	
Polytelitidae																			
Australian King Parrot	*Alisterus scapularis*											●	●		●	●	●	●	
Platycercidae																			
Crimson Rosella	*Platycercus elegans*			●				●				●			●	●	●		
Eastern Rosella	*Platycercus eximius*	●		●	●	●	●	●	●	●			●	●	●	●	●	●	●
Cuculidae																			
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*											●	●			●			
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*									●	●	●	●		●	●			
Pheasant Coucal	*Centropus phasianinus*								●		●	●	●	●	●	●			
Strigidae																			
Southern Boobook	*Ninox noveseelandiae*							●											
Tytonidae																			
Barn Owl	*Tyto alba*					●			●										
Podargidae																			
Tawny Frogmouth	*Podargus strigoides*	●	●					●	●		●	●	●		●	●			
★Marbled Frogmouth	*Podargus ocellatus*							●											

APPENDIX 3 contd. Avifauna species recorded from all survey sites along the Lismore/Mullumbimby transmission line corridor.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Aegothelidae																			
Australian Owlet-nightjar	*Aegotheles cristatus*								●										
Alcedinidae																			
Azure Kingfisher	*Ceyx azurea*		●					●			●	●	●		●	●			
Kookaburra	*Dacelo novaeguineae*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	
Forest Kingfisher	*Halcyon macleayii*					●					●		●		●	●			
Meropidae																			
Rainbow Bee-eater	*Merops ornatus*	●	●	●		●		●		●	●				●	●		●	
Coraciidae																			
Dollarbird	*Eurystomus orientalis*											●							
Pitiidae																			
Noisy Pitta	*Pitta versicolor*															●			
Hirundinidae																			
Welcome Swallow	*Hirundo neoxena*	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Campephagidae																			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●
Varied Triller	*Lalage leucomela*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		
Muscicapidae																			
Rose Robin	*Petroica rosea*			●	●								●						
Scarlet Robin	*Petroica multicolor*										●				●				
Eastern Yellow Robin	*Eopsaltria australis*			●							●	●			●				
Jacky Winter	*Microeca leucophaea*										●	●	●		●	●	●		●
Pale-yellow Robin	*Tregellasia capito*								●										
Golden Whistler	*Pachycephala pectoralis*		●	●	●			●	●		●	●	●	●	●	●	●		
Little Shrike-thrush	*Colluricincla megarhyncha*		●														●		
Grey Shrike-thrush	*Colluricincla harmonica*	●						●		●	●	●	●				●		●
Grey Fantail	*Rhipidura fuliginosa*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Willie Wagtail	*Rhipidura leucophrys*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Orthonychidae																			
Logrunner	*Orthonyx temminckii*											●	●		●		●		
Eastern Whipbird	*Psophodes olivaceus*	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Sylviidae																			
Tawny Grassbird	*Megalurus timoriensis*									●									
Golden-headed Cisticola	*Cisticola exilis*	●								●	●								

APPENDIX 3 contd. Avifauna species recorded from all survey sites along the Lismore/Mullumbimby transmission line corridor.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Maluridae																			
Superb Fairy-wren	*Malurus cyaneus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Variegated Fairy-wren	*Malurus lamberti*			●		●		●	●	●									
Red-backed Fairy-wren	*Malurus melanocephalus*							●	●	●			●		●	●			
Acanthizidae																			
Yellow-throated Scrubwren	*Sericornis citreogularis*												●						
White-browed Scrubwren	*Sericornis frontalis*										●		●						
Brown Thornbill	*Acanthiza pusilla*	●	●	●	●	●	●	●	●		●	●	●	●	●	●		●	●
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*											●							
Climacteridae																			
White-throated Treecreeper	*Climacteris leucophaea*		●	●	●	●		●	●	●	●	●	●		●		●		
Meliphagidae																			
Little Friarbird	*Philemon citreogularis*																		
Noisy Miner	*Manorina melanocephala*	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●
Lewin's Honeyeater	*Meliphaga lewinii*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Brown Honeyeater	*Lichmera indistincta*			●	●	●				●									
White-cheeked Honeyeater	*Phylidonyris nigra*											●							
Eastern Spinebill	*Acanthorphynchus tenuirostris*														●				
Scarlet Honeyeater	*Myzomela sanguinolenta*		●	●		●		●		●	●	●	●		●	●	●		
Dicaeidae																			
Mistletoebird	*Dicaeum hirundinaceum*											●							
Pardalotidae																			
Striated Pardalote	*Pardalotus striatus*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
Zosteropidae																			
Silvereye	*Zosterops lateralis*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
Ploceidae																			
Red-browed Firetail	*Emblema temporalis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Oriolidae																			
Figbird	*Sphecotheres viridis*	●	●	●	●	●		●	●		●	●	●	●	●	●	●	●	●
Dicruridae																			
Spangled Drongo	*Dicrurus hottentottus*										●	●	●		●	●	●		
Paradisaeidae																			
Satin Bowerbird	*Ptilonorhynchus violaceus*											●			●				
Regent Bowerbird	*Sericulus chrysocephalus*															●			

APPENDIX 3 contd. Avifauna species recorded from all survey sites along the Lismore/Mullumbimby transmission line corridor.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Paradisaeidae contd																			
Green Catbird	*Ailuroedus crassirostris*			●		●		●			●	●	●	●	●	●	●		●
Artamidae																			
Dusky Woodswallow	*Artamus cyanopterus*																		●
Grallinidae																			
Australian Magpie-lark	*Grallina cyanoleuca*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
Cracticidae																			
Grey Butcherbird	*Cracticus torquatus*												●						
Pied Butcherbird	*Cracticus nigrogularis*	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
Australian Magpie	*Gymnorhina tibicen*	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Pied Currawong	*Strepera graculina*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Corvidae																			
Australian Raven	*Corvus coronoides*												●						
Torresian Crow	*Corvus orru*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

★ Schedule 12 species (NP&W Act 1974).

APPENDIX 4 Avifauna species recorded during the current survey along the proposed Lismore/Mullumbimby transmission line corridor, including records from various databases for the general area.

COMMON NAME	SCIENTIFIC NAME	A	B	C	D
Podicipedidae					
Hoary-headed Grebe	*Poliocephalus poliocephalus*		●	●	
Australasian Grebe	*Tachybaptus novaehollandiae*	●	●	●	
Pelecanoidae					
Australian Pelican	*Pelecanus conspicillatus*		●	●	
Sulidae					
Australasian Gannet	*Morus serrator*		●	●	
Anhingidae					
Darter	*Anhinga melanogaster*		●	●	●
Phalacrocoraidae					
Great Cormorant	*Phalacrocorax carbo*		●	●	●
Pied Cormorant	*Phalacrocorax varius*		●	●	
Little Black Cormorant	*Phalacrocorax sulcirostris*		●	●	
Little Pied Cormorant	*Phalacrocorax melanoleucos*	●	●	●	●
Ardeidae					
Pacific Heron	*Ardea pacifica*	●	●	●	●
White-faced Heron	*Ardea novaehollandiae*	●	●	●	●
Cattle Egret	*Ardeola ibis*	●	●	●	●
Great Egret	*Egretta alba*		●	●	●
Little Egret	*Egretta garzetta*		●	●	●
Intermediate Egret	*Egretta intermedia*	●	●	●	●
Striated Heron	*Butorides striatus*		●	●	●
Rufous Night Heron	*Nycticorax caledonicus*		●	●	●
★Black Bittern	*Dupetor flavicollis*		●		●
Ciconiidae					
★Black-necked Stork	*Ephippiorhynchus asiaticus*		●	●	●
Plataleidae					
Glossy Ibis	*Plegadis falcinellus*		●		●
Sacred Ibis	*Threskiornis aethiopica*	●	●	●	●
Straw-necked Ibis	*Threskiornis spinicollis*	●	●	●	●
Royal Spoonbill	*Platalea regia*		●	●	●
Yellow-billed Spoonbill	*Platalea flavipes*		●	●	
Anatidae					
Black Swan	*Cygnus atratus*		●	●	●
Pacific Black Duck	*Anas superciliosa*	●	●	●	●
Mallard	*Anas platyrhynchos*			●	●
Grey Teal	*Anas gibberifrons*		●	●	●
Chestnut Teal	*Anas castanea*			●	
Australasian Shoveler	*Anas rhynchotis*			●	
Pink-eared Duck	*Malacorhynchus membranaceus*		●	●	●
Hardhead	*Aythya australis*		●	●	●
Maned Duck	*Chenonetta jubata*		●	●	●
Pandionidae					
★Osprey	*Pandion haliaetus*		●		●
Accipitridae					
Black-shouldered Kite	*Elanus notatus*	●	●	●	●
Crested Hawk	*Aviceda subcristata*	●	●	●	●
Brahminy Kite	*Haliastur indus*		●	●	●
Whistling Kite	*Haliastur sphenurus*	●	●	●	●
Brown Goshawk	*Accipiter fasciatus*	●	●	●	●
Collared Sparrowhawk	*Accipiter cirrhocephalus*			●	●
Grey Goshawk	*Accipiter novachollandiae*		●	●	●
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		●	●	●
Wedge-tailed Eagle	*Aquila audax*		●	●	●
Little Eagle	*Hieraaetus morphnoides*		●	●	●
Spotted Harrier	*Circus assimilis*		●	●	●
Marsh Harrier	*Circus aeruginosus*		●	●	
Falconidae					
Peregrine Falcon	*Falco peregrinus*		●	●	●

APPENDIX 4 contd. Avifauna species recorded during the current survey along the proposed Lismore/Mullumbimby transmission line corridor, including records from various databases for the general area.

COMMON NAME	SCIENTIFIC NAME	A	B	C	D
Falconidae contd.					
Little Falcon (Australian Hobby)	*Falco longipennis*			●	●
Brown Falcon	*Falco berigora*		●	●	●
Australian Kestrel	*Falco cenchroides*	●	●	●	●
Megapodiidae					
Australian Brush-turkey	*Alectura lathami*	●		●	●
Phasianidae					
Brown Quail	*Coturnix australis*	●	●	●	●
King Quail	*Coturnix chinensis*				●
Turnicidae					
Red-chested Button-quail	*Turnix pyrrhothorax*				●
Rallidae					
Buff-banded Rail	*Rallus philippensis*		●	●	●
Lewin's Rail	*Rallus pectoralis*	●		●	●
Australian Crake	*Porzana fluminea*	●		●	
Spotless Crake	*Porzana tabuensis*				●
★Bush-hen	*Gallinula olivacea*		●	●	●
Dusky Moorhen	*Gallinula tenebrosa*	●	●	●	●
Purple Swamphen	*Porphyrio porphyrio*	●	●	●	●
Eurasian Coot	*Fulica atra*		●	●	●
Gruidae					
★Brolga	*Grus rubicundus*		●		
Jacanidae					
★Comb-crested Jacana	*Irediparra gallinacea*		●	●	●
Columbidae					
★Superb Fruit-Dove	*Ptilinopus superbus*	●			●
★Rose-crowned Fruit-Dove	*Ptilinopus regina*	●	●	●	●
★Wompoo Fruit-Dove	*Ptilinopus magnificus*	●	●	●	●
Topknot Pigeon	*Lopholaimus antarcticus*	●	●	●	●
White-headed Pigeon	*Columba leucomela*	●	●	●	●
Feral Pigeon	*Columba livia*		●	●	
Spotted Turtle-Dove	*Streptopelia chinensis*	●	●	●	●
Brown Cuckoo-Dove	*Macropygia amboinensis*	●	●	●	●
Peaceful Dove	*Geopelia placida*	●	●	●	●
Bar-shouldered Dove	*Geopelia humeralis*	●	●	●	●
Emerald Dove	*Chalcophaps indica*	●	●	●	●
Common Bronzewing	*Phaps chalcoptera*		●		
Crested Pigeon	*Ocyphaps lophotes*	●	●	●	●
Wonga Pigeon	*Leucosarcia melanoleuca*		●	●	●
Cacatuidae					
★Red-tailed Black-Cockatoo	*Calyptorhynchus magnificus*			●	●
★Glossy Black-Cockatoo	*Calyptorhynchus lathami*		●		●
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	●	●	●	●
Galah	*Cacatua roseicapilla*		●	●	●
Sulphur-crested Cockatoo	*Cacatua galerita*	●	●	●	●
Loriidae					
Rainbow Lorikeet	*Trichoglossus haematodus*	●	●	●	●
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	●	●	●	●
Little Lorikeet	*Glossopsitta pusilla*		●		
Polytelitidae					
Australian King-Parrot	*Alisterus scapularis*	●	●	●	●
Platycercidae					
Crimson Rosella	*Platycercus elegans*	●	●	●	●
Eastern Rosella	*Platycercus eximius*	●	●	●	●
Pale-headed Rosella	*Platycercus adscitus*		●		
Cuculidae					
Oriental Cuckoo	*Cuculus saturatus*		●		●
Pallid Cuckoo	*Cucluus pallidus*			●	

APPENDIX 4 contd. Avifauna species recorded during the current survey along the proposed Lismore/Mullumbimby transmission line corridor, including records from various databases for the general area.

COMMON NAME	SCIENTIFIC NAME	A	B	C	D
Cuculidae contd.					
Brush Cuckoo	*Cuculus variolosus*		●	●	●
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*	●	●	●	●
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	●	●		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		●	●	●
Little Bronze-Cuckoo	*Chrysococcyx malayanus*			●	
Common Koel	*Eudynamis scolopacea*		●	●	●
Channel-billed Cuckoo	*Scythrops novaehollandiae*		●	●	●
Pheasant Coucal	*Centropus phasianinus*	●	●	●	●
Strigidae					
Southern Boobook	*Ninox noveseelandiae*	●	●	●	●
Tytonidae					
Barn Owl	*Tyto alba*	●	●	●	●
Podargidae					
Tawny Frogmouth	*Podargus strigoides*	●	●	●	●
★Marbled Frogmouth	*Podargus ocellatus*	●		●	●
Aegothelidae					
Australian Owlet-nightjar	*Aegotheles cristatus*	●			●
Caprimulgidae					
White-throated Nightjar	*Caprimulgus mystacalis*		●	●	●
Apodidae					
White-throated Needletail	*Hirundapus caudacutus*		●	●	●
Fork-tailed Swift	*Apus pacificus*		●		●
Alcedinidae					
Azure Kingfisher	*Ceyz azurea*	●	●	●	●
Kookaburra	*Dacelo novaeguineae*	●	●	●	●
Forest Kingfisher	*Halcyon macleayii*	●	●	●	●
Sacred Kingfisher	*Halcyon sancta*		●	●	●
Meropidae					
Rainbow Bee-eater	*Merops ornatus*	●	●	●	●
Coraciidae					
Dollarbird	*Eurystomus orientalis*	●	●	●	●
Pitiidae					
Noisy Pitta	*Pitta versicolor*	●	●	●	●
Menuridae					
★Albert's Lyrebird	*Menura alberti*			●	
Atrichornithidae					
★Rufous Scrub-bird	*Atrichornis rufescens*			●	●
Hirundinidae					
White-backed Swallow	*Cheramoeca leucosternum*			●	
Welcome Swallow	*Hirundo neoxena*	●	●	●	●
Tree Martin	*Cecropis nigricans*		●	●	●
Fairy Martin	*Cecropis ariel*		●	●	●
Motacillidae					
Richard's Pipit	*Anthus novaeseelandiae*		●	●	
Campephagidae					
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	●	●	●	●
White-bellied Cuckoo-shrike	*Coracina papuensis*			●	●
★Yellow-eyed Cuckoo-shrike	*Coracina lineata*		●		●
Cicadabird	*Coracina tenuirostris*		●	●	●
Varied Triller	*Lalage leucomela*	●	●	●	●
Muscicapidae					
White's Thrush	*Zoothera dauma*			●	●
Rose Robin	*Petroica rosea*	●	●	●	

APPENDIX 4 contd. Avifauna species recorded during the current survey along the proposed Lismore/Mullumbimby transmission line corridor, including records from various databases for the general area.

COMMON NAME	SCIENTIFIC NAME	A	B	C	D
Muscicapidae contd.					
Scarlet Robin	*Petroica multicolor*	●			
Eastern Yellow Robin	*Eopsaltria australis*	●	●	●	●
Jacky Winter	*Microeca leucophaea*	●		●	●
Pale-yellow Robin	*Tregellasia capito*	●	●	●	●
Crested Shrike-tit	*Falcunculus frontatus*			●	●
★Olive Whistler	*Pachycephala olivacea*			●	●
Golden Whistler	*Pachycephala pectoralis*	●	●	●	●
Rufous Whistler	*Pachycephala rufiventris*		●	●	●
Little Shrike-thrush	*Colluricincla megarhyncha*	●	●	●	●
Grey Shrike-thrush	*Colluricincla harmonica*	●	●	●	●
Black-faced Monarch	*Monarcha melanopsis*		●	●	●
Spectacled Monarch	*Monarcha trivirgatus*		●	●	●
★White-eared Monarch	*Monarcha leucotis*		●	●	●
Leaden Flycatcher	*Myiagra rubecula*		●	●	●
Satin Flycatcher	*Myiagra cyanoleuca*		●		
Restless Flycatcher	*Myiagra inquieta*		●	●	●
Rufous Fantail	*Rhipidura rufifrons*		●	●	●
Grey Fantail	*Rhipidura fuliginosa*	●	●	●	●
Willie Wagtail	*Rhipidura leucophrys*	●	●	●	●
Orthonychidae					
Logrunner	*Orthonyx temminckii*	●	●	●	●
Eastern Whipbird	*Psophodes olivaceus*	●	●	●	●
Timaliidae					
Grey-crowned Babbler	*Pomatostomus temporalis*		●	●	
Sylviidae					
Clamorous Reed-Warbler	*Acrocephalus stentoreus*		●	●	
Tawny Grassbird	*Megalurus timoriensis*	●	●		
Golden-headed Cisticola	*Cisticola exilis*	●	●	●	●
Maluridae					
Superb Fairy-wren	*Malurus cyaneus*	●	●	●	●
Variegated Fairy-wren	*Malurus lamberti*	●	●	●	●
Red-backed Fairy-wren	*Malurus melanocephalus*	●	●	●	●
Acanthizidae					
Large-billed Scrubwren	*Sericornis magnirostris*		●	●	●
Yellow-throated Scrubwren	*Sericornis citreogularis*	●	●	●	●
White-browed Scrubwren	*Sericornis frontalis*	●	●	●	●
Speckled Warbler	*Sericornis sagittatus*		●		
Brown Warbler	*Gerygone mouki*		●	●	●
Mangrove Warbler	*Gerygone laevigaster*		●		
White-throated Warbler	*Gerygone olivacea*		●	●	●
Brown Thornbill	*Acanthiza pusilla*	●	●	●	●
Buff-rumped Thornbill	*Acanthiza reguloides*		●	●	●
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	●	●	●	●
Yellow Thornbill	*Acanthiza nana*			●	
Striated Thornbill	*Acanthiza lineata*			●	●
Neosittidae					
Varied Sittella	*Daphoenositta chrysoptera*			●	●
Climacteridae					
White-throated Treecreeper	*Climacteris leucophaea*	●	●	●	●
Brown Treecreeper	*Climacteris picumnus*			●	
Meliphagidae					
Red Wattlebird	*Anthochaera carunculata*		●		●
Little Wattlebird	*Anthochaera chrysoptera*		●	●	●
Striped Honeyeater	*Plectorhyncha lanceolata*		●	●	
Noisy Friarbird	*Philemon corniculatus*		●	●	●
Little Friarbird	*Philemon citreogularis*		●	●	
Blue-faced Honeyeater	*Entomyzon cyanotis*		●	●	●
Noisy Miner	*Manorina melanocephala*	●	●	●	●
Lewin's Honeyeater	*Meliphaga lewinii*	●	●	●	●
Yellow-faced Honeyeater	*Lichenostomus chrysops*		●	●	●

APPENDIX 4 contd. Avifauna species recorded during the current survey along the proposed Lismore/Mullumbimby transmission line corridor, including records from various databases for the general area.

COMMON NAME	SCIENTIFIC NAME	A	B	C	D
Meliphagidae contd.					
Fuscous Honeyeater	*Lichenostomus fuscus*			●	
White-naped Honeyeater	*Melithreptus lunatus*			●	
Brown Honeyeater	*Lichmera indistincta*	●	●	●	●
White-cheeked Honeyeater	*Phylidonyris nigra*	●	●	●	●
Eastern Spinebill	*Acanthorphynchus tenuirostris*	●	●	●	●
Scarlet Honeyeater	*Myzomela sanguinolenta*	●	●	●	●
Dicaeidae					
Mistletoebird	*Dicaeum hirundinaceum*	●	●	●	●
Pardalotidae					
Spotted Pardalote	*Pardalotus punctatus*			●	●
Striated Pardalote	*Pardalotus striatus*	●	●	●	●
Zosteropidae					
Silvereye	*Zosterops lateralis*	●	●	●	●
Passeridae					
House Sparrow	*Passer domesticus*		●	●	
Ploceidae					
Red-browed Firetail	*Emblema temporalis*	●	●		●
Double-barred Finch	*Poephila bichenovii*		●	●	●
Chestnut-breasted Mannikin	*Lonchura castaneothorax*		●	●	●
Nutmeg Mannikin	*Lonchura punctulata*		●	●	
Sturnidae					
Common Starling	*Sturnus vulgaris*		●	●	●
Oriolidae					
Olive-backed Oriole	*Oriolus sagittatus*		●	●	●
Figbird	*Sphecotheres viridis*	●	●	●	●
Dicruridae					
Spangled Drongo	*Dicrurus hottentottus*	●	●	●	●
Paradisaeidae					
Satin Bowerbird	*Ptilonorhynchus violaceus*	●	●	●	●
Regent Bowerbird	*Sericulus chrysocephalus*	●	●	●	●
Green Catbird	*Ailuroedus crassirostris*	●	●	●	●
Paradise Riflebird	*Ptiloris paradiseus*			●	●
Grallinidae					
Australian Magpie-lark	*Grallina cyanoleuca*	●	●	●	●
Artamidae					
White-breasted Woodswallow	*Artamus leucorhynchus*		●	●	●
Dusky Woodswallow	*Artamus cyanopterus*		●	●	
Cracticidae					
Grey Butcherbird	*Cracticus torquatus*	●	●	●	●
Black-backed Butcherbird	*Cracticus mentalis*		●		
Pied Butcherbird	*Cracticus nigrogularis*	●	●	●	●
Australian Magpie	*Gymnorhina tibicen*	●	●	●	●
Pied Currawong	*Strepera graculina*	●	●	●	●
Corvidae					
Australian Raven	*Corvus coronoides*	●		●	●
Torresian Crow	*Corvus orru*	●	●	●	●

★ Schedule 12 species (NP&W Act 1974)

A Species recorded from all sites surveyed during the current study along the proposed Lismore/Mullumbimby transmission line corridor.

B RAOU records for 10-minute grids bounded by 28°45' to 28°55'S & 153°15' to 153°25'E.

C NSW Bird Atlassers records for 10-minute grids centred on 28°45' x 153°15', 28°45' x 147°25' and 28°35' x 153°25'.

D NSW NP&WS Wildlife Atlas records for the Lismore/Mullumbimby area (28°37' to 28°51'S & 153°14 to 153°25'E and 28°34' to 28°51'S & 153°25 to 153°30'E).

APPENDIX 5 Mammal species recorded from all sites surveyed along the proposed Lismore/Mullumbimby transmission line corridor. NSW Wildlife Atlas records (NP&WS) from the general region are also noted.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	
Tachyglossidae																				
Short-beaked Echidna	*Tachyglossus aculeatus*					●		●				●			●	●			●	*
Dasyuridae																				
Brown Antechinus	*Antechinus stuartii*			●		●						●	●							*
Peramelidae																				
Northern Brown Bandicoot	*Isoodon macrourus*							●						?	●	●				*
Long-nosed Bandicoot	*Perameles nasuta*											●		?					●	*
Phascolarctidae																				
★Koala	*Phascolarctus cinereus*		●	●		●					●	●								*
Phalangeridae																				
Mountain Brushtail Possum	*Trichosurus caninus*		●			●		●	●						●	●		●	●	*
Common Brushtail Possum	*Trichosurus vulpecula*							●							●	●			●	*
Pseudocheiridae																				
Common Ringtail Possum	*Pseudocheirus peregrinus*							●												*
Molossidae																				
White-striped Mastiff-bat	*Nyctinomus australis*	●							●				●		●					
Pteropodidae																				
Grey-headed Flying Fox	*Pteropus poliocephalus*							●												*
Vespertilionidae																				
★Little Bent-wing Bat	*Miniopterus australis*											●	●		●				●	*
Gould's Wattled Bat	*Chalinolobus gouldii*																		●	*
★Large-footed Myotis	*Myotis adversus*							●			●		●		●					*
Muridae																				
Bush Rat	*Rattus fuscipes*			●				●	●		●	●	●		●	●	●		●	*
Introduced Species																				
Brown Hare	*Lepus capensis*					●														*
House Mouse	*Mus musculus*	●						●				●							●	*
Fox	*Vulpes vulpes*														●					*
Rabbit	*Oryctolagus cuniculus*														✤					*

★ Schedule 12 species (NP&W Act 1974) * NSW Wildlife Atlas (NP&WS).

✤ in Fox/dog scat

APPENDIX 6 Herpetofauna recorded from all survey sites along the proposed Lismore/Mullumbimby transmission line corridor. NSW Wildlife Atlas records (NP&WS) from the general region are also noted.

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	
Myobatrachidae																				
Brown-Striped Frog	*Limnodynastes peronii*		●	●		●		●	●	●						●	●		●	*
Spotted Grass Frog	*Limnodynastes tasmaniensis*								●											
Hylidae																				
Green Tree Frog	*Litoria caerulea*		●	●	●			●	●		●	●	●		●	●				*
Eastern Dwarf Tree Frog	*Litoria fallax*		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	*
Lesueur's Frog	*Litoria lesueuri*							●							●	●				*
Bufonidae																				
Cane Toad	*Bufo marinus*		●	●															●	*

COMMON NAME	SCIENTIFIC NAME	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	
REPTILES																				
Chelidae																				
Eastern Snake-necked Turtle	*Chelodina longicollis*						●	●		●	●	●	●	●	●	●				*
Agamidae																				
Eastern Water Dragon	*Physignathus lesueurii*			●			●	●	●	●		●	●	●	●	●	●			*
Varanidae																				
Lace Monitor	*Varanus varius*		●					●		●		●			●	●				*
Scincidae																				
Cream-striped Shinning Skink	*Cryptoblepharus virgatus*	●		●					●			●								
Land Mullet	*Egernia major*							●							●	●			●	*
Eastern Water Skink	*Eulamprus quoyii*							●				●				●			●	*
Dark-flecked Garden Sunskink	*Lampropholis delicata*	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●			*
Tree-base Litter Skink	*Lygisaurus foliorum*							●												*
Yellow-bellied Three-toed Skink	*Saiphos equalis*		●																	*
Boidae																				
Carpet Python	*Morelia spilota*	●		●				●	●			●	●		●	●	●			*
Colubridae																				
Eastern Brown Tree Snake	*Boiga irregularis*											●								
Elapidae																				
Rough-scaled Snake	*Tropidechis carinatus*							●				●				●			●	*
Eastern Bandy Bandy	*Vermicella annulata*							●								●				*

★ Schedule 12 species (NP&W Act 1974). * NSW Wildlife Atlas Records (NP&WS).

Appendix I
Archaeological Report

Archaeological Survey of the Lismore to Mullumbimby Transmission Line.

Commissioned for Pacific Power
by Sinclair Knight Merz, Consulting Engineers.

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August 1994.

Contents

Report Synopsis

This archaeological investigation was commissioned by Sinclair Knight Merz for Pacific Power who propose to construct a 132kV transmission line to connect Lismore 132/66kV substation, to a point near Mullumbimby Power Station at Laverty's Gap (Map 4). This archaeological report forms part of the EIS for this proposed development.

The aim of the archaeological investigation was to identify areas of archaeological sensitivity within the transmission line corridor. These areas were identified from a site prediction model which was developed for the study area and a survey of sample sites identified by that model. The prediction model was developed from an evaluation of academic theories, cultural studies, consultants' reports, physical and bio-geographical reviews for the North Eastern Region and the archival records and physical evidence held at the Richmond River Historical Society. A search of the National Parks and Wildlife Service Site Records was carried out and aerial maps supplied by Pacific Power and the 1:25000 maps for Lismore 9540-2-N, Dunoon 9540-1-S, Huonbrook 9540-1-N were used.

Prior to undertaking the field work the Ngulingah, Tweed Byron and the Jali Land Councils were contacted by phone and the scope of the archaeological survey outlined. Maps of the route were sent to the Land Councils for their consideration. At the conclusion of the field work, the consultants visited each Land Council to deliver additional maps and inform them that prior to any construction of the transmission line, detailed consultation with them would take place. (The study area is not within the Jali Land council boundaries)

Field work was carried out from 1/8/94 to 5/8/94 by Mills and Wilkinson. 13 areas were surveyed; 10 areas identified from the predictive model and 3 randomly selected.

No archaeological evidence was found during the survey. However given the lack of archaeological research in the area and poor surface visibility encountered in many of the surveyed areas, we recommend that further archaeological investigation be carried out prior to the construction of the transmission line. In particular sub-surface excavation in areas 1,2,5,8 (Map 2) which were identified as P.A.D.s (areas of potential archaeological deposit).

It is also recommended that detailed consultation with the Ngulingah and Tweed Byron Aboriginal Land Councils be carried out to ensure that all areas significant to Aboriginal people are identified. This must be completed prior to work commencing on the transmission line.

1. Details of the Development Proposal and Consultancy Brief.

1.1 The Development Proposal.

To meet the growing demand for electricity in the Lismore, Byron and Ballina areas, Pacific Power proposes to construct a 132kV transmission line to connect Lismore 132/66kV substation, located approximately 3 km to the west of Lismore, to a point near Mullumbimby Power Station at Laverty's Gap, approximately 5 km south west of Mullumbimby.

1.2 The Consultancy Brief

This is a preliminary archaeological assessment of the proposed transmission route. The consultants were commissioned to:

(a) Carry out a review of relevant literature.
(b) Develop a predictive model of expected site type and distribution.
(c) Survey sample areas along the route identified by the predictive model as having archaeological potential.
(d) Identify the Land Councils through whose land the development passes. Consult with these Councils about the development proposal and if possible have them identify areas of special significance to Aboriginal people.
(e) Identify any European Cultural Heritage sites.
(e) Prepare an archaeological report.
(f) Make management recommendations if necessary.

2. Aboriginal Consultation

It was assumed from the map of Aboriginal Land Councils boundaries that the proposed electricity transmission lines passed through the following land Councils' Territories:
(i) Ngulingah Land Council (offices in Lismore)
(ii) Tweed Byron Land Council (offices in Chinderah)
(iii) Jali Land Council (offices on Cabbage Tree Island)

Prior to undertaking the field work, the sites curator of each Land Council was contacted by phone and the scope of the archaeological investigation outlined. Each Land Council was sent a copy of a map of the proposed route supplied by Pacific Power and asked if they would discuss the development at a Land Council meeting.

During the field work period each Land Council was visited by the consultants. At this time, the Jali Sites Officer confirmed that the proposed route was just outside the boundaries of Jali territory, a fact that could not be adequately confirmed from either the maps or the other two Land Councils involved.

It was stressed to the Land Councils that this was a preliminary archaeological investigation and that they would be informed when development was scheduled to begin.

3. Review of Relevant Literature

3.1 Background

The activities and movement of Aboriginal people in the landscape can be extrapolated from an examination of the following evidence:
(i) Physical evidence; artefacts (stone tools, boomerangs, shields, canoes, grinding stones,woven items); ceremonial evidence (scarred or carved trees, bora rings, stone arrangements); art work (painting and engraving); occupation sites (rockshelters, open camp sites, middens); burial sites; quarries, axe grinding grooves.
(ii) Ethnographic evidence obtained by anthropologists observing Aboriginal groups over time and the recording of memories and stories related by older tribal members.
(iii) Historic records; observations of Aborigines at contact, made by early European explorers and settlers. These reports often emphasise the unusual or are biased by preconceived European values on the part of the recorder.
(iv) Reconstruction of environmental conditions which existed in the past and the assessment of ways in which Aboriginal people may have utilised the environment to satisfy their needs.

Attempts were made to include all types of evidence in the literature review.

3.2 Overview of Sources used in the Literature Review

3.2.1 National Parks and Wildlife Service Sites Register

No sites are registered in the NPWS register for the study area however sites have been recorded in the immediate vicinity. These sites are:

Night Cap Range:
04-4-0035 Stone arrangement
04-4-0034 Shelter with deposit
04-4-0031 Terania Creek, shelter with deposit

Whian Whian Area
04-4-0033 Shelter with deposit
04-4-0027 Shelter with deposit
04-4-0030 Shelter with deposit

Booyong
04-4-0046 Open camp site

Nth West of the Study area
04-1-0048 Shelter with deposit
04-1-0048 Shelter with deposit

West of the Study area
04-4-0048 Open camp site

Known sacred sites and ceremonial sites in the area include the Nimbin Rocks which are home to the Spirit man Nyimbunji and the Bora Grounds at Tucki Tucki and Lennox Head.

3.2.2 Academic Research, Cultural Studies and Consultants Reports

Between 1973 and 1988 a total of 68 field surveys were carried out by consultants in the Northern Region (Byrne 1989) These reports identify Aboriginal sites in the region and provide a basis for predicting the location of sites in unsurveyed areas. The main problem this information poses for this study is that archaeological surveys are mostly a direct result of development applications and in the Northern Region, most development proposals are for areas on the immediate coastal strip. Therefore the site distribution patterns for the region tend to be skewed towards the coastal strip.

Additionally, the archaeological evidence for coastal settlement eg shell middens is more durable and visible in the landscape than archaeological evidence of forest settlement. Consultants reports however, give an indication of the site types and their distribution in the northern region and as such are significant to the development of a model for site type and distribution. The sites types and distribution patterns are summarised in Charts 1 and 2 (Byrne 1989)

The only extensive academic study carried out in the Northern Districts was by McBryde (1974). She concluded from her extensive regional sampling of a variety of Aboriginal sites in the Northern Tablelands, that Aboriginal people moved throughout the landscape on a seasonal basis with a prior knowledge of the fruiting and seeding patterns of plants, the feeding patterns of animals and the seasonal exposure of shell beds. The best documented account of the movement of large numbers of people for ceremonial activities is that of the triennial bunya nut feasts in the Bunya Mountains and Blackall Range (Bundock 1898, Petrie 1904).

Other researchers who have concentrated their studies in specific locations refute this model. Lampert (1971) identified evidence for specialised marine adaptations on the NSW coast and Godwin's (1985) research in the Apsley and Upper Macleay gorges presents a model of Aboriginal people living in this ecosystem on a permanent basis. Collins (1991) suggests that it would have been possible for Aboriginal people in the Byron Bay area to exploit both rainforest and aquatic resources simultaneously.

It may well follow from these examples that there could be evidence to support an Aboriginal group with specialised "Big Scrub" adaptations, however this evidence is not forthcoming from the surveys and research carried out to date. There are no sites in the Big Scrub area. It is the coastal strip adjacent to the study area where midden sites bear witness to extensive use of the area by Aboriginal people. Two scenarios could be drawn from this disparity in site densities:

: Aboriginal people did not use the "Big Scrub" because it was "tough going", therefore there are no sites.

: Aboriginal people did use the "Big Scrub" but no sites are now visible because:

(a) the sites have been destroyed by the clearing of the "Big Scrub".

(b) the sites are hidden by the dense vegetation.

(c) specialised rainforest tool kit items are not so obvious in the landscape as are piles of shells and rainforest tool kit items are of a less durable type.

(d) there have been no surveys to locate sites in the area.

3.2.3 Bio-geographical Reports -Flora and Fauna Reports

Gunninah Consultants (1993), Lott and Dugan (1993) and Holmes (1987) have carried out extensive studies in the remnant "Big Scrub" areas and from these reports it is possible to create a picture of the environment in which Aboriginal inhabitants of the area could have lived.

Definition
The title "Big Scrub" originated with the early settlers to the region. It refers to an area once covered by the largest continuous tract of subtropical rainforest in Australia (Holmes 1987).

Location
The precise boundaries of the "Big Scrub" have been a point of contention among geographers (Lott and Dugan 1993, p. 8). For the purposes of this report, it is assumed that the "Big Scrub" occupied the area between Lismore, Terania Creek, Mullumbimby, Byron Bay, Broken Head, Ballina and the Blackwall Range, from sea level to altitudes of about 300 metres (Map 4) (Holmes 1987). The scrub was cleared so quickly by cedar cutters followed by dairy farmers that no precise information as to its extent or vegetational variety was recorded.

Topography
The "Big Scrub" area is a low basaltic plateau which is part of the residual slopes of the Mount Warning shield volcano. The plateau is dissected by the Richmond River and its tributaries which cut through the plateau and run south to Lismore. Rhyolite produced by a second lava flow from Mt Warning forms the northern boundary to the "Big Scrub" in the Whian Whian State Forest.

Soils
The main soil type is red basalt. There are also areas of alluvial basalt associated with the streams and especially the Wilson River. In the northern margins there are some areas of soils derived from rhyolite.

Vegetation
The "Big Scrub" was a heterogeneous environment, with inclusions of sclerophyll forest, grassland and swamps and considerable variation between the most luxuriant and the drier types of rainforests (Holmes 1987). The fact that the "Big Scrub" was such a varied environment is most significant for its use by Aboriginal people. It seems likely that such a rich ecological zone would be prized territory, equally as rich in resources as the coastal zone where archaeological evidence abounds.

3.2.4 Richmond River Historical Society Archives

Aborigines of the study area belong to the Bunjalung language group. Exact details of territorial organisation is difficult to ascertain because of the dramatic changes European invasion brought to the lives of the Aboriginal inhabitants of the area.

The Richmond River Historical Society has both physical and ethnographic evidence of

Aboriginal use of the study area. (Chart 3) Mrs West describes how in 1881, around 100 Aboriginals were camped at Nimbin and that they "walked to and from the Tweed passing through Nimbin." (Blackfellows at "Brookside" RRHS) Mrs Mary Bundock recalls "seeing Aboriginal people dressed for ceremony in red and yellow ochre and adorned with parrot feathers." She lists each man's weapons as "a couple of spears, three or four boomerangs, a tomahawk." They also wore "strings of beads made from pieces of cane and some wore a piece of nautilus shell ground into an oval shape and hung on the breast by a string. These were highly valued and obtained by exchange from the blacks of the coast about 50 miles away." (Bundock 1898)

Records of the physical evidence held in the Richmond River Historical Society Museum have been plotted on Map 3. Artefacts found by local farmers and presented to the Museum together with diaries and other ethnographical accounts of Aboriginal groups in the area provided by early settlers, reveal a group of people with a specialised tool kit including nulla nullas, boomerangs and shields made from rainforest timbers, woodworking axes and wedges, grinding stones to prepare beans and nuts, toe holes cut in tree trunks to aid the raiding of honey bees nests, dilly bags woven from vines and water carrying vessels constructed from palm leaves. Several of these finds were originally located close to the transmission line. It seems unlikely that these skills and strategies for living in a forest environment were acquired from occasional hunting forays into the "Big Scrub." They are consistent with more regular or permanent utilisation of the resources of the rainforest area.

Of special interest are the areas described as "grasses". These "grasses" areas (Diagram1) are distributed throughout the "Big Scrub" (Stitt RRHS 1953). One possible explanation is that they are pockets of a different soil type which did not support the growth of trees. Another possible explanation is that Aborigines kept these areas clear by burning and that the "grasses" were an integral part of their meeting and moving within the "Big Scrub" area.

4. Predictive Models

4.1 Model of site type and distribution developed from a purposeful sampling strategy

After consideration and assessment of the evidence provided by the Literature review, physical and bio-geographical evidence, the aerial photographs and the 1:25000 maps, it is anticipated that the following site types are the most likely to be found and their locations will be influenced by the predominant creek, spur and ridge topography of the area. In view of the clearing and agricultural activities which have taken place in the area, special attention was given to areas of remnant vegetation.

(a) Most "living areas" will be within 500 metres from water.
(b) In **creek areas:** axe grinding grooves, scarred trees, river pebbles for use in tool making, burial sites, open stone scatters and ochre may be found.
(c) On **spurs** adjacent to creeks: stone scatters, scarred trees, isolated artefacts and "living areas" may be found.
(d) **Ridge** areas: open stone scatters, isolated artefacts, scarred trees, stone arrangements.

Several mythological sites are known to occur within the "Big Scrub" region. In particular several have been located in the Lismore area. It is not possible to predict the location of mythological sites as the location is heavily dependent on cultural factors. Detailed consultation with the Aboriginal Community will be required to ensure that such sites are not affected.

Sites 1-10 (Map 2) were selected for investigation from these criteria. All areas of intense agricultural activity were eliminated.

4.2 Model of site type and distribution developed from a probabilistic sampling strategy.

After initial survey investigations along the route, it became obvious that the density and extent of grass cover in all areas, including creek banks, made it extremely difficult to locate archaeological evidence. Areas of remnant vegetation had become overgrown with introduced weeds which made access difficult and restricted ground visibility. It was decided, therefore to target any exposed areas of ground in the survey area. This included building sites (Photo 3), macadamia nut plantations (Photo 4) and land cleared for crops (Photo 2). These sites were randomly chosen but they did represent areas in the different targeted topographical zones identified in the predictive model.

5. Testing of Models in the Field.

5.1 Survey Strategy and Methodology

10 areas were selected on the basis of their topographical position, (creek beds, slopes adjacent to creeks and ridge areas), proximity to water and the expected Aboriginal use of the areas as identified by the literature review.

Three additional sites were selected at random. These were areas of extensive ground visibility.

All sites were surveyed on foot.

5.2 Survey Constraints

Approximately 90% of the surveyed area had been denuded of its natural rainforest vegetation cover and replaced, in the main, by dense kikuyu grass which is fodder to the cattle which now graze there. Both the clearing and the grazing have had a dramatic effect on the land (Photos 1 and 5).

(a) Surface visibility in the kikuyu grassed area was zero. The density of the vegetation cover was such that not even the creek banks, vehicle paths or animal tracks were devoid of vegetation cover (Photos 1 and 6).

(b) Scarred or carved trees if they existed are likely to have been removed during clearing.

(c) Creek bank areas had been damaged by cattle (Photo 8)

(d) Many areas of remnant rainforest vegetation had been invaded by lantana, wait-a while vines and other weeds which made surveying difficult (Photo 9).

(e) Flooding has occurred in all creek areas.

5.3 Discussion of sample areas

Area 1: Boorie Creek (Photo 1)

Area surveyed: approximately 1 sq km
Topography: Valley floor through which the Boorie Creek meanders. Large rounded river pebbles present in the creek.
Vegetation: Entire area covered by dense kikuyu grass. Creek banks damaged by cattle but little exposed ground. The area has been extensively disturbed by farming activities. No original vegetation remains.
No Archaeological evidence was found. The valley floor through which the creek meanders appears to flood however the rising ground adjacent to the flood plain area could contain archaeological deposit. Investigation of this area is recommended.

Area 2: Numulgi Creek

Area surveyed: approximately 1 sq km
Topography: valley floor and adjacent slopes and knoll area.
The creek has been dammed. There was seepage across the surveyed area. Cattle have used the area extensively and the banks have been damaged and a large "boggy area" has developed on the edges of the creek. (Photo 8) There are large basalt boulders in the creek, but no evidence of axe grinding grooves. There is also some outcropping basalt on the knoll approximately 50 metres above the creek.
Vegetation: The entire area is covered by dense kikuyu grass. This grass cover extends from the very edges of the creek to the knoll. There is no original vegetation in the area.
No Archaeological evidence was found however investigation of the knoll areas which lie to the north east and north west of the creek is recommended.

Area 3: Ridge Area above Boorie Creek

Area surveyed: approximately 1000 sq metres
Topography: Ridge overlooking Boorie Creek. There are some small basalt boulders in the area. The land falls steeply from the ridge to the creek.
Vegetation: Some remnant rainforest vegetation remains in this area. However there is much weed infestation of the understorey which restricted surface visibility. The remainder of the area is covered with kikuyu grass. The survey was confined to a drainage line which had been made with a buldozer when a dam was being constructed. This was the only area with any visibility.
No Archaeological evidence was found and no areas of potential archaeological deposit were identified.

Area 4(i) : Modanville ridge, gully and ephemeral water course which feed into the Numulgi Creek

Area surveyed: 1000 sq metres
Topography: The ridge line falls away steeply into a narrow creek bed.
Vegetation: Remnant rainforest remains in the gully and the watercourse area however the invasion of weeds, lantana and wait-a-while vines made surface visibility difficult. The spur area is covered with kikuyu grass and visibility was zero.
No Archaeological evidence was found and no areas of potential archaeological deposit were identified.

Area 4 (ii): (Photo 3) On the spur area, approximately 100 m from site 4(i)
A bulldozer was being used to clear a building site. Permission was given for the inspection of this area which was approximately 80 x 100m. This area was surveyed in N/S transects at 10 metre intervals.
No archaeological evidence was found and surface visibility was extensive. It was concluded that it was an area of low archaeological potential.

Area 5: Rainforest Remnants along Boomerang Creek.(Photo 11)

Area surveyed: 500m x 30m
Topography: This is a flat plateau area which falls sharply into the curve of Boomerang Creek. The creek bed is broad at this point and a waterfall drops over steep basalt outcrops into a deep pool. The creek contains large basalt pebbles. There was no evidence of axe grinding grooves.
Vegetation: This area gives an insight into how the rainforest must have been in prehistoric times. The land owner who accompanied us related how as a young man, he had caught eels, crayfish and mullet in the creek. He had also seen turtles, platypus, echidna, koalas, scrub turkeys and paddymelon kangaroos in the area. He identified a variety of fruiting trees such as figs, black bean and cherry apples and discussed the woodworking qualities of the trees. This area is an extremely rich and diverse food resource.

No Archaeological evidence was found however it is most likely that this area was used by Aboriginal people. Also there has been little disturbance in the area. Archaeological investigation which targets the creek bank adjacent to the pool area and the knoll to the west of the creek is recommended.

Area 6: Turkey Creek (Photo 2)

Area surveyed: 1.5 sq km. This area was surveyed in SE/NW transects at 50 metre intervals

Topography: Ridge area which falls away gently to the south and east but sharply to the west into Turkey Creek. The ridge area is gently undulating farmland. A large amount of underlying rock, basalt, blue stone and andesite had been exposed by clearing.

Vegetation: The entire ridge area had been recently cleared by a bulldozer so that macadamia trees could be planted. Large trees had been uprooted and pushed into piles ready for burning. The surface visibility was 100%.

No Archaeological evidence was found and as there were extensive areas of exposed surface with excellent visibility, it was concluded that this was an area of low archaeological potential.

Area 7: Goonengerry Ridge (Photo 7)

Area surveyed: approximately 500 sq metres.

Topography: This is the highest point on the survey line. From the aerial photographs, it appeared that there was a large amount of stone on the surface.This proved to be bedrock fragments, not stone arrangements.

Vegetation: There is no natural vegetation remaining. The entire area is covered by dense kikuyu grass. Visibility is difficult except for the basalt boulders which erupt at the crest of the hill.

No Archaeological evidence was found. Bedrock was exposed across this area and no areas of potential archaeological deposit were identified. Because this area is prominent in the landscape it may be of significance to Aboriginal people. This possibility would need to be investigated.

Area 8: Donaghy's Bridge on the Wilson River (Photo 6)

Area surveyed: approximately 1 sq km

Topography: This included the creek bed, the steep sloping southern bank and adjacent undulating farm land. The creek bed contained rounded basalt river stones and there were some sections of the creek bed where the water ran through basalt outcrops. There was no evidence of axe grinding grooves in the creek bed.

Vegetation: The creek banks were, for the most part, steep and there was evidence of flood deposited debris up to 2 metres above the water line. The banks were heavily vegetated with rainforest species but introduced weeds eg lantana made access difficult.However, there was one area of approximately 100 sq metres where the lantana had been cleared. Here the visibility was about 90%. The adjacent farming land was cleared of vegetation and covered with a dense mat of kikuyu grass.

No Archaeological evidence was found. Approximately 500-750m from the road bridge on the southern side of the river is a large tract of pasture land overlooking the river. It is recommended that further investigation in this area is undertaken.

Area 9: Mullumbimby Power Station (Photo 10)

The Mullumbimby Power Station was classified by the National Trust of Australia (NSW) in 1979. It will not be affected by the proposed development. The adjacent area on which the new Power Station is to be built has been disturbed by previous building and road construction.

No Archaeological evidence was found and no areas of potential archaeological deposit were identified.

Area 10 (i): A spur and creek area west of Dunoon

Area surveyed: approximately 500 metres along the creek banks at the junction of two ephemeral creeks.

Topography: Gently undulating spur area which sloped steeply down to the creek bed.

Vegetation: The spur area was under cultivation with macadamia nuts and the creek banks were heavily vegetated with remnant rainforest. Surface visibility was restricted in this area by growth of introduced weeds such as lantana and wait-a while vine. The creek bed was overgrown and choked with weed growth. Visibility in the area was virtually zero.

No Archaeological evidence was found and no areas of potential archaeological deposit were identified.

Area 10 (ii): (Photo 4) Adjacent to 10(i) a macadamia nut plantation adjacent to a large dam.

Area Surveyed: approximately 1 sq km.
It was decided to survey in the macadamia nut farm because the farming method leaves the areas under the trees free of vegetation. These plantations represent the best ground visibility in the area.

Topography: Gently undulating farmland.

Vegetation: The area under the trees is kept free from weeds and grass so that the fallen nuts can be collected. The visibility in these cleared areas was 90%.

Archaeological Evidence: Although no evidence was found during the survey, the foreman at the site described an axe which had been uncovered during the planting of the trees. From this description, the artefact may have been a blue stone axe, approximately 10-15cm in length and 5-7cm in width. It had been shaped or waisted to take a handle.

The area had been extensively modified by agriculture and no areas of potential archaeological deposit were identified.

6 Assessment of sites of Historical Significance

6.1 Mullumbimby Power Station was classified by the National Trust in 1979 and is not affected by the development proposal.

6.2 Other sites of potential significance
The maps of the proposed route were reviewed by a member of the Lismore Branch of the National Trust and the president of the Richmond River Historical Society and they agreed that there were no sites of Historical significance in the path of the proposed development route. During the survey no evidence of early European occupation was observed.

7 Survey Results

There was no archaeological evidence found during the survey but four areas of potential archaeological deposit were identified. These are areas 1,2, 5, 8 (Map 2).

8. Recommendations

1. As little is known about the archaeology of this area, we recommend that further detailed archaeological investigations be carried out prior to the construction of the transmission line.

2. Initial consultation was made with the Ngulingah and the Tweed Byron Land Councils by the archaeologists, Mills and Wilkinson and the proposed route of the upgraded transmission line was explained. These groups have not as yet confirmed whether there are any sites significant to them along the route. We recommend that detailed consultation with these Aboriginal groups should be carried out as part of further archaeological investigations.

3. Due to poor ground visibility along the survey route, it is recommended that subsequent investigations prior to the construction of the transmission lines include a test excavation program in those areas identified as archaeologically sensitive.

These recommendations are made on the basis of the National Parks and Wildlife Act of 1974 (as amended), whereby it is illegal to damage, deface or destroy and Aboriginal relic without the written permission of the Director. Should any further relics be encountered during the course of the development, officers of the National Parks and Wildlife Service should be informed without delay.

9. Distribution of Reports

3 Copies

Ms Helen Clemens
Manager
Cultural Resources Unit
Head Office
NPWS
43 Bridge Street
Hurstville 2220

Pacific Power
c/- Sinclair Knight Merz
1 Chandos Street
St Leonards 2065

1 Copy

Mr Terry McGee
Ngulingah Local Aboriginal Land Council
5 Club Lane
Lismore 2480

Mr Sam Lever
Tweed Byron Local Aboriginal Land Council
29 Morton Street
Chinderah 2487

Mr J. Riley
Richmond River Historical Society
Molesworth Street
Lismore 2480

10. Bibliography

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11 Appendices

11.1 Maps

Map 1: Location of Aboriginal Sites in the Northern Region

Map 2: Transmission Line Route and Location of Areas sampled in the survey

Map 3: Location of artefacts and Ethnographic Evidence plotted from Records of the Richmond River Historical Society.

Map 4: Boundaries of the "Big Scrub" defined by Holmes (1987)

11.2 Photographs

Photo 1: Boorie Creek (Area 1)

Photo 2: Cleared area near Turkey Creek (Area 6)

Photo 3: Modanville Ridge (Area 4)

Photo 4: Macadamia Nut Plantation (Area 10(i))

Photo 5: Goonengerry Ridge (Area 7)

Photo 6: Banks of Wilson Creek (Area 8)

Photo 7: A cleared path through Kikuyu grass (Area 2)

Photo 8: Numulgi Creek banks damaged by cattle

Photo 9: Dense weed growth in Modanville gully (Area 4(i))

Photo 10: Mullumbimby Power Station (Area 9)

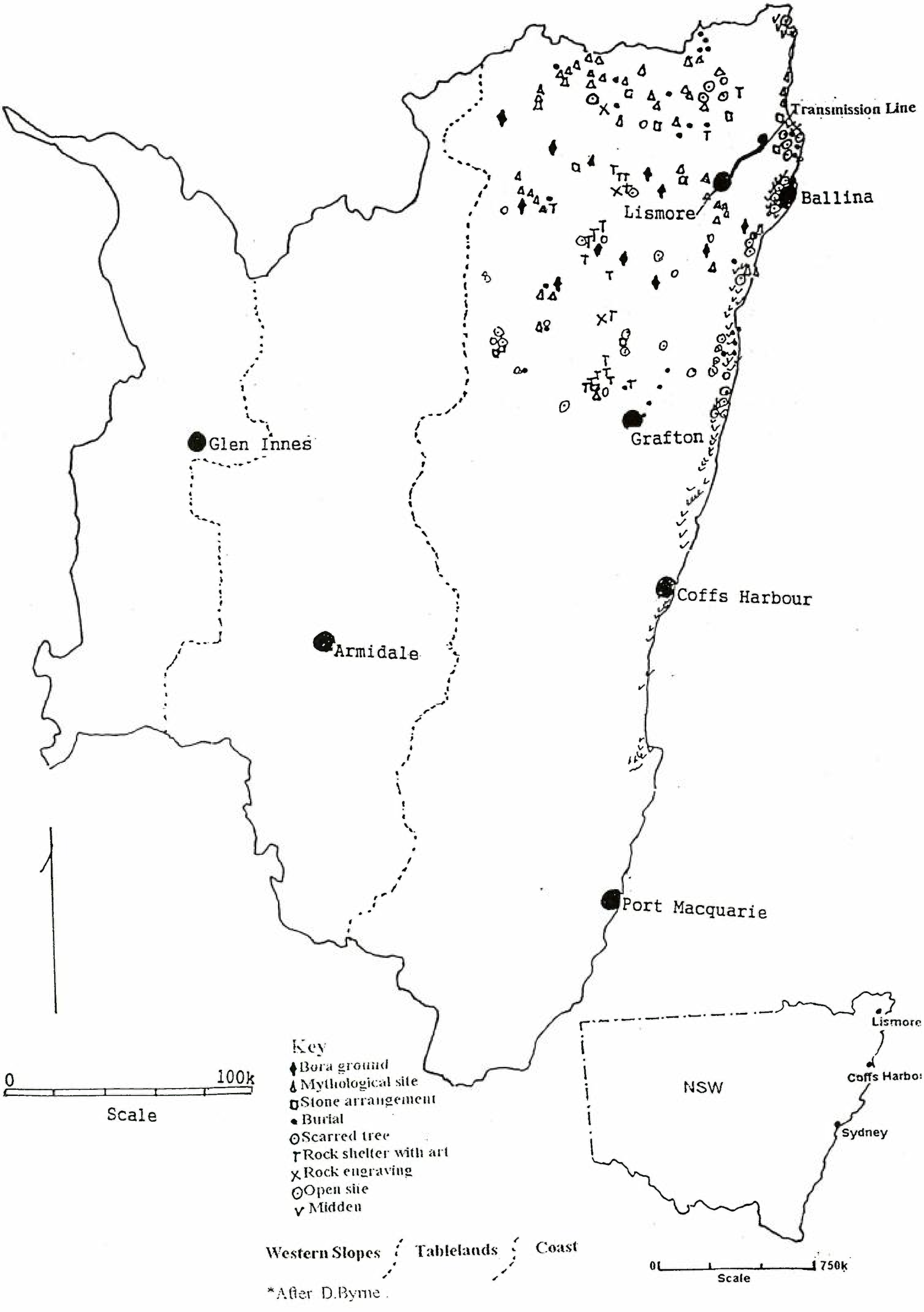
Photo 11: Rock Outcrops Boomerang Creek (Area 5)

11.3 Diagrams

11.4 Charts

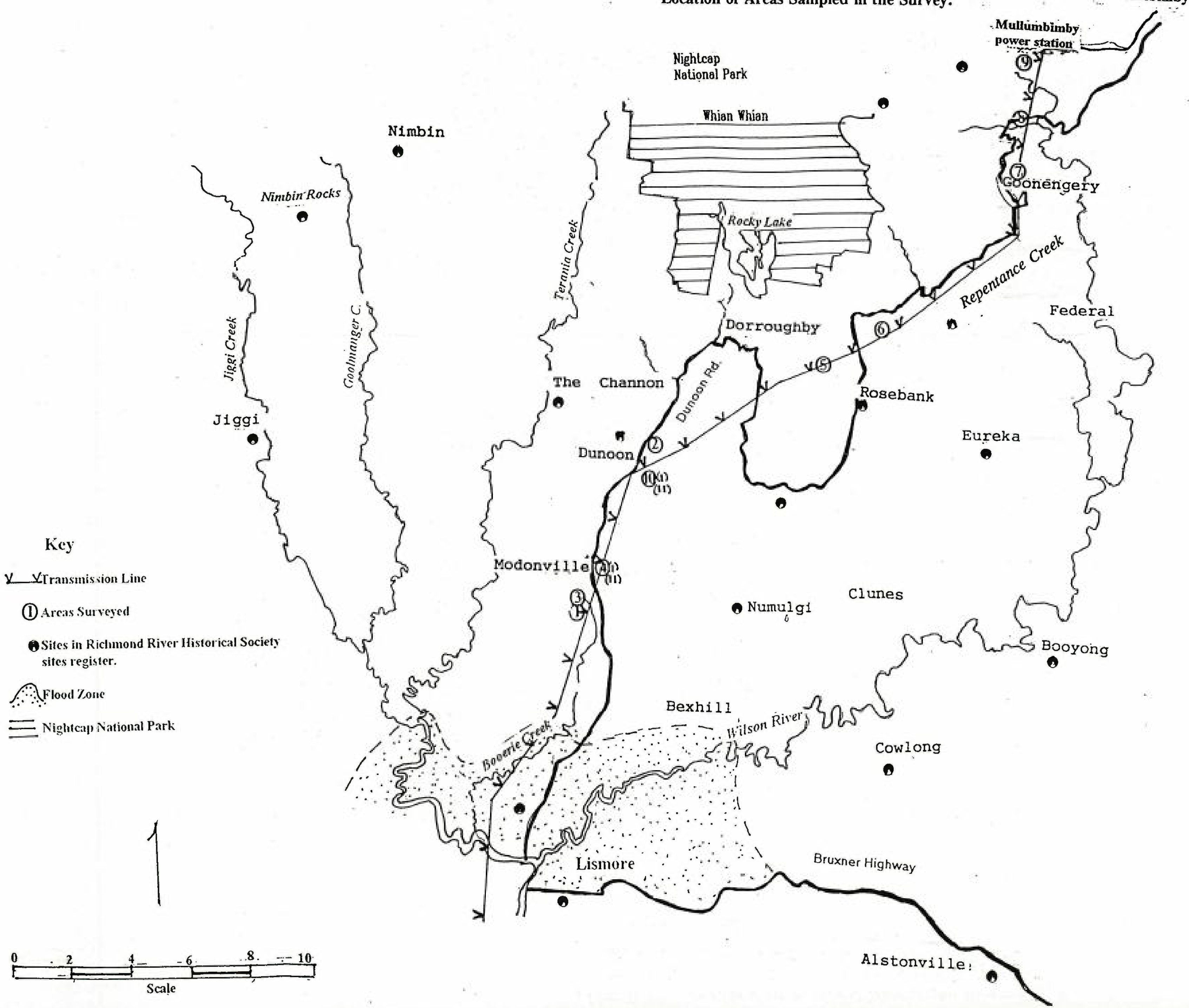
Map 1

Location map showing the transmission line and NPWS recorded sites from the Queensland border to Grafton in the coastal division.

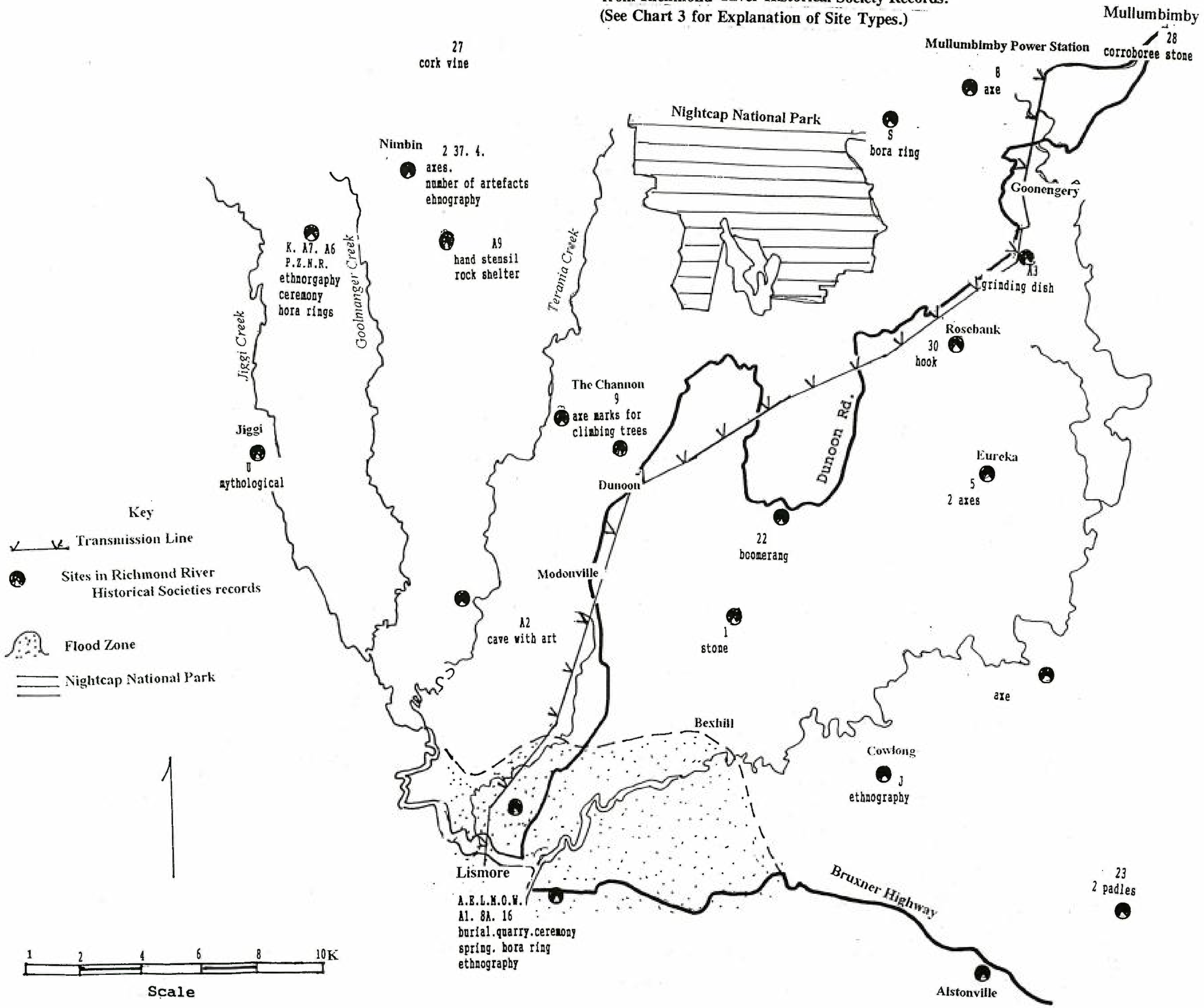


Map 2. Transmission Line Route

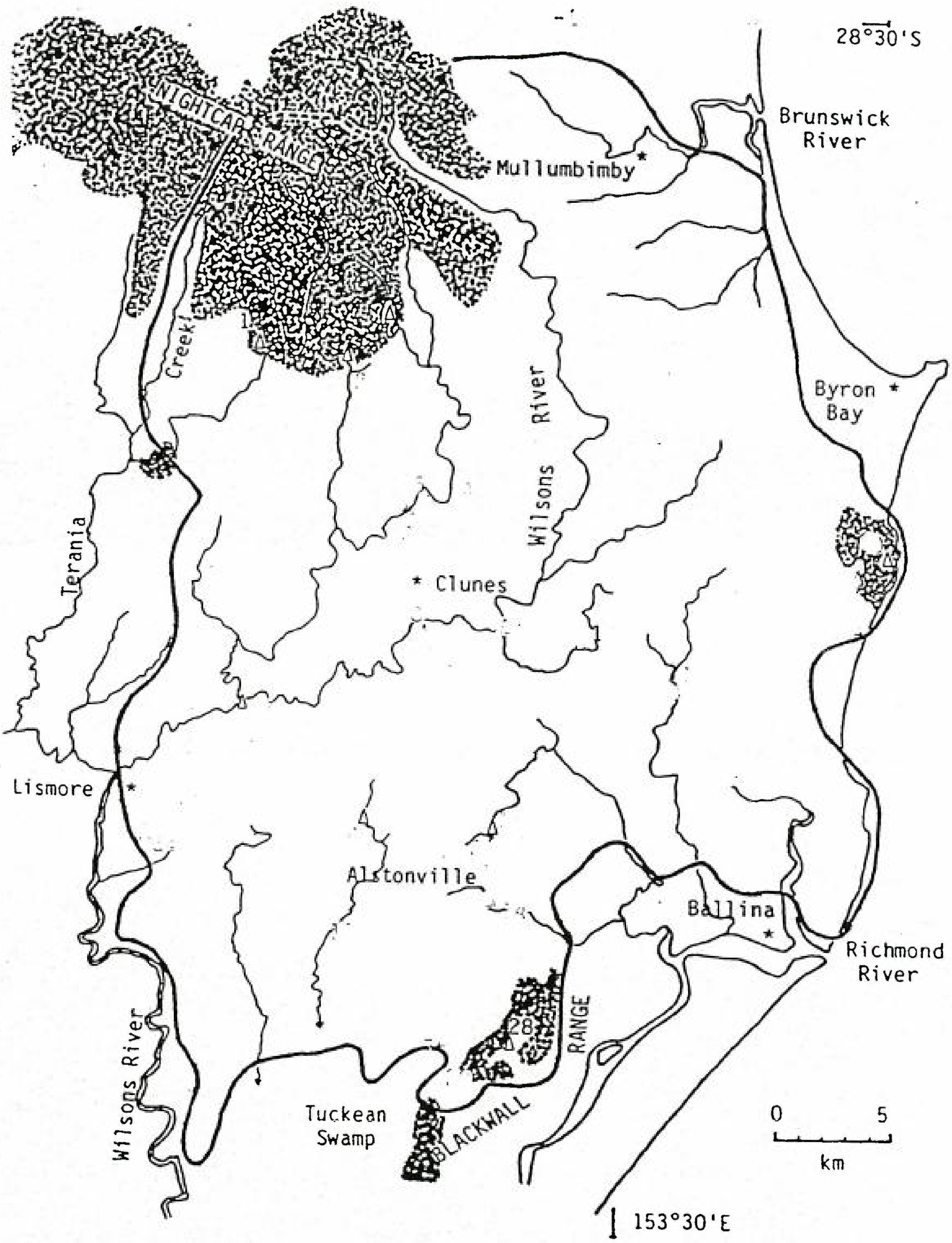
Location of Areas Sampled in the Survey.



Map 3. Location of Artefacts and Ethnographic Evidence from Richmond River Historical Society Records. (See Chart 3 for Explanation of Site Types.)



Map 4. Boundary of the "Big Scrub" as defined by Holmes (1987)



Solid line indicates boundary of region, except in northern mountainous area where broken line represents approximate boundary only. Stippling represents expansive forested areas.

Photo 1: Boorie Creek (Area 1)

Photo 2: Cleared area near Turkey Creek (Area 6)

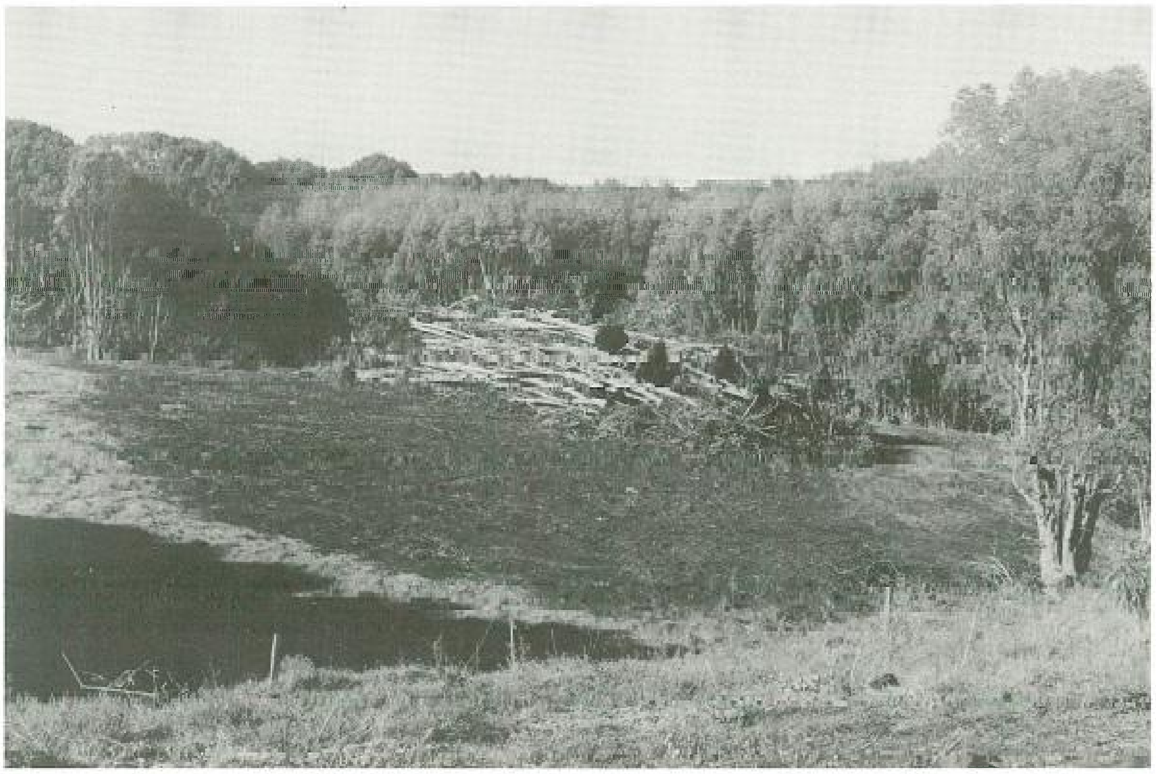


Photo 3: Modanville Ridge (Area 4)

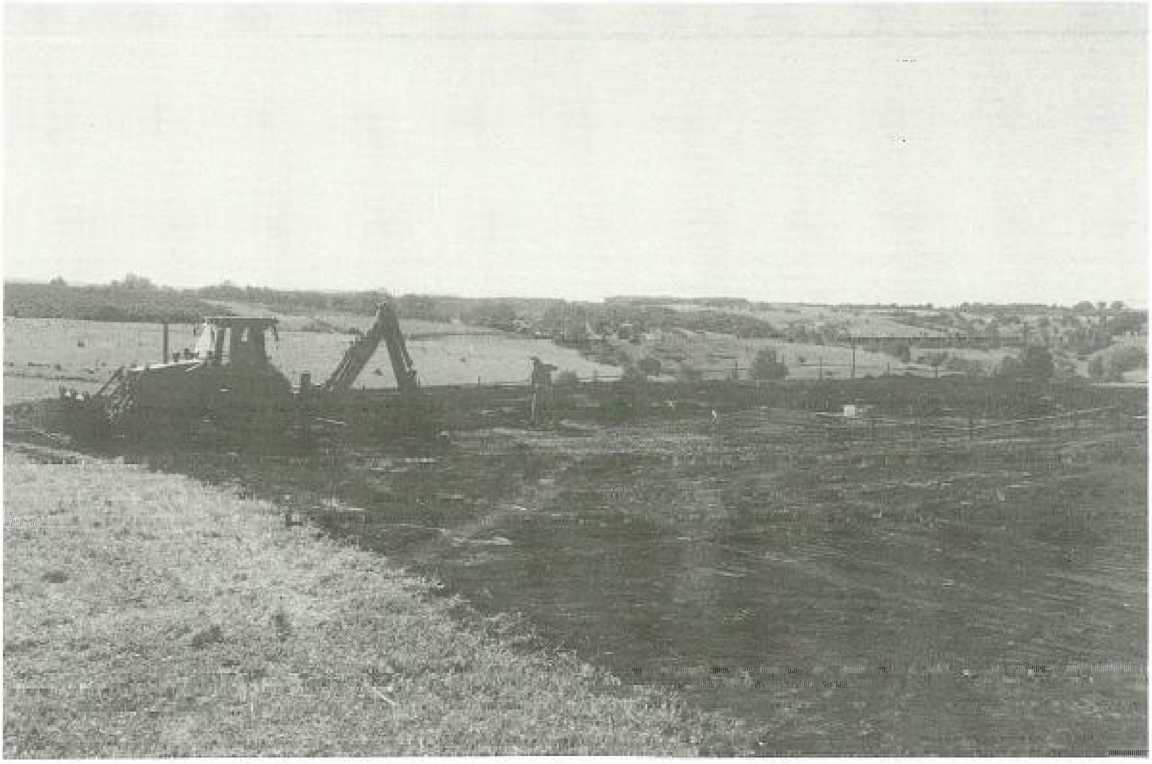


Photo 4: Macadamia Nut Plantation (Area 10(i))

Photo 5: Goonengerry Ridge (Area 7)

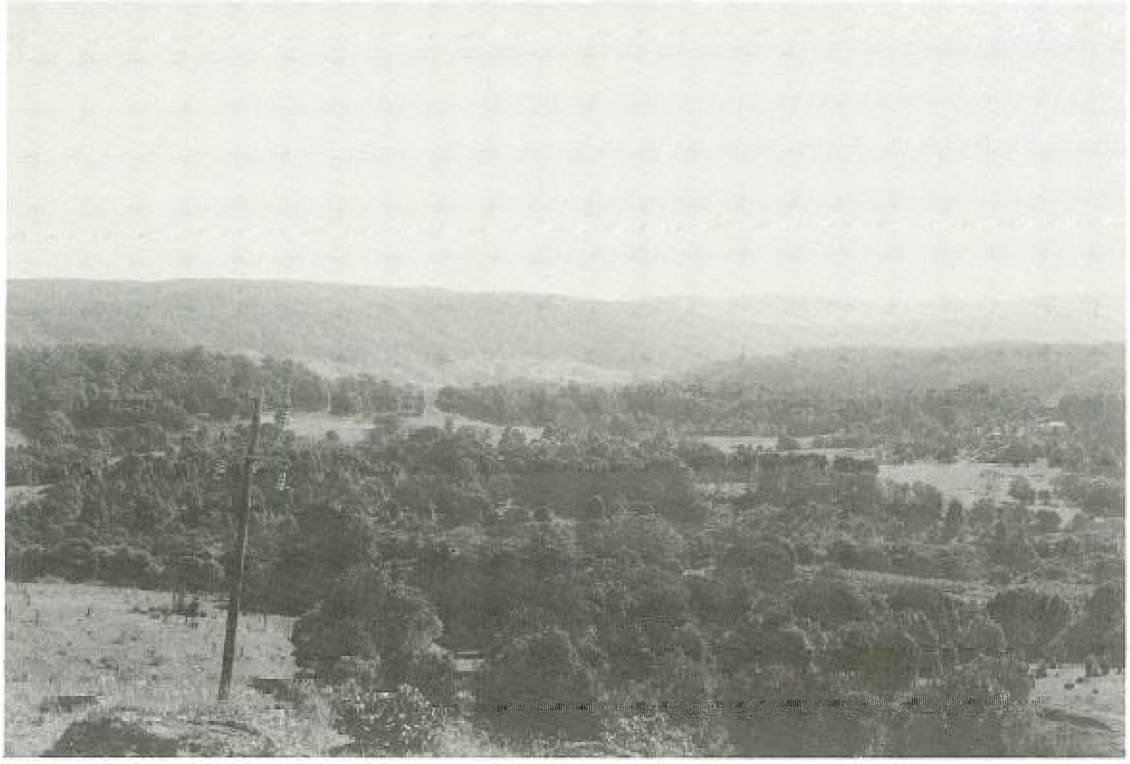


Photo 6: Banks of the Wilson Creek (Area 8)

Photo 7: A cleared path through Kikuyu grass (Area 2)

Photo 8: Numulgi creek banks damaged by cattle

Photo 9: Dense week growth in Modanville gully (Area 4(i))

Photo 10: Mullumbimby Power Station (Area 9)

Photo 11: Rock Outcrops Boomerang Creek (Area 5)

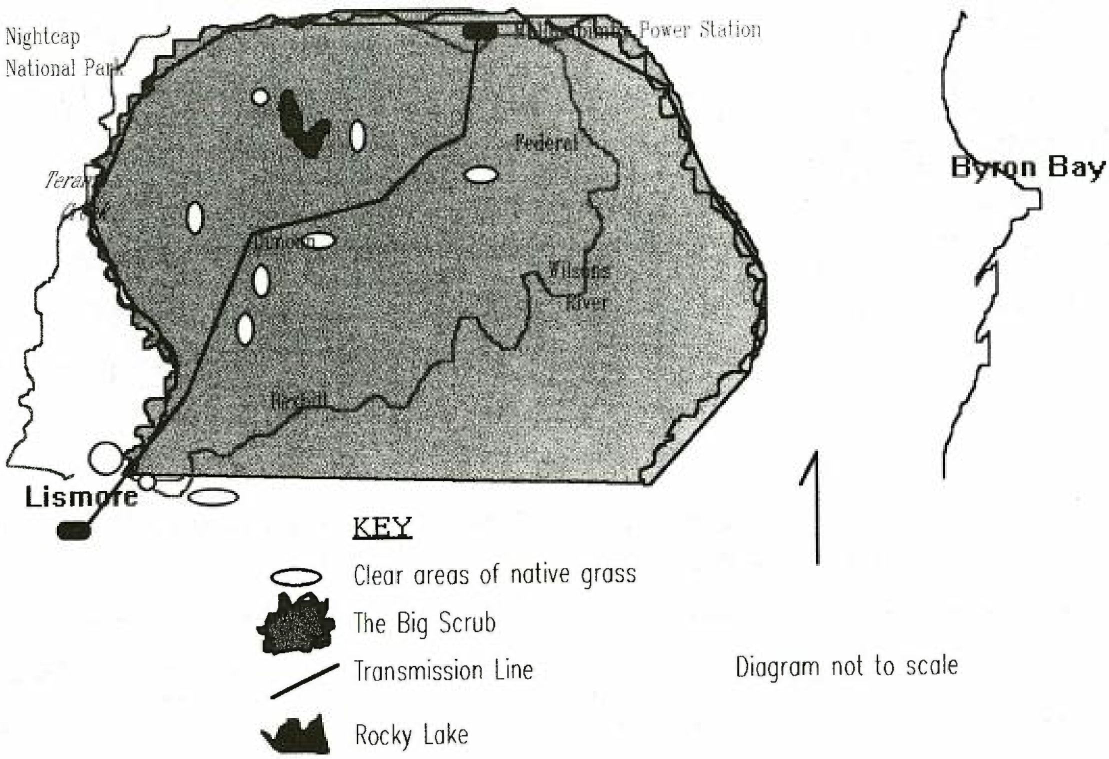


Diagram 1
Estimated dimensions of the Big Scrub from Lismore to Mullumbimby and patches of native grasses within the scrub.

Source – Mr.J.Riley of the Richmond River Historical Society.

Chart 1. **Graph of Site Distribution in Northern Region From NPWS Records. (Byrne 1989 p. 34)**

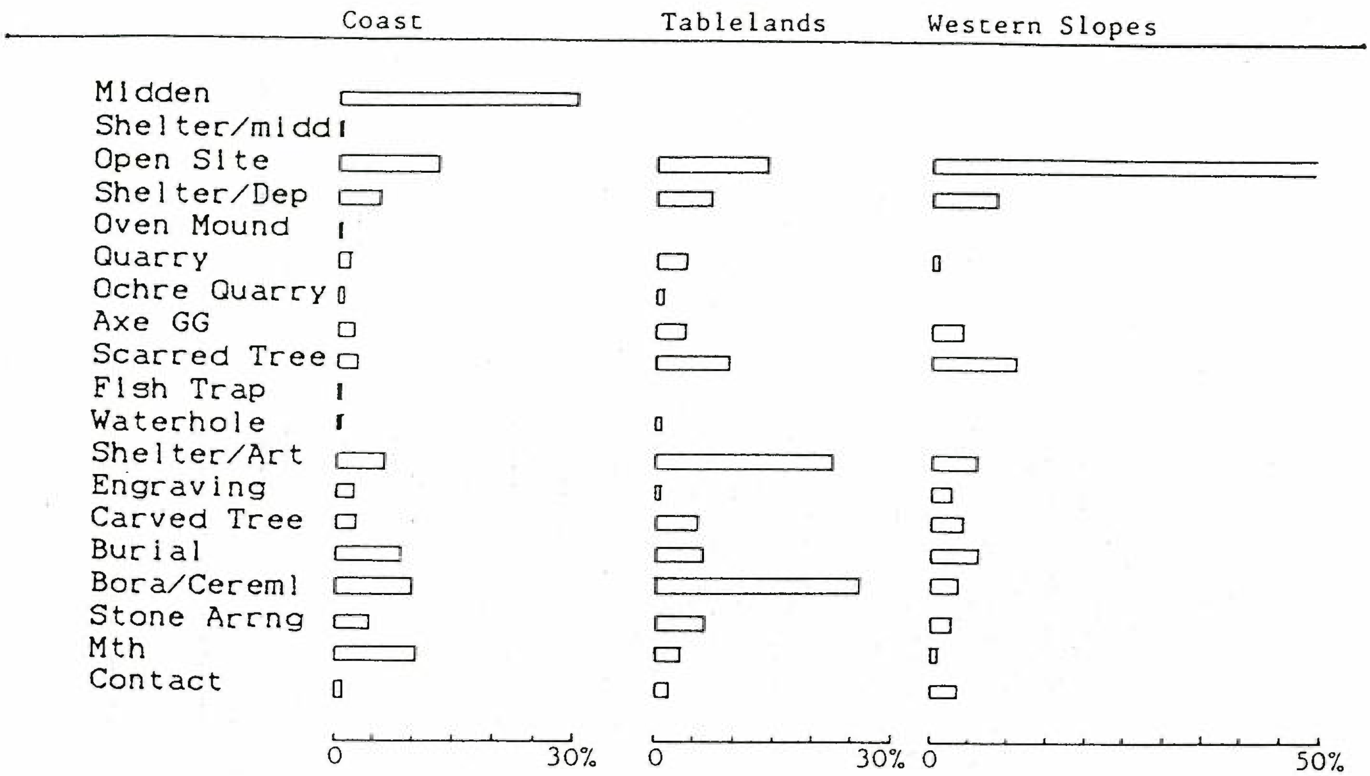


Chart 2. **Summary of Consultancy Briefs and the Topographical Zones in which they were conducted. (Byrne 1989 p. 28)**

	Coast	Tablelands	Western Slopes	Tot	%
Water pipeline	3	1	–	4	6
Mine – sand	3	–	–	3	4
Mine – rock	3	1	1	5	7
Mine – coal	–	1	–	1	2
Oil – seismic line	2	1	–	3	4
ELCOM trans line	6	–	–	6	9
Housing sub-div	14	–	–	14	21
Resort	5		–	5	7
Road	2	–	–	2	3
Building	1	1	–	2	3
Sewerage	5	–	–	5	7
Military	1	–	–	1	2
Dam	2	1	1	4	6
Flood mitig	3	–	–	3	4
Logging	3	–	–	3	4
Recreation	1	–	–	1	2
NPWS management	2	–	–	2	3
Non-specific	3	1	–	4	6
Survey Tot:	59	7	2	68	
%	87	10	3		

Chart 3. Aboriginal Artefacts Relevant to the Study Area as Recorded in the Richmond River Historical Society Site Records.

Cat. no.	Description of Artefact	Location of Artefact	loc.no
4729	Aboriginal Stone Artefacts	G.Mitchell's farm Numulgi	1
RRHS # 2	Aboriginal axe head	Nimbin	2
2003 D-1	Aboriginal axe	Tabulum	3
3243C	Aboriginal axe	Main Arm Mullumbimby	4
3640 A	2 Aboriginal axes	Eureka	5
-	4 Aboriginal axes	Lillian Rock	6
4397	Aboriginal axe	Upper Mangogarie	7
"	Grinding Stone	"	
2275	Axe small head type	Wilson Creek	8
2178	Axe marks in trees-to collect honey	The Channon	9
945	Dilly bag-dyed tree bark	Tuckie Tuckie	10
2265	Aboriginal axe	McKees Hill	11
2645	Aboriginal axe	Wyaliah	12
2523 F	Aboriginal axe	Monaltrie	13
2579	Aboriginal axe	Mullulgum	14
374	Aboriginal axe	-	15
572-A	axe -depression for palm of hand	Lismore battle ground	16
2954	Aboriginal axe	Nimbin	17
266	Aboriginal axe	Booyong	18
2645	Aboriginal axe	Camp Creek-Monaltrie	19
4169	Aboriginal axe	Lennox Head between Bora Ring & creek	20
1000	Aboriginal axe	Rock Valley	21
2978	Boomerang	Coopers Creek, Corndale	22
745	2 Boomerangs	Myrtle Creek	24
4898	Breastplate	Billy Brothers	25
--	Core	Empire Vale - Richmond River	26
5177	Cork Vine-contained drinkable water	Blue knob	27
960	Corroboree stone	Mullumbimby	28
1057	Fighting stick- carved handle.	----	29
949	Fish hook-bone	Rosebank	30
7	Nulla Nulla	Wyralla	31
631	2 paddles	Tuckerimba	32
895	Shield	Rutheven - after flood	33
2523	2 wooden spears approx. 8 feet long	Monaltrie	34
891	Aboriginal stone with hole- used with vine wound through hole -weapon.	South Gundyrimba	35
2617	Woomera -made from kopak tree.	-----	36
-------	Variety of artefacts located in paddocks	Nimbin	37
-------	Stone trackway	Tuntable Falls	38

*loc no - refers to the numbers and letters allocated as artefacts and sites in Map 3.

Site Type	Description	Reference	loc.no
Burial	Behind main cemetery at Lismore	Mrs. Bertha Kapeen (1988)	1A
Burial	Adjoining later school site-Uralba-1850	P.Simpson "Reminisces" R.R.H.S	2B
Burial	Behind Carlton Park Race Course	R.R.H.S	3C
Burial	Grave of Susan Capps - Wiyabal elder - 1906	M.Gray -Ocean View, R.R.H.R	4D
Camp site	Quarry site - North lismore	Fletcher Roberts	E
Camp site	Blakebrook	M.Oaks - Ron Heron	F
Camp site	Flying fox ground at Keerrong	Parks A.W. Keerrong - Ron Heron	G
Camp site	On Brookside at Nimbin	Mrs.West "Blackfellows at Brookside"	H
Camp site	Near Cowlong	Mrs. G. Manwaring	J
Camp site	Near Nimbin Rocks	Jiggi P.S. 75th Anniversary booklet	K
Camp site	Curriers Creek near Lismore - 1 month camp to celebrate wedding between tweed man and a Lismore woman.	W.Flick "A dying Race" 1982	L
Ceremonial	Near a spring at Nth . Lismore	Lyle Roberts	M
Ceremonial	Parrots nest-Djurebil for hoop vine, the boundary between the Gilibal, Wiyabal and Bunjalung proper.	Mr. R.Collins Mallangaree 1985	N
Ceremonial	Bora Ring near Lismore racecourse 1870 a fight witnessed between 500 Richmond men and 500 Tweed men.	W.Flick "A dying race"	O
Ceremonial	Messages tapped on the Booyong Tree could be heard up to 8kilometres away	W.Flick "A dying race"	O
Ceremonial	Nimbin rocks - legend of Balugan (hero/warrior) and clever little man, guardian of the area.	Descendants of the Wiyabal Roberts area. Keper of Nimbin rocks . M.Oaks "The first inhabitants" P.204	P
Ceremonial	Mount Boorabee - Djurebil for koalas	Lyle Roberts	Q
Ceremonial	Nimbin Bora Rings - Two rings on opposite sides of Goolmanger Creek near its junction with Cabbage Tree Creek	Mrs. west "Aboriginies on Birkside"	R
Ceremonial	Dunoon Bora Rings	J.G.Steel P.22	S
Ceremonial	Blue Knob - held on flat area high on south side of mountain. Also ceremonial caves and mythical site.	M.J.Oaks 1980 NPWS site register	T
Ceremonial	Jiggi - great battle fought in the dreamtime	S.Morgan	U
Ceremonial	Nimbin area - womens ceremonial site a. Before marriage b. When hair turned grey	J.Oakes -" The first inhabtants "	V

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J

Appendix J
Electric Magnetic Field Measurements

LISMORE - MULLUMBIMBY 132 KV TRANSMISSION LINE
MODANVILLE SCHOOL REPORT

SITE MEASUREMENTS 20TH JULY 1994

Magnetic field measurements were carried out in and around the school during a meeting with the Headmistress and parent representatives. In conjunction with the measurements information relating to electric and magnetic fields was conveyed and discussed. In attendance were Murray Williams, Don Paton and Bruce Howard from Pacific Power.

Readings were taken at one metre above ground level and are were measured in milliGauss. The readings were taken between (approximately) 3:30 pm and 5:00 pm when the load in the 66 kV line varied between 129 and 137 amps.

MAGNETIC FIELD MEASUREMENTS

LOCATION	MAGNETIC FIELD (mG)
Below 66 kv line	8.9
Access Gate (on Iannas's property away from school)	2.8
At Iannas's House fence (away from school)	0.5
Below 11kv line (between 66kv and school)	2.4
School boundary fence (closest to 66kv)	0.4
Outside corner of Library building (closest corner to 66kv)	0.3
Centre of library room (closest room to 66kv)	0.3
Door to Library (farthest part of room from 66kv)	0.7
Surface of 240v switch board for library (next to door)	18.0
Vacuum cleaner in Library	
On surface	500.0
300 mm from surface	27.0
Entrance to classroom 2	1.9
Centre of classroom 2	0.7
Electric heater in classroom 2	
On surface	39.0
300 mm from surface	6.0
1000 mm from surface	0.4

Computer in classroom 2	
On surface of screen	75.0
300 mm from screen	10.0
1000 mm from screen	2.0
TV in classroom 2	
On surface of screen	77.0
300 mm from screen	11.0
1000 mm from screen	2.0
Urn in Staffroom	
Surface of urn	13.0
300 mm from surface	1.0
1000 mm from surface	0.7
Photocopier in staffroom	
Surface of photocopier	13.0
300 mm from surface	2.0
1000 mm from surface	0.7
Doorway to office	1.6
Computer in office	
On surface of screen	22.0
300 mm from screen	2.0
1000 mm from screen	0.8
On Principal's desk	
In Middle	1.4
At Rear, against wall	8.0
(possible cable in wall)	

BRUCE HOWARD

3RD AUGUST 1994

FOR YOUR INFORMATION
PACIFIC POWER

NORTHERN RIVERS ELECTRICITY

HEAD OFFICE: 17 Prince Street, GRAFTON. 2460
ALL MAIL TO: General Manager, P.O. Box 5, GRAFTON. 2460
PHONE: (066) 42 1844
FAX: (066) 42 7083

Your Ref:
Our Ref: DS:
JB

23 December 1993

ELECTRIC AND MAGNETIC FIELDS

TULLERA NSW 2480

Dear Sir

I refer to a visit by Dennis Simpson of this Distributor on 9 December 1993 regarding magnetic fields in your home and the adjacent area including nearby 66 kV and 11 kV overhead lines.

The measurements taken directly beneath the 66 kV conductors were found to be up to 15 milligauss (mG).

Halfway to the adjacent 11 kV overhead line which is located 15 metres to the east a magnetic field strength of 5.5 mG was obtained. This field strength decreased to 1.7 mG directly beneath the 11 kV overhead conductors.

At the carport which is located 20 metres east of the 11 kV line and midway to the house a magnetic field strength of 0.4 mG was obtained.

Measurements taken within the house were then found to be 0.1 to 0.2 mG and were the same as those obtained in the yard area 20 metres further to the east.

These values are considered to be basically background levels as no change resulted when electricity supply within the house was temporarily isolated and distance away from overhead lines and house increased.

Exceptions to these readings were obtained when the gauss meter was placed adjacent the TV (166mG) and electric drill (155 mG).

It was also noted that these values decreased very quickly when the meter moved only centimetres away from the appliances.

The ESAA brochure on "Electric and Magnetic Fields" which was given to you indicated the approximate levels one could anticipate from appliances in the home and power lines.

The magnetic field readings obtained are comparable to these levels.

Mr B Fryer

The exposure limits for the general public which incorporate a margin of safety for magnetic fields are:

1,000 mG	continuous exposure
1,000 to 10,000 mG	Short term exposure

These values are given in the interim standard being developed by the International Radiation Protection Association (IRPA) in collaboration with the World Health Organisation.

In November 1989, the (Australian) National Health and Medical Research Council (NHMRC), the organisation responsible for advising the Australian community on the highest practicable standards of public health, adopted and approved the IRPA guidelines for publication as an NHMRC document.

You will note that the magnetic fields measured are much less than those of the interim standard that have been adopted.

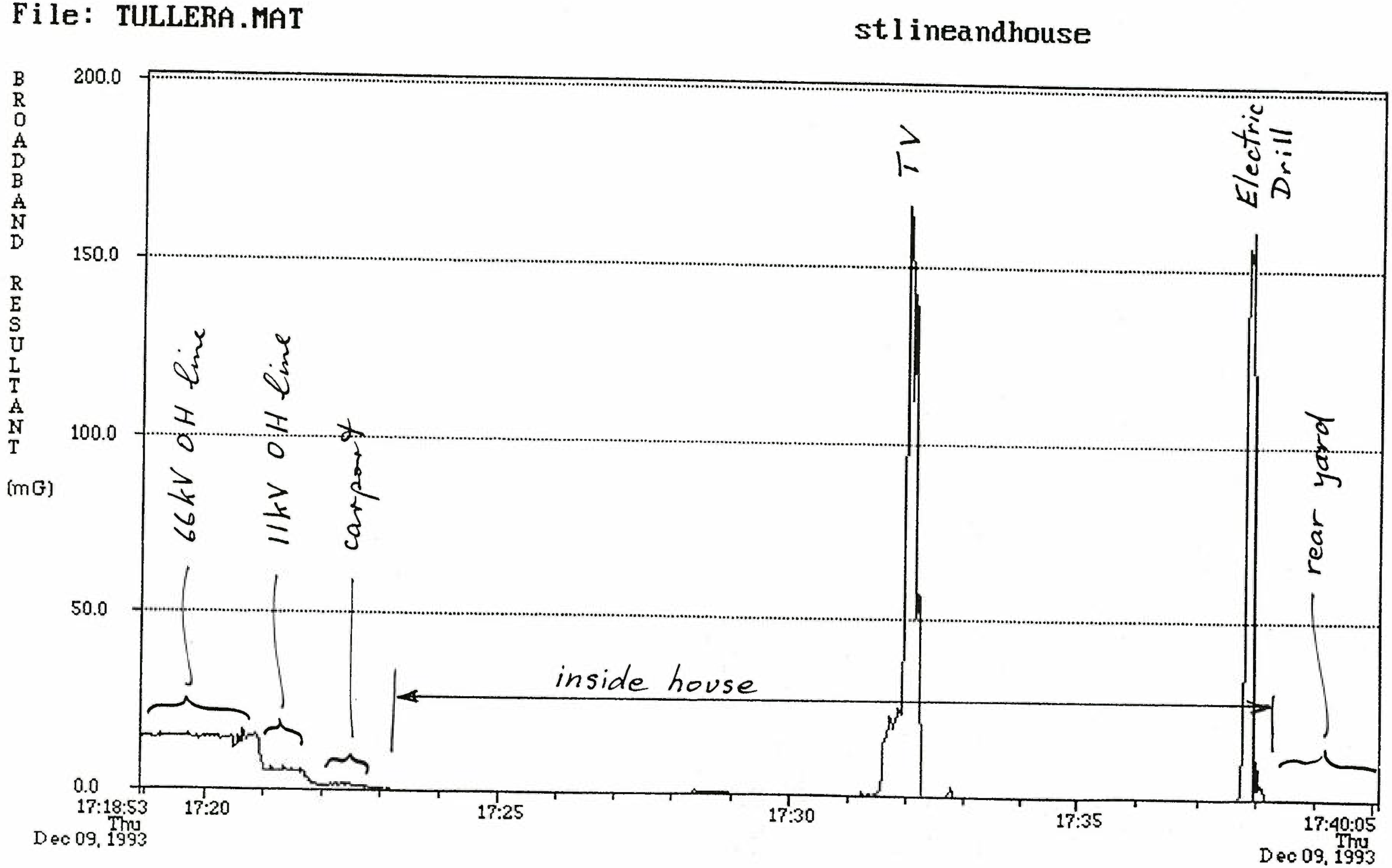
Notwithstanding, should you wish to discuss the matter further please do not hesitate to contact me.

Yours faithfully

DSimpson

DENNIS SIMPSON
ACTING TECHNICAL
SERVICES ENGINEER

File: TULLERA.MAT



File: TULLERA.MAT