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VOLUME 3

PACIFIC HIGHWAY - State Highway No.10

BRUNSWICK HEADS BYPASS

Environmental Impact Statement

ROADS & TRAFFIC AUTHORITY
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APPENDICES / WORKING PAPERS

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APPENDIX A

EIS Directors Requirements, Department of Planning

New South Wales Government

Department of Planning

Remington Centre
175 Liverpool Street, Sydney 2000
Box 3927 G.P.O. Sydney 2001
DX . 15 Sydney

Telephone : (02) 391 2000 Ext:
Fax No : (02) 391 2111

Contact : Ruth Burlakov
Ext. 2071

Our reference : G91/00433/001

Your reference : TEP:10/621325

Mrs M Whipp
Roads and Traffic Authority
DX13 SYDNEY

25 SEP 1991

Dear Mrs Whipp,

State Highway No. 10 - Pacific Highway, Shire of Byron
Proposed Brunswick Heads Bypass

Thank you for your letter of 27 August, 1991 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 bear a certificate required by clause 59 of the Regulation (see Attachment No 1).

3. In addition, pursuant to clause 58 of the Regulation, the Director requires that the following matters be specifically addressed in the EIS:

- justification for choosing the selected route over others considered, consider also the 'do nothing' option;
- flora and fauna survey of the portion of the flora reserve affected by the route, measures intended to compensate for this loss and expected impact on the remaining portion of the reserve;
- impact of the proposal on the local flooding regime;
- provisions for local access to and from the highway;
- any adverse impacts during the construction and operation of the highway on the Brunswick River;
- consideration of the impact of proposed future extensions to this route on SEPP 14 Wetland no. 62 and any possible impacts on SEPP 14 Wetlands 64 & 65;

. results of consultation with:

- Department of Water Resources;
- National Parks and Wildlife Service;
- Department of Conservation and Land Management;
- Byron Shire Council.

4. 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.

5. 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.

6. When the EIS is completed, four (4) copies should be forwarded to the Secretary, Attention: Manager, Assessment Branch pursuant to Section 112(2) of the Act, as well as details of the exhibition period and public display locations.

7. 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, the Roads and Traffic Authority 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.

8. 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.

9. 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.

10. If there is no objection 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.

11. It would be appreciated if a copy of the determination could be forwarded to the Department for our information.

12. Should you require any further information regarding this matter please do not hesitate to contact us again.

Yours faithfully

Peter Hamilton
Manager
Assessments Branch
As Delegate for the Director

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 MAJOR ROAD DEVELOPMENT IN A RURAL/ SUBURBAN ENVIRONMENT

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.

It is the responsibility of the determining authority to decide whether an EIS is required (unless the proposal is a prescribed activity). While the site characteristics largely determine the need for an EIS to be prepared, in general major road developments in rural/suburban environments have the potential to create problems for local residents and landholders due to land resumption, loss of access, severence effects on agricultural activities, sterilisation of minerals, noise generation, erosion and siltation; and impacts on flora and fauna, visual amenity, local and regional traffic flows, and local commercial interests.

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for such major road developments. It is intended to assist the preparation of the EIS. 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 such a major road development. 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 road works, particularly in relation to, and compatibility with, the arterial and local road network and any traffic management schemes in force or proposed and including the criteria used for route selection. It should provide an indication of adjacent developments, and land use activities, as well as details of the site, land tenure, zonings and relevant forward planning proposals, and any other land use constraints including natural environmental features sensitive to the impact of the proposal.

It may also be appropriate for the EIS to describe statutory procedures for implementing the proposal.

This section should provide specific information on the nature, intent and form of the development. Particular details that may generally be relevant include:

- The form and physical dimensions of the proposed roadworks, including locations and dimensions of bridge structures and associated facilities.
- Earthworks involved including details of cut and fill and balancing of volumes proposed.
- Presence of median strips, barriers to pedestrians, and grade separation proposals at intersecting roads.
- Provision of facilities for faunal corridors.
- Flood prevention measures.
- Alterations to access to adjoining properties.
- Resumptions required of existing development to accommodate the proposed road.
- Construction problems envisaged including staging of works, source and transport and assembly of plant and materials, employment details, construction camps, access arrangements, alternative routes and traffic management proposals for local and through traffic, and hours of operation for demolition/construction works etc.
- rehabilitation proposals on completion.

2. Description of the Environment.

This section 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 aspects of the environment should be described to the extent necessary for assessment of the environmental impact of the proposed development. In particular:

- Geography, topography, geology and geotechnical data, meteorology, hydrology etc.
- Noise and air quality where appropriate for impact consideration.

- Aesthetics.
- 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 or items having architectural/heritage significance.
- Existing traffic levels and traffic flow patterns.
- Socio economic aspects including local commercial activities.

3. Assessment of Alternative Routes.

The EIS should include a proper assessment of the alternative routes considered in the feasibility study for the proposal including the key physical and engineering constraints as well as the environmental and economic factors pertinent to same including clear reasons for rejecting such alternatives in favour of the recommended proposal.

4. Analysis of Environmental impacts.

Environmental impacts usually associated with a major road development in a rural/suburban environment and related activities are listed below. Where relevant to the specific proposal, these should be addressed in the EIS, taking into account the adequacy of safeguards proposed to minimise them both during construction and when in use after completion:

- Likely noise disturbance caused by the construction of the road, and by traffic operating on the completed roadway, on any nearby residential and commercial buildings. A map depicting anticipated noise contour levels in relation to residences and inhabitants involved may be necessary. Consideration should be given to both existing and proposed residential developments for such an analysis.
- Emission of air pollutants from vehicular traffic affected by the proposal, and their impact on the local and regional environment.
- Stormwater runoff and erosion and siltation potential.
- Impact on natural vegetation and faunal movement, flood plains, drainage patterns, (particularly sedimentation from construction activity).
- Mineral sterilization and subsidence potential.
- Visual impact, particularly on residential developments by both day and night taking into account the following effects of the proposed road:

  - Scale in relation to the natural landscape and adjacent residential and commercial development.
  - Appearance from nearby and afar.
  - Lighting effects on existing and proposed residential/ commercial buildings.

- Changes in traffic patterns.
- Impacts of traffic at entry/exist points.
- Impact on historic buildings, heritage items and matters of archaeological interest.
- Effect on commercial and agricultural operations and changes in community characteristics caused by severence.

In addition, any potential for hazard or risks to public safety and any proposal to monitor and reduce environmental impacts should be included.

5. 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 State Pollution Control Commission in regard to air, water and noise impacts and relevant pollution control legislation requirements.
- The Traffic Authority with regard to traffic and road development aspects.
- Any servicing authorities which may be required to supply water, power, etc.
- The Soil Conservation Service 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.
- The National Parks and Wildlife Service with regard to impact on known archaeological sites.
- Local Councils through whose areas the road passes.

It is the responsibility of the person preparing the EIS to determine those Departments relevant to the proposed development.

5. Supporting information.

The EIS should refer by suitable appendices to all relevant studies/investigations that have been carried out in support of the proposals. This supporting documentation should be made available during the period of public display of the EIS.

New South Wales Government

Department of Planning

Remington Centre
175 Liverpool Street, Sydney 2000
Box 3927 G.P.O. Sydney 2001
DX . 15 Sydney

Telephone : (02) 391 2000 Ext: 2071
Fax No : (02) 391 2111

Contact : Richard Pearson

Our reference : G91/00433/001

Your reference: TEP 10/62. 1325

Mrs M Whipp
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

Dear Mrs Whipp,

PROPOSED BRUNSWICK HEADS BYPASS

I refer to your letter dated 20 July 1992 indicating that the RTA is now intending to examine two routes in detail in the preparation of this EIS.

2. I confirm that the Director's requirements issued by the Department on 25 September 1991 apply in respect of both the red route and pink route as identified in your letter.

3. Additionally, the following requirements should also be addressed for each route:

- a full assessment of the value of the closed heathland and the impact of each proposed route on the heathland;
- future plans for the expansion of Brunswick Heads and relationship to each route;
- impact on agricultural land;
- results of preliminary soil survey to investigate the likelihood of encountering acid sulphate soils and, if necessary, measures required to control impacts;
- noise impact.

4. You will be aware that while an EIS can consider any number of alternatives to a proposal, a proposed activity must be identified in the EIS. In this case, only one of the pink route or the red route could be identified as the proposed activity.

5. Should you require any further information regarding this matter, please do not hesitate to contact us again.

Yours sincerely,

B Adams 20.8.92

B. Adams
Manager
Assessments and Major Hazards Branch
As Delegate for the Director

APPENDIX B

FIS Directors Requirements, National Parks and Wildlife Service

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

Environmental Planner
Roads and Traffic Authority
P.O. Box K198
HAYMARKET NSW 2000

Attention: Mr Bruce McNamara

Our reference: A 12413 JB:JB
Your reference: TEP 10/62.1325

Dear Mr McNamara,

RE: STATE HIGHWAY 10 - PACIFIC HIGHWAY, SHIRE OF BYRON
PROPOSED BRUNSWICK HEADS BYPASS
DIRECTOR'S REQUIREMENTS - FAUNA IMPACT STATEMENT

In reply to your letter dated 13 March 1992, the Fauna Impact Statement (FIS) must meet all of the requirements of Section 92D(1) of the National Parks and Wildlife Act, 1974. Pursuant to Section 92D(3), in addition to the basic requirements set out in Section 92D(1) I require the following:

1) A full fauna survey is required to be conducted along the proposed route and all feasible alternative routes, and surrounding areas likely to contribute to fauna habitat (study area).

2) A description of the local and regional distribution of endangered fauna known or likely to occur in the study area.

3) An assessment of dispersal or movement areas or routes of these species and any barriers to interbreeding opportunities between populations of endangered fauna.

4) A description of the habitats of endangered fauna known to occur in the study area, habitat distribution within the study area and regional distribution of these habitats. Habitat critical to life cycle events of these endangered species should be identified.

5) A description of the location, nature and extent of habitat degradation which may result from the proposed activity and the likely effect on endangered fauna known or likely to occur in the study area. A full discussion of all alternative routes should be included.

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Australia
PO Box 1967
Hurstville 2220
Fax: (02) 585 6555
Tel: (02) 585 6444

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6) Provide detailed information on the proposed habitat restoration for all alternative routes. This should include the expected time taken to restore habitat, any proposals or opportunities to improve habitat and the likely impact on fauna, particularly during the time the habitat is being restored.

7) Describe the likely impact of the proposal on increased mortality of fauna with regard to increased predation and road kills, and any measures proposed to ameliorate these impacts.

8) A description of proposed fauna underpasses, including the design, location, predicted usage and any incidental impacts, such as, increased predation and any proposed amelioration of expected impacts. The description should also indicate which species are expected to utilise the underpasses.

9) Details of an on-going monitoring of the effectiveness and impact of the proposed fauna underpasses, and remediation measures.

The Fauna Impact Statement which satisfies the above requirements must be forwarded in writing to the National Parks and Wildlife Service. Should you require any further information, please contact Ms Diane Campbell, Manager, Threatened Species Unit, on (02) 585 6444.

Yours sincerely,

W.J. Gillooly
Director

15 APR 1992

FAXED
20.8.92

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

Environmental Planner
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

Our reference: A12473 JA:JA
Your reference: TEP 10/62.1325

25 AUG 1992

Attention: Bruce McNamara

DIRECTOR'S REQUIREMENTS FOR STATE HIGHWAY 10 - PACIFIC HIGHWAY, SHIRE OF BYRON, PROPOSED BRUNSWICK HEADS BYPASS - FAUNA IMPACT STATEMENT

Thank you for your letter dated 20 July, 1992, requesting further requirements for a Fauna Impact Statement for the above development.

The Fauna Impact Statement (FIS) must meet all of the requirements of Section 92D(1) of the National Parks and Wildlife Act, 1974. Pursuant to Section 92D(3), in addition to the basic requirements set out in Section 92D(1), I require the following:

1) A full fauna survey is required to be conducted along the proposed route and all feasible alternative routes, and surrounding areas likely to contribute to fauna habitat (study area). Sampling methodology should specifically target endangered species known or likely to occur in the study area. The Service considers that the following Schedule 12 species may occur in the study area:

Part 1 - Threatened
Green and Golden Bell Frog (*Litoria aurea*)
Red Goshawk (*Erythrotriorchis radiatus*)

Part 2 - Vulnerable and Rare
Wallum Froglet (*Crinia tinnula*)
White-eared Monarch (*Monarcha leucotis*)
Osprey (*Pandion haliaetus*)
Ground Parrot (*Pezoporus wallicus*)
Eastern Grass Owl (*Tyto longimembris*)
Long-nosed Potoroo (*Potorous tridactylus*)
Queensland Blossom Bat (*Syconycteris australis*)
Queensland Long-eared Bat (*Nyctophilus bifax*)
Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*)
White-stiped Mastif Bat (*Nyctinomus australis*)
Hoary Bat (*Chalinolobus nigrogriseus*)
Queensland Tube-nosed Bat (*Nyctimine robinsoni*)
Black Flying Fox (*Pteropus alecto*)
Large-footed Mouse-eared Bat (*Myotis adversus*)
Greater Broad-nosed Bat (*Scoteanax reuppellii*)
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)

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2) A full description of the methodology used in any additional survey work including dates of survey, weather conditions, number of traps, configuration of traps etc. Identification of reptiles, frogs and bats should be confirmed by a recognised authority (eg. Australian Museum) for species of taxonomic uncertainty.

3) A description of the local and regional distribution of endangered fauna known or likely to occur in the study area.

4) An assessment of dispersal or movement areas or routes of endangered fauna species and any barriers to interbreeding opportunities between populations of these species.

5) A description of the habitats and potential habitats of endangered fauna known or likely to occur in the study area, habitat distribution within the study area and regional distribution of these habitats . Habitat critical to essential behavioural patterns of the endangered species should be identified.

6) A description of the location, nature and extent of habitat degradation which may result from the proposed activity and the likely effect on endangered fauna known or likely to occur in the study area. A full discussion of these factors in relation to all alternative routes should be included.

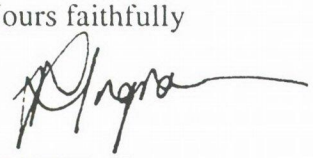
7) Provide detailed information on the proposed habitat restoration for all alternative routes. This should include the expected time taken to restore habitat, any proposals or opportunities to improve habitat and the likely impact on fauna, particularly during the time the habitat is being restored.

8) Describe the likely impact of the proposal on increased mortality of fauna with regard to increased predation and road kills, and any measures proposed to ameliorate these impacts.

9) Detailed comparison of the endangered fauna known or likely to occur on each proposed route and the impacts of the proposal on those endangered fauna and the effectiveness of mitigation measures.

The Fauna Impact Statement which satisfies the above requirements must be forwarded in writing to the National Parks and Wildlife Service. Should you require any further information, please contact Mr Peter Brookhouse, Manager, Threatened Species Unit, on (02) 585 6424.

Yours faithfully



for W J Gillooly
Director

20 AUG 1992

APPENDIX C

Relevant Sections of some of The Legislation applying to this Project

(4) A reference in this Act to the exercise of a function includes, where that function is a duty, a reference to the performance of that duty.

(5) Subject to section 56, a reference in this Act to the Director or a council preparing an environmental planning instrument or an environmental study includes a reference to the Director or a council, as the case may be, causing that environmental planning instrument or environmental study to be prepared on his or its behalf.

(6) The Minister may, by order published in the Gazette, declare any land, whether or not consisting of areas or parts of areas, to be a region for the purposes of this Act.

(7) A reference in this Act to a direction is a reference to a direction in writing.

(8) A power, express or implied, to give a direction under this Act includes a power to revoke or amend the direction.

(9) A referen … form includes a reference to a form that is to

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Significant effect on the environment of protected fauna

4A. For the purpose of sections 77, 90 and 112, in deciding whether there is likely to be a significant effect on the environment of protected fauna the following factors must be taken into account:

(a) the extent of modification or removal of habitat, in relation to the same habitat type in the locality;

(b) the sensitivity of the species of fauna to removal or modification of its habitat;

(c) the time required to regenerate critical habitat, namely, the whole or any part of the habitat which is essential for the survival of that species of fauna;

(d) the effect on the ability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities;

(e) any proposal to ameliorate the impact;

(f) whether the land is currently being assessed for wilderness by the Director of National Parks and Wildlife under the Wilderness Act 1987;

(g) any adverse effect on the survival of that species of protected fauna or of populations of that fauna.

Explanatory note

Items (1) and (2) provide guidance to public authorities in assessing the impacts of developments when exercising their statutory powers under the Act.

"determining authority" means a Minister or public authority and, in relation to any activity, means the Minister or public authority by or on whose behalf the activity is or is to be carried out or any Minister or public authority whose approval is required in order to enable the activity to be carried out;

"nominated determining authority", in relation to an activity, means the determining authority nominated by the Minister in accordance with section 110A in relation to the activity;

"proponent", in relation to an activity, means the person proposing to carry out the activity.

Nomination of nominated determining authority

110A. (1) Where the approval of more than one determining authority is required in relation to an activity or an activity of a specified class or description (either in respect of the carrying out of the activity or the granting of an approval in respect of the activity), the Minister may, by order published in the Gazette and in a newspaper circulating throughout the State, nominate a determining authority to be the nominated determining authority in relation to the activity or an activity of that class or description for the purposes of this Part.

(2) Where, under subsection (1), the Minister has nominated a determining authority to be the nominated determining authority in relation to an activity or an activity of a specified class or description, any other determining authority which would otherwise be required to comply with the provisions of this Part in relation to the activity or an activity of that class or description is not required—

(a) to comply with section 112 (2) or (3); or

(b) to comply with section 113 (subsection (3) excepted),

in relation to the activity or any activity which comes within that class or description but shall, in all other respects, comply with the relevant provisions of this Part.

Duty to consider environmental impact

111. For the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.

Decision of determining authority in relation to certain activities

112. **(1)** A determining authority shall not carry out an activity, or grant an approval in relation to an activity, being an activity that is a prescribed activity, an activity of a prescribed kind or an activity that is likely to significantly affect the environment unless—

(a) the determining authority has obtained or been furnished with and has examined and considered an environmental impact statement in respect of the activity—

(i) prepared in the prescribed form and manner by or on behalf of the proponent; and

(ii) except where the proponent is the determining authority, submitted to the determining authority in the prescribed manner;

(b) notice referred to in section 113 (1) has been duly given by the determining authority (or, where a nominated determining authority has been nominated in relation to the activity, by the nominated determining authority), the period specified in the notice has expired and the determining authority has examined and considered any representations made to it or any other determining authority in accordance with section 113 (2);

(c) the determining authority has complied with section 113 (3);

(d) where it receives notice from the Secretary that the Minister has directed that an inquiry be held in accordance with section 119 with respect to the activity, the inquiry has been held and the determining authority has considered the findings and recommendations of the Commission of Inquiry and any advice given to it by the Minister in accordance with section 114; and

(e) where it receives notice from the Secretary that the Director has decided that an examination be undertaken in accordance with section 113 (5), that examination has been carried out and the determining authority has considered the report furnished to it in accordance with that subsection.

(2) The determining authority or nominated determining authority, as the case requires, shall, as soon as practicable after an environmental impact statement is obtained by or furnished to it, as referred to in subsection (1), but before giving notice under section 113 (1), furnish to the Secretary a copy of the statement.

(3) A determining authority or nominated determining authority, as the case requires, shall furnish such number of additional copies of an environmental impact statement to the Secretary as the Secretary may request.

(4) Before carrying out an activity referred to in subsection (1) or in determining whether to grant an approval in relation to such an activity, a determining authority which is satisfied that the activity will detrimentally affect the environment—

(a) may, except where it is the proponent of the activity—

(i) impose such conditions or require such modifications as will in its opinion eliminate or reduce the detrimental effect of the activity on the environment; or

(ii) disapprove of the activity; or

(b) may, where it is the proponent of the activity—

(i) modify the proposed activity so as to eliminate or reduce the detrimental effect of the activity on the environment; or

(ii) refrain from undertaking the activity.

(5) Where a determining authority, not being the proponent of an activity, imposes conditions as referred to in subsection (4) (a) (i) or disapproves of an activity as referred to in subsection (4) (a) (ii), the determining authority shall, by notice in writing to the proponent, indicate the reasons for the imposition of the conditions or for disapproving of the activity.

(6) The provisions of subsection (4) have effect notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act.

(7) Where a nominated determining authority has been nominated in relation to an activity, no other determining authority which may grant an approval in relation to the activity shall be concerned to inquire whether or not the nominated determining authority has complied with this section or section 113.

Decision of determining authority in relation to certain activities

112. (1) A determining authority shall not carry out an activity, or grant an approval in relation to an activity, being an activity that is a prescribed activity, an activity of a prescribed kind or an activity that is likely to significantly affect the environment unless—

(a) the determining authority has obtained or been furnished with and has examined and considered an environmental impact statement in respect of the activity—

(i) prepared in the prescribed form and manner by or on behalf of the proponent; and

(ii) except where the proponent is the determining authority, submitted to the determining authority in the prescribed manner;

(b) notice referred to in section 113 (1) has been duly given by the determining authority (or, where a nominated determining authority has been nominated in relation to the activity, by the nominated determining authority), the period specified in the

Section 112 (**Decision of determining authority in relation to certain activities**):

After section 112 (1A), insert:

(1B) Without in any way limiting the provisions of subsection (1), a determining authority must not carry out an activity, or grant an approval in relation to an activity, being an activity which is likely to significantly affect the environment of any protected fauna unless a fauna impact statement has been prepared in accordance with section 92D of the National Parks and Wildlife Act 1974.

(1C) Despite subsection (1B), where an environmental impact statement has been prepared pursuant to subsection (1) which addresses the matters set out in section 92D (1) of the National Parks and Wildlife Act 1974, no separate fauna impact statement is required.

(1D) A determining authority must forthwith forward a copy of any environmental or fauna impact statement referred to in subsection (1B) or (1C) to the Director of National Parks and Wildlife.

...tion (3) sets a threshold above which determining authorities should require the assistance of a fauna impact statement in assessing the impacts of developments when exercising their statutory powers under the Act. A one-stop process is envisaged. Proposed subsection (1C) prevents duplication of effort.

(b) a transformation of a locality;

(c) any environmental impact on the ecosystems of the locality;

(d) a diminution of the aesthetic, recreational, scientific or other environmental quality or value of a locality;

(e) any effect upon a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social signficance or other special value for present or future generations;

(f) any endangering of any species of fauna or flora;

(g) any long-term effects on the environment;

(h) any degradation of the quality of the environment;

(i) any risk to the safety of the environment;

(j) any curtailing of the range of beneficial uses of the environment;

(k) any pollution of the environment;

(l) any environmental problems associated with the disposal of waste;

(m) any increased demands on resources, natural or otherwise, which are, or are likely to become, in short supply; and

(n) any cumulative environmental effect with other existing or likely future activities.

57. (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) a 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;

(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.

58. (1) In the preparation of an environmental impact statement for the purposes of Part V of the Act, the person preparing the statement shall consult with the Director and shall, in completing the preparation of the statement, have regard to any requirements notified to him in writing by the Director in respect of the form and content of the statement.

(2) Where the Director is consulted under subclause (1), any requirements that he may notify under that subclause shall be notified within 28 days of the consultation.

(3) Where the Director notifies requirements referred to in subclause (1), he shall, at the same time, inform the relevant determining authority of those requirements except where the determining authority has prepared the environmental impact statement.

59. An environmental impact statement that has been prepared by or on behalf of a determining authority or that is submitted to a determining authority shall bear a certificate by the person who prepared the statement to the effect that it has been prepared in accordance with clauses 57 and 58.

60. (1) A notice required to be given under section 113 (1) of the Act shall—

(a) be published in at least 2 newspapers, one being a daily newspaper circulating generally throughout the State and the other being a local newspaper circulating at least once weekly in the locality where the activity is proposed to be carried out;

(b) be so published at least on 2 separate occasions, the second occasion being not more than 20 days nor less than 14 days after the first occasion; and

(c) be so published as to appear in 2 or 3 columns in the display section of the newspapers.

DIRECTOR'S REQUIREMENTS

Under section 92D (2) of the NP & W Act, any person preparing the Fauna Impact Statement must consult with the Director of National Parks and Wildlife for any Director's requirements relating to form and content of the statement.

The consultation must be made in writing and addressed to:

The Director
National Parks and Wildlife Service
P O Box 1967
HURSTVILLE 2220

Attention: Threatened Species Unit

The requirements will be issued from NPWS's Head Office within 28 days of the written consultation, and will deal with specific fauna issues to be addressed, if necessary.

SECTION 92 D REQUIREMENTS

Under Section 92 D of the National Parks and Wildlife Act, 1974, a Fauna Impact Statement-

> *"must include to the fullest extent reasonably practicable:*
>
> *(i) a full description of the fauna to be affected by the actions and the habitat used by the fauna;*
>
> *(ii) an assessment of the regional and statewide distribution of the species and the habitat to be affected by the actions and any environmental pressures on them;*
>
> *(iii) a description of actions and how they will modify the environment and affect the essential behavioural patterns of the fauna in the short and long term where long term encompasses the time required to regenerate essential habitat components;*
>
> *(iv) details of the measures to be taken to ameliorate the impacts;*
>
> *(v) details of the qualifications and experience in biological science and fauna management of the person preparing the statement and of any other person who has conducted research or investigation relied upon."*

APPENDIX D

Letters from Authorities and Non Government Bodies

NRMA

24 December, 1991
Our Ref: GJ/lt R1528

National Roads &
Motorists' Association
A.C.N. 000 010 506

151 Clarence Street
Sydney NSW 2000
Australia
Telephone (02) 260 9222
Facsimile (02) 260 8472

Ms A Ross
Environmental Planner
Roads & Traffic Authority
PO Box K198
HAYMARKET NSW 2000

Dear Ms Ross

Brunswick Heads

I refer to your letter of 27 September 1991 inviting the NRMA to comment on the above proposal. Thank you for this opportunity, and I apologise for the delay.

The NRMA fully supports in principle the construction of bypass of Brunswick Heads in order to remove the major conflict that occurs in this vicinity between through and local traffic.

We look forward to making further detailed comments once the Environmental Impact Statement is released. The NRMA contact for this proposal will be our Rural Traffic Engineer, Grant Johnston who can be contacted on (02) 260 8248.

Thank you once again for this opportunity.

Yours sincerely

Peter Steele
Chief Traffic Engineer

QR 31/12
ms whipp

Lt-R1528GJco

DEPARTMENT OF MINERAL RESOURCES

NEW SOUTH WALES GOVERNMENT

MINERALS AND ENERGY HOUSE
29-57 CHRISTIE STREET
CORRESPONDENCE PO BOX 536
ST LEONARDS NSW 2065
DX 3324 ST LEONARDS
TELEPHONE (02) 901 8888
FACSIMILE (02) 901 8777

RECEIVED
25 NOV 1991
Environmental Planning Section

The Environmental Planner
Roads And Traffic Authority
P.O. Box K198
Haymarket. N.S.W. 2

Our Ref : L91-0505
Your Ref : TEP: 10/62.1325
For Further Information
Ring: J. O'Neill
Tel : 901-8254

Proposed Brunswick Heads Bypass
Environmental Impact Statement

Reference is made to your letter dated 27th September, 1991 regarding the Environmental Impact Statement for the proposed Brunswick Heads Bypass.

The proposed route affects Exploration Licence No.s 3096 and 3698 held by Australmin Pacific N.L. (C/- Newcrest Mining Ltd.), who because of physical access constraints have been unable to conduct exploration over the subject area to determine the extent of the available mineral resource.

The Exploration Manager (Mr. J. Pearson) for Newcrest has sought a meeting with the RTA for discussions with a view of jointly accessing, and possibly developing resources (copy of letter attached). If this meeting can be arranged this Department would appreciate details of any agreements entered into.

Advice however from technical officer of this Department indicate the presence of heavy mineral sands and until such time that this resource has been fully identified, this Department would raise mining objections, especially if this resource should prove to be economically viable.

In the case of the mineral resource being viable this Department would encourage the extraction of said resource and on completion of this venture would then be in a position to review its objections.

Unless however a meeting between the RTA and Newcrest can come to some kind of working arrangement and be compatible this Department must object to the proposed bypass, atleast until the mineral resource in this area has been fully identified and the extracion if possible of the said minerals completed.

J L O'Neill 21/11/91.

J. O'Neill
for DIRECTOR GENERAL

R 26/11
rs arhpp

WOODBURN MINERAL SANDS

A Wholly Owned Subsidiary of Newmont Australia Limited

Exploration Office
Unit 10, 48 Tamar Street, Ballina NSW 2478
Telephone: (066) 86 9555 Fax: (066) 86 0177

FACSIMILE TRANSMISSION

TO: Mr R. Brown

FROM: Mr J. Pearson

DATE: 28 October 1991

SUBJECT: **EL 3096 Proposed Highway Route**

OUR REF: 005

NO. OF PAGES SENT: 1

If there are any problems with this transmission, please contact: Fiona Smith

MESSAGE:

The fax dated 25/10/91 showing outline of proposed road route has been reviewed. I advise that based on historical information there are inferred resources of heavy minerals in and around the proposed road route. As holders of EL 3096, we have been unable to drill evaluate this area due to physical access constraints. We would appreciate meeting with the proponents of the development with a view to jointly accessing, and possibly developing resources. Can you advise of the timing and status of the development and, if it is possible to arrange contact with the proponents.

Yours sincerely,

JOHN PEARSON
EXPLORATION MANAGER.

Newcrest Mining Limited
A.C.N. 005 683 625
Mineral Sands Exploration Office
Unit Ten 48 Tamar Street Ballina NSW 2478
P.O. Box 67 Woodburn NSW 2472
Telephone 066 86 9555 Fax 066 86 0177

MARIE WHIPP ENV. PLAN

4 November 1991

Division Engineer
Roads & Traffic Authority
PO Box 576
GRAFTON NSW 2460

Attention: Mr B. Parks

Dear Sir,

Re: PROPOSED HIGHWAY DIVERSION - BRUNSWICK HEADS

Newcrest Mining Limited is the manager and owner of Exploration Licence No: 3096 which was granted by the Department of Mineral Resources on 2 June 1988. EL 3096 is located on the North Coast of NSW between the towns of Byron Bay and Brunswick Heads as shown on the attached plan.

At present this Company is investigating several areas of potential concentration of heavy minerals (rutile, zircon, ilmenite) on the north coast, in order to supplement the present production from our Newrybar Project, north of Lennox Head.

I have been advised that the RTA is currently planning a highway diversion to the west of the town of Brunswick Heads. The area planned for this diversion holds some potential for the occurrence of heavy minerals although we have not been able to adequately sample this area of interest. I therefore request your co-operation in the accessing of this area so that we may be able to drill test this zone to determine its economic significance.

Yours sincerely

JOHN PEARSON

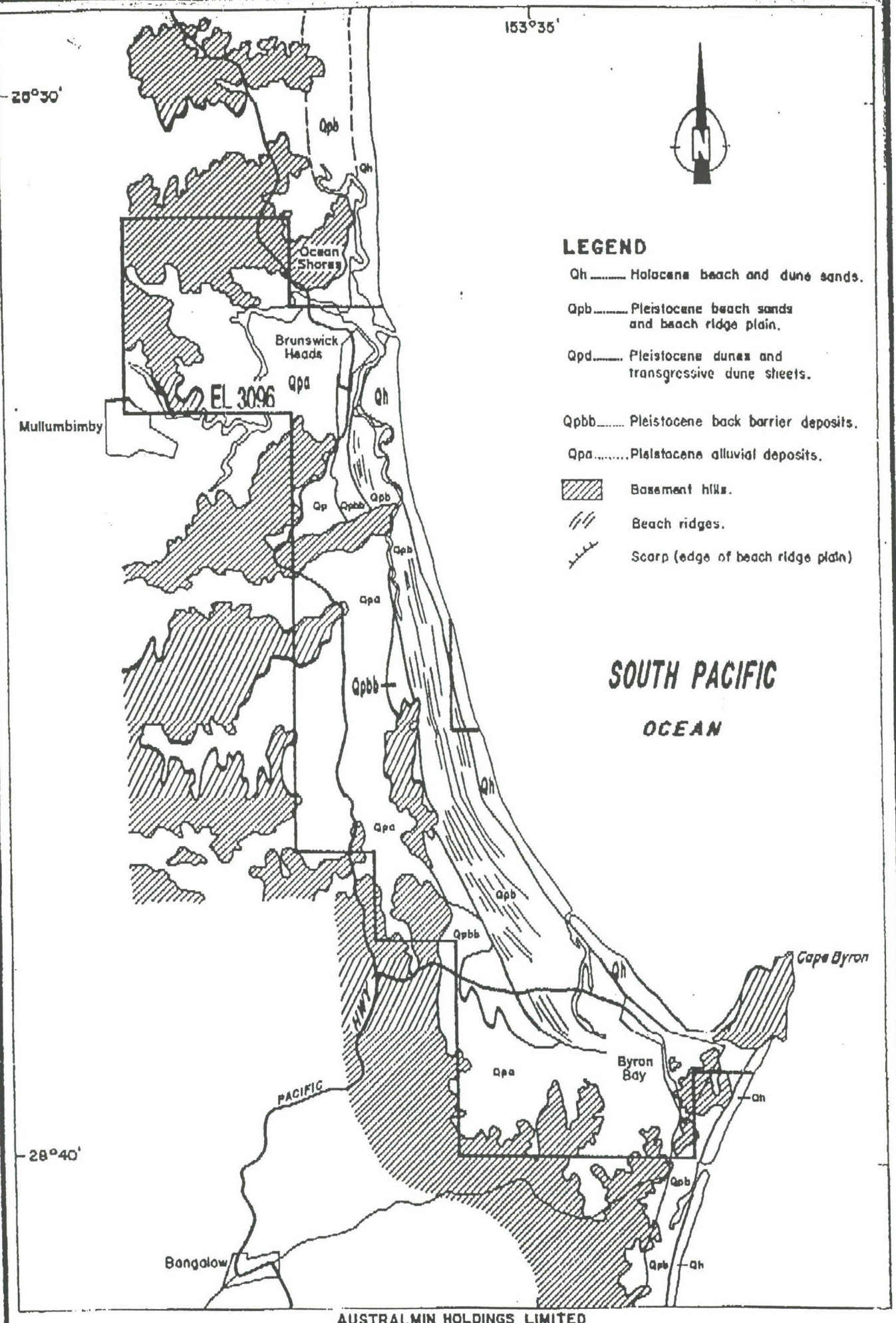
cc:

NORTH EASTERN DIV.
RECD. 5 NOV 1991
ACTION BY
OSM

File No.
10/62. ~~163~~ 1194

Reg No.
176

ljp089.ji



AUSTRALMIN HOLDINGS LIMITED

NORTHERN N.S.W. MINERAL SANDS PROJECT

BYRON BAY EL 3096

STATE POLLUTION CONTROL COMMISSION

HUNTER & NORTH COAST REGION

Our Reference: 250505A
DJK:SG

Your Reference:

Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

Attention: Maria Whipp

Dear Madam

PROPOSED BRUNSWICK HEADS BYPASS
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY

We refer to your letter of 27 September 1991 concerning the preparation of an Environmental Impact Statement (E.I.S.) for the above proposal.

The Commission recommends that the following matters be addressed in the EIS.

1 Noise Pollution

The road deviation may result in a noise impact to previously unaffected residences.

The Commission's environmental goal for traffic noise relative to arterial roads is a maximum $L_{A10,\ 18\ hours}$ noise level of 63dB(A) when measured at one metre from a residential facade or other noise sensitive location.

The figure of 63dB(A) includes 2.5dB to allow for reflected noise from the facade. If reflection during measurement is unlikely, as for instance when measuring on open land before the residence is built, 2.5dB should be added to the measured value.

We are unable to say if the proposed route will meet the above guidelines. A range of noise attenuation methods are available if required, including earth mounds, rigid barriers, vegetation buffers and low noise pavements. Further information can be provided on these matters if required.

2 Air Pollution

The construction of the road by-pass may also cause air and noise pollution impacts. It is recommended that the by-pass be constructed in stages to minimise the duration of impact on any affected residences. Adequate dust suppression of unsealed roads and materials stockpiles will also be necessary.

Newcastle Office: 117 Bull Street, P.O. Box 488G Newcastle, 2300. Phone: (049) 26 9971 Fax: (049) 29 6712
Grafton Office: 49 Victoria Street, P.O. Box 498 Grafton, 2460. Phone: (066) 42 0535 Fax: (066) 42 0606

3 Water Pollution

The road by-pass should be designed to have a minimal impact on existing local drainage patterns. Suitable measures should be included to control erosion and sedimentation from surface runoff during and after construction.

With respect to the proposed encroachment on an SEPP 14 Wetland, the EIS should address the following matters:

- the impact of the permanent loss of a portion of the wetland.
- the effect of the road deviation on the hydrology of the wetland; ie discharges to and from the wetland, flow paths and the water level within the wetland.
- details of any measures proposed to mitigate or compensate for the impact on the wetland due to the construction of the road deviation.

If the road deviation is to be a freeway road or a tollway, and will be constructed by the Minister for Roads it will be scheduled under the Noise Control Act, 1975. Pollution Control Approval would therefore be required from the Commission prior to the commencement of any work.

We trust this information is of assistance. Should you have any further enquiries please telephone the undersigned on (066) 420535.

Yours faithfully

D. J. Keats

14 OCT 1991

D J Keats
Acting Deputy Regional Manager
North Coast
for Secretary

1/1/111/4:DW

AUSTRALIAN HERITAGE COMMISSION

53 Blackall Street
Barton ACT 2600

GPO Box 1567
Canberra ACT 2601
AUSTRALIA

Phone (06) 271 2111
Fax (06) 273 2395

29 June 1992

Ms Annette Ross
Environmental Planner
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

Dear Ms Ross

STATE HIGHWAY NO.10 - PACIFIC HIGHWAY. SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS - ENVIRONMENTAL IMPACT STATEMENT (EIS).

I refer to your letter of 27 May 1992 regarding the impact of the proposed Brunswick Head Bypass on the national estate values of the Brunswick Heads Nature Reserve.

The Commission has examined the various options for the proposed bypass and believes all routes that bisect the nature reserve will have an impact on significant vegetation communities found there, particularly sub-tropical rainforest.

From the information provided the black option would have the greatest impact on the national estate values of the area, affecting a highly significant area of undisturbed sub-tropical rainforest of a type which is now of restricted distribution due to extensive clearing.

Both the blue and the red options will also bisect sub-tropical rainforest. From the information provided it is not possible to compare these options. Details of the amount of clearing which would be required for each option is needed, together with a description of the actual plant communities to be disturbed by each. When the EIS is produced a detailed description of the vegetation along both routes should be included along with basic information on the extent of clearing required.

The green option would have the least impact on the national estate values of the nature reserve because it would be located entirely outside the reserve.

; Whipp

The EIS should also include a discussion regarding a "do nothing" option, and an option which would only involve widening sections of the current road.

The Commission looks forward to providing more detailed comments on the proposal when the EIS has been produced.

Yours sincerely

Sharon Sullivan
Executive Director

New South Wales Government

NSW Agriculture & Fisheries

North Coast

Our reference: RJS:JF 598
Your reference: TEP: 10/62.1325

North Coast Agricultural Institute
Wollongbar NSW 2480

Telephone: (066) 240349

Facsimile: (066) 281 744
Telex: AA 66344 NCAI

Environmental Planner
Roads & Traffic Authority
P O Box K198
HAYMARKET NSW 2000

ATTENTION: MRS M WHIPP

6 December 1991

RECEIVED
16 DEC 1991
Environmental Planning Section

Dear Sir/Madam,

RE: STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY. SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS - ENVIRONMENTAL IMPACT STATEMENT

Thank you for your letter of 27 September 1991 requesting comments on the proposed by-pass at Brunswick Heads. On the information provided, our preliminary assessment indicates there will be few major impacts on agricultural industries.

I would suggest that in the future, on-site inspections of proposed highway routes be arranged with local district officers of this Department. These inspections will be useful in identifying the range of issues which may require a more detailed investigation in an Environmental Impact Assessment.

NSW Agriculture is able to provide a Consulting Service in Environmental Impact Assessments on matters relating to agricultural land and drainage. This service is provided in the North Coast Region by contacting Mr Bob Smith, Regional Liaison Officer on 066 240349.

Attached is a list of contact officers throughout the region who will be able to assist you in the preliminary assessments.

Yours faithfully,

R.A. STEVENS
Regional Director of Agriculture
North Coast Region

N·S·W AGRICULTURE & FISHERIES CENTENARY 1890-1990

Mr Tim Bale
District Livestock Officer (Dairying)
NSW Agriculture
P O Box 253
TAREE NSW 2430 Ph: 065 527299 Fx: 065 524909

Tony Dowman
District Livestock Officer (Dairying)
NSW Agriculture
P O Box 141
KEMPSEY NSW 2440 Ph: 065 626244 Fx: 065 625614

Arthur Akehurst
District Horticulturist
NSW Agriculture
P O Box 136
MACKSVILLE NSW 2447 Ph: 065 681488 Fx: 065 682298

David Stevenson
District Horticulturist
NSW Agriculture
P O Box 530
COFFS HARBOUR NSW 2450 Ph: 066 520525 Fx: 066 522289

John Betts
District Agronomist
NSW Agriculture
Agricultural Research
& Advisory Station
GRAFTON NSW 2460 Ph: 066 420420 Fx: 066 447251

Bob Smith
Regional Liaison Officer
NSW Agriculture
Wollongbar Agricultural Institute
Bruxner Highway
WOLLONGBAR NSW 2477 Ph: 066 240349 Fx: 066 281744

Ian Atkinson
District Horticulturist
NSW Agriculture
P O Box 9
MULLUMBIMBY NSW 2482 Ph: 066 842100 Fx: 066 841500

David Peasley
District Horticulturist
NSW Agriculture
P O Box 823
MURWILLUMBAH NSW 2484 Ph: 066 722099 Fx: 066 723571

New South Wales Government

NSW Agriculture & Fisheries

North Coast

Our reference:
Your reference: 10/62.1325

North Coast Agricultural Institute
Wollongbar NSW 2480

Telephone: (066) 240 384

Facsimile: (066) 281 744

Mrs M Whipp
Roads and Traffic Authority
P O Box K198
HAYMARKET NSW 2010

22 October 1991

Dear Mrs Whipp

STATE HIGHWAY NO 10 - PACIFIC HIGHWAY. SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS - ENVIRONMENTAL IMPACT STATEMENT.

Thank you for your letter of 27 September 1991, in which you requested advice from NSW Fisheries in regard to the above proposal.

The following information should be provided in this documentation.

1. An analysis of the flora of this site and the impact of the proposal.

2. An assessment of the impact of the proposal on water quality or flow and the subsequent impacts on the oyster industry.

3. An assessment of possible options to the proposed overall route and their relative impacts on estaurine flora and water quality.

If you have any further questions please contact me on (066) 240 394.

Yours faithfully

Craig Copeland
for R Claxton
Director
NSW Fisheries

Please note: All future correspondence on environmental or fisheries habitat matters on the North Coast should be addresed to:

The Director, NSW Fisheries, C/- Wollongbar Agricultural Institute, Wollongbar 2477
Attention: Mr Craig Copeland

Mr Tim Bale
District Livestock Officer (Dairying)
NSW Agriculture
P O Box 253
TAREE NSW 2430 Ph: 065 527299 Fx: 065 524909

Tony Dowman
District Livestock Officer (Dairying)
NSW Agriculture
P O Box 141
KEMPSEY NSW 2440 Ph: 065 626244 Fx: 065 625614

Arthur Akehurst
District Horticulturist
NSW Agriculture
P O Box 136
MACKSVILLE NSW 2447 Ph: 065 681488 Fx: 065 682298

David Stevenson
District Horticulturist
NSW Agriculture
P O Box 530
COFFS HARBOUR NSW 2450 Ph: 066 520525 Fx: 066 522289

John Betts
District Agronomist
NSW Agriculture
Agricultural Research
& Advisory Station
GRAFTON NSW 2460 Ph: 066 420420 Fx: 066 447251

Bob Smith
Regional Liaison Officer
NSW Agriculture
Wollongbar Agricultural Institute
Bruxner Highway
WOLLONGBAR NSW 2477 Ph: 066 240349 Fx: 066 281744

Ian Atkinson
District Horticulturist
NSW Agriculture
P O Box 9
MULLUMBIMBY NSW 2482 Ph: 066 842100 Fx: 066 841500

David Peasley
District Horticulturist
NSW Agriculture
P O Box 823
MURWILLUMBAH NSW 2484 Ph: 066 722099 Fx: 066 723571

AUSTRALIAN
HERITAGE
COMMISSION

53 Blackall Street
Barton ACT 2600

GPO Box 1567
Canberra ACT 2601
AUSTRALIA

Phone (06) 271 2111
Fax (06) 273 2395

1/1/111/4:DW

22 October 1991

RECEIVED
3 . OCT 1991
Environmental Planning Section

Environmental Planner
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

Dear Sir

STATE HIGHWAY NO10 - PACIFIC HIGHWAY. SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS - ENVIRONMENTAL IMPACT STATEMENT

I refer to your letter of 27 September 1991 regarding the environmental impact statement currently being prepared for the above-mentioned bypass. The Brunswick Head Nature Reserve is the only area listed in the Register of the National Estate within the immediate vicinity of the bypass.

From the map attached to your letter it appears that the bypass ends on the southern shore of the Brunswick River. The Brunswick Heads Nature Reserve is located on the northern shore of the river, and therefore the proposed by-pass would not have any adverse impacts on its national estate values.

The Commission, therefore, has no comments on the proposed route of the bypass.

Yours sincerely

Sharon Sullivan
Director

2/1/11
ms arkipp

DEPARTMENT
OF LANDS
(Division of DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT)

Roads & Traffic Authority,
P.O. Box K198,
HAYMARKET. N.S.W. 2000

YOUR REF:
OUR REF: HO91 H 245
CONTACT OFFICER: Annette Wheeler:RM
TELEPHONE NO.: 2286498

ATTENTION: MARIA WHIPP

PROPOSED BRUNSWICK HEADS BY-PASS - E.I.S.

The Department has prepared a report as a determining authority for the above proposal under Clause 56 of the Environmental Planning and Assessment Regulation 1980 to satisfy Section 111 of the Environmental Planning and Assessment Act, 1979.

It was concluded that an E.I.S. is required to address a number of matters relating to Crown lands. In particular, sterilizing Crown lands with potential for urban development, displacement of a caravan park, alienation of the recreation function of a recreation reserve, potential flooding and drainage problems on Crown lands and the effects on a reserve for the preservation of native flora. Details of these matters were outlined in our letter 20th November, 1991.

The effects of both the construction stage and continuing use of completed roadway needs to be addressed in terms of Crown lands.

To enable this Department to carry out its responsibilities under Section 112 of the Environmental Planning and Assessment Act, 1979, could you please forward a copy of the E.I.S. to the Land Resources Branch and subsequently the submissions received in respect of the E.I.S.

I look forward to continued liaison in this matter.

Yours sincerely,

REX BOWEN 24/1/92
Manager
Land Resources Branch

RECEIVED
30 JAN 1992
Environmental Planning Section

23-33 Bridge Street Sydney NSW Australia 2000 Box 39 GPO Sydney NSW Australia 2001
Telephone (02) 228 6111 Fax (02) 228 6140

15th October, 1991

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Road and Traffic Authority
P.O. Box K198
HAYMARKET 2000

RECEIVED
24 OCT 1991
Environmental Planning Section

Our reference: F/0389
Your reference: TEP:10/62.1325

Dear Mrs Whipp,

Re: State Highway No. 10 Pacific Highway. Proposed Brunswick Heads Bypass.

Thank you for your letter of 27th September, 1991.

As requested the Service provides the following comments:

1. The proposal to engage Dr. H.J. Hall to conduct the Aboriginal Archaeological study component of the EIS is supported. Further, it is recommended that this survey be enlarge to cover the proposed northern extension of the by-pass.

2. That a full flora and fauna survey be conducted with particular emphasis on rare and endangered species.

3. That an investigation into the impacts upon the SEPP 14 wetland area be carried out with particular emphasis on the hydrological impacts, impacts upon wading birds, and impacts upon the aquatic fauna of the river.

4. That a review be undertaken to place in a regional context the importance of the areas natural vegetation and to assess the impact of the loss of this vegetation particularly when considering the cumulative loss of vegetation throughout the region.

5. The proposed northern extension of the by-pass appears to be directed through the western part of Brunswick Heads Nature reserve. This is a small

Lismore District
Suite 9
Colonial Arcade
75 Main Street
Alstonville
PO Box 91
Alstonville 2477
Fax: (066) 28 3937
Tel: (066) 28 1177

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

Australian-made 100% recycled paper

narrow reserve containing important stands of swamp forest, littoral rainforest and wet sclerophyll forest.

The Service objects in the strongest possible terms to any proposal that would affect this important reserve.

If you have any further queries please do not hesitate to contact Senior Ranger David Charley or Superintendent Guy Holloway at our Alstonville office on (066) 28.1177.

Yours faithfully,

D. Charley

David Charley
for DIRECTOR

New South Wales Government

Water Resources

Environmental Planner
Roads & Traffic Authority
P O Box K198
HAYMARKET NSW 2000

Telex: 166966
Facsimile: (066) 43 1161
Telephone: (066) 42 0568
Ext:
Contact Name:
Our Reference: K. Roberts
G90/54

29 NOV 1991

Dear Mrs Whipp

Re: State Highway 10 - Pacific Highway. Proposed Brunswick Heads Bypass.

The Department apologises for the delay in replying to your letter of the 27 October 1991.

The following comments should assist in the preparation of the E.I.S.:

a) Adequate safeguards should be included to ensure protection of surface and groundwaters from contamination.

b) The proposed bridge over the Brunswick River is in a tidal section of the river. Requests for advice regarding channel stability, riparian vegetation and flood hydrology should be made to the Department of Public Works.

c) Attached is a copy of the Department's general requirements for Environmental Impact Statements which may be of use for you in preparation of this and future E.I.S.'s.

Yours faithfully

K. Roberts
Regional Environmental Officer
North Coast Region

RECEIVED
- 5 DEC 1991
Environmental Planning Section

NORTHERN RIVERS ELECTRICITY

HEAD OFFICE: 17 Prince Street, Grafton. N.S.W. Fax: (066) 42 7083

All Mail to: General Manager, P.O. Box 5, Grafton. 2460 Phone: (066) 42 1844

Your Ref: TEP: 10/62.1325
Our Ref: GRW:H10/4
WP

1st November, 1991

EVIRONMENTAL IMPACT STATEMENT -
PROPOSED BRUNSWICK HEADS BYPASS

RECEIVED
- 7 NOV 1991
Environmental Planning Section

The Environmental Planner,
Roads & Traffic Authority,
P.O. Box K198,
HAYMARKET. N.S.W. 2000

Dear Madam,

I refer to your letter of 27th September 1991 calling for submissions to assist in the preparation of the above Environmental Impact Statement.

Apart from a major issue for N.R.E. concerning shared corridors on new power lines, which I discuss later in this letter, there are two comments of obvious impact on Northern Rivers Electricity:

(i) Some existing power lines would be cut by the proposed route and, as the electricity supply will need to be maintained, some reconstruction and/or raising may be necessary along with access considerations. This would be at R.T.A's cost.

(ii) Some existing sections of highway may become redundant and, where these contain existing power lines within the road reserve, there will be a need to provide for their maintenance should the land/ easement be disposed of by R.T.A.

The future provision of electricity supply to the coastal area from Brunswick Heads to Kingscliff presents considerable challenges in view of the expected population growth and development as well as the environmental sensitivity. In many parts of this area N.R.E. has few or no existing power line routes.

There is a clear need to establish a 66,000 volt to 11,000 volt substation in the Ocean Shores area and this is proposed at the site of an existing 11,000 volt switching station shown as "substation" near Ocean Shores and adjacent to the existing highway on the map you provided. A substation near Pottsville is also almost certainly required.

AR 7/11

FOR FURTHER ENQUIRIES CONTACT Mr. Gary Wardrop
Phone Grafton (066) 42 9141

A 66,000 volt transmission line connection to the south and one to the north will be required at Ocean Shores. N.R.E. intends to upgrade existing 11,000 volt lines wherever possible, this impacting further on some crossings as mentioned in (i) above, but some new route sections will be necessary.

The electricity distribution industry is now experiencing great difficulty in obtaining new line routes across private property and the community reaction is clearly indicating a need for shared corridors amongst various services. Recent experience on the North Coast indicates a trend by your organisation to acquire smaller corridors to the possible exclusion of other services. In suggesting a review of this practice, N.R.E. is appreciative of the following safety considerations and constraints:

(a) Collision hazards with poles on roadsides and an increased setback objective in higher speed zones.

(b) Possible hazards due to some traditional methods of pole maintenance and access from roadsides.

(c) Landscape/beautification objectives.

N.R.E. considers that if new single pole power lines are incorporated within highway corridors, then in concert, an appropriate management plan can be developed. For example, concrete poles or certain construction designs can dramatically reduce the frequency of maintenance requirements, different plant and methodologies can reduce hazards and/or access requirements, etc.

I therefore strongly urge that consideration be given in this instance particularly, and generally, to providing sufficient highway easement/ corridor to allow new single pole power lines in specific predetermined locations. In this case, we could determine these more specifically. N.R.E. is most willing to share, in an appropriate manner, the negotiations and costs of acquiring the necessary land/easement and approvals. In the bottom line analysis, both organisations are serving similar community needs.

In seeking your considerations of the above, I am prepared for greater detailed interaction to assist in the E.I.S. preparation and generally. Finally I suggest that, in the spirit of environmental assessment and overall planning objectives, these electricity matters should be addressed in your E.I.S.

If I can be of further assistance, or to advise me of further detail and timing requirements in regard to the above matters, please do not hesitate to contact myself (phone 066-429141).

Yours faithfully,

Gary Wardrop

G.R. WARDROP,
DESIGN & DEVELOPMENT ENGINEER.

MSB Waterways

Hunter & Nth Coast Region
Coffs Harbour Jetty
Coffs Harbour NSW 2450
P.O. Box J23

Telephone: (066) 52 3311
Facsimile: (066) 52 7382

22 October 1991

Environmental Planner
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

RECEIVED
- 5 NOV 1991
Environmental Planning Section

ATT: Mrs M Whipp

Dear Mrs Whipp

Thank you for your letter of 27 September 1991 regarding the proposed Brunswick Heads Bypass, Environmental Impact Statement.

The MSB Waterways Authority has responsibility for navigation and boating safety in NSW. In the case of a bridge the role of the Authority is to grant approval for the crossing, to advise on the navigational safety of the structure, and the need for aids to navigation (lights) and signage of the structure.

Mr Lawrie McEnally, Operations Supervisor, North Coast, is available to consider your proposals and can be contacted on (066) 51-3400 or at the above address.

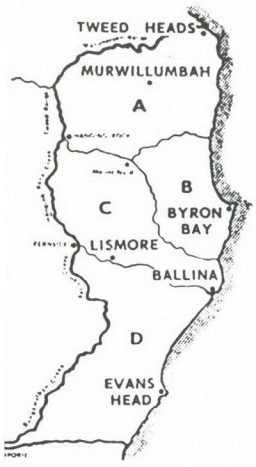
Thank you for your early advice on this matter.

Yours faithfully

Peter Jackson
Regional Manager North

R 5/11
mr whipp

Printed on recycled paper



Tweed—Lismore Rural Lands Protection Board

61 CONWAY STREET
LISMORE

Phones (066) 21 2317
21 2318
Fax (066) 21 2928

P.O. BOX 16,
LISMORE, 2480.

YOUR REF.:

OUR REF.: RLT:JA

23rd October, 1991

Mrs. M. Whipp,
Roads & Traffic Authority,
P.O. Box K198,
HAYMARKET 2000

Dear Madam,

RE - State Highway No. 10 - Pacific Highway, Shire of Byron, Proposed Brunswick Heads Bypass- Environmental Impact Statement.

This Board has examined the proposed route to bypass Brunswick Heads and can raise no objections. The Board also has no comment to make on this proposal as it can see no way that its activities will be affected.

Yours faithfully,

R. L. Timbrell

R.L. Timbrell
SECRETARY

New South Wales Government

epartment of Conservation and Land Management
Incorporating the Soil Conservation Service
Murwillumbah District Office

P.O. Box 796 Murwillumbah NSW 2484

Phone: (066) 725488

Contact: H.B. Hungerford

Our Ref: 126

Your Ref:

Maria Whipp
Environmental Planner
Roads and Traffic Authority
P.O. Box K198
HAYMARKET NSW 2000

Dear Madam

E.I.S. Proposed Brunswick Heads Bypass
Your letter TEP: 10/62.1325 dated 27 September 1991

I refer to your letter dated 27 September 1991 addressed to our Chatswood Head office.

It is suggested that the range of issues that have been addressed in the E.I.S. for the Proposed Chinderah Bypass also be addressed in the E.I.S. for the Proposed Brunswick Heads Bypass.

Additionally, you are advised that the Soil Conservation Service has several areas north of Brunswick Heads, along the proposed highway route, mapped as Protected Land under provisions of the Soil Conservation Act.

Figure 2 supplied with your letter does not have sufficient clarity or explanation to relate the proposal to the mapped areas of Protected Land. However, attached for your information are copies of (section of) the Brunswick Heads 1:25000 Protected Land map and Explanatory Notes on Restrictions On Destruction Of Trees On Protected Land.

Particularly in respect of the proposal north of the Brunswick River, issues of erosion and sediment control and revegetation need to be addressed as does the matter of slope instability (and potential slope instability) as reflected by the area requiring stabilization over recent years by the R.T.A. in the north western corner of Portion 187, Parish Billinudgel, County Rous.

If you require clarification of further information please contact me on 066 725488.

Yours faithfully

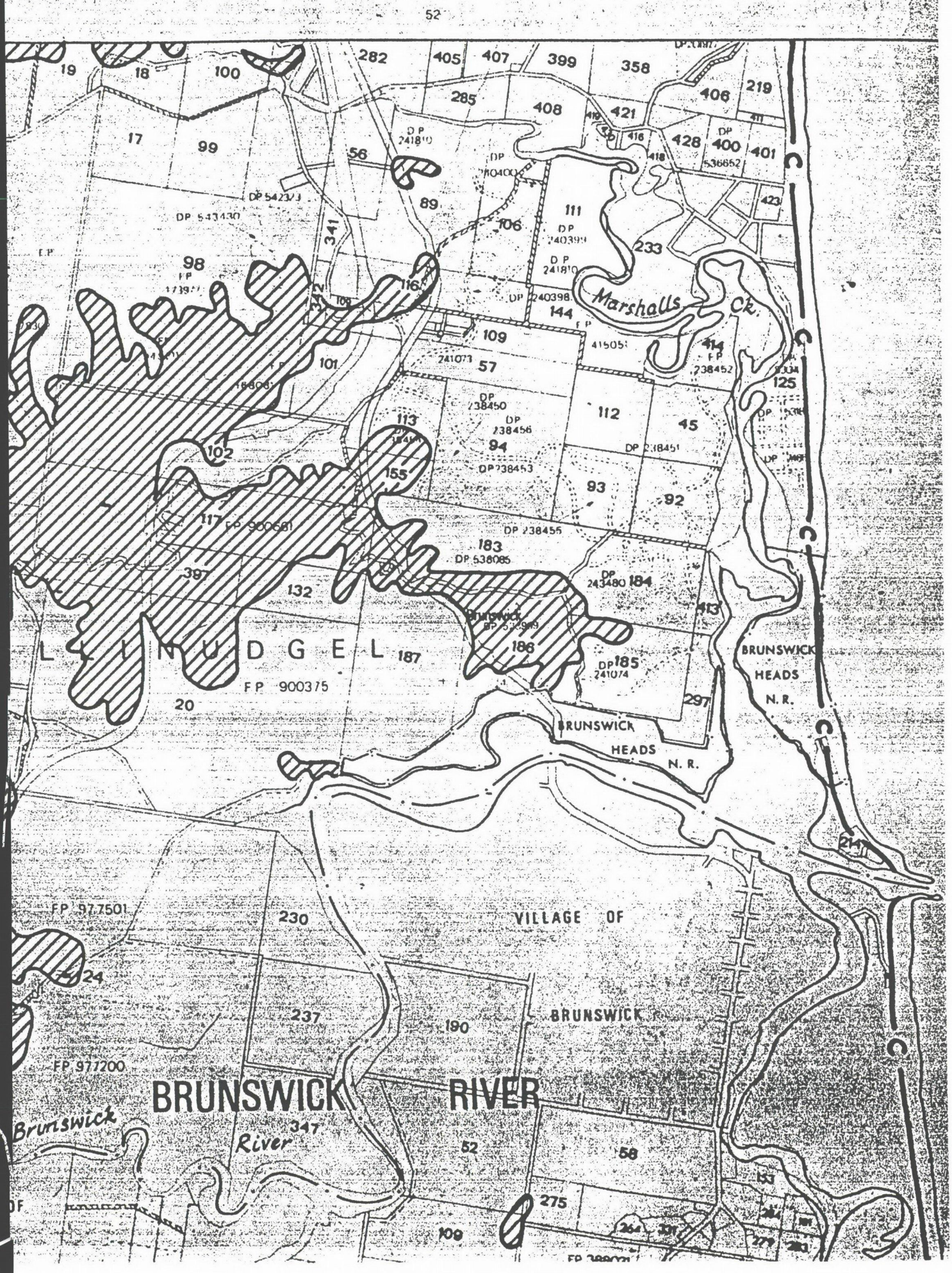
.....

H.B. Hungerford
District Soil Conservationist
MURWILLUMBAH

23 October, 1991

Projection UTM

BRUNSWICK 1



SOIL CONSERVATION SERVICE OF NEW SOUTH WALES
MURWILLUMBAH

RESTRICTIONS ON DESTRUCTION OF TREES ON PROTECTED LAND

---

1. *Soil Conservation Act*

The Soil Conservation Act, 1938, requires owners, occupiers and holders or grantees of timber rights, to make application to the Soil Conservation Service for an authority before destroying or injuring trees growing on protected land.

2. *Protected Land*

Protected land means land mapped by the Soil Conservation Service as having slopes generally in excess of 18 degrees from the horizontal; land in the bed or within 20 metres of the bank of any river, stream, lake, lagoon or swamp mapped or listed by the Service; or land mapped by the Service as being environmentally sensitive, or affected by or liable to, erosion, siltation or degradation.

3. *Why is it necessary?*

The way land is used requires careful planning and management if costly land degradation is to be avoided. Silt in rivers is the main form of pollution throughout rural areas of New South Wales. Siltation can render works entirely ineffective and seriously degrade waterways to the general disadvantage of the community.

Generally a vigorous tree cover is recognised as the most effective control of erosion on steep lands and is of major importance along river banks.

Appropriate land use and sympathetic land management will protect the land and water resources and minimise the rate of soil erosion and stream sedimentation; the loss of shelter for livestock; the loss of wildlife habitats; and the reduction in landscape amenity.

4. *What land is affected?*

These provisions of the Soil Conservation Act apply to all land mapped as protected land or along prescribed watercourses or water bodies, irrespective of tenure. That is to say, private property (freehold) and leased lands are included as well as lands held under tenure from the Crown.

5. *Prohibition to Prevail*

If a person is prohibited from doing anything under these provisions or an authority issued by the Service nothing in any other Act may permit the doing of that thing, except as provided for in paragraph 10 hereunder.

6. *What are the restrictions relating to 'protected land'?*

The Soil Conservation Act provides that, unless the authority of the Soil Conservation Service has been obtained, a person shall not

(a) ringbark, cut down, fell, poison or otherwise destroy, or cause to be destroyed; or
(b) top, lop, remove or injure or cause to be injured, any tree ('tree' includes sapling, shrub and scrub) on protected land.

7. *How is Protected Land Identified?*

Maps showing protected land are located in the Murwillumbah office of the Soil Conservation Service, and may be inspected by any person during normal office hours.

8. *Applications*

The application form can be obtained from the Murwillumbah office of the Soil Conservation Service.

Write to or phone:

Soil Conservation Service
P.O. Box 796
Murwillumbah NSW 2484
Phone: (066) 725488

9. *Procedures - Protected Land*

As soon as possible after receiving an application to lop or destroy trees on protected land, the Soil Conservation Service staff will arrange an inspection of the area concerned. If it approves of the application, the Service will issue an authority under section 21D of the Act subject to conditions considered necessary to control erosion and siltation and to generally eliminate or mitigate any adverse effects on the environment.

10. *Exemptions from Protected Land Provisions*

Anybody who is required or authorised to lop or destroy any tree on protected land having a slope in excess of 18 degrees within a notified catchment area by or under any other Act or by any licence, permit,authority or consent granted or issued under any such Act is not required to obtain an authority to do so under the Soil Conservation Act.

Similarly, an owner or occupier of protected land having a slope in excess of 18 degrees need not apply for an Authority should he wish to cut or destroy in any period of one year -

(a) no more than 7 trees per hectare;

(b) the trees growing on no more than 2 hectares of each separate area of protected land where the area of not more than 2 hectares does not comprise more than a quarter of the separate area of

protected land, other than for the development of a banana plantation, horticulture or the growing of crops; or the construction of a vehicular track or road.

(c) the trees comprising a banana plantation or orchard involving the normal harvesting and management of banana plantations and orchards, other than the complete destruction of the plantation or orchard.

11. *Penalties*

Any person who contravenes these provisions of the Soil Conservation Act is liable to a fine of up to $10,000 for each offence if dealt with in the Local Court, though any prosecution may continue to be launched in the Land and Environment Court where the maximum fine under the Act of $50,000 may be imposed.

12. *Remedial Measures*

If a person contravenes these provisions by damaging or destroying trees and the operations have resulted in or are liable to result in soil erosion, land degradation, siltation, or obstruction to the flow of a river or lake, or any adverse effect on the environment, the Soil Conservation Service can require that person to carry out remedial measures to its satisfaction or the Minister can authorise the Service to undertake the work and recover the cost from the landholder. Failure to comply with such a notice may also attract the same penalties as in paragraph 11 above.

13. *Further Advice*

The Soil Conservation Service is conscious of the Government's wish that - "the provisions work in the interests of the whole of the State, as well as in the interests of the individual landholder".

Before destroying trees on any land, consult the local office of the Soil Conservation Service and obtain advice. The local officers understand your problems of land use, know how to deal with them and are keen to assist.

Brunswick Heads Progress Association Inc.

BRUNSWICK HEADS, N.S.W. 2483

RECEIVED
2 4 OCT 1991
Environmental Planning Section

The Environmental Planner,
R.T.A.
P.O. Box K198,
Haymarket. NSW 2000.

Dear Mrs. Whipp,

Ref;- STATE HIGHWAY NO 10 - PACIFIC HIGHWAY -BRUNSWICK HEADS BYPASS T E 1325

The Association appreciates your invitation and our opportunity to comment on the environmental impact of the proposed Brunswick Heads bypass.

This proposal is timely. The impact, in human terms, of the ever increasing flow and heavy character of highway traffic can be corrolated to the hazzards created to a wide section of the community. Council studies have identified that the Brunswick Heads population primarily consists of young families and an aged, retired group. As a bypass will dramatically reduce traffic flow through the township to that of a local character, so will the safety and amenity of the population be improved. Diversion of the highway traffic will also be safer and more easily regulated. There will be less driver fatigue and frustration caused by the speed restrictions, conflict with local traffic and by pedestrians particularly the children and the aged group.

In environmental terms, the Association is unable to identify any adverse factor arising out of the proposal and suggest that benefits will completely overshadow any opposing consideration. However, we believe that such matters as drainage and flood studies should be considered as a matter of engineering by RTA engineering staff.

The impact upon the business sector of the community can confidently be predicted, in our view, by drawing on the experience of the like communities of Nambucca Heads particularly, and Batemans Bay. In these places as in Beenleigh, Qld, accelerated economic growth has resulted.

The sector designated "Wetlands" you refer to is understood to be on the northern side of the Brunswick River. In this case the Association will raise no adverse comment for two reasons:-

(1) We see the Association's role as being specifically concerned with Brunswick Heads and as such north of the river falls without our accepted interest. The Ocean Shores Progress Association may be pleased to comment on this matter.

(2) Notwithstanding the above comment and in general terms, I believe the Association would seek that "Wetlands" be treated with sensitivity and extreme care. Disturbance to these areas should be avoided where possible for the survival of the creatures that rely upon it and it's importance to our own welfare. With an approach consistant with these views I suggest that the Association could be expected to not oppose it.

Bypass of Brunswick Heads has been on the Association's agenda for many years as an essential ingredient to the development and future lifestyle of our community. We therefore unreservedly support the proposal and seek it's early fruition.

Yours faithfully,

Ann Bennett

Sectetary

For exchange of information please refer to:-

Neville Franks
P.O. Box 100,
Brunswick Heads. 2483.

(066) 851244

RH:JZ(LE680)
R REF: CR 096/2
UR REF: TEP:10/62.1325

PUBLIC WORKS

NEW SOUTH WALES

The Environmental Planner,
Roads & Traffic Authority,
P.O. Box K198,
HAYMARKET. N.S.W. 2000

RECEIVED
25 OCT 1991
Environmental Planning Section

Contact: Mr. R. Hagley
Phone: (066)211655

22/10/91

Attn: Maria Whipp

Dear Mrs. Whipp,

State highway No.10 - Pacific Highway
Proposed Brunswick Heads Bypass -
Environmental Impact Statement

I refer to your letter of 27th September, 1991 concerning the preparation of an E.I.S. for the subject bypass proposal.

Public Works considers that the following issues need to be addressed in an E.I.S. for the proposal:

Flooding

The E.I.S. should assess the existing flood levels and behaviour and describe the impact the bypass would have on those levels and behaviour in particular where existing development is affected. It is recommended that the assessment of flooding cover a range of flood conditions, say 1%, 5% and 20% A.E.P. events. Such an assessment should be carried out in accordance with the guidelines set out in the State Government's Floodplain Development Manual.

Surface Water

The E.I.S. should address measures for protecting surface waters from contamination both during construction and when the road is operational.

Brunswick Heads Boatharbour

The proposed bypass lies outside of the area associated with the Department's Brunswick Heads Boatharbour works. However it is recommended that the Authority liaise with Byron Shire Council and this Department concerning proposed upgrading of the intersection of the boatharbour/boat launching ramp access road with the Pacific Highway.

Enquiries concerning these matters should be directed to Mr. Richard Hagley on telephone (066) 211655.

Yours faithfully,

M.K. Harrap,
Regional Engineer,
Lismore.

AL 25/10

NSW PUBLIC WORKS DEPARTMENT, REGIONAL OFFICE, P.O. BOX 22, LISMORE, NSW 2480. TEL: (066) 21 1660 FAX: (066) 21 4920

OFFICE OF ENERGY
NEW SOUTH WALES GOVERNMENT

MINERALS AND ENERGY HOUSE
29-57 CHRISTIE STREET
CORRESPONDENCE PO BOX 536
ST LEONARDS NSW 2065
DX 3324 ST LEONARDS
TELEPHONE (02) 901 8888
FACSIMILE (02) 901 8777

Mrs Maria Whipp
Environmental Planner
Roads and Traffic Authority
260 Elizabeth Street
SURREY HILLS 2010

17 OCT 1991

Dear Mrs Whipp

I refer your letter dated 27 September 1991 seeking comments to assist you in your preparation of an Environmental Impact Statement on the Roads and Traffic Authority proposal to construct a bypass of Brunswick Heads in accordance with Part V of the Environmental Planning and Assessment Act.

The Office of Energy does not foresee any aspects of the proposal which could affect, or be affected by, any works, property or planning which come under the Office's administration.

Thank you for providing an opportunity to comment.

Yours sincerely

B Bosler
Director Energy Resources and Policy Division

New South Wales Government

Forestry Commission of N.S.W.

Forestry Office

P.O. Box 945,
MURWILLUMBAH. 2484

14.10.1991

Mrs. M. Whipp,
Roads and Traffic
Authority,
P.O. Box K198,
Haymarket. N.S.W. 2000

Your reference: TEP:10/62.1325

Our reference : 357 IGR:LJG

Telephone: (066) 72 1213

Fax: (066) 72 5112

ear Madam,

State Highway No. 10 - Pacific Highway.
Proposed Brunswick Heads Bypass-
Environmental Impact Statement.

With reference to your letter of 27th September, 1991 I wish to advise at the Forestry Commission's only interest in the proposal is the moval of timber from any areas of Crown-timber land that may be volved.

We would be anxious to salvage any merchantable sawlogs if they are esent from Crown land or road reserves prior to the trees being pushed er and burnt.

Apart from this aspect we have no other interest in the proposal and other matters which need to be addressed in your Environmental Impact atement.

Yours faithfully,

I.G. Robertson,
District Forester. IG

PATROL COMMANDER'S OFFICE
BYRON BAY 2481

10 October 91

Ref 91/1301/23

Mrs M Whipp

Roads & Traffic Authority
P.O. Box K198
HAYMARKET NSW 2000

State Highway No. 10 - Pacific Highway. Shire of Byron.
Proposed Brunswick Heads Bypass - Environmental Impact Statement.

- - -

Forwarded for information as outlined in the attached report of Sergeant Welsh, Sector Leader Brunswick Heads. Further information can be obtained by either contacting myself on Telphone 066 856300 or Sergeant Welsh at Brunswick Heads on Telephone 066 851277.

Inspector
Patrol Commander

Patrol Commander.
BYRON BAY.

State Highway No. 10 - Pacific Highway. Shire of Byron/.
Proposed Brunswick Heads Bypass - Environmental impact statement.

- - - - - - - -

From my understanding of the route of the proposed for the Brunswick Heads bypass, from viewing of the attached plan and general inquiries from local residents there will be little or no impact upon thex environment in that area.

From the local residents and the Police view the Brunswick Heads bypass is a long overdue step in the right direction by eliminated the heavay volume of traffic from the main part of this town.

Forwarded for information and necessary attention.

K.J.WELSH
Sergeant
Sector Leader
Brunswick Heads Police Sation.
5 October, 1991.

TELE. (066) 231525
FAX (066) 231 529.



PATROL COMMANDER'S OFFICE
LISMORE 2480
2 October, 1991
Ref.....
91/1301/23
BYRON BAY

Patrol Commander
BYRON BAY 2481

State Highway No. 10 - Pacific Highway. Shire of Byron.
Proposed Brunswick Heads Bypass - Environmental impact statement.

* * * *

Referred for information and attention.

C. J. JURD
PATROL COMMANDER

bb:dr.

Sector Leader
BRUNSWICK HEADS

Referred for comment in the first instance.

K W Jones
Senior Sergeant
abs Patrol Commander
Police Station Byron Bay
3 October, 1991
91/403
Sgt WELSH

DEPARTMENT
OF LANDS

(Division of DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT)

Roads and Traffic Authority
P.O. Box K198
HAYMARKET NSW 2000

YOUR REF.:
OUR REF.:
CONTACT OFFICER:
TELEPHONE NO.:

Attention: Mrs M. Whipp

Your ref:TEP: 10/62.135
Our ref: HO91H245
Telephone:066-420 666

STATE HIGHWAY No.10 - PROPOSED BRUNSWICK HEADS Bypass
ENVIRONMENTAL IMPACT STATEMENT-PRELIMINARY COMMENTS

Reference is made to your letter dated 27 September 1991 seeking input into the forthcoming Environmental Impact Statement (EIS) for the Brunswick Heads highway Bypass.

The following, details issues which are of concern to the Grafton Office of the Department of Conservation and Land Management and which should be addressed in the EIS:

(1) Relocation of the Ferry Reserve Caravan Park

The Ferry Reserve Caravan Park is located within R74701 for Public Recreation shown by blue colour on Diagram "A". The eventual construction of the Bypass will absorb the majority of the land currently occupied by the Caravan Park. The RTA should now assist to identify options for the relocation of the Ferry Reserve Caravan Park.

(2) Mobile Home Park

This Office has undertaken investigations into the establishment of a Mobile Home Park within the Crown land west of the town of Brunswick Heads. The proposed location of the bypass will have a detrimental effect on sites selected. The RTA should investigate alternative sites for a Mobile Home Park within Crown land east of the proposed bypass.

(3) Urban Development/Village Expansion

The location of the proposed Bypass effectively severs the Crown land which has previously been identified as being suitable for Urban Development (village expansion) including community facilities. The impingement of the proposed Bypass over the Crown land may have, or place restrictions on any future urban development (subdivision design etc) east of the Bypass.

(4) Drainage/Flooding

This Office is concerned in respect to any drainage/flooding problems on the crown land which may result from the construction of the Bypass. This is especially in regard to Crown land-east of the proposed Bypass identified for urban development.

(5) Aboriginal Land Claims

There are three Aboriginal Land Claims (No 2330-HO85H1350; No 2334-HO85H1354 and No 2335-HO85H1355) affected by the proposed Bypass. The RTA is aware of these claims and any action on them has been deferred pending the outcome of the EIS exhibition and final survey of the Bypass.

With respect to (1) above it should be noted that a tentative meeting has been arranged, involving officers from the Grafton Office, Department of Conservation and Land Management, Byron Shire Council and the Roads and Traffic Authority to discuss the future/relocation of the Ferry Reserve Caravan Park.

The northern extension of the route which is not scheduled for construction within 5 years does not affect any Crown land (apart from the crossing of the Brunswick River) and this Office makes no comment of this proposal.

Further information can be obtained on the above matters by contacting the Manager, Grafton Office of the Department of Lands, Division of the Department of Conservation and Land Management, State Office Block, Grafton, 2460. Larry Griffin

Rex Bowen 20/11/81
For SECRETARY OF LANDS

ANNEXURE "B"

DIAGRAM B (N.E.)
SCALE 8 CHAINS

DIAGRAM C (S.E.)
SCALE CHAINS 0 4 8 CHAINS

LEGEND

BROWN COLOUR: CROWN ROAD

PURPLE COLOUR: VACANT CROWN LAND COMPRISING:-
- PT. PORTION 58
- PT. PORTION 331 PT. R.79621 FOR FUTURE PUBLIC REQUIREMENTS NOTP 24.5.57 (ADDED GAZ. 13.7.73)
- LOT 395 D.P. 724679 - PT R.79621 FOR FUTURE PUBLIC REQUIREMENTS NOTP 24.5.57
- PT. PORTION 329

ORANGE COLOUR: FREEHOLD LAND (INCLUDES PART PORTIONS 264, 154, 33.)

GREEN COLOUR: PT. LOT 396 D.P. 724680 - PART R 38114 FOR PRESERVATION OF NATIVE FLORA NOTP 6.8.04 - BYRON SHIRE COUNCIL TRUSTEE.

RICHMOND RIVERS GOLD FIELD

ANNEXURE A

BRUNSWICK

RIVER

from Murwillumbah

Marshalls Creek

R. L. APPLN. BY N.F. BALL

L B 68 - 733

GF 82 H 72

SMALL CRAFT POINT GF 85. H. 209

Refer GF 82 H 304

B. BATSON PTY. LTD. GF 82 H 304

R 80457

for Public Recreation

Notified March 21, 1958

PACIFIC HIGHWAY

R 23966

R 69040

APPLN. LAND CLAIM 2.336 HO. 85 H. 1356

D.P. 728662

for Future Public Requirements

Pt. P.O 69/15

Notified

R 179A R

S.H. No. 10

TWEED

D.P. 729252 MS. 4438 GFN.

276

3.95 ha

250

NEWBEE

PANDANUS COURT

FAWCETT ST.

MULLUMBIMBI

BRUNSWICK STREET

S.H. No. 10 TWEED HIGHWAY

FINGAL

CUDGEN ST

BOWER ST

BOOYUN

SURVEY

NANA

AREA

SHORT

BYRON

TEVEN ST

MINYON STREET

CEMETERY Public Dedicated Park

Dedd 1-4-77 July 11, 1884

PACIFIC

Simpsons

to Ballina

See Res Diagram 82

268

ALLOT 5 RE-DISP B70-857

PRE-SCHOOL GF 91 H. 611

Ms 453 Gfn.

869

D.P. 729296

Ms 4607 Gfn

Filling of Secs 2 & 3

STUDY

5.82 ha incl. Esm't

D.P. 772

Key GF 85 H 54

GF 80 H 361

333

316

417

419

273

328

409

190

34 - 20

52

58

153

JOINS DIAGRAM 'B'

LEGEND

BROWN COLOUR : CROWN ROADS

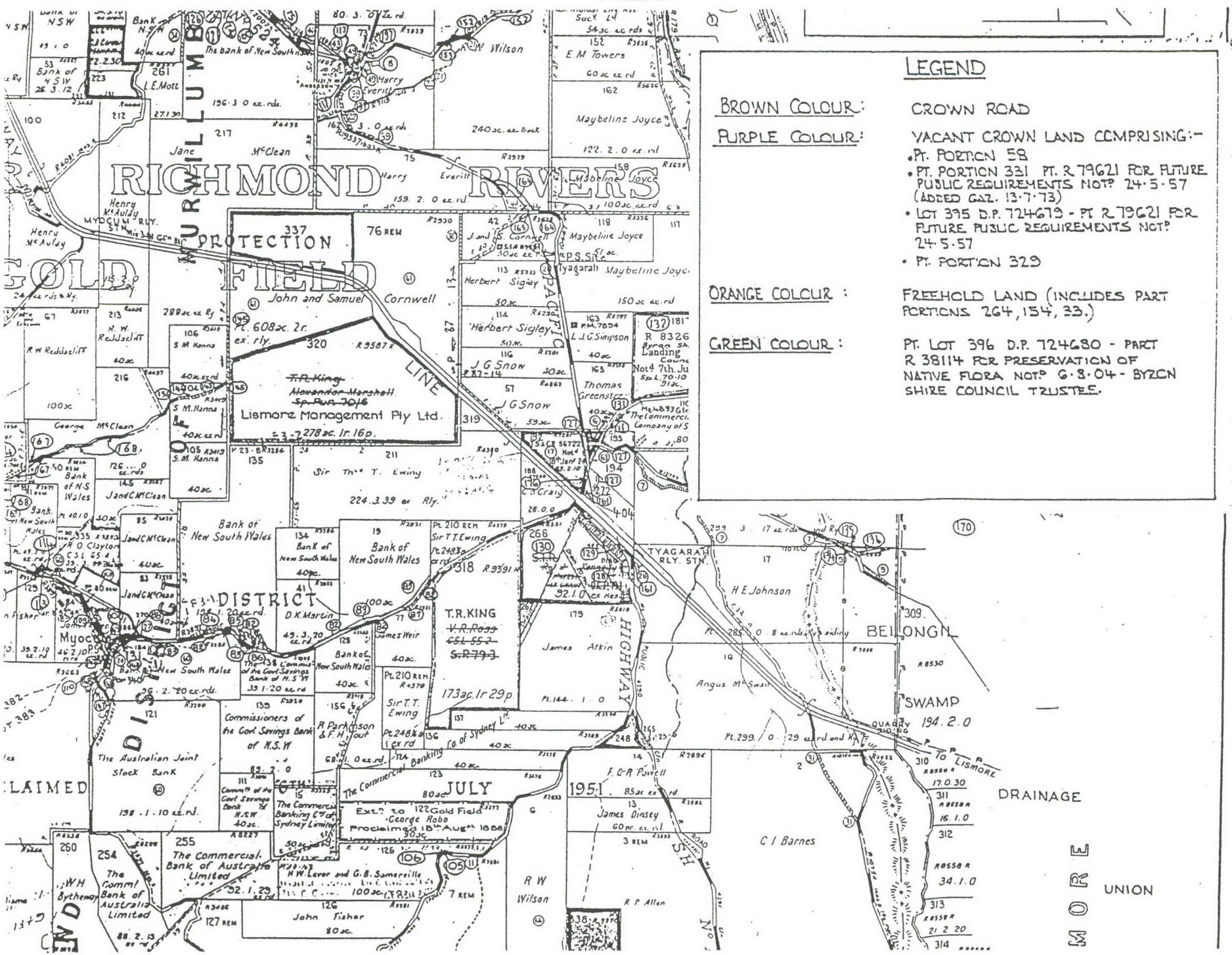
PURPLE COLOUR : VACANT CROWN LAND PT LOT 417 D.P. 729100 & PT LOT 419 D.P. 729256

ORANGE COLOUR : FREEHOLD LAND

BLUE COLOUR : A. R 74701 FOR PUBLIC RECREATION NOTIFIED 18·1·52 AND 23·10·70 BYRON SHIRE COUNCIL TRUSTEE - APPOINTED 10TH APRIL, 1987 (INCLUDES FERRY RESERVE CARAVAN PARK)

GREEN COLOUR : PT. LOT 412 D.P. 728662 - R 69040 FOR FUTURE PUBLIC REQUIREMENTS NOTIFIED 23RD FEBRUARY, 1940. HELD UNDER PERMISSIVE OCCUPANCY 1969/15 MURWILLUMBAH FOR GRAZING BY P., D., G & V. ULLIANA

PINK COLOUR : PUBLIC ROAD


RICHMOND RIVERS
GOLD FIELD
MURWILLUMBAH
PROTECTION
LINE
HIGHWAY
DISTRICT
LEGEND
BROWN COLOUR: CROWN ROAD
PURPLE COLOUR: VACANT CROWN LAND COMPRISING:-
• Pt. PORTION 58
• PT. PORTION 331 PT. R 79621 FOR FUTURE PUBLIC REQUIREMENTS NOT? 24·5·57 (ADDED GAZ. 13·7·73)
• LOT 395 D.P. 724679 - PT R 79621 FOR FUTURE PUBLIC REQUIREMENTS NOT? 24·5·57
• Pt. PORTION 329
ORANGE COLOUR: FREEHOLD LAND (INCLUDES PART PORTIONS 264, 154, 33.)
GREEN COLOUR: PT. LOT 396 D.P. 724680 - PART R 38114 FOR PRESERVATION OF NATIVE FLORA NOT? 6·8·04 - BYRON SHIRE COUNCIL TRUSTEES.
Lismore Management Pty Ltd.
T.R. KING
T.T. King
Alexander Marshall
Sp. Pur. 7016
V.R. Rogg
CSL 55-2
S.R. 793
173ac. 1r 29p
Ext? to 122 Gold Field
George Robo
Proclaimed 18th Aug? 1888
1951
JULY
DRAINAGE
SWAMP
TYAGARAH RLY. STN.
BELONGIL
Bank of New South Wales
The Commercial Bank of Australia Limited
The Australian Joint Stock Bank
Commissioners of the Govt Savings Bank of N.S.W
The Commercial Banking Co of Sydney Limited
The Bank of New South Wales
Bank of N.S.W
Jane McClean
Henry McAuley
Harry Everill
Maybelline Joyce
Herbert Sigley
J.G. Snow
Thomas Greenstreet
H.E. Johnson
Angus McSmith
James Atkin
James Dinsey
C.I. Barnes
R.W. Wilson
John Fisher
J. and S. Cornwell
John and Samuel Cornwell
Sir Thos T. Ewing
James Weir
F.G.R. Powell
R.P. Allen
H.W. Bythenay
H.W. Lever and G.B. Somerville
R.P. & F.H. Jout
R. Parkinson
D.K. Martin
R.O. Clayton
J. and C.M. McClean
S.M. Hanna
R.W. Reddacliff
L.J.G. Simpson
The Commercial Company of S
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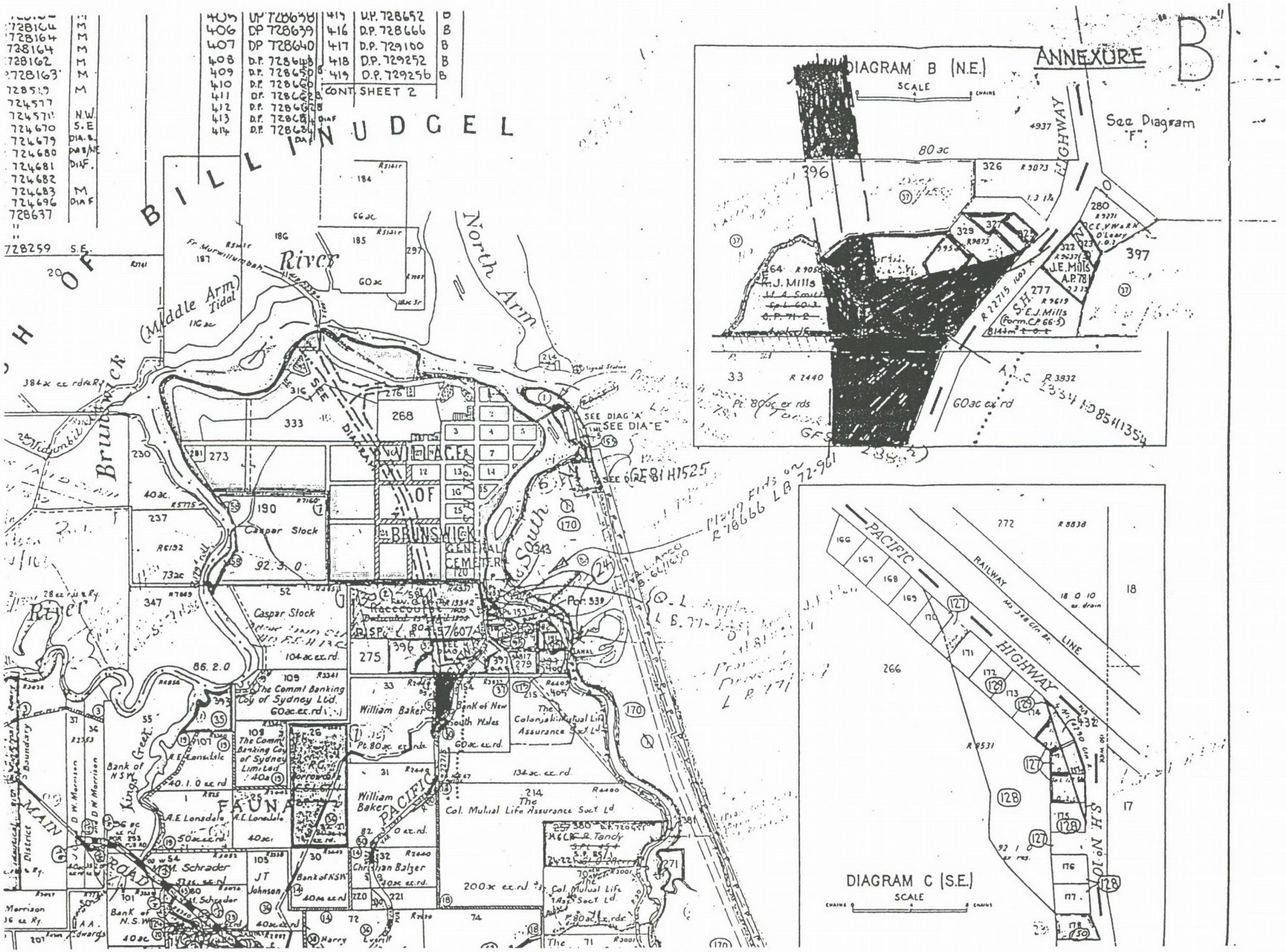
MOREE


ANNEXURE B
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S.E.J. Mills
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60 ac ex rd
A.L.C. R 3932
DIAGRAM C (S.E.)
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RAILWAY
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LINE
S.H. No 10
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130
131
132
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GENERAL
CEMETERY
Caspar Stock
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86.2.0
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60 ac ex rd.
134 ac. ex. rd.
200 ac ex rd
William Baker
Bank of New South Wales
The Colonial Mutual Life Assurance
Col. Mutual Life Assurance Soc. Ltd
Christian Balzer
Bank of N.S.W.
Bank of N.S.W.
The Comml Banking Coy of Sydney Ltd.
A.E. Lonsdale
M. Schrader
JT Johnson
Harry
Lyall
Brunswick River
(Middle Arm) Tidal
North Arm
South Arm
Pacific
King Geo.
Main
Road
SEE DIAG 'A'
SEE DIA 'E'
SEE DIAGRAM
SEE GE 81 H 1525
Plan Finds on R 78666 LB 72-961
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L B 171
Proposed
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D.P. 729100
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D.P. 729256
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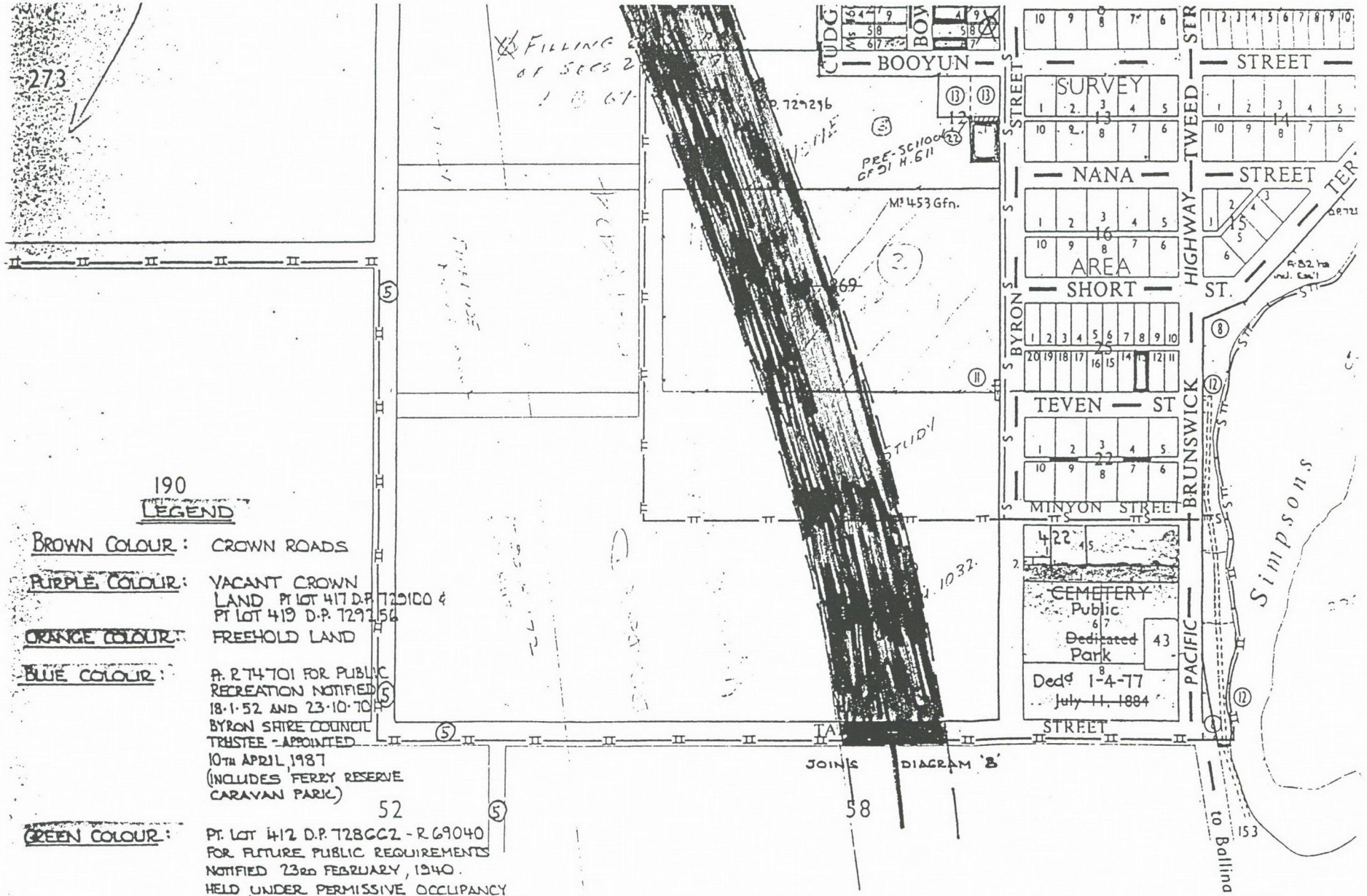


LEGEND

BROWN COLOUR: CROWN ROADS

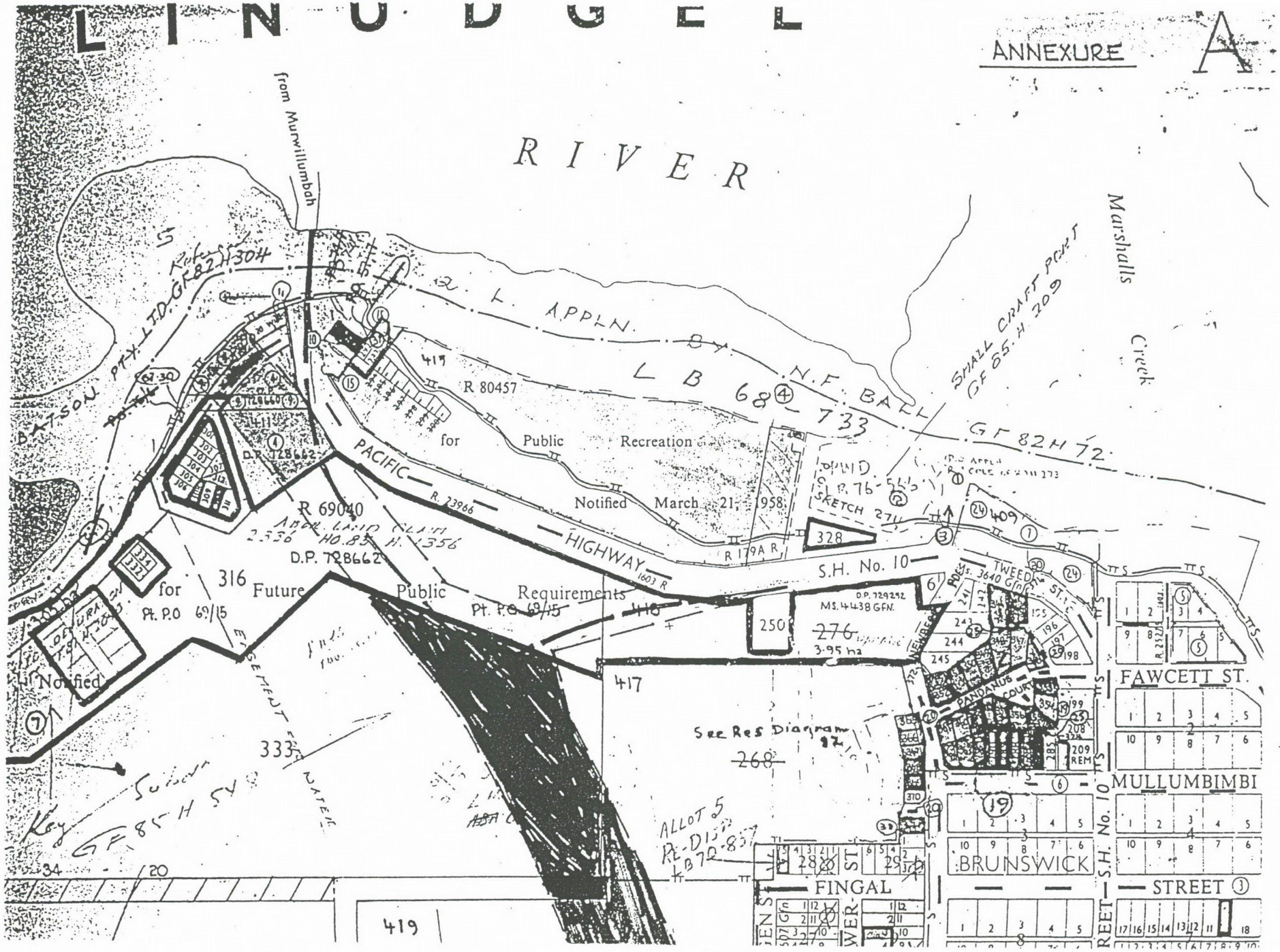
PURPLE COLOUR: VACANT CROWN LAND PT LOT 417 D.P. 729100 & PT LOT 419 D.P. 729156

ORANGE COLOUR: FREEHOLD LAND

BLUE COLOUR: A. R 74701 FOR PUBLIC RECREATION NOTIFIED 18·1·52 AND 23·10·70 BYRON SHIRE COUNCIL TRUSTEE - APPOINTED 10TH APRIL, 1987 (INCLUDES FERRY RESERVE CARAVAN PARK)

GREEN COLOUR: PT. LOT 412 D.P. 728662 - R 69040 FOR FUTURE PUBLIC REQUIREMENTS NOTIFIED 23RD FEBRUARY, 1940. HELD UNDER PERMISSIVE OCCUPANCY 1969/15 MURWILLUMBAH FOR GRAZING BY P., D., G & V. ULLIANA

PINK COLOUR: PUBLIC ROAD



LINUDGEL
ANNEXURE A
RIVER
from Murwillumbah
Marshalls Creek
SMALL CRAFT PORT GF 85.H 209
Q. L. APPLN. BY N.F. BALL GF 82H 72
LB 68④-733
R 80457
for Public Recreation
Notified March 21, 1958
PACIFIC HIGHWAY
R. 23966
R 69040
D.P. 728662
316
for Future Public Requirements
Pt. P.O 69/15
Notified
333
417
419
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276
3.95 ha
D.P. 729252
MS. 4438 GFN.
S.H. No. 10
TWEED ST.
PANDANUS COURT
FAWCETT ST.
MULLUMBIMBI
BRUNSWICK
STREET
FINGAL
See Res Diagram
268
ALLOT 5
BATSON PTY. LTD. GF 82H 304
Key
GF 85H 54

DEPARTMENT
OF LANDS

YOUR REF: TEP 10/62.1325
OUR REF. GF 81 R 424
CONTACT: LARRY GRIFFIN
PHONE: 066 42 0549
29 NOV 1991

ATTENTION: MARIA WHIPP

DEAR MRS. WHIPP,

PROPOSED BRUNSWICK HEADS BYPASS

THE DEPARTMENTS CONCERNS WERE EXPRESSED IN OUR LETTER OF 20-11-91. THE SUBJECT OF THIS LETTER IS RESERVE NO. 38116 FOR PRESERVATION OF NATIVE FLORA, WHICH WAS NOT DISCUSSED IN THE PREVIOUS LETTER.

THIS OFFICE DOES NOT HAVE ANY DETAILED INFORMATION ON THE RESERVE THERE HAS NOT BEEN ANY TRUSTEES APPOINTED TO MANAGE THE RESERVE ON BEHALF OF THE DEPARTMENT. HOWEVER IT IS KNOWN THAT THE RESERVE IS COVERED WITH HEALTHY NATURAL VEGETATION, SOME MATURE TREES. THE EFFECT OF THE BY-PASS ON THE RESERVE SHOULD BE MINIMISED, AS FAR AS IS PRACTICABLE.

THE EFFECT OF THE BY PASS ON THE FLORA RESERVE SHOULD BE ADDRESSED IN THE E.I.S. THIS OFFICE WILL REVIEW SUBMISSIONS RECEIVED ON THE EIS AND REVIEW THE DOCUMENT, IN A SECTION 6(2) REPORT, AS PART OF ITS RESPONSIBILITIES AS A DETERMINING AUTHORITY UNDER PART V OF THE ACT.

YOURS SINCERELY,
Larry J Griffin

FOR REGIONAL DIRECTOR,
NORTH COAST.

49 Victoria Street Grafton NSW Australia 2460 PO Box 11 Grafton NSW Australia 2460
Telephone (066) 42 0546 Fax (066) 42 0556

New South Wales Government

Department of Planning

NORTHERN REGIONAL OFFICE

Mrs. M. Whipp
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

N.S.W. Government Offices
49 Victoria Street,
Grafton 2460.
P.O. Box 6, Grafton 2460.

Telephone: (066) 42 0622 Ext:
Fax No: (066) 42 0640

Contact:

Our reference: G91/00433/Z01
Your reference: JS:LW
TEP:10/62.1325

25 OCT 1991

Dear Mrs. Whipp,

STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY, SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS - ENVIRONMENTAL IMPACT STATEMENT

I refer to your letter of 27th September, 1991 requesting comments regarding the Environmental Impact Statement (EIS) for the proposed Brunswick Heads Bypass. The Department has already issued specifications for this particular EIS. These specifications address the Department's concerns regarding this particular aspect of the proposal.

2. However, concern is expressed about the incremental development of the total Pacific Highway bypass project from Tweed Heads to Brunswick River. The main issue is that the finalisation of one section of the bypass serves to pre-empt the next section of the bypass route. This is of particular concern where State Environmental Planning Policy No. 14 - Coastal Wetlands applies. While SEPP 14 does not prohibit developments, it does require additional environmental assessment under that State Policy as well as Council's consent and the Director of Planning's concurrence. The Director's concurrence should not be assumed. The onus is on the applicant to demonstrate that the development is environmentally acceptable. This should include detailed consideration of alternative routes.

3. While the R.T.A. is to provide an environmental overview of the future route within the Part V EIS, this does not allow for comprehensive assessment of the total proposed route under the Environmental Planning and Assessment Act, 1979, nor satisfy the development process outlined in SEPP 14.

4. In order to provide a proper assessment of the total highway bypass, a comprehensive EIS (under Part V and Part IV of the Act) would be more acceptable. Such a comprehensive EIS would provide proper assessment of all planning constraints including SEPP 14 and SEPP 26, and also allow for consideration of all proposed mitigating measures. In the absence of one comprehensive EIS the stages of the total route should not be structured so as to compromise or pre-empt decisions on sensitive environmental areas such as coastal wetlands.

5. The R.T.A. also needs to provide detailed consideration of alternative routes. These routes should be located on a map and their full economic, social and environmental assessment compared with the preferred route.

6. The Department appreciates consultation with regard to the future planning of the Pacific Highway. Should you wish to discuss this further please contact Jennifer Sullivan or Mike Svikis of this office.

Yours sincerely,

Trevor Prior
Manager
(Northern Regions)

NEW SOUTH WALES **DEPARTMENT OF TRANSPORT**

227 ELIZABETH STREET
SYDNEY NSW AUSTRALIA
GPO BOX 1620
SYDNEY 2001 AUSTRALIA
FACSIMILE (02) 268 2900
TELEPHONE (02) 268 2800

RECEIVED
- 4 NOV 1991
Environmental Planning Section

The Environmental Planner
Roads and Traffic Authority
PO Box K198
HAYMARKET 2000

29 October 1991

STATE HIGHWAY NO 10 - PACIFIC HIGHWAY. SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS - ENVIRONMENTAL IMPACT STATEMENT. Your reference TEP:10/62.1325

Dear Madam

I refer to your letter of 27 September 1991 covering the EIS for the Proposed Brunswick Heads Bypass.

This Department's administration has no works or activities underway or programmed which would affect or be affected by the proposal. I would however draw your attention to the Northern Rivers Region Transport Study which is currently underway. The RTA's representative on this study is Mr Rod Tudge, phone 218 6612, and it would be appropriate for you to maintain contact with Mr Tudge who would be in a position to keep you up to date with developments in the Study.

Yours faithfully

Bob Leavens
Manager - Strategy & Projects

RL 4/11
ms Whipp

APPENDIX E

Proposed Brunswick Heads Bypass
An Invitation to Comment

STATE HIGHWAY No. 10

PACIFIC HIGHWAY

PROPOSED BRUNSWICK HEADS BYPASS

AN INVITATION TO COMMENT



PREPARED BY:

ROADS AND TRAFFIC AUTHORITY

North Eastern Division

THE PROPOSAL

The new road is to be two lanes with an overtaking lane for southbound traffic. Provision is to be made for a future duplication of carriageway. Major junctions are proposed at both ends of the Bypass to provide access to Brunswick Heads.

One corridor option has been identified by the Roads and Traffic Authority to the west of Brunswick Heads, and it passes generally through open forest and grazing land.

An Environmental Impact Statement is to be prepared to examine the impact that the Bypass could have on flooding, flora and fauna and on the local Community. Other effects may be identified during the course of the community consultation programme.

PUBLIC COMMENT

Public comment is now sought as a first step in the Environmental Impact Statement process. If you have any comments which you think we need to know to adequately investigate the proposal you are urged to complete the attached questionnaire.

An aerial photograph showing the proposal will be on display at Brunswick Heads Post Office from 25 September 1991 to 11 October 1991.

Closing date for comments is 25 October 1991, and can be sent to:-

The Divisional Engineer
Roads and Traffic Authority
PO Box 516
GRAFTON NSW 2460

For further information please call or write to:

Bruce Parks, (066) 42 0156 or Robert Kook, (066) 42 0154
at the Roads and Traffic Authority, Divisional Office, 31 Victoria Street, GRAFTON

APPENDIX F

Community Newsletter No. 1
(20 January 1992)

ENVIRONMENTAL IMPACT STATEMENT

BRUNSWICK HEADS BYPASS

COMMUNITY NEWSLETTER NO. 1

JANUARY 1992



PROGRESS TO DATE

YOUR COMMENT

IN YOUR OPINION WHICH OPTION WILL BE THE BEST BYPASS AND WHY?

RED _____

_____

BLACK _____

_____

BLUE _____

_____

GREEN _____

_____

ARE THERE OTHER OPTIONS WHICH SHOULD BE INVESTIGATED? _____

_____

_____

FOR YOUR PREFERRED OPTION WHAT ADVANTAGES AND DISADVANTAGES DO YOU SEE?

_____

_____

_____

_____

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ANY OTHER COMMENTS OR INFORMATION YOU CAN PROVIDE TO ASSIST THE AUTHORITY IN THE PREPARATION OF THE EIS.

_____

_____

_____

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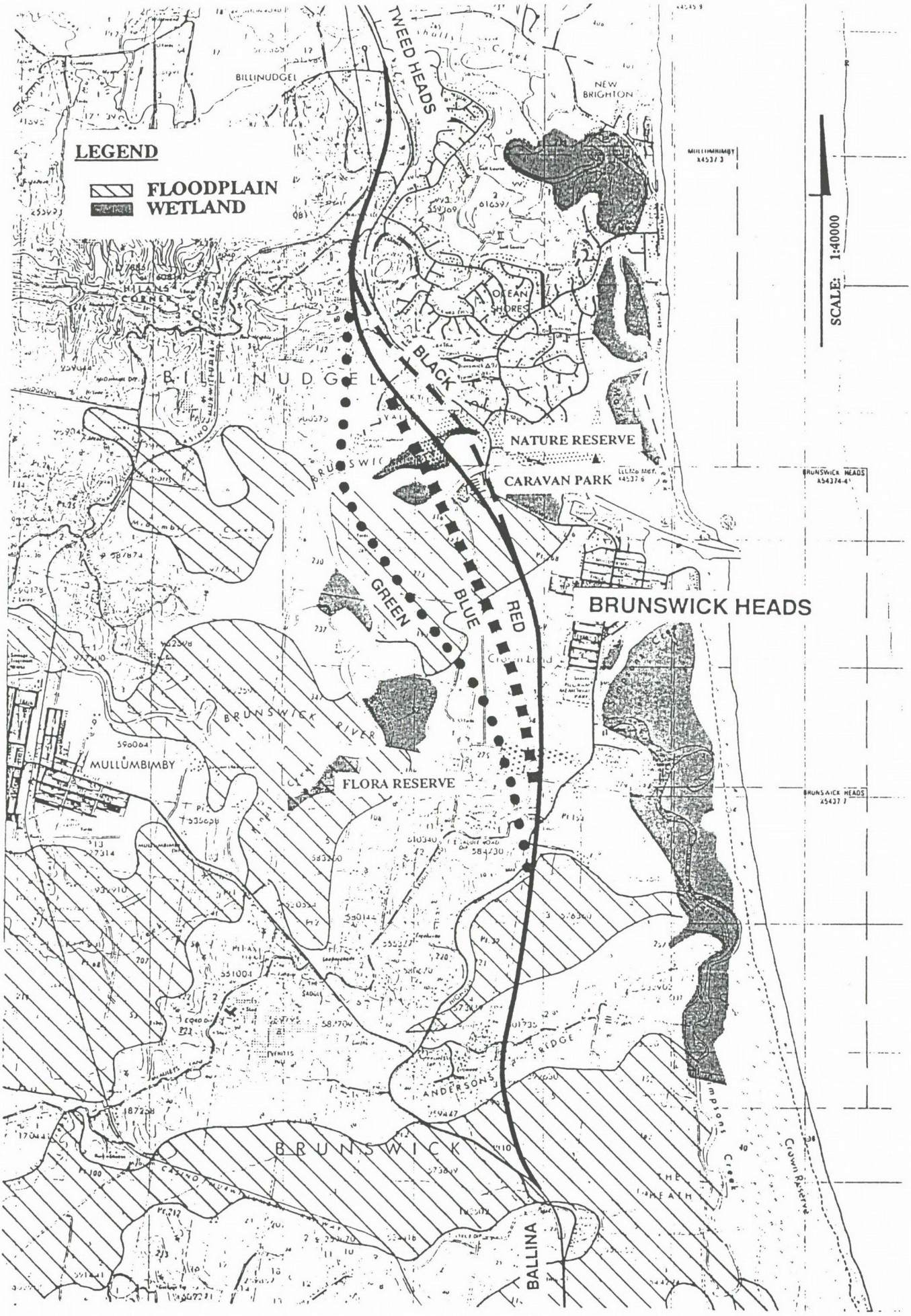
_____

DO YOU WISH TO RECEIVE FURTHER NEWSLETTERS? _____

NAME .....

ADDRESS .....


LEGEND
FLOODPLAIN
WETLAND
SCALE: 1:40000
TWEED HEADS
BILLINUDGEL
NEW BRIGHTON
OCEAN SHORES
BLACK
NATURE RESERVE
CARAVAN PARK
BRUNSWICK HEADS
GREEN
BLUE
RED
BRUNSWICK RIVER
MULLUMBIMBY
FLORA RESERVE
ANDERSONS RIDGE
BRUNSWICK
BALLINA

APPENDIX G

Current Climate Change Scenario for the Australian Region

CLIMATE CHANGE SCENARIOS FOR THE AUSTRALIAN REGION

Issued November 1992

Climate Impact Group, CSIRO Division of Atmospheric Research

Current scientific understanding predicts global warming in the next few decades with a high degree of probability. However, uncertainty in future greenhouse gas emissions, shortcomings in climate modelling, and difficulties in determining the regional implications of climate change from global estimates, mean that detailed and accurate predictions of future climate change at a regional level cannot be made yet. Therefore, *this is not a forecast.*

This set of scenarios is based on the best available science as at November 1992. Scenarios represent a multiplicity of plausible futures. They should *therefore be used as a guide for sensitivity studies only.* Users are advised to investigate possible impacts over the full range of the scenarios provided.

In constructing climate change scenarios there are many sources of uncertainty. Where possible these have been taken into account. Changes outside the ranges given here cannot, however, be ruled out, nor can confidence levels be reliably quantified.

This set of scenarios will be updated as new information comes to hand. For this and other reasons, users are advised to consult the Climate Impact Group (CSIRO Division of Atmospheric Research) before applying this set of scenarios to any particular problem. *This is a summary statement.* More detailed studies are available for a number of regions and topics, or can be done on a consultative basis.

All values given in this summary are relative to 1990 levels.

These scenarios differ from those previously prepared by the Climate Impact Group in two important respects: scenarios at two future dates are included, and uncertainties associated with emissions scenarios have been incorporated explicitly.

Greenhouse Gas Emissions

The IPCC supplement (IPCC, 1992) identifies a broad range of plausible future greenhouse gas emissions in the absence of emission policies beyond those already adopted. Figure 1 shows revised IPCC scenarios for CO_2 emissions (IS92a–f) compared to the IPCC 'business-as-usual' scenario (SA90) used in the original IPCC Scientific Assessment (IPCC, 1990). For other greenhouse gases, the IS92a–f scenarios contain a similar range of possible future emissions.

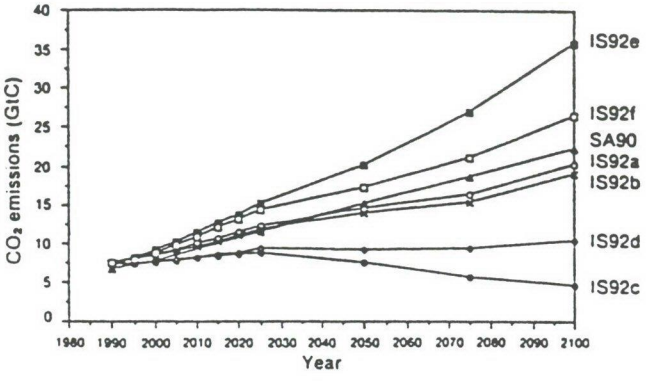


Figure 1 New IPCC scenarios for CO_2 emissions (IS92a–f) compared to the original IPCC (1990) single emissions scenario (SA90).

The regional climate change scenarios given below allow for these new estimates of the uncertainty associated with future greenhouse gas emissions.

Global Warming

The results of global climate models (GCMs) suggest that if the atmospheric CO_2 concentration instantaneously doubled from its pre-industrial level and the climate were allowed to come to a new equilibrium, the resultant mean surface air temperature increase would lie in the range 1.5–4.5°C. This warming value is known as the climate sensitivity. However, this describes a highly idealised situation. In reality CO_2 is increasing continuously, and is not the only greenhouse gas that needs to be considered. Furthermore, because of the large capacity of the oceans to absorb heat, changing greenhouse gas concentrations and global climate would not be in equilibrium.

New scenarios of future global warming that take into account the range of climate sensitivities as well as a range of future greenhouse gas emissions, have been produced by Wigley and Raper (1992). They used a simple model which allowed for the absorption of heat by the oceans. Figure 2 shows the range of future global warming they calculated. The upper limit of this warming corresponds to the highest emission scenario (IS92e) combined with the greatest climate sensitivity (4.5°C). The lower limit is based on IS92c and a climate sensitivity of 1.5°C.

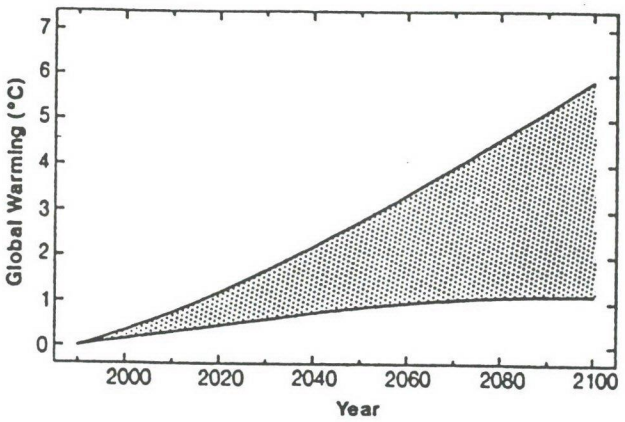


Figure 2. Scenarios of future global warming fall within the shaded region of the graph.

These curves indicate an average global warming in the range 0.6–1.7°C by 2030 and 1.0–3.9°C by 2070. The regional scenarios given below are based on these scenarios of global warming.

The scenarios do not take into account the possible effect of sulfate aerosol or CO_2 fertilisation. These factors are not well understood at present but are being actively researched. Calculations by Wigley and Raper (1992) based on their 'best guess' of the magnitude of these effects suggest reductions in estimates of future global warming of 20–30%. However, any reduction due to sulfate aerosol may not be as great in the southern hemisphere, where the concentration of sulfate aerosol is less than in the northern hemisphere. Depending on the development of the science, we may incorporate these factors into future scenarios.

Climate Change for Australia

TEMPERATURE AND RAINFALL

The following scenarios of regional changes in temperature and rainfall are based on:

- global warming scenarios as outlined above, which provide information on the magnitude of the climate response
- the regional results of five recent GCM equilibrium experiments analysed by CSIRO, which provide information on the regional pattern of the climate response.

The GCM results are used to produce plausible ranges of local temperature and rainfall change per degree of global warming. These values are multiplied by appropriate global warming values to obtain ranges of local temperature and rainfall change for particular times in the future.

This approach assumes that the pattern of regional climate response at any time in the future will be in proportion to the pattern of response for equilibrium conditions. It also does not allow for possible changes in El Niño–Southern Oscillation (ENSO) behaviour—an important climatic feature not simulated in current GCMs.

Within the ranges given in the following tables, there are some combinations of temperature and rainfall change that are not mutually consistent. Most of the lower limits of possible change in the tables assume the lowest climate sensitivity, but where rainfall may decrease the highest climate sensitivity must be assumed to obtain the lower limit. It is not possible to deal adequately with this problem in a summary document. Therefore we ask users to consult us, to ensure that they use the most appropriate climate change information in their studies.

Table 1 Scenarios of temperature change for locations in the Australian region. Values for 2030 are rounded to the nearest half degree and those for 2070 to the nearest degree.

Region	*Local warming per degree global warming (°C)*	*Warming in 2030 (°C)*	*Warming in 2070 (°C)*
Northern Coast (north of about 25°S)	0.3 – 1.0	0 – 1.5	0 – 4
Southern Coast (south of about 25°S)	0.8 – 1.2	0.5 – 2.0	1 – 5
Inland (more than about 200 km from coast)	0.5 – 1.4	0.5 – 2.5	1 – 5

Temperature

Table 1 gives scenarios of temperature changes for the Australian region. Ranges of local warming per degree global warming are given for three regions. These ranges represent differences amongst GCMs, and seasonal variation (although the latter was small). Using these values and the information from Figure 2, we then calculate the ranges of warming for 2030 and 2070. The scenarios for these dates incorporate the additional uncertainty associated with estimating global warming, namely: the range of climate sensitivities, and the range of plausible future emission scenarios.

Compared to the scenario issued in 1991, the above ranges for 2030 represent a downward revision in the warming scenarios for the Australian region. This is due to significant improvements in the method used to construct regional scenarios for particular dates in the future from GCM data, the availability of new GCM data, and the adoption of the Wigley and Raper (1992) global warming scenarios which are a little less than those given in IPCC (1990).

Rainfall

Scenarios of rainfall change are given in Table 2. In the summer half-year (November to April), the same ranges are given for locations throughout Australia, but in the winter half-year (May to October) separate values are given for locations within three different parts of the continent (sub-regions) (see Figure 3). These sub-regions were determined by the spatial pattern of rainfall change as simulated by the five GCMs used. In the winter half-year, no rainfall scenarios are given for the regions with very low rainfall in central and northern Australia.

Changes outside the ranges given in the table and large local variations from place to place could occur, particularly in locations where topography strongly controls rainfall patterns (such as along the southern and eastern coasts).

These scenarios of rainfall change would have the effect of extending southwards the region where summer rainfall is dominant.

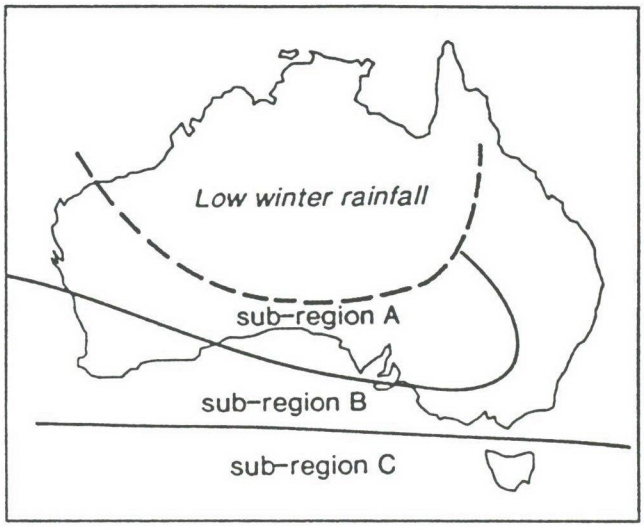


Figure 3 Key to sub-regions used for winter rainfall change.

A general increase in rainfall intensities, and in the occurrence of heavy rainfall events, is also plausible. This change is difficult to quantify at present.

There is a possibility of longer dry spells in southern Australia associated with a reduction in the number of days on which rain falls.

Table 2 Scenarios of rainfall change for locations in the Australian region. Sub-regions are as defined in Figure 3. 2030 and 2070 values are rounded to the nearest 10%.

Season	*Region*	*Response per degree global warming*	*Change in 2030*	*Change in 2070*
Summer half-year (Nov. to April)	Any location	0 – +10%	0 – +20%	0 – +40%
Winter half-year (May to Oct.)	Locations in sub-region A	0 – -5%	0 – -10%	0 – -20%
	Locations in sub-region B	-5 – +5%	-10 – +10%	-20 – +20%
	Locations in sub-region C	0 – +5%	0 – +10%	0 – +20%

EXTREME EVENTS

Extreme events are likely to change in magnitude and frequency more rapidly than the averages. This, together with other changes indicated by current research, implies more very hot days, fewer frosts, more floods and dry spells.

EL NIÑO—SOUTHERN OSCILLATION (ENSO)

In northern and eastern Australia, El Niño years are generally dry, whereas in anti-El Niño years heavy rain often occurs. Future behaviour of ENSO is uncertain. In the absence of evidence to the contrary, El Niños and anti-El Niños can be assumed to continue, with consequent drought and flood years.

TROPICAL CYCLONES

These important, but small-scale events are difficult to model and are a major research priority. Present indications are:

- Region of origin likely to remain unchanged
- Change in intensities and southward extent still uncertain
- Preferred paths may alter
- Location and frequency affected by ENSO.

ALPINE SNOWCOVER

Higher temperature is expected to reduce the duration of alpine snowcover, and any increases in precipitation are unlikely to be sufficient to compensate for this. The extent of the reduction will depend on the magnitude of local warming. The reduction is likely to be quite marked for any local warming in excess of 2°C. Impact will be greater at lower elevation.

WINDS

- Possible strengthening of monsoon westerlies of northern Australia and in the south-east trade winds during summer.
- Change in mid-latitude westerlies not yet clear.

CLOUD

Direction of change expected to correspond to that of rainfall. Quantitative estimates await further investigation.

EVAPORATION

2–4% increase in potential evaporation per degree of local warming.

SEA LEVEL

The scenarios of global mean sea level change for 1990–2100 are shown in Figure 4. These are calculated by Wigley and Raper (1992) and are based on their calculated range of global warming given above in Figure 2. The curves indicate sea level rises above the 1990 level of 5–35 cm by 2030 and 10–80 cm by 2070. The 2030 range is slightly greater than the original IPCC (1990) and earlier CSIRO estimates, because allowance has been made for the range of possible emission scenarios, as given above.

Local variations due to changes in weather and ocean currents, especially affecting the magnitude and frequency of extreme events, such as storm surges, waves, and estuarine flooding, should also be taken into account.

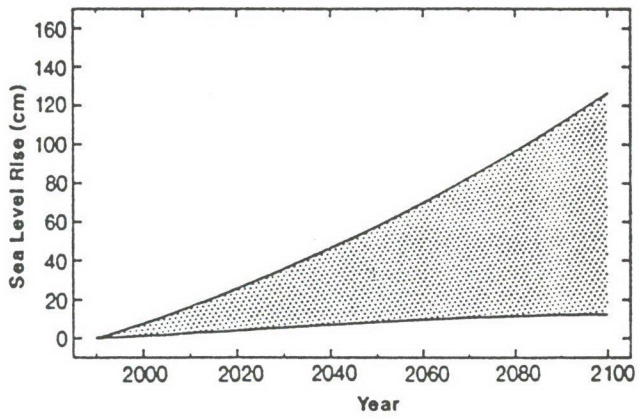


Figure 4 Scenarios of future rise in mean sea level.

Ozone Depletion

ULTRAVIOLET RADIATION

While not due to the greenhouse effect, decreases in upper atmospheric ozone as a result of CFC and halon emissions are expected to increase the intensity of ultraviolet light. Assuming compliance with the 1990 Montreal Protocol for emission of ozone depleting substances, ozone depletion is estimated to be greatest around 2002. At that time, consequent ultraviolet light increases are estimated to be 5–10% or more over most of Australia. Ozone levels are expected to recover over the following half-century. Local ultraviolet exposure will be highly dependent on any changes in cloudiness, which are uncertain at present. An increase in ultraviolet exposure is expected to have deleterious effects on terrestrial organisms and near-surface marine organisms.

Direct CO_2 Effects

Increased CO_2 concentrations may significantly increase the growth rates of many plants. Figure 5 shows the range of future CO_2 concentrations calculated by Wigley and Raper (1992) for the IPCC (1992) emission scenarios (Figure 1). The curves indicate, the CO_2 concentration to be in the range of 450–500 ppmv by 2030 and 510–760 ppmv by 2070. These ranges do not include the effect of CO_2 fertilisation of the terrestrial biosphere, which may reduce these estimated concentrations.

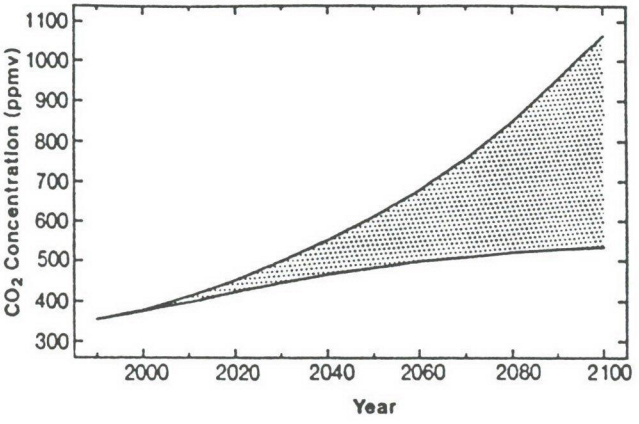


Figure 5 Scenarios of future CO_2 concentrations (after Wigley and Raper 1992).

The effect on plants of increased CO_2 should not be considered in isolation from the effect of likely future climate change, or other factors such as nutrient limitation.

Although plant water-use efficiency increases with increased CO_2 in controlled environments, the overall effect of increasing CO_2 concentration on water use in a competitive field environment is unknown.

Other Factors Affecting Climate

VOLCANOS

Major volcanic eruptions, such as that of Mt. Pinatubo in 1991, may lead to temporary coolings over land of the order of 0.2–0.5°C. After two or three years, temperatures should return to the interrupted warming trend.

SOLAR VARIATION

There is no conclusive evidence that solar variability has had major effects on global climate over the last century, and no reason to expect warming or cooling due to such variations in the next 100 years large enough to significantly mitigate or amplify the enhanced greenhouse effect.

OCEAN CIRCULATION

Possible changes in ocean circulation provide one of the major uncertainties about future climate change. At present this is a major topic of research. Such changes may explain some of the cooling in the Northern Hemisphere from the 1940s to the 1970s, and could lead to unanticipated regional changes in climate.

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Figures 2 and 4 were drawn from data kindly supplied to the Climate Impact Group by T.M.L. Wigley and M. Hulme of the Climate Research Unit, University of East Anglia. The GCM data used here was generously provided by climate modellers at CSIRO, Bureau of Meteorology Research Centre, Geophysical Fluid Dynamics Laboratory, United Kingdom Meteorological Office, and the Canadian Climate Center.



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APPENDIX H

Byron Shire - Development Control Plan No. 1
Part J: Coastal Erosion Lands

J1.1 Citation

This policy, which may be cited as either "Byron Shire Development Control Plan No. 1, Part J" or as "Byron Shire Coastal Erosion Lands Policy", constitutes part of a development control plan as provided for by section 72 of the Environmental Planning and Assessment Act 1979.

J1.2 Application

This policy shall apply to all land, both rural and urban in the Shire of Byron, shown as being affected by coastal erosion on maps supplied to Council by the NSW Department of Public Works.

J1.3 Objectives

The objectives of this plan are:

- To make provision for the orderly and economic development of land within the coastal erosion zones.
- To ensure that such development is carried out in a manner which does not adversely affect coastal processes and which will not be adversely affected by coastal processes.
- To provide guidelines for determination of the merits of development on coastal lands as required by section 90(1)(g) of the Environmental Planning and Assessment Act 1979.

J1.4 Definitions

In this policy, except in so far as the context or subject matter otherwise indicates or requires:

Map

means Development Control Plan No. 1 Map titled 'Coastal Erosion Lands'.

Immediate impact line

means the line shown on the map marking the extent of land considered to be under immediate threat of coastal erosion.

50 year erosion line

means the line shown on the map indicating that the land to the seaward side of that line may come under threat from coastal erosion within 50 years.

100 year erosion line

means the line shown on the map indicating that the land to the seaward side of that line may come under threat from coastal erosion within 100 years.

J1.5 Development application

In determining an application for development on land the subject of this policy, Council will take into consideration all those matters listed under section 90 of the Environmental Planning and Assessment Act 1979.

J2.1 Precinct 1

Beach escarpment to the immediate impact line

Generally no new buildings or works are preferred within this precinct.

Development that is of a community nature, which relates to the use of the beachfront, may be considered, provided that any building is easily removable and does not require a major service main extension.

Where vacant urban-sized lots exist wholly within this precinct, the location of unregistered mobile homes as defined by Ordinance 71 of the Local Government Act, may be considered.

These may comprise more than one unit, but all units must be capable of separation and relocation by four wheel drive car (rather than truck) within the space of 12 hours. Erection of sacrificial structures, such as verandahs, may be possible where these do not prejudice relocation of other building sections.

J2.2 Precinct 2

Between the immediate impact line and the 50 year erosion line

Development within this precinct will be considered on the understanding that any consent granted will be subject to the proviso that should the erosion escarpment come within 50 metres of any building then the development consent will cease.

If the development consent does cease then the owner of the land will be responsible for the removal of any or all buildings from the site, or, where possible, to a location on the site further than 50 metres from the erosion escarpment.

(cont....)

J2.2 Precinct 2 *(cont)*

Prior to lodging an application with Council, the developer of the land must determine whether buildings are to be relocatable or demolished, should the consent cease.

Notwithstanding the above, all Class 1 residential buildings (dwelling-houses) must be relocatable. Extensions to existing dwellings may also be required to be demountable, taking into consideration the additional floor space proposed and the likely effect of the extension on the ability of the building to be relocated in an emergency.

The height of buildings is limited to 7.5 metres.

Section 3 lists the conditions of consent likely to apply to dwellings in this precinct.

J2.3 Precinct 3

Between the 50 year and 100 year erosion lines

Development within this precinct will be considered on the understanding that any consent granted will be subject to the proviso that should the erosion escarpment come within 50 metres of any building then the development consent will cease.

If the development consent does cease then the owner of the land will be responsible for the removal of any or all buildings.

The height of buildings is limited to 7.5 metres, except in areas shown hatched on the map, where the height of buildings is limited to 9.5 metres.

The option of demolition as the means of removal will be available to all buildings including Class 1 residential buildings.

J2.4 Existing buildings

This clause applies to Precinct 1 only.

In this clause, "gross floor area" means the sum of all the floor plan areas of a building, where "floor plan area" has the meaning ascribed to it in Part C of this plan (Residential Development).

Extensions or alterations to existing buildings will be considered on their merits. Consideration will be given to the location of the erosion escarpment, the type of building involved and access to the site. Alterations or extensions will be considered where there will be no adverse effect on the ability of the building to be removed in an emergency. Generally extensions to existing buildings will be limited to:

(a) where the gross floor area of the existing building is less than 100 m2 - extensions that will make the gross floor area no greater than 100 m2;

(b) where the gross floor area of the existing building is 100 m2 or more - 10% of the gross floor area of the existing building at the date of commencement,

providing that only one such extension per building will be permitted from the commencement date.

J2.5 Servicing

The provision of vehicular access, water, sewerage, electricity, telephone and other services will be considered on the merits of each case. In principle, all services should be provided from the landward side of the development such that the building is between the services and the erosion escarpment.

J2.6 Rebuilding

This clause applies to Precinct 1 only.

Where an existing building is destroyed totally or partially through accident or damage caused by other than coastal processes, the building may be repaired or rebuilt so that:

(a) the total floor area of the rebuilt or repaired building is no greater than the total floor area before the damage occurred;

(b) the repairs or rebuilding have no detrimental effect on the ability of the building to be relocated in an emergency;

(c) where possible, the building is relocated at the time of rebuilding or repair to a position on the site as far as possible from the erosion escarpment; and

(d) the repairs or rebuilding are effected within 12 months of the date when the damage occurred.

J2.7 Beach protection

Any work carried out by individual property owners to protect land from erosion will require the consent of Council.

Council will consider consent for such works only where, in the opinion of Council, such works will have no adverse effect on any adjoining properties or on any coastal processes.

J3.1 Conditions - Precinct 2

This clause lists the conditions of consent likely to apply to dwellings on land within Precinct 2:

(a) The dwelling-house shall be designed and constructed so that it can be easily removed from the site by road vehicle. The plans of the building shall include an adequate description of the removal procedures.

(b) Further to subclause (a), at the time of submission of a building application, a certificate is to be provided from a practising structural engineer as to the adequacy of this building to be easily dismounted and readily removed from the site by road vehicle.

(c) The dwelling shall be located so as to maximise as far as practicable the distance from the nearest point of the building to the seaward boundary of the site with due consideration given to subclause (a) above and to any relevant local government building ordinances.

(d) Subsequent to any approval being given for a relocatable dwelling, no works shall be carried out on the property which might hinder the ready relocation of the building. Such works might include the construction of walls, fences, screens, enclosures, brick veneering, landscaping or the fixing of joints or structural members by welding or other means.

(e) A restriction as to user will be placed on the title pursuant to the provisions of section 88E of the Conveyancing Act 1919, stating:

"The subject land and any improvements erected thereon shall not be used for the purpose of (land use) in the event that the erosion escarpment, as defined by the Works and Services Director of the Council of the Shire of Byron from time to time, comes to within 50 metres of any buildings or any part thereof at any time erected on the said land."

(f) This development consent shall cease if at any time the erosion escarpment, as defined by the Works and Services Director of the Council of the Shire of Byron, comes to within 50 metres of any building associated with this development. The buildings shall then be removed by the owner of the land.

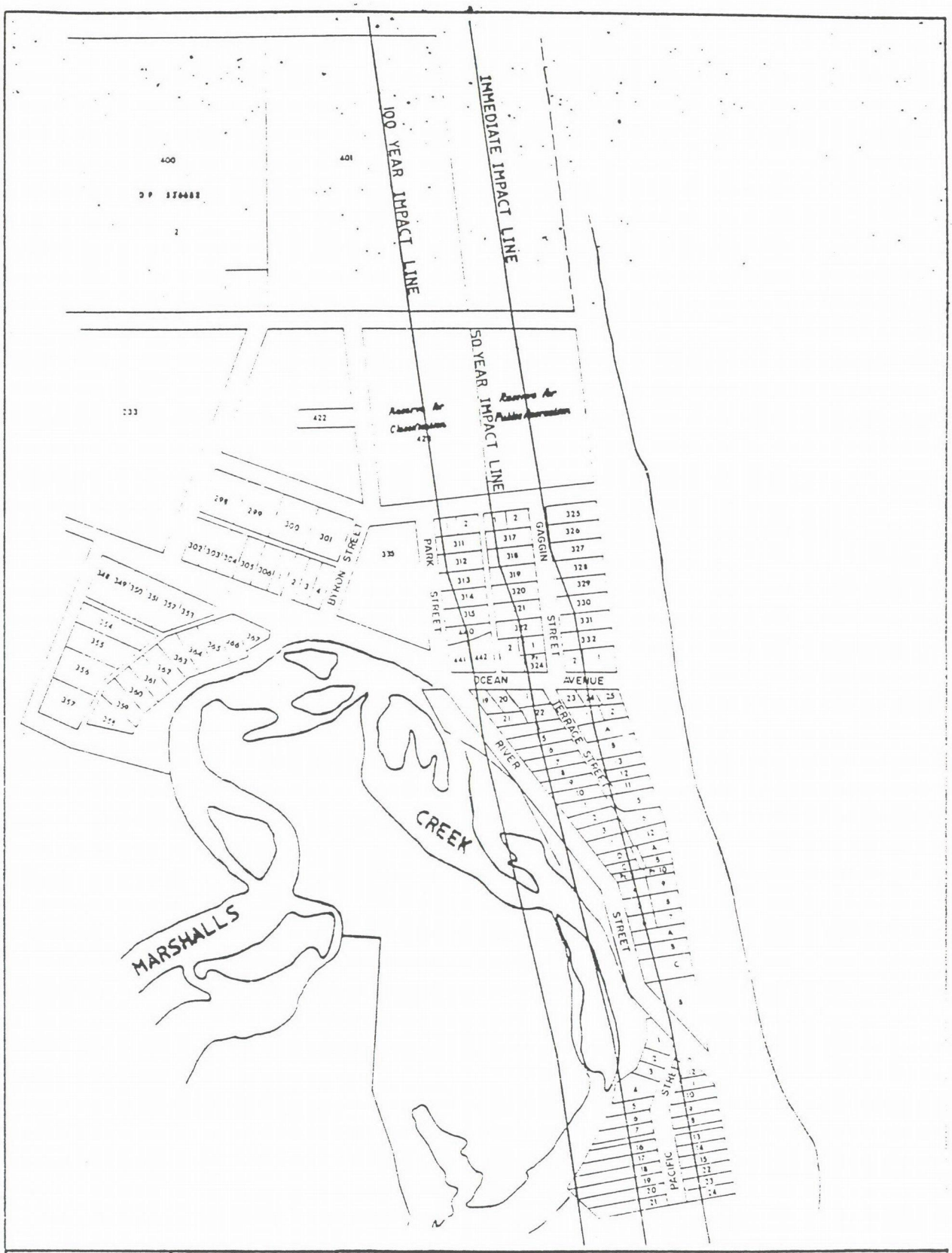
J3.2 Conditions - Precinct 3

This clause lists the conditions of consent likely to apply to dwellings on land within Precinct 3:

(a) A restriction as to user will be placed on the title pursuant to the provisions of section 88E of the Conveyancing Act 1919, stating:

"The subject land and any improvements erected thereon shall not be used for the purpose of (land use) in the event that the erosion escarpment as defined by the Works and Services Director of the Council of the Shire of Byron from time to time comes to within 50 metres of any buildings or any part thereof at any time erected on the said land."

(b) This development consent shall cease if at any time the erosion escarpment as defined by the Works and Services Director of the Council of the Shire of Byron comes to within 50 metres of any building associated with this development. The building shall then be removed by the owner of the land.



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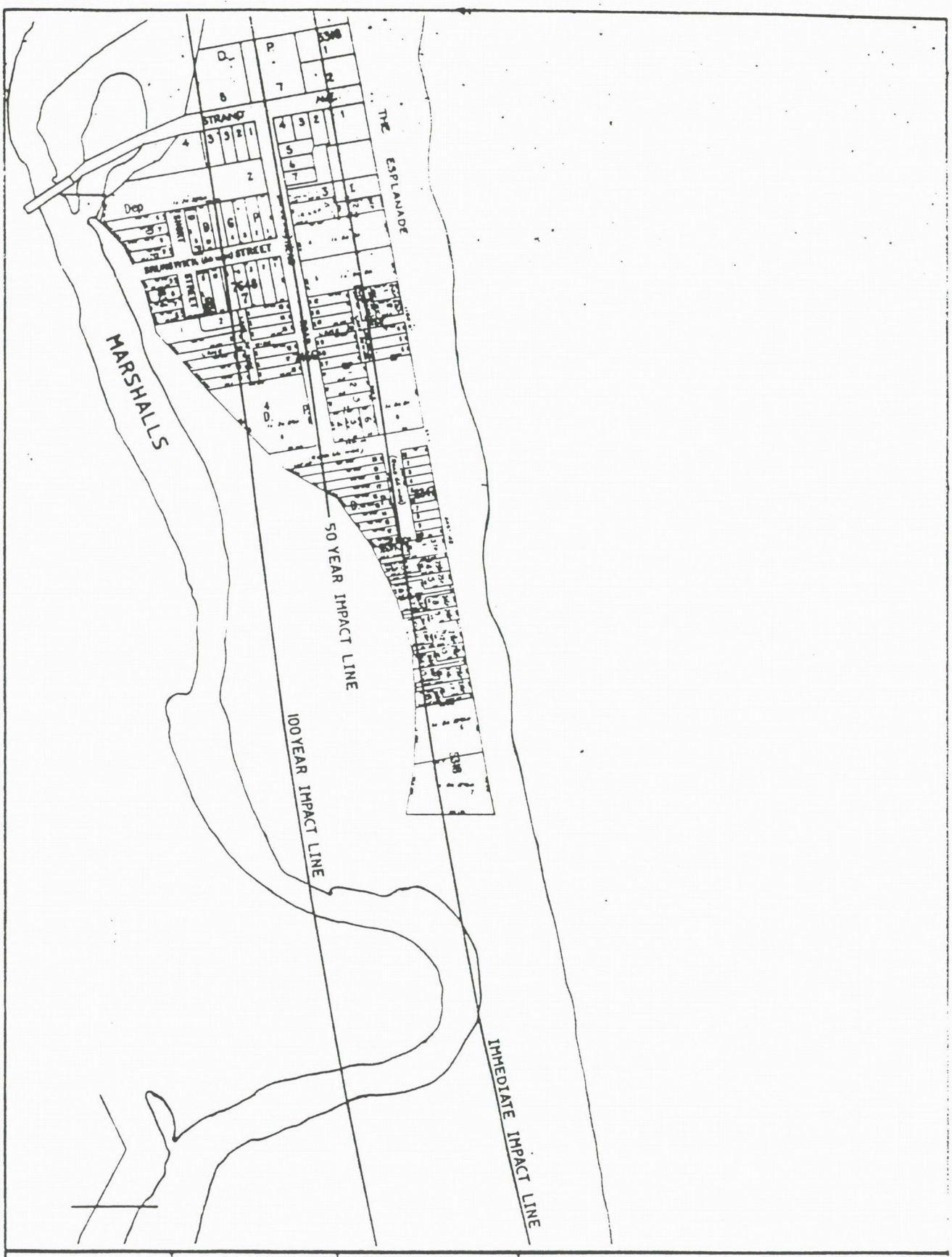

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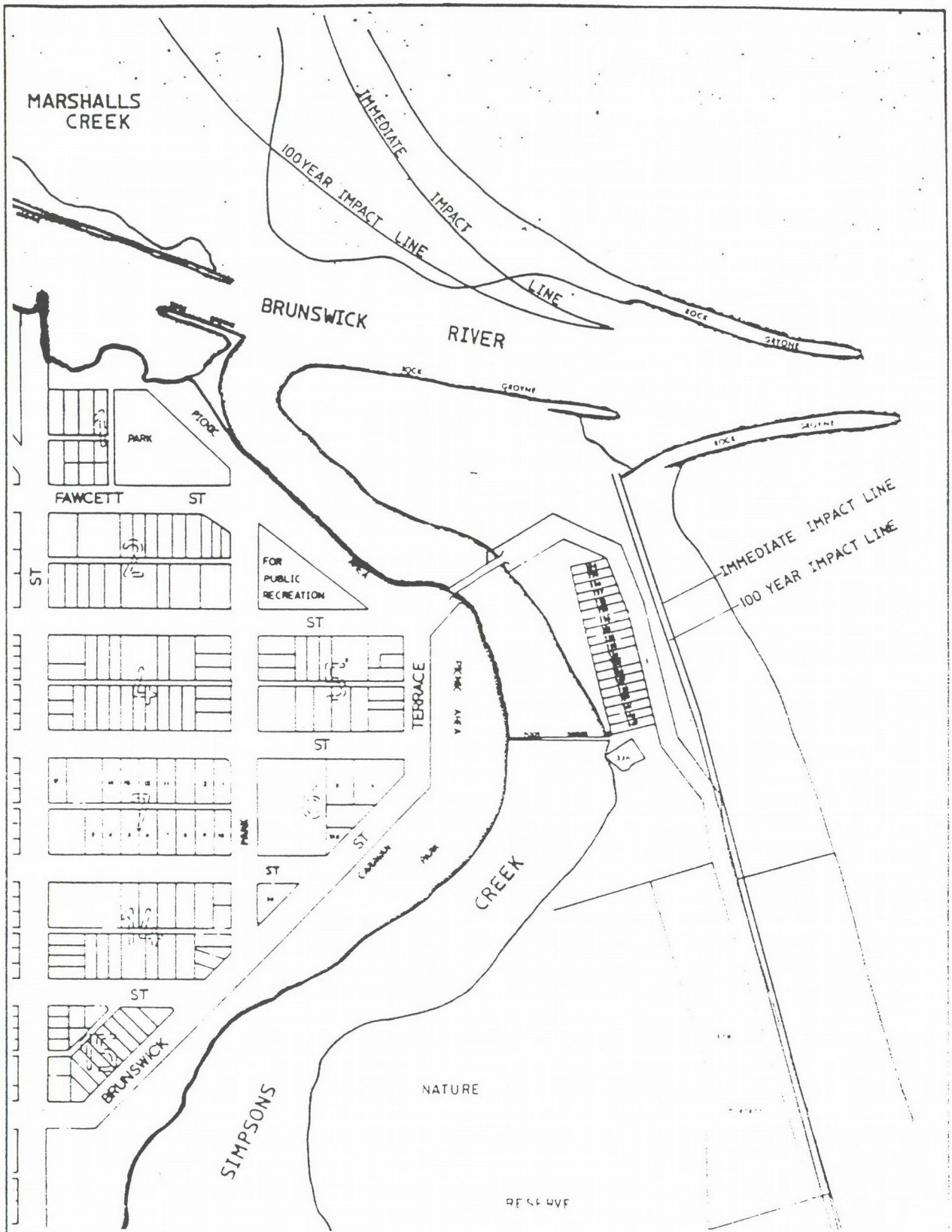

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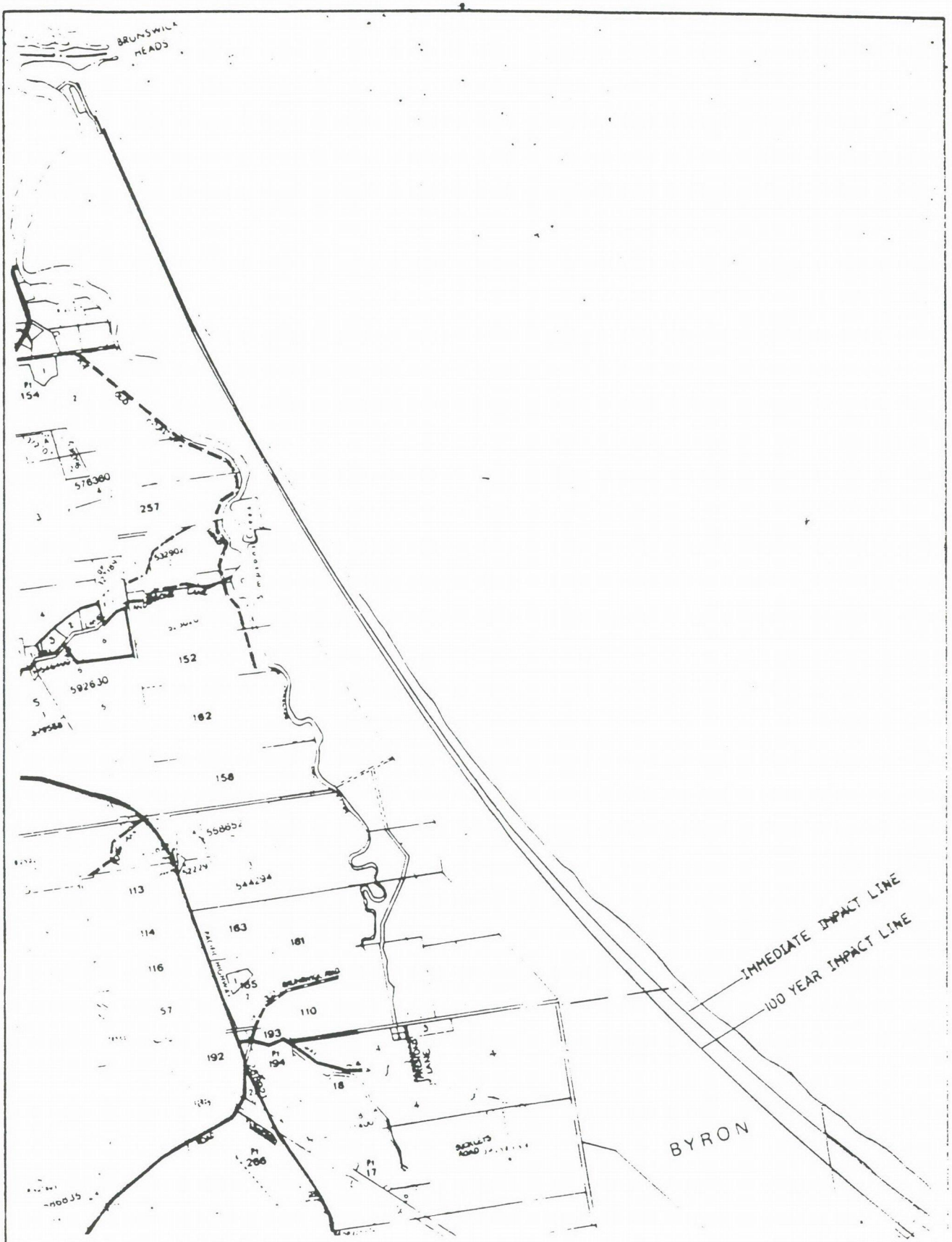

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BYRON SHIRE COUNCIL

COASTAL EROSION DEVELOPMENT CONTROL PLAN

APPENDIX I

University of Queensland
Archaeological Services Unit (1991)

An Archaeological Assessment
of RTA's Proposed Brunswick Heads Bypass
and Future Development to 51.0 kms North of Ballina

THE UNIVERSITY OF QUEENSLAND ARCHAEOLOGICAL SERVICES UNIT
REPORT NO. 192.

AN ARCHAEOLOGICAL ASSESSMENT OF THE NEW SOUTH WALES ROAD AND TRAFFIC AUTHORITY'S PROPOSED BRUNSWICK HEADS BYPASS AND FUTURE DEVELOPMENT TO 51.0 KMS NORTH OF BALLINA.

A report to the
New South Wales Road And Traffic Authority

By

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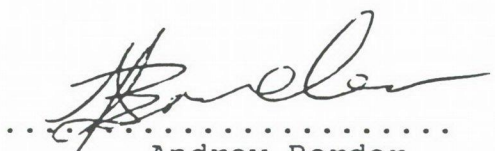

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1.0 INTRODUCTION

This report presents the results of an archaeological examination of the New South Wales Road Traffic Authority's proposed Brunswick Heads (Pacific Highway) Bypass which is referred to here as the Bypass Route (see Figure 1). In addition an assessment of the proposed development of the Pacific Highway on the northern side of the Brunswick River, from 46.7 to 51.0 kms north of Ballina (see Figure 2), was carried out. The study was undertaken by the University of Queensland Archaeological Services Unit (UQASU) for the client, the New South Wales Road and Traffic Authority (RTA). Fieldwork was conducted on the 7th of November, 1991.

The potential impacts of the proposed development on the archaeological record are assessed and the methods used in the archaeological survey and the survey results are described. The report also includes an overview of the current knowledge of the archaeological record of the North Coast of New South Wales and relevant aspects of aboriginal use of the area. The study discovered no archaeological sites.

1.1 The Scope Of The Study

The New South Wales RTA propose to construct a Pacific Highway Bypass to the West of Brunswick Heads. The RTA brief for the study states that:

> ...the EIS will...be described as 42.5 kms to 46.7 kms north of Ballina (the Brunswick Heads Bypass). A detailed overview of the section to 51.0 kms north of Ballina will be examined within the EIS.

In effect the study can be divided into two parts. Part One, the, Bypass Route, extends from a point 500 metres south of Saddle Road (to the South of Brunswick Heads) as far as the Brunswick River where it rejoins the existing Pacific Highway. In total the route for the bypass is 3.4 km long and located within a corridor 100 metres wide (called the Bypass Route Corridor).

Part Two begins at the Brunswick River (46.7 kms north of Ballina) and continues to 51.0 kms north of Ballina (4.3 kms in length). Detailed planning of the route has not yet been carried out and this part of the study is aimed at assisting in this process.

1.2 Rationale

Archaeological sites or materials provide the evidence to study past human behaviour and cultural evolution where no written records exist. The archaeological record is a non-renewable resource and particularly sensitive to land development as it exists on the surface of, or within, the ground. Archaeological resources are therefore protected under

the New South Wales National Parks And Wildlife Service Act 1979 and the Environmental Planning And Assessment Act 1979 (Byrne 1985). Under these acts it is an offence to knowingly destroy archaeological relics and it is the responsibility of the National Parks And Wildlife Service to manage this resource.

1.3 Development Methods

Initial preparation for the Bypass Route requires complete clearing of all vegetation by a bulldozer. At this stage it should be assumed that this will occur throughout the entire 100 metre Bypass Route Corridor in low lying areas. In this first stage of construction vegetation clearing will result in sub-surface disturbance down to an estimated depth of around 30 centimetres, but possibly more in certain situations (i.e. where the bulldozer sinks in waterlogged areas). The ridge at the southern end is to be removed down to the level of the rest of the Bypass Route and this will also result in the complete destruction of the corridor.

Surface preparation then occurs. This may entail the removal of sediments in low lying areas to obtain a firm base although the specific location and extent of such work will not be known until soil testing analysis has been completed. Installation of flood control structures would also occur in this phase and include excavations. The road foundation is then built up with fill to a level of one to two metres above the existing ground surface. Road formation and surfacing is then completed and the shoulder batter and corridor areas revegetated with local floral species (Robert Kook, NSW RTA, Grafton pers. comm.).

1.4 Impact Assessment

Surface archaeological sites within the entire 100 metre Bypass Route Corridor will be destroyed in the course of the development. Sub-surface archaeological sites existing up to at least 30 centimetres below the surface, and at greater depths where excavations are determined to be necessary, will also be destroyed.

1.5 Aboriginal Consultation

The Tweed/Byron Local Aboriginal Land Council (LALC) was contacted with respect to the proposed development and as part of the community consultation program. It was arranged for the chairman of the council, Mr Franc Krasna, to participate in the survey. He also stated that he was not aware of any concerns local Aborigines had regarding the proposed development and a statement from him to this effect is included in Appendix 1.

1.6 The Study Region

The proposed Bypass Route crosses a typical Northern New South Wales coastal environment. The major watercourse is the Brunswick River which marks the northern boundary of the Bypass Route.

Along the beaches and coastal plain geology consists of Quaternary deposits of beach and dune sands backed or overlain by similarly aged riverine deposits of gravels, alluvium or sand along estuaries and coastal lowlands. The hills and higher areas to the west of the coastal plain generally consist of the Palaeozoic Neranleigh-Fernvale formation with outcrops of the Cainozoic Lamington Volcanics.

Prior to extensive clearing, which came with European settlement of the area, sub-tropical rainforest and wet or dry sclerophyll forests occurred extensively along the coastal hills and lowlands. Estuaries and creeks supported mangroves with fringing riverine forests of Casuarina, sub-tropical rainforests or sclerophyll forests. Low lying marshy or swampy areas, where the original vegetation has been often left intact, support paper barks (Melaleuca sp.), tea tree (Leptospermum sp.) and banksia (Banksia sp.) with a ground cover of reeds or coarse grasses. Coastal dunes and swamps are dominated by littoral scrubland or coastal heath, the latter consisting predominantly of banksia (B. integrifolia or serrata) (see Byrne [1895] or Davies [1991] for further details).

2.0 BACKGROUND

This section of the report provides a brief overview of the current knowledge concerning Aboriginal cultural history and early European settlement.

2.1 Aboriginal Cultural History

There have been numerous studies and papers published concerning this aspect on the North Coast of New South Wales (e.g. Byrne 1985; Coleman 1982; Crowley 1978, 1991; Lilley 1984; Mathews 1897; Steele 1984; Sullivan 1987; Tindale 1974). Recent reviews of the current literature, which also result from archaeological impact assessments, are available in Byrne (1985), Davies (1991) and Navin (1990).

According to Tindale (1974) the Minjunbal socio-linguistic group occupied land extending from Cape Byron north to Southport (in Southern Queensland) and inland as far as Nerang Creek and Murwillumbah. However Davies (1991) notes that there is conflicting evidence concerning the naming of sub-groupings, or clans, and location of their estates. For example, while Steele (1984:49) describes the Tweed River area as the territory of the Moorung-Moobar clan, the Tweed Byron

LALC (quoted in Davies [1991]) maintain that this group only occupied the northern side of the river and that the southern side was owned by the Coodjunbarra. Crowley lists the catchments of the Clarence, Richmond and Tweed Rivers as belonging to a broad linguistic group who spoke a language called Bandjalang. Tindale (1974) only names the area of the Bandjalang as extending from the Clarence river as far north as Ballina. He lists the Arakwal group as occupying land from Ballina to Cape Byron, where the study area is located.

Clearly a number of tribal groups with many sub-groups and clans existed on the NSW North Coast as described by Crowley (1991). He (1991:16) suggests that this could be explained as a result of a greater antiquity of Aboriginal settlement in the area as opposed to regions further south. However, alternative explanations could be offered (see examples from other resource rich but climatically diverse coastal areas such as south west Victoria [Lourandos 1983] and the rainforest coast of North Queensland).

Various estimates have been made for Aboriginal populations of coastal New South Wales ranging from one person/0.3 to 1.5 km^2 (see Byrne [1985] for a summary of estimates). On the north coast Aboriginal people are said to have maintained a sedentary existence moving periodically between large base camps in contrast to the inland groups who are described as more mobile (Coleman 1982; Lilley 1984). Ceremonial activities were an important part of Aboriginal life and are evidenced archaeologically by the presence of bora grounds and stone arrangements and described by early observers. The most well known of these were the Bunya Festivals, held in the ranges north of Brisbane about every three years, when nuts from the Bunya Pines were particularly plentiful, and to which people from the north coast of New South Wales travelled (Petrie 1904).

Resources along the coastal zone have been described as rich and varied (Sullivan 1978). Archaeological excavations at Wombah, on the Clarence River estuary, suggest a heavy emphasis on estuarine resources (McBryde 1982). Although terrestrial resources were probably abundant, and hunted as well, McBryde (1982:33) found that in the Wombah middens "...the material evidence for fishing and hunting as a major contributor to the food supply" was not strong. Rainforests and coastal wetlands are indicated as having supplied a range of resources such as fruits (Exocarpus cupressiformus), fern roots (Pteridium esculentum and Blechnum sp.), yams or tubers (Dioscorea transversa and Colocasia macrorrhiza) and nuts (Macadamia ternifolia, Araucaria bidwillii and Castanospemum australe).

In summary, relatively high Aboriginal populations, large sedentary base camps and an extensive resource base suggest that a diversity of archaeological sites will occur in the study area.

2.2 European Impact

Oxley was the first European to officially make contact with the Aborigines of the North New South Wales coast when he visited the area in 1823. Although the area was not officially opened for settlement until 1842 Europeans, in the form of runaway convicts from the Brisbane penal settlement had most likely penetrated the region prior to this (Davies 1991). Real settlement did not begin until the 1860's with most activity before this involving cedar getting. By the late 1890's the basic structure of European farming consisting of dairying and market gardening, which was to persist until the present day, had become established. Sand mining began in the 1930's with the result that few of the coastal dune formations have been left untouched by this activity (Davies 1991). Forestry has always been an important industry in the area resulting in wholesale clearance of what were once extensive forests (Byrne 1985).

2.3 Archaeological Record

A general overview of the literature and the New South Wales National Parks and Wildlife Service site records suggests that scarred trees, burials, bora grounds, stone arrangements and stone artefact quarries may occur within the study area

Davies (1991:12) notes that while numerous archaeological surveys have been conducted along the Northern New South Wales Coast few archaeological sites have been located. Most of the major midden sites which have been located are found south of Ballina as shown in Figure 4. Within the Brunswick heads area studies have been conducted by Barz (1982) and Navin (1990) for the Ocean Shores Development on the northern side of the Brunswick River, by Piper (1983) at Belongil Swamp, Byron Bay and by Davies (1991) for Telecom's Optic Fibre Route between Anderson's Ridge and Banora Point.

Piper (1983) located only one damaged shell midden and Barz (1982) found 14 small clusters of pipi shell on Crabbes Beach. Davies (1991) recorded two shell middens and one historic site. Navin (1990) located 21 previously unrecorded sites of which 10 sites were found in beach foredune situations. One site, a scarred tree, was located in a coastal valley, six sites were located on hills or ridges and five sites on old beach and dune systems.

According to Byrne (1985) artefact scatters are most likely to be found along the ridges in flat areas. Previous research in coastal situations suggest middens are likely to occur in beach dunes, along estuaries and in areas surrounding coastal wetlands. Navin's (1990) survey, where samples of between 5% and 60% of individual environmental zones were obtained, provides a basis for developing a site location model for the area and assessing the archaeological sensitivity of

individual environmental zones for this local area. The information from all these studies may be summarised as follows:

(i) Coastal Dune Systems
Middens consisting of thin shell lenses, predominantly pipi, and burials. High archaeological sensitivity.

(ii) Coastal Valleys
Scarred trees, artefact scatters and middens. Low archaeological sensitivity.

(iii) Hills and Ridges
Site density equivalent to coastal dune systems consisting predominantly of artefact scatters with associated shell material as well as bora rings, stone arrangements, stone artefact quarries and scarred trees. High archaeological sensitivity.

(iv) Old Beach and Dune Systems
Middens which may have associated stone artefactual material. High archaeological sensitivity.

3.0 THE SURVEY

The following section outlines the expectations, methods and results of the fieldwork conducted along the proposed Highway Bypass Route.

3.1 Expectations

Taking into account the particular environment along the Bypass Route, the overview of the archaeological and ethnographic information and Aboriginal consultation it was apparent that the archaeological site types likely to be encountered were stone artefact scatters, which generally indicate campsite locations, and shell middens which also indicate camp site locations where shellfish, and probably other resources, have been consumed and the remains discarded.

3.2 Environmental Description

A major constraint to the survey was thick vegetation along most of the route (Plate 1). However cleared areas at the extreme southern and northern ends of the Route provided relatively good ground surface visibility. The route has been previously marked out a number of years ago by bulldozing a track within the Bypass Corridor and this enabled a sample of the route to be properly inspected (Plate 2).

The Route can be divided into a number of discrete units within which topography, soils and vegetation are relatively uniform. These units, along with a general assessment of ground surface visibility in each one, are identified as follows:

(i) Ridge unit which extends from Saddle Road to the Creek Flood Plain with gradients averaging around 1:5. The land is cleared and lightly grassed with ground surface visibility around 30%.

(ii) Closed mixed eucalypt and paperbark woodland found along the floodplain of the small creek from the base of the ridge to about 150 metres north of Track Two. Ground surface visibility was around 5% (Plate 3).

(iii) Mixed paperbark and banksia encircles the low marshy area in the middle of the Bypass Route. of 400 metres). After rain this zone appears to become waterlogged and has a permanent ground cover of sphagnum moss. Ground surface visibility was generally nil.

(iv) Marshland, where water lies permanently, exists along the middle of the Bypass Route extending for about 500 metres. Vegetation consists of tea tree and reeds. Ground surface visibility was nil (Plate 4).

(v) River Floodplain is found at the northern end of the bypass route. Vegetation consists of Casuarina with moderate grass cover and ground surface visibility was found to vary between 10% and 60% (plate 5).

3.3 Survey Methodology And Results

Part of the Brunswick Heads Bypass Route, beginning at the southernmost end and extending as far as Track One, had been surveyed for archaeological sites in November 1990 (archaeological assessment of Telecom's proposed Optic Fibre Cable Route between Anderson's Ridge and Banora Point by Davies [1990] and Mr. Franc Krasna, Tweed/Byron LALC representative). In consultation with Mr. Krasna it was decided that this section of the route did not require further inspection. A visual inspection made from the Pacific Highway confirmed that this section of the route was either well grassed or vegetated with paperbark and reeds.

The remainder of the route was searched by foot from Track One to the southern bank of the Brunswick River. On this part of the route Transects were walked along the western boundary of the corridor from Track One to about 150 metres north of Track

Two and then east to the old bulldozed path. Another Transect was walked beginning at Track Two and following the bulldozed path far as the cleared area at the northern end of the route. From the cleared area to the Caravan a transect of 20 metres wide was covered.

Of the total Bypass Corridor of 340,000 m^2 it was estimated that 21,500 m^2 was sampled by ground surface inspection on foot. This represents 6.3% of the proposed development route. Adding previously sampled areas then the total sampled area amounts to about 10%. As already stated no archaeological sites were found.

It is concluded that extensive archaeological sites are not likely to exist within the Highway Bypass Corridor. However, it is possible that undetected archaeological material may be encountered within the Bypass Corridor. There is also the likelihood that archaeological sites may be buried under existing sediments.

4.0 PART TWO OVERVIEW- 47.6 TO 51.0 KMS NORTH OF BALLINA

An inspection of the proposed route for future development of the Pacific Highway was also carried out as part of the EIS. This section of the route extends from the Northern bank of the Brunswick River, between 46.7 and 51.0 kms north of Ballina (see Figure 2).

The strategy employed for Part Two of the study was to access the route along existing roads. Where possible, parts of the route were inspected on foot and where this was not feasible the route was inspected visually from vantage points along access roads, tracks or from the Pacific Highway.

4.1 Environmental Description

Three broad environmental types were identified for Part Two of the study and are described as follows:

(i) River Floodplains found along the Brunswick River. Vegetation consists of mangrove and marshland near the river with Casuarina forest on more elevated ground. Ground surface visibility was generally poor and around 5-10%.

(ii) Slopes and Ridges which constitute the majority of the route. Sub-tropical rainforest occurs in this environmental zone and it is assumed that, for the most part, this was the original vegetation type. However, most of the ridges and slopes have now been cleared for grazing and are vegetated with grasses. Ground surface visibility is around 10% (Plate 6).

(iii) Creeks with associated Lowlands occur on Billinudgel and Marshalls Creek. This environmental zone was probably originally vegetated with tall forest or rainforest which has now been cleared and mostly supports coarse grasses or reeds. Ground surface visibility is around 0-5%.

4.1 Results

(i) River Floodplain

This zone was inspected via the access track to the Sewerage Treatment Works. The site location model predicts that this environmental zone is the one most likely to contain archaeological sites.

Disturbance in this area enabled surface and sub-surface inspections. While no archaeological sites were discovered two pieces of oyster shell and a piece of fine grained siliceous stone with probable flaking scars were found. Given the context, in alluvial sands, it is possible that this material is archaeological and suggests that archaeological sites may occur in the area.

(ii) Ridges and Slopes

The site location model suggests that ridges are likely to contain stone artefact scatters on level areas (Byrne 1985; Navin 1990). Bora rings have also been recorded in such situations near Lismore. Given the obtrusive nature of bora rings then any which may have existed along the route would have already been recorded, which is not the case. Other site types which may occur are scarred trees, stone artefact quarries or stone arrangements.

(iii) Lowland Creeks

Because of the importance of these environments in Aboriginal economies, where water is readily available and vegetable and aquatic resources are commonly found, they are likely to contain sites. However, the site location model predicts that this environmental zone will have a low density of archaeological sites.

4.3 Assessment

For assessment purposes the route may be divided into three sections as shown in Figure 2. Section One of the route, from the Brunswick River to the gravel pit, and Section Three of the route, beginning at the road just north of the caravan park and extending to the end of the proposed route, are the areas where archaeological sites are most likely to be found in a relatively undisturbed context. In particular, Section

Three of the route, which crosses the same ridge on which Navin (1990) recorded six sites further to the east, must be considered to have a high archaeological sensitivity.

A considerable amount of disturbance has occurred in Section Two due to clearing of the land for grazing, banana plantations and other agricultural pursuits, quarrying of road fill and semi-urban development (i.e. construction of roads, including the Pacific Highway, and land sub-division). Such disturbance is most noticeable beginning at the southernmost gravel pit on Banana Road and extending as far as the road just north of the caravan park. Any archaeological sites which may have existed along this section of proposed route are likely to be severely disturbed of destroyed.

It is concluded that the route 46.7 to 51.0 kms north of Ballina is likely to contain archaeological sites as described. The chances of this are far greater than along the proposed Bypass Route. Given future development of the area an archaeological survey will need to be carried out in Sections One and Three. In Section Two it is recommended that spot checks be carried out in areas not grossly disturbed.

5.0 RECOMMENDATIONS

1. It is recommended that no constraints be placed on the Brunswick Heads Bypass in terms of archaeological remains.

2. It is recommended that the New South Wales Road Traffic Authority be advised that sub-surface archaeological material may exist within the Brunswick Heads Bypass Route Corridor and, if so, will most likely be identifiable as a concentration of shell material (i.e. shell midden). If such material, or other archaeological material is found or excavated during construction of the Brunswick Heads Bypass all work should cease and the National Parks and Wildlife Service, Grafton and the Tweed/Byron LALC should be immediately advised of the situation.

3. It is recommended that, in the event of development of the Pacific Highway as far as the point described as 51.0 kilometres north of Ballina, then an archaeological assessment of Sections One and Three of the route and spot checks in Section Two, as described in 4.3 above, be carried out.

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8.0 APPENDIX 1: Statement from the Tweed/Byron Local Aboriginal Land Council.

TWEED BYRON LOCAL ABORIGINAL LAND COUNCIL

P.O. Box 6160
Tweed Heads South NSW 2486
Telephone (075) 54 3238

13 November 1991

Andrew Border

University of Queensland
Archaeological Services Unit
Department of Anthropology & Sociology
ST LUCIA QLD 4072

RE: ARCHAEOLOGICAL SURVEY - RTA BRUNSWICK HEADS BYPASS.

Statement

The area addressed in this Statement concerns the proposed road corridor which is being considered to allow traffic to bypass the township of Brunswick Heads.

A survey of this corridor was conducted on the 7 November 1991. The survey was undertaken by Andrew Border (Archaeologist) with a representative from our Land Council who assisted in the field survey and consulation.

A ground search of this 4.2 kilometre strip did not locate any sites or artifacts. Most of the route disects large areas of natural vegetation which occurs in vegetation sequence types.

The geography of the route is mostly lowland and the likelihood of sites being located in these sections are considered very low. The higher sections of the route have been disturbed by clearing for cattle grazing and farming and the likelihood of sites being present is also very low.

Our Land Council have no objection to the Brunswick Head proposed Bypass in relation to Aboriginal Sites.

We hope that a detailed study will be undertaken to assess the environmental significance of this area as we are unaware of any similar wet heath areas occurring in our Land Council boundary.

A Predictive Site Location Model was carried out on two sections of the road corridors to the north of the proposed Brunswick Heads Bypass route.

13 November 1991

RE: ARCHAEOLOGICAL SURVEY - RTA BRUNSWICK HEADS BYPASS.

The geography and vegetation varied considerably and our Land Council would require a separate archaeological assessment of these areas.

Should any findings of Aboriginal origin be located or uncovered along the proposed Brunswick Heads Bypass Route we require that our Land Council or the National Parks and Wildlife Service be contacted immediately.

Yours faithfully

Franc Krasna

Franc Krasna
CHAIRPERSON

C.C. N.P.W.S. SABU DUNN

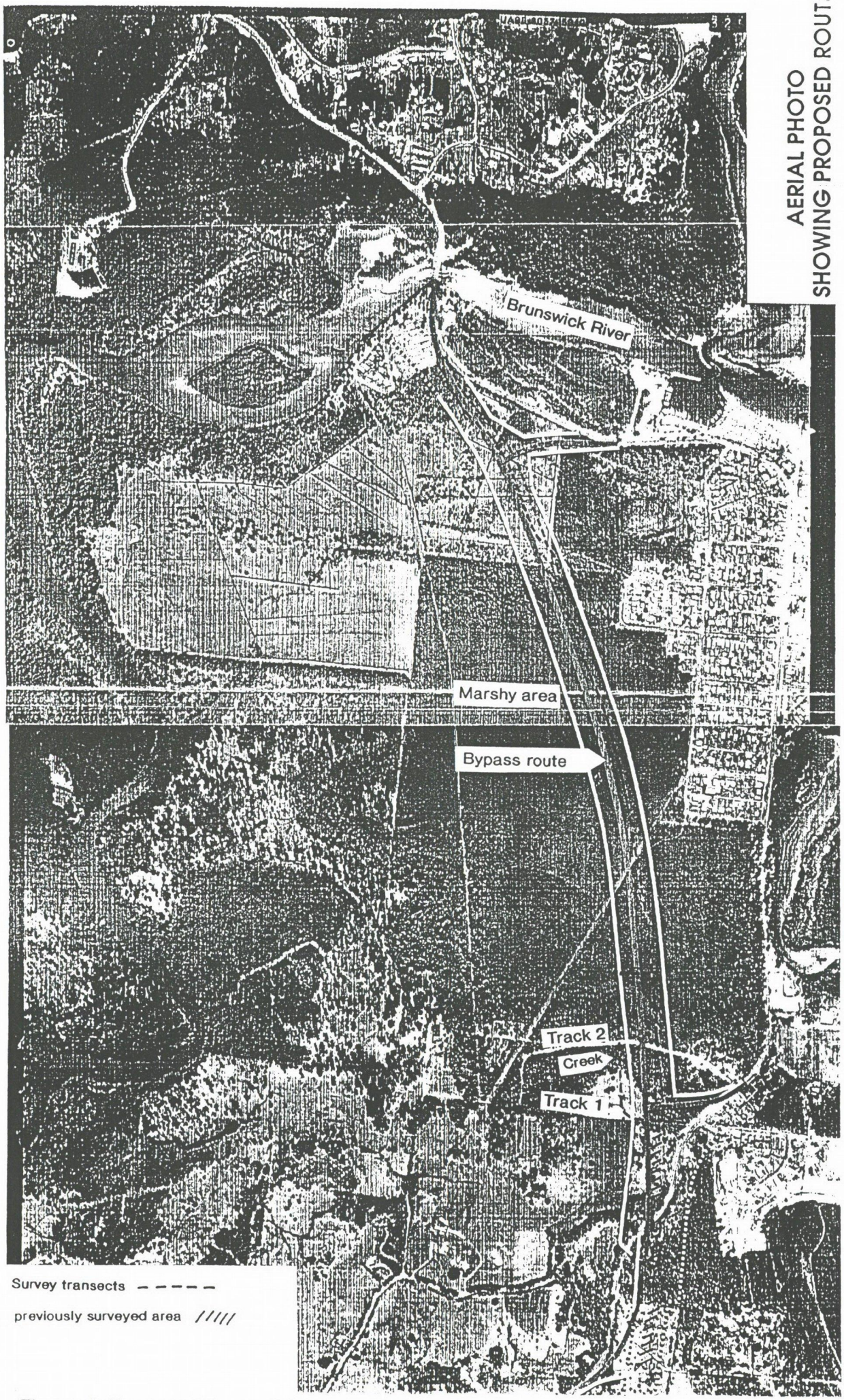

Figure 1: Proposed Brunswick Heads Bypass Route.

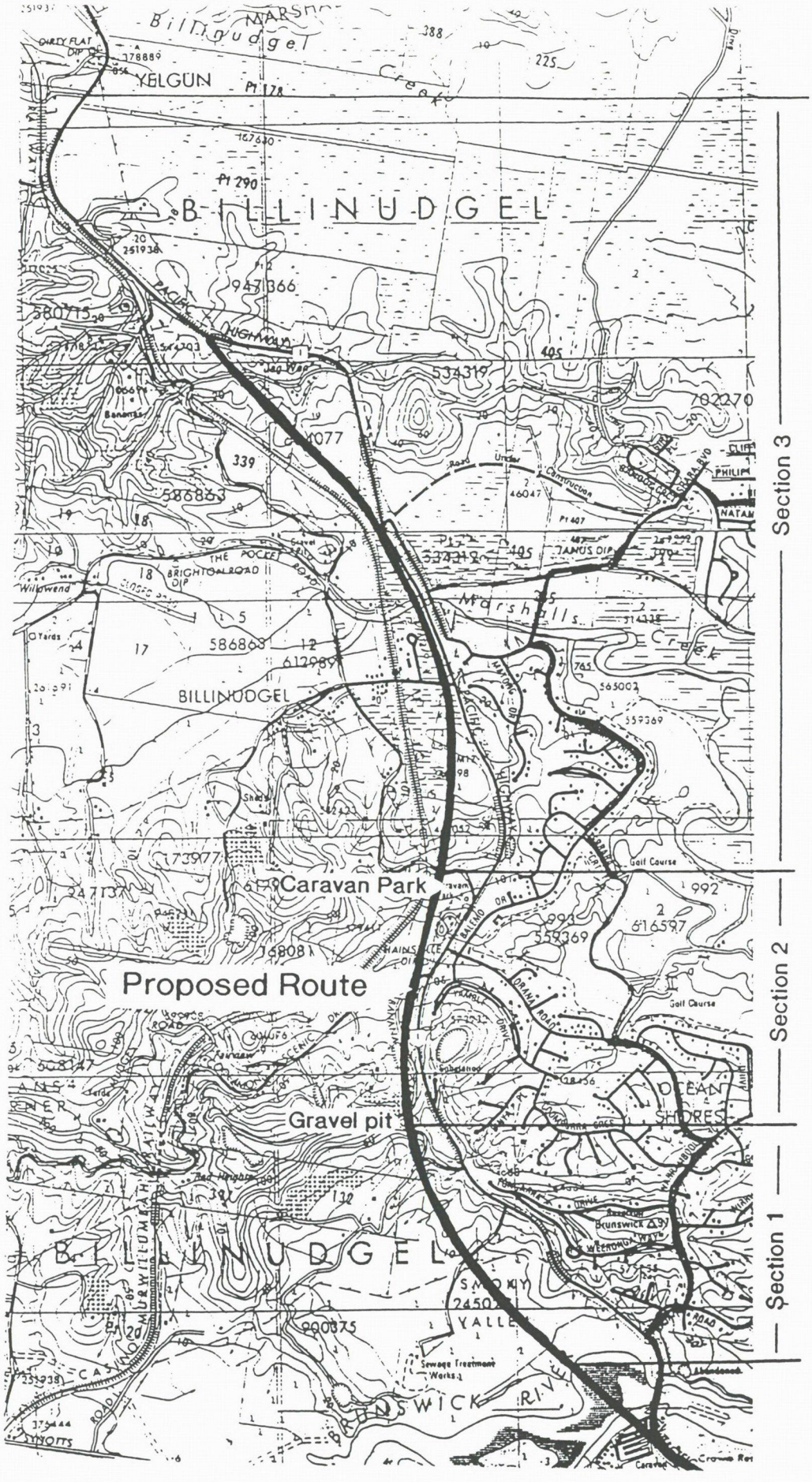

Figure 2: Proposed route 47.6 kms to 51.0 kms north of Ballina.

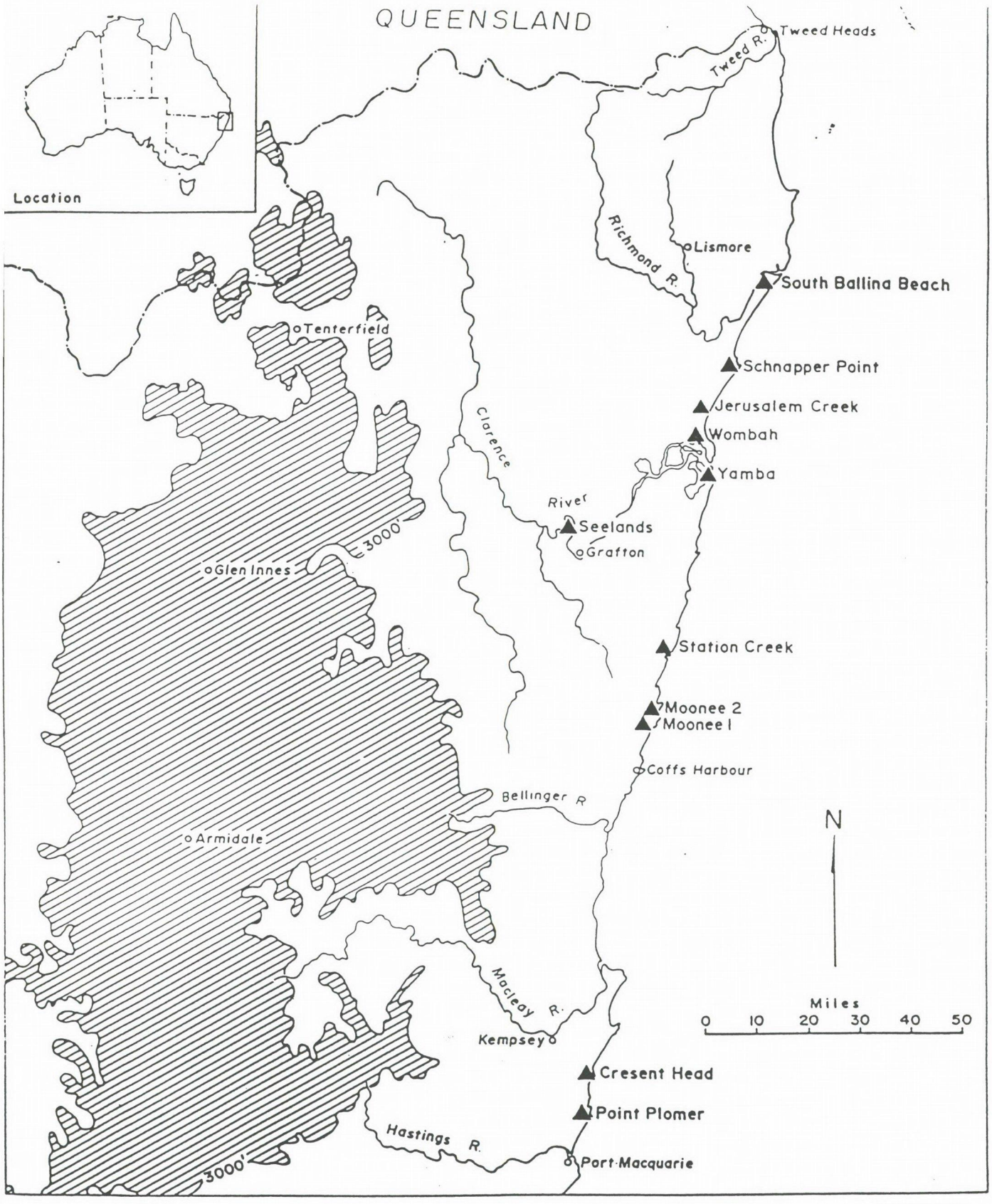

Figure 3: Map showing major midden sites of the North Coast of NSW (Source: McBryde 1982).

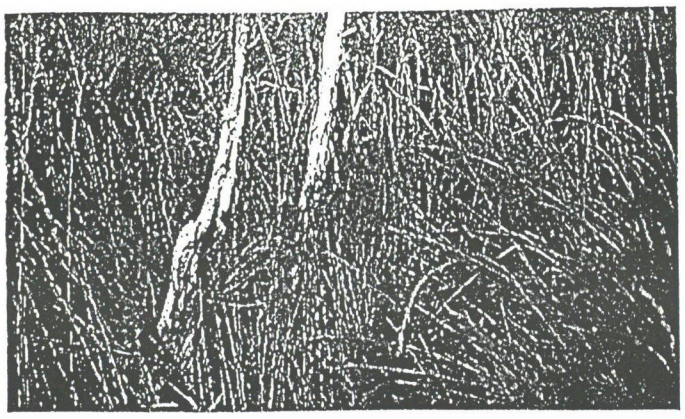

Plate 1: Thick vegetation at the southern end of the Bypass Route.

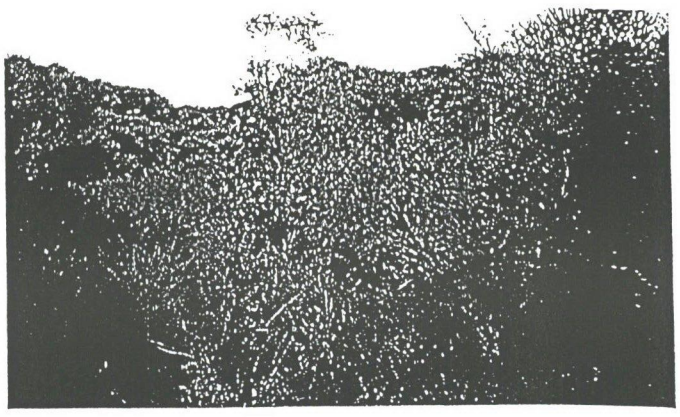

Plate 2: Bulldozed track.

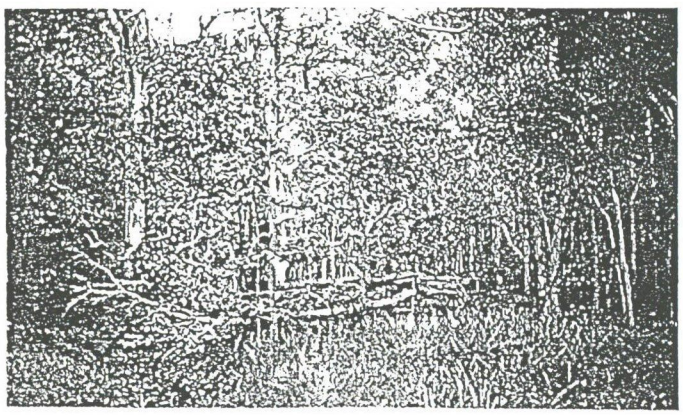

Plate 3: Mixed paperbark and eucalypt woodland.

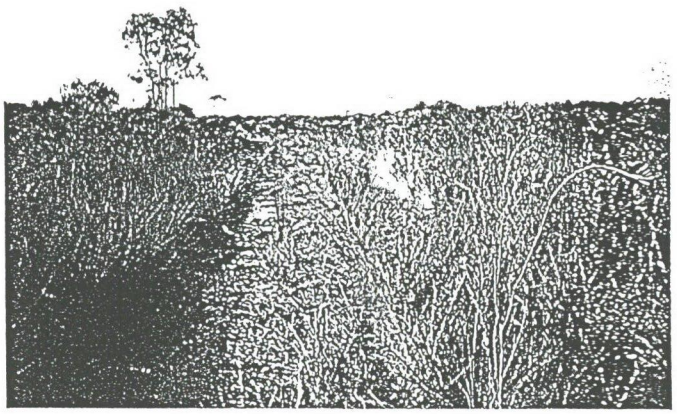

Plate 4: Marshland

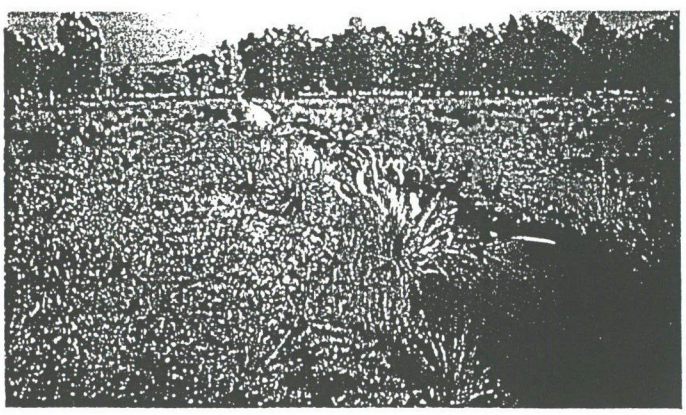

Plate 5: River floodplain.

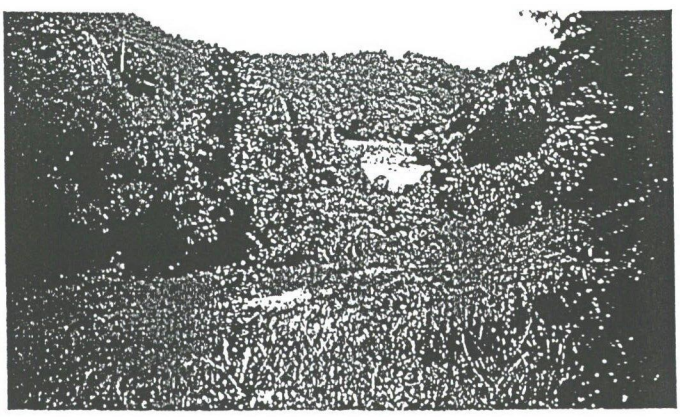

Plate 6: Slopes and ridges.

THE UNIVERSITY OF QUEENSLAND ARCHAEOLOGICAL SERVICES UNIT
REPORT NO. 204.

AN ARCHAEOLOGICAL ASSESSMENT OF THE NEW SOUTH WALES ROAD AND TRAFFIC AUTHORITY'S PROPOSED SECOND OPTION (PINK CORRIDOR) FOR A BRUNSWICK HEADS BYPASS.

A report to the
New South Wales Road And Traffic Authority

By

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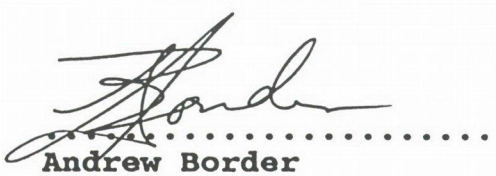
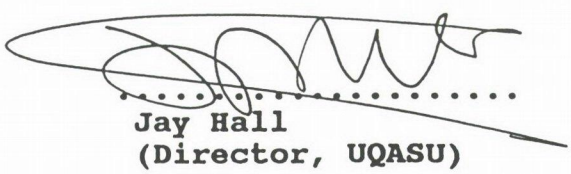
August, 1992



Andrew Border
(Consultant, UQASU)



Jay Hall
(Director, UQASU)

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LIST OF FIGURES

1. Options for the Brunswick Heads Bypass Route 2

1.0 INTRODUCTION

This report presents the results of an archaeological study of additional options for the New South Wales Road And Traffic Authority's proposed Brunswick Heads (Pacific Highway) Bypass referred to in this report as the Pink Corridor and the Modified Red Corridor. An initial option, the Red Corridor was assessed by the consultants in November 1991 (Border 1991). The three options for the Bypass Route are shown in **Figure 1.** The study was also required to nominate a preferred corridor out of these three corridors. The study also included consultation with the Tweed Byron Local Aboriginal Land Council (LALC).

The aim of this study was to determine whether archaeological sites existed in the Pink Corridor and Modified Red Corridor and, if so, assess the impact of the development on these. The methods used and results obtained in the archaeological survey are also described. A general environmental description, an overview of the current knowledge of archaeological sites and aspects of aboriginal use of the North Coast of New South Wales can be found in the first study (Border 1991).

No archaeological sites were discovered in the Pink Corridor. However shell material, suspected of being part of a shell midden was located along the verges of the existing Pacific Highway immediately south of Brunswick Heads Township in the path of the Modified Red Corridor.

1.1 The Scope Of The Study

The brief for the study required the following issues to be addressed:

(i) A field study of both the Modified Red Corridor and of the Pink Corridor to identify any archaeological sites;

(ii) Consultation with the Tweed Byron Local Aboriginal Land Council;

(iii) Selection of a preferred corridor stating clearly the criteria and reasons for the selection;

(iv) A report summarising the findings of the study and indicating any archaeological sites found and which discusses the likely impacts of the development on identified sites. The report is to make recommendations in relation to recording, preservation and destruction of archaeological sites.

Both options are located within a corridor 100 metres wide. The Red Corridor extends from a point 500 metres south of Saddle Road (to the south of Brunswick Heads) as far as the Brunswick River where it rejoins the existing Pacific Highway. The route for the bypass is 3.4 km long. The Modified Red

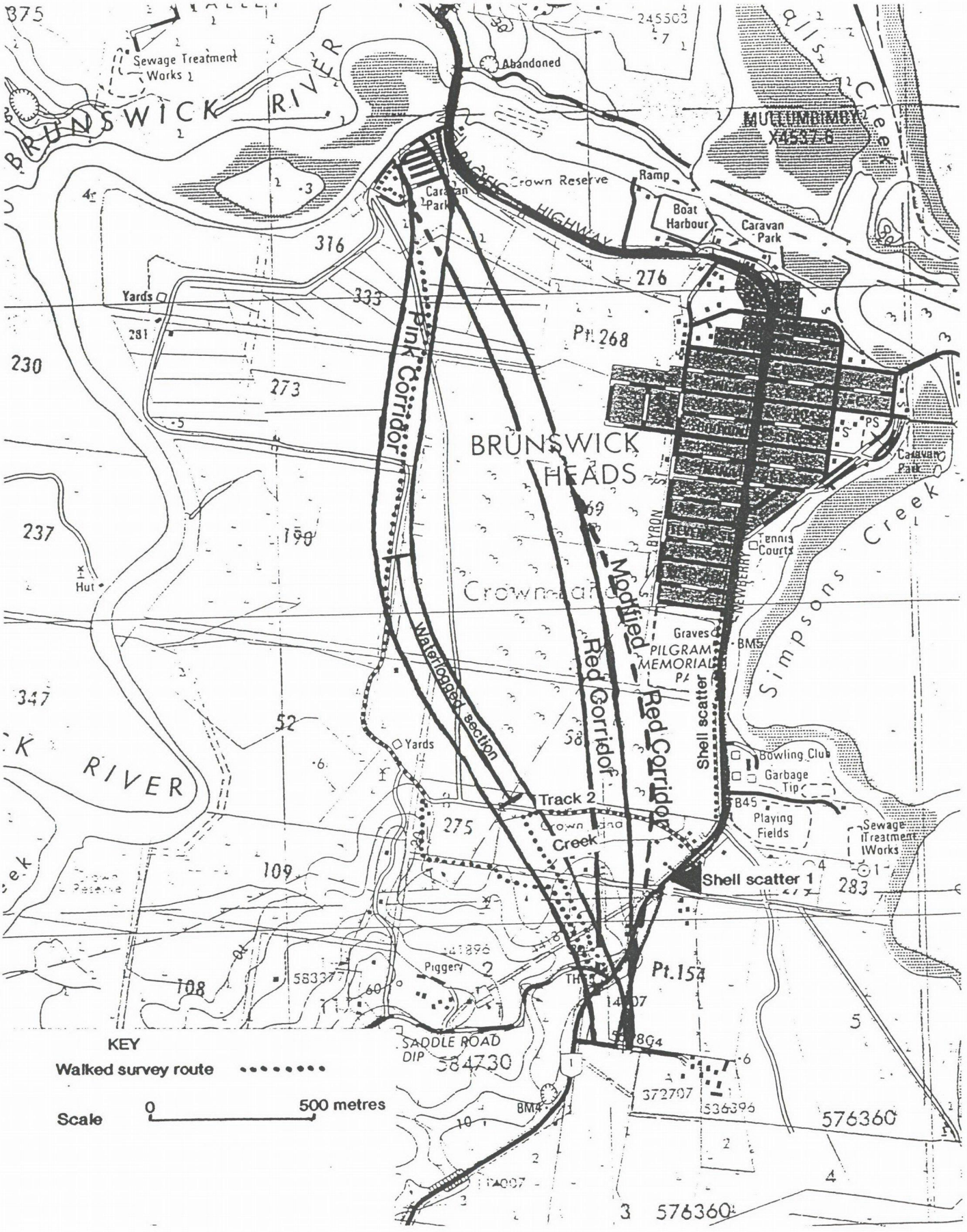

Figure 1. Options for the Brunswick Heads Bypass Route.

Corridor begins at the same place but continues due north until it nears Pilgrim Memorial Park at which point it bends northwest to rejoin the Red Corridor.

The Pink Corridor extends from Saddle Road to the Brunswick River where it also rejoins the existing Pacific Highway. This route is about 3 km in length.

1.2 Rationale

Archaeological sites provide evidence to study past human behaviour and cultural development where no written records exist. Archaeological sites are a non-renewable resource and particularly sensitive to land development because they exist within or on the surface of the ground. Archaeological sites are therefore protected under the New South Wales National Parks And Wildlife Service Act 1979 and the Environmental Planning And Assessment Act 1979 (Byrne 1985). Under these acts it is an offence to knowingly destroy archaeological relics and it is the responsibility of the National Parks And Wildlife Service to manage this resource.

1.3 Development Methods

Initial preparation for the Bypass Route requires complete clearing of all vegetation by a bulldozer. This will occur throughout the entire 100 metre Bypass Route Corridor in low lying areas. In this first stage of construction vegetation clearing will result in sub-surface disturbance down to an estimated depth of around 30 centimetres, but possibly more in certain situations (i.e. where the bulldozer sinks in waterlogged areas). The ridge at the southern end is to be removed down to the level of the rest of the Bypass Route and this will also result in the complete destruction of the corridor.

Surface preparation then occurs. This may entail the removal of sediments in low lying areas to obtain a firm base although the specific location and extent of such work will not be known until soil testing analysis has been completed. Installation of flood control structures would also occur in this phase and include excavations. The road foundation is then built up with fill to a level of one to two metres above the existing ground surface. Road formation and surfacing is then completed and the shoulder batter and corridor areas revegetated with local floral species (Robert Kook, NSW RTA, Grafton pers. comm.).

1.4 Impact Assessment

Surface archaeological sites within the entire 100 metre Bypass Route Corridor will be destroyed in the course of the development. Sub-surface archaeological sites existing up to

at least 30 centimetres below the surface, and at greater depths where excavations are determined to be necessary, will also be destroyed.

1.5 Aboriginal Consultation

The Tweed Byron (LALC) was contacted with respect to the proposed development and as part of the community consultation program. Although it was arranged for a representative of the Tweed Byron LALC to participate in the survey circumstances did not allow this on the day. However, Mr Sam Lever of the Tweed Byron LALC stated that they were happy for the study to proceed providing they were kept informed of the results of the survey and the location of any sites (see Appendix 8.1).

2.0 BACKGROUND

This section of the report provides a brief overview of the environment, Aboriginal cultural history and archaeological research in the region.

2.1 The Study Region

The proposed Bypass Route crosses a typical Northern New South Wales coastal environment. The major watercourse is the Brunswick River which marks the northern boundary of the Bypass Route.

Along the beaches, coastal plain and estuaries geology consists of Quaternary deposits of beach and dune sands backed or overlain by similarly aged riverine deposits of gravels, alluvium or sand. The hills and higher areas to the west of the coastal plain generally consist of the Palaeozoic Neranleigh-Fernvale formation with outcrops of the Cainozoic Lamington Volcanics.

Prior to extensive clearing, which came with European settlement of the area, sub-tropical rainforest and wet or dry sclerophyll forests occurred extensively along the coastal hills and lowlands. Estuaries and creeks supported mangroves with fringing riverine forests of Casuarina, sub-tropical rainforests or sclerophyll forests. Low lying marshy or swampy areas, where the original vegetation has been often left intact, support paperbarks (Melaleuca sp.), tea tree (Leptospermum sp.) and banksia (Banksia sp.) with a ground cover of reeds or coarse grasses. Coastal dunes and swamps are dominated by littoral scrubland or coastal heath, the latter consisting predominantly of banksia (B. integrifolia or serrata) (see Byrne [1985] or Davies [1991] for further details).

2.2 Aboriginal Cultural History

There have been numerous studies and papers published concerning this aspect on the North Coast of New South Wales (e.g. Byrne 1985; Coleman 1982; Crowley 1978, 1991; Lilley 1984; Mathews 1897; Steele 1984; Sullivan 1987; Tindale 1974). Recent reviews of the current literature, which also result from archaeological impact assessments, are available in Byrne (1985), Davies (1991) and Navin (1990).

According to Tindale (1974) the Minjunbal socio-linguistic group occupied land extending from Cape Byron north to Southport (in Southern Queensland) and inland as far as Nerang Creek and Murwillumbah. However Davies (1991) notes that there is conflicting evidence concerning the naming of sub-groupings, or clans, and location of their estates. For example, while Steele (1984:49) describes the Tweed River area as the territory of the Moorung-Moobar clan, the Tweed Byron LALC (quoted in Davies [1991]) maintain that this group only occupied the northern side of the river and that the southern side was owned by the Coodjunbarra. Crowley lists the catchments of the Clarence, Richmond and Tweed Rivers as belonging to a broad linguistic group who spoke a language called Bandjalang. Tindale (1974) only names the area of the Bandjalang as extending from the Clarence river as far north as Ballina. He lists the Arakwal group as occupying land from Ballina to Cape Byron, where the study area is located.

Clearly a number of tribal groups with many sub-groups and clans existed on the NSW North Coast as described by Crowley (1991). He (1991:16) suggests that this could be explained as a result of a greater antiquity of Aboriginal settlement in the area as opposed to regions further south. However, alternative explanations could be offered (see examples from other resource rich but climatically diverse coastal areas such as south west Victoria [Lourandos 1983] and the rainforest coast of North Queensland).

Various estimates have been made for Aboriginal populations of coastal New South Wales ranging from one person/0.3 to 1.5 km^2 (see Byrne [1985] for a summary of estimates). On the north coast Aboriginal people are said to have maintained a sedentary existence moving periodically between large base camps in contrast to the inland groups who are described as more mobile (Coleman 1982; Lilley 1984). Ceremonial activities were an important part of Aboriginal life and are evidenced archaeologically by the presence of bora grounds and stone arrangements and described by early observers. The most well known of these were the Bunya Festivals, held in the ranges north of Brisbane about every three years, when nuts from the Bunya Pines were particularly plentiful, and to which people from the north coast of New South Wales travelled (Petrie 1904).

Resources along the coastal zone have been described as rich and varied (Sullivan 1978). Archaeological excavations at

Wombah, on the Clarence River estuary, suggest a heavy emphasis on estuarine resources (McBryde 1982). Although terrestrial resources were probably abundant, and hunted as well, McBryde (1982:33) found that in the Wombah middens "...the material evidence for fishing and hunting as a major contributor to the food supply" was not strong. Rainforests and coastal wetlands are indicated as having supplied a range of resources such as fruits (Exocarpus cupressiformus), fern roots (Pteridium esculentum and Blechnum sp.), yams or tubers (Dioscorea transversa and Colocasia macrorrhiza) and nuts (Macadamia ternifolia, Araucaria bidwillii and Castanospemum australe).

In summary, relatively high Aboriginal populations, large sedentary base camps and an extensive resource base suggest that a diversity of archaeological sites will occur in the study area.

2.3 Archaeological Background

While numerous archaeological studies have been conducted on the northern coast of New South Wales few archaeological sites have been located (Davies 1991:12). It is likely that this is more a reflection of the amount of development which has occurred in the area rather than the real pre-European distribution of sites. Development has been most intensive within the immediate coastal zone but the general pattern of small scale intensive farming practices further inland would also have had considerable impact on archaeological sites.

In the assessment for the Red Corridor previous studies were used to identify the types of sites and archaeological sensitivity of broad environmental zones (predicative site location model). This model may be summarised as follows:

(i) Coastal Dune Systems are likely to contain middens consisting of thin shell lenses (predominantly pipi) and burials and have a relatively high archaeological sensitivity.

(ii) Coastal Valleys may contain scarred trees, artefact scatters and middens and have a relatively low archaeological sensitivity.

(iii) Hills and Ridges have a site density equivalent to coastal dune systems but will consist predominantly of artefact scatters with associated shell material as well as bora rings, stone arrangements, stone artefact quarries and scarred trees. Archaeological sensitivity is seen as moderate.

(iv) Old Beach and Dune Systems will contain middens which may have associated stone artefactual material and will have a high archaeological sensitivity.

3.0 THE SURVEY

The following section outlines the expectations, methods and results of the fieldwork conducted along the proposed Highway Bypass Routes.

A major constraint on the survey was thick vegetation in the middle section of the route. In particular a waterlogged section in this area, vegetated with thick paperbark forest, was unable to be inspected.

3.1 Expectations

Taking into account the particular environment along the Bypass Route, the overview of the archaeological and ethnographic information and Aboriginal consultation it was apparent that archaeological sites were likely to be encountered in the Bypass Corridors. These may consist of stone artefact scatters (which generally indicate camp site locations) and shell middens (which also indicate camp site locations) where shellfish, and probably other resources, have been consumed and the remains discarded.

3.2 Environmental Description

The route can be divided into discrete environmental units within which topography, soils and vegetation are relatively uniform. These units, along with a general assessment of ground surface visibility in each one, are identified as follows:

(i) Ridges which extend from Saddle Road to the Creek Flood Plain with gradients averaging around 1:5. The land is cleared and either cultivated or lightly grassed with ground surface visibility of around 30% (Plate 1).

(ii) Closed mixed eucalypt and paperbark woodland found along the flood plain of the small creek from the base of the ridges to about 150 metres north of Track Two. Ground surface visibility was around 5% (Plate 2).

(iii) Mixed paperbark or Banksia marshland exists along the middle of the bypass route extending for about 1 km. Ground surface visibility was nil (Plate 3).

(v) River Flood plain is found at the northern end of the bypass route. Vegetation consists of Casuarina with moderate grass cover. Ground surface visibility was found to vary between 10% and 60% (Plate 4).

3.3 Survey Methodology And Results

The Pink Corridor was inspected on foot from the boundary of the Caravan Park to Saddle Road except for the thickly forested waterlogged section (**Figure 1**). This corridor covers approximately 300,000 m^2 (3,000 m long x 100 m wide). During the survey an area of about 10 m wide was inspected along 2 km of the proposed corridor. Thus the sample of the Pink Corridor amounted to 20,000 m^2 or 6.6%. As already stated no archaeological sites were found within the corridor.

The river flood plain is a similar environmental setting to that in which the Wombah middens on the Clarence River estuary are located. While surveys will not necessarily be sufficient to determine if similar shell middens or other archaeological sites exist below the surface drainage channels cut across the flood plain in this area enabled random sub-surface inspections. No archaeological sites were found on this inspection suggesting that they probably do not occur in this area.

Only a small section at the southern end of the Modified Red Corridor was inspected. This was because most of this option crosses low lying waterlogged marshland. During inspection of this part of the route "pippi" shell (Plebidonax deltoides) was found lying on a sandy verge beside the existing Pacific Highway at the point indicated in **Figure 1** and called Shell Scatter 1 (Plate 5). While this scatter resembles disturbed shell midden it was established that this material was not in situ and may therefore have been moved to its present position from somewhere else. The concentration consisted of about 130 fragments of shell greater than 1 cm in size. On top of the cutting a thin scatter was evident for about 60 metres along the track at a maximum density of about 1 shell/m^2. The area where this scatter of shell is apparent has been greatly disturbed during construction and maintenance of the existing highway (Plate 6). A transect was walked into the bushland for a distance of about 70 metres at a right angle to the road to establish if a midden existed nearby in undisturbed areas. Holes dug into the ground by a small animal (probably bandicoots) enabled sub-surface inspections. However no shell midden was detected.

A further inspection was carried in the partly cleared area on the western side of the Pacific Highway as far as the edge of Brunswick Heads township. This part of the survey revealed that from opposite the Bowling Club to the southern edge of Brunswick Heads badly fragmented shell (probably pippi), pieces of oyster and the occasional whelk were found along the western edge of the track running beside the Pacific Highway. At one point, in the undisturbed bushland about 15 metres from the edge of the track and north of the Bowling Club, some sub-surface and apparently in situ shell material was found.

Further work would be needed to establish whether the shell scatter extending from the Bowling Club to the picnic area is

in situ and archaeological. McBryde (1982) cites cases on the North Coast of New South Wales where shell middens have been used to provide road base and this may have occurred in this instance. However, none of this shell scatter is within the Modified Red Corridor and if the impacts of the development are kept within the described corridors no further assessment will be necessary.

4.0 CONCLUSIONS

No archaeological sites were discovered in either of the corridors proposed for the development. Given previous archaeological research on the North Coast of New South Wales the river flood plain at the northern end of the study area is potentially the most archaeologically sensitive area. However, good ground surface visibility, the ability to obtain a large sample of the area due to the open cleared nature of the country and sub-surface sampling facilitated by the presence of drainage channels suggest that if archaeological sites were present they would have been located. It is concluded that archaeological sites are unlikely to occur in this area.

The low lying sandy area where the proposed Southern Access Road diverges from the existing Pacific Highway is considered archaeologically sensitive as suggested by the site location model and presence of possible disturbed midden material on the verges of the present highway. The Road and Traffic Authority are therefore advised that archaeological sites may exist undetected in this area.

5.0 ROUTE SELECTION

The criteria for determining route selection are based on the need to avoid areas identified as archaeologically sensitive and minimising the impact on known archaeological sites. In addition, previous disturbance of land can also be taken into consideration because sites which may have existed in these areas are likely to be disturbed and their scientific value diminished. Thus, the criteria for determining route selection are:

(i) the proximity of the route to archaeological sites;

(ii) the impact of the development on archaeologically sensitive areas;

(iii) the level of disturbance of the natural environment along the route.

The Modified Red Corridor is least preferred because it passes through an area where suspected shell midden material is located. While this material is not in situ it may indicate the presence of a midden nearby. This option also passes closest to a possible midden located along the western side of

the Pacific Highway opposite the Bowling Club. In addition the low dune located between Simpsons Creek and the low lying wet lands, along which the existing Pacific Highway runs, is an area of potentially high archaeological sensitivity and any development should avoid this area if possible. This option would also have the greatest impact on undisturbed environments. Only about 30% of this route passes through previously disturbed environments most of which occur at the northern end of the corridor.

The Pink Corridor is the most desirable from an archaeological point of view because it has less impact on potentially archaeologically sensitive areas and passes at a greater distance from a possible archaeological site. About 60% of the land which this route crosses has also been disturbed by either clearing or cultivation.

6.0 RECOMMENDATIONS

1. It is recommended that the Pink Corridor is the preferred route for the Highway Bypass and that there are no constraints on this route in terms of known archaeological sites.

2. It is recommended that the New South Wales Road and Traffic Authority be advised that sub-surface archaeological material may exist within the options for the Brunswick Heads Bypass and, if so, will most likely be identifiable as a concentration of shell material (i.e. a shell midden). If such material, or other archaeological material, is found or excavated during construction of the Brunswick Heads Bypass all work should cease and the National Parks and Wildlife Service, Grafton and the Tweed Byron LALC should be immediately advised of the situation.

3. It is recommended that, if the New South Wales Road And Traffic Authority finds it necessary to use the Modified Red Corridor, then an additional archaeological assessment be carried out to determine whether the shell material lying along the western side of the Pacific Highway, from the Bowling Club to the Picnic area, is archaeological and, if so, assess the impacts of the development on this site.

4. It is recommended that, in view of the potential archaeological sensitivity of the sandy area at the southern end of the Red Corridor where the access road would be located, the Tweed Byron LALC monitor initial earth works in the area and that New South Wales Road and Traffic Authority advise them when this is to begin.

5. It is recommended that no permit to destroy is necessary for the suspected disturbed shell midden material located in the Southern Access Road corridor.

7.0 REFERENCES CITED

Border, A. 1991. An archaeological assessment of the New South Wales Road and Traffic Authority's Proposed Brunswick Heads Bypass and future development to 51.0 kms north of Ballina. Unpublished report to the Road and Traffic Authority.

Byrne, D. 1985. Archaeological sites in the Ulmarra Shire: A background for site management. Unpublished report NSW National Parks and Wildlife Service.

Davies, S. 1991 An archaeological assessment of the proposed Telecom Optic Fibre Route between Andersons Ridge Regenerator Station and Banora Point Telephone Exchange, Northern Region, New South Wales. Unpublished report to Telecom Australia, Concord West.

8.0 APPENDICES

8.1 Statement from the Tweed Byron Local Aboriginal Land Council.

TWEED BYRON LOCAL ABORIGINAL LAND COUNCIL

P.O. Box 6160,
Tweed Heads South, NSW 2486
Telephone (075) 24 3238
Fax. (075) 24 6951

Chairperson:

Secretary:

14th August 1992

Ms Su J. Davies
Manager,UQASU
Department Anthropology and Sociology
The University of Queensland
QUEENSLAND, 4072

RE: STATE HIGHWAY NO.10-PACIFIC HIGHWAY. SHIRE OF BYRON. PROPOSED BRUNSWICK HEADS BYPASS.

Dear Ms Davies

Further to our phone conversation on the 10th August 1992 concerning the Archaeological assessment carried out by Andrew on the Brunswick heads Bypass and talks that I had with Andrew when he came to the Land Council office on the 6th August 1992 concerning the study area.

The Tweed Byron L.A.L.C concerns then were if any sites were found that we would be contacted and this has taken place regarding the road edge area.

I was unable to attend the day that Andrew carried out the field work.

After talking with yourself on the 10th August 1992 I rang Andrew about the survey area,he told me that he found an area of scattered shell matierial on the edge of the road which could of been fragments of a old midden or more likely road fill that had come from a area close by but out side the survey area.

In any case it could not be said that this was a midden because of the extensive damage or was it just shell fragments from the road fill,there w ere no other flakes or supporting evidence which could of determined that it was.

We don,t see that the first bypass is as acceptable as the second one.We are pleased with the consultation we have had with Su Davies and Andrew regarding this area and would indorse there recommendations in this matter.

Please find attached an account for our input thank you.

Your sincerely

Sam Lever
Co-ordinator



Plate 1: Cultivated ridges on Pink Corridor



Plate 2: Mixed paperbark and eucalypt wood land

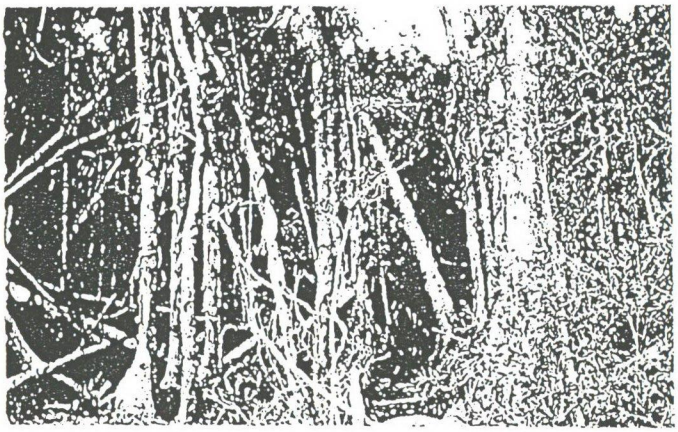

Plate 3: Paperbark marsh land on Pink Corridor

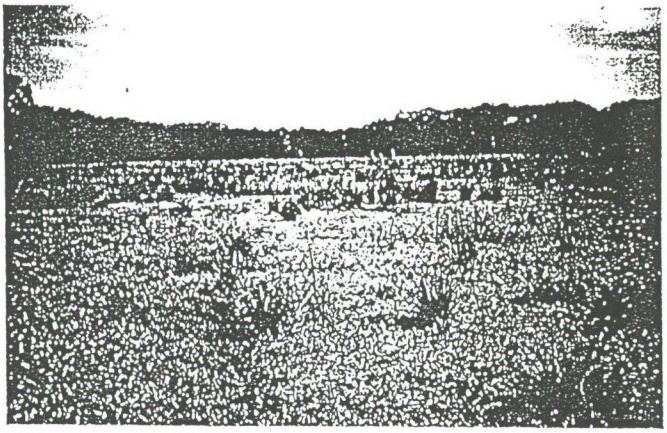

Plate 4: River floodplain near Caravan Park



Plate 5: Pippi shell in highway cutting

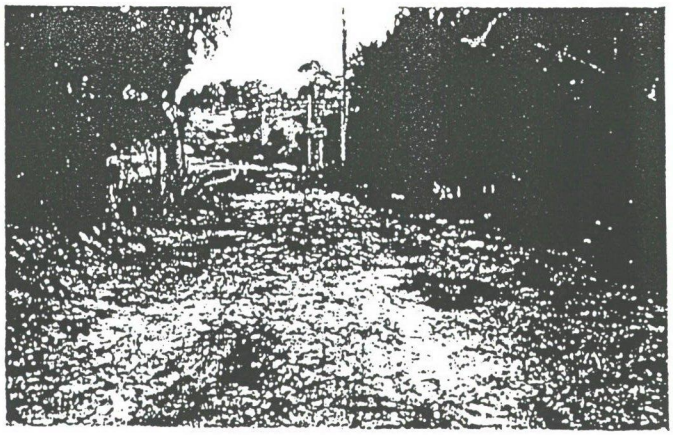

Plate 6: General area of pippi shell scatter

APPENDIX
TO

THE UNIVERSITY OF QUEENSLAND ARCHAEOLOGICAL SERVICES UNIT
REPORT NUMBERS 192 AND 204

AN ARCHAEOLOGICAL ASSESSMENT OF CORRIDOR G OF THE NEW SOUTH WALES ROADS AND TRAFFIC AUTHORITY'S PROPOSED BRUNSWICK HEADS BYPASS.

A Report to
Roads and Traffic Authority
PO Box K198
HAYMARKET NSW 2000

By

S. Davies
Department Anthropology and Sociology
The University of Queensland
St Lucia 4072

October, 1992

S. Davies
(Manager, UQASU)

J. Hall
(Director, UQASU)

1.0 INTRODUCTION

This appendix presents the results of an archaeological assessment of Corridor G of the proposed RTA's Brunswick Heads Bypass. Corridor G is located to the west of Corridors A (Red), E (Red Modified) and D (Pink) which have previously been subjected to an archaeological survey by UQASU (see Border 1991, 1992) (Figure 1).

2.0 BACKGROUND

Although archaeological sites were not located in Corridor A, E or D, Border (1991, 1992) notes that, in general, the major constraint to the surveys were poor ground surface visibility. Border (1992) did note, however, that at the northern end of Corridor D "good ground surface visibility and the ability to obtain a large sample of the area due to the open cleared nature of the country and sub-surface sampling facilitated by the presence of drainage channels suggest that if archaeological sites were present they would have been located". He concluded that archaeological sites were unlikely to occur in this northern area. However, to the south, in the low-lying sandy area where the proposed Southern Access Road diverges from the existing Pacific Highway, Border (1992) located possible disturbed midden material on the verges of the present highway. From an archaeological perspective, Border (1992) suggests that a Bypass corridor located to the west of Corridors A and E is preferred because it has less impact on potentially archaeologically sensitive areas and passes at a greater distance from a possible archaeological site.

3.0 THE SURVEY

Fieldwork was conducted on the 13th October, 1992. Mr Sam Lever from the Tweed Byron Local Aboriginal Land Council participated in the survey and his statement is attached.

3.1 Corridor G

From south to north the Corridor can be divided into four units as follows:

1) North from Saddle Road for some 500m the Corridor traverses undulating hills with gradients averaging around 1:5. The land is cleared and covered mainly in pasture.

2) Extending north for some 350m from the base of these hills is a section of Rainforest Scrub containing species such as Palm, Cunjevoi (Alocasia macrorrhizos), Fig and Tree Fern.

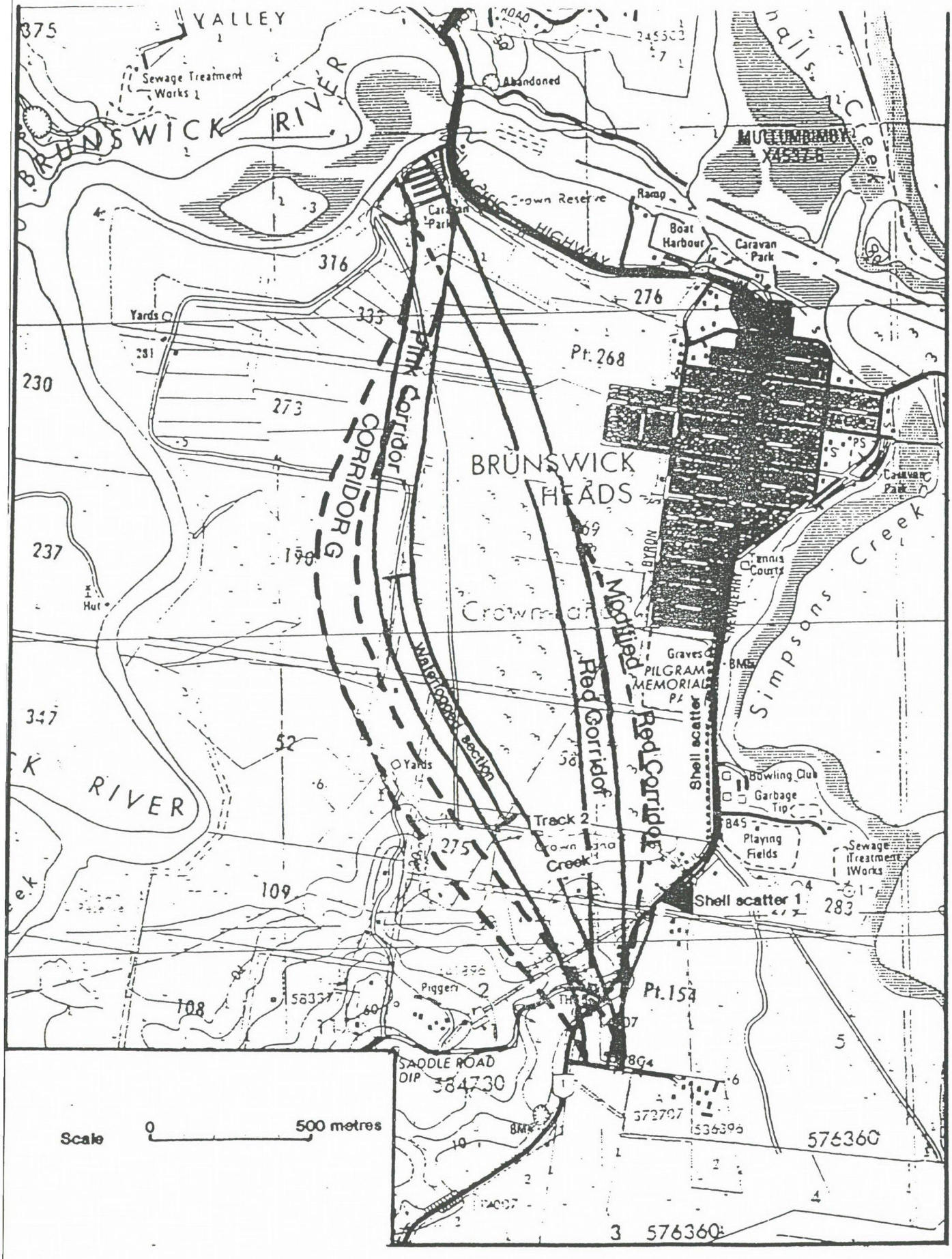

Figure 1. Location of Corridor G.

3) Closed mixed eucalypt and paperbark woodland with an understorey of Bracken (Pteridium esculentum) extends from the Rainforest Scrub north for some 1.2kms.

4) The remainder of the Corridor traverses River Floor Plain. Some sections are cleared and vegetation consists mainly of Casuarina and grasses.

3.2 Expectations

Based on background research from the surveys of Corridors A, E and D, it was expected that a number of archaeological sites types were likely to be located during this survey including:

* Stone Artefact scatters (indicative of Aboriginal camping places).

* Shell middens (indicative of Aboriginal camping places where shellfish, and probably other resources, have been consumed and the remains discarded).

* Scarred or carved trees (indicative of the manufacture of material culture items or ritual activity).

Based upon current knowledge of the historical and archaeological record for the region a number of expectations regarding site type locations were
expected as follows:

* Stone artefact scatters (or isolated stone artefacts) were expected, especially along the spine of the hills in the undulating terrain in the southern section of the Corridor.

* Shell Middens and Stone Artefact scatters (or isolated stone artefacts) were expected in slightly elevated areas within the mixed Eucalypt and paperbark woodland and river flood plain area in the northern section of the Corridor.

* In the area of closed mixed Eucalypt and paperbark woodland some older trees might contain scars produced by Aboriginal axes during the removal of bark pieces for huts or other items of material culture or as the result of ritual/ceremonial activities.

3.3 Survey Method

In order to take into account the above expectations a full ground search on foot was carried out within the 100m-wide corridor from where it diverges from the Pacific Highway in the south to where it merges with Corridor D (Pink Corridor - previously surveyed) in the north. The only area not inspected was a 200m section within the Rainforest Scrub where the

ground surface was totally covered in thick leaf litter and vegetation. With two people surveying an estimated 30-40% sample of the Corridor was subjected to inspection. This percentage cannot be accurately estimated as the exact location of the corridor was unclear (see Section 3.4).

3.4 Survey Constraints

The major constraints to the survey were vegetation, which inhibited ground surface visibility, and the lack of markings indicating the exact position of the Corridor.

Ground surface visibility was categorised as follows:

1) Poor ground surface visibility (0-10%) was characteristic of at least 90% of the corridor, especially in grazing paddocks, rainforest scrub and the mixed Eucalypt and paperbark woodland.

2) Medium ground surface visibility (11-70%) was characteristic of the River Flood Plain section of the corridor and some disturbed segments in the paddocks and mixed Eucalypt and paperbark woodland.

3) Good ground surface visibility (71-100%) was characteristic of a limited number of locations such as the dirt track traversing the spur spine in the southern section of the corridor and at a narrow section between the rainforest scrub and the mixed eucalypt and paperbark woodland where a dirt track is present.

The exact location of the proposed Bypass corridor was not pegged. Hence, the location was estimated from contour maps and from pacing out distances from boundary fences, corner posts and other relevant features.

4.0 SURVEY RESULTS

Despite a relatively high expectation of locating archaeological sites, especially on the slightly elevated sections, nothing relating to past Aboriginal culture was found. This negative result may be a result of poor ground surface visibility.

In summary, while there is little doubt that Aborigines used this area - probably for many thousands of years - their presence was not detected archaeologically.

5.0 RECOMMENDATIONS

1) As archaeological sites were not located within Bypass Corridor G, it is recommended that no heritage constraints be placed on the proposed development.

2) It is recommended that the Roads and Traffic Authority contact the Tweed Byron Local Aboriginal Land Council prior to the commencement of initial earth works in the Bypass Corridor and invite them to monitor this part of the construction process.

3) Should activities associated with the Bypass construction uncover anything which may be interpreted as Aboriginal in origin, it is recommended that all work should cease and the National Parks and Wildlife Service, Grafton, and the Tweed Byron Local Aboriginal Land Council should be immediately advised of the situation.

6.0 ACKNOWLEDGMENTS

Thanks to Mr Sam Lever, Tweed Byron Local Aboriginal Land Council and Mr Jack Bashforth, property owner, Brunswick Heads, for their assistance and advice.

7.0 REFERENCES CITED

Border, A. 1991 An Archaeological Assessment of the New South Wales Roads and Traffic Authority's Proposed Brunswick Heads Bypass and Future Development to 51.0kms north of Ballina. Unpublished report to the New South Wales Roads and Traffic Authority.

Border, A. 1992 An Archaeological Assessment of the New South Wales Roads and Traffic Authority's Proposed Second Option (Pink Corridor) for a Brunswick Heads Bypass. Unpublished Report to the New South Wales Roads and Traffic Authority.

TWEED BYRON LOCAL ABORIGINAL LAND COUNCIL

P.O. Box 6160,
Tweed Heads South, NSW 2486
Telephone (075) 24 3238
Fax. (075) 24 6951

Chairperson:

Secretary:

19th September 1992

Ms Su J. Davies
Manager, UQASU
Department Anthropology and Sociology
The University of Queensland
QUEENSLAND, 4072

RE: STATE HIGHWAY No.10-PACIFIC HIGHWAY. SHIRE OF BYRON
PROPOSED BRUNSWICK HEADS BYPASS.

Dear Ms Davies

I am writing to put forward the view of the above L.A.L.C in regards to the survey that Ms Su Davies and myself carried out on the 13th September 1992 on the third possible route.

The plan we had was hard to follow because of lack of land marks survey pegs to show clearly the path of the road we covered a large area and within these areas there were no visible sites.

Visibility in the survey area was very poor and we ask that if this route is taken then the land council ask that we be given the opportunity to survey the area once the surface is removed we ask that this be a condition of the proceedings on any of the Brunswick Heads Bypass Routs.

We beleave that the fist route would not have such a impact on the bush land as the third.

Thank you

Yours sincerely

Sam Lever
Co-ordinator

APPENDIX J

COMMISSIONER SIMPSON - Comments and Recommendations on DMR Submission to Commission of Inquiry into Draft LEP Shire of Byron 1987

Report to the
Council of the Shire of Byron

A Public Hearing into Submissions made
in respect of

DRAFT LOCAL ENVIRONMENTAL PLAN
SHIRE OF BYRON

William Simpson
Deputy Chairman
OFFICE OF THE COMMISSIONERS OF INQUIRY
FOR ENVIRONMENT AND PLANNING

February 1987

HEARING NO. F12

NAME: DEPARTMENT OF MAIN ROADS

COMMENT AND RECOMMENDATION:

The proposed 9(a) zoning of the future location of Pacific Highway deviation should be retained throughout the length under review at the hearing (F13, F14, F15). No other acceptable route was presented. The general highway construction programme in the State indicates that the construction of a road of the envisaged standard is certain though its construction is presently not imminent. On balance the identification of the route on the plan is in the public interest.

I consider the route of the reservation is appropriate for a limited access highway. Its identification on the plan well in advance of its likely construction does create difficulties for some owners but provision is made in the plan for those who wish to increase their capital investment in the land, to have the question of development or acquisition resolved.

Its location should be adjusted to accord with the revised plan received by Council on 6.1.87 (Note. This accords with evidence in Hearing No.D10 that Lot 1376 is no longer affected).

A check should be made regarding any other amendments which may have been made since the preparation of the plan.

The "Expressway" identification on the plan should be amended to the appropriate description for the future limited access highway,.

The north-west end of Balemo Drive should be amended on the plan to accord with the detail on the above D.M.R. plan.

Consideration might be given to providing for the connection of Balemo Drive to the New Brighton Road and/or to the proposed limited access highway. The means of access generally to Ocean Shores in the future may also be worthy of further consideration.

. . .

APPENDIX K

Brunswick Heads EIS - Aquatic Flora and Fauna

Peter Parker, 1992

STATE HIGHWAY NO.10 - PACIFIC HIGHWAY

BRUNSWICK HEADS BYPASS

ENVIRONMENTAL IMPACT STATEMENT

AQUATIC FLORA AND FAUNA

Prepared by Peter Parker
Environmental Consultant
Broken Head Road
Broken Head 2481
ph: (066) 853 148
fax (066) 858 361

February 1992

SUMMARY

* This report details the findings of a survey of the intertidal and subtidal areas of the Brunswick River estuary in the vicinity of four proposed highway bypass routes. It is considered that the black route provides the least impact on vegetation and fauna. The next best alternative is the red route. Development of either the blue or green routes is not recommended.

* Six vegetation associations were identified. Three mangrove associations, two saltmarsh associations and swamp sclerophyll forest were mapped.

* Although no rare or threatened plants were recorded the plant associations were considered to be of high conservation value. This was due to the role they play in the marine food web.

* Some affected Coastal Wetlands are mapped under SEPP 14. An area within the green route should be investigated by the Department of Planning for possible addition to the Coastal Wetlands Policy.

* The assessment of the impact of the proposed routes on vegetation communities concluded that the black route was the least destructive. The order of increasing impact was black, red, blue and green.

* A total of 43 species of birds were recorded from the Brunswick River estuary. These were recorded between the green route and the groynes seaward of the existing highway bridge. The pied oyster catcher was the only species observed that is listed as vulnerable or rare. This species was located on the rocky groynes to the seaward side of the existing highway bridge and is therefore unlikely to be affected by the development of any of the proposed routes.

* Invertebrates were collected from the intertidal and subtidal sediments in the vicinity of the 4 routes. A total of 16 species in 15 families were recorded. Crabs dominated the intertidal sediments in both species numbers and numbers of individuals collected. The invertebrates sampled are widespread in the estuaries of south-eastern Australia.

* The impact of the proposed bypass routes on fauna was assessed on the basis of rare or threatened species and edge effect. It was considered that the black route provided the least impact. The order of increasing impact was black, red, blue and green.

* The Brunswick River is of great value to the commercial oyster industry. The green and blue routes will have no effect on existing leases. The black and red routes will affect 2 lease holders. There is a strong likelihood that co-operation between the RTA, NSW Fisheries and the respective growers will minimise any inconvenience to oyster farmers.

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1.0 INTRODUCTION

The Roads and Traffic Authority (RTA) is presently investigating a new route for the Pacific Highway to bypass Brunswick Heads. The existing highway is utilised by large numbers of vehicles passing through the Brunswick Heads village. Recent surveys established that over 71% of these vehicles would use the Bypass (RTA 1991).

The new road will contain two lanes plus an additional overtaking lane for southward bound traffic. Junctions will be provided at each end of the bypass to allow access to Brunswick Heads.

Four potential routes have been selected by the RTA and will be thoroughly investigated in accordance with the requirements of the Environmental Planning and Assessment Act, 1979 (EPA, Act). The proposed routes have been designated colour codes. These are from east to west: black; red; blue; and green (Map L).

This report examines the impact that each of these routes will have on aquatic flora and fauna (excluding fish). It surveys the wetlands found along the approaches to the Brunswick River, discusses the proposed bridge crossing and reviews the impacts to commercial oyster farmers.

The upper topographical boundary for this survey was the spring high tide mark; the lower boundary being approximately 0.5 m below spring low tide. The upper survey boundary corresponds to the limit of studies being undertaken by White (pers. comm.).

2.0 EVALUATION CRITERIA

Evaluation criteria are standards or measures for comparing the routes and selecting a preferred alternative.

2.1 Definition of Criteria

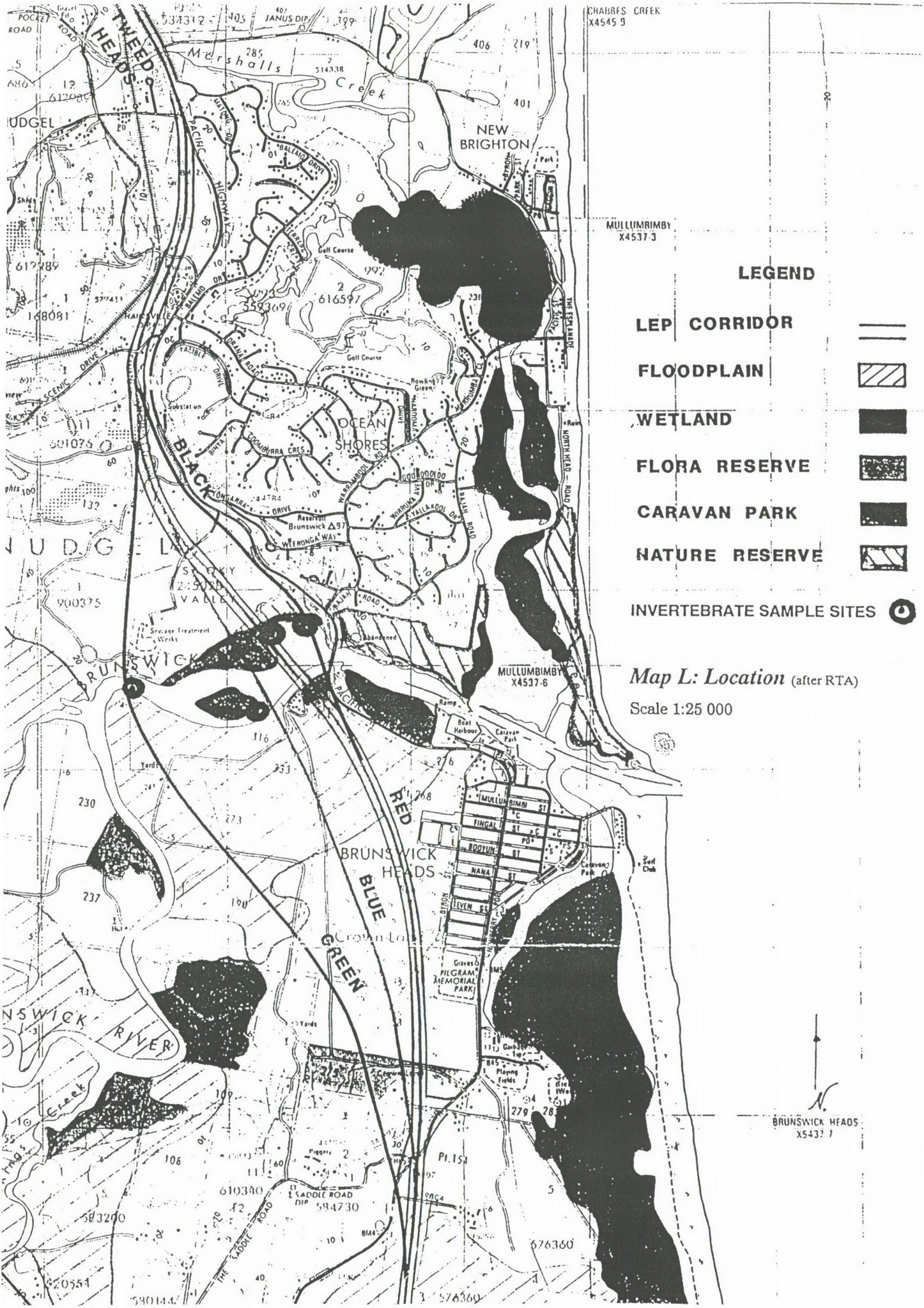
Each route option will be evaluated according to:

* Its impact on rare or threatened flora or fauna or species of local importance;
* The degree of naturalness or previous disturbance to the area;
* Its impact on the diversity of species found along the subject route;
* Its impact on Coastal Wetlands (SEPP 14: Numbers 62, 64 and 65);
* Its impact on fishery habitat, especially commercial oyster farms; and
* The degree of "edge" effect that a new highway will produce;

These criteria take into consideration the requirements of the EPA Act, 1979 and the EPA Regulation 1980.

3.0 PREVIOUS STUDIES

For many years naturalists and fishers have enjoyed the Brunswick River estuary for both its splendid scenery and as a supply of table fish. Shorebirds that grace the mudflats and mangrove forests have been admired by many. Despite the popularity of this estuary, few studies of the wildlife exist. There have been no surveys of the invertebrates of the mud flats (infauna and epifauna) and few comprehensive surveys of the estuarine vegetation or wildlife.


CHABBES CREEK
X4545 9
MULLUMBIMBY
X4537-3
LEGEND
LEP CORRIDOR
FLOODPLAIN
WETLAND
FLORA RESERVE
CARAVAN PARK
NATURE RESERVE
INVERTEBRATE SAMPLE SITES
Map L: Location (after RTA)
Scale 1:25 000
MULLUMBIMBY
X4537-6
BRUNSWICK HEADS
X5433 7
TWEED HEADS
NEW BRIGHTON
OCEAN SHORES
BRUNSWICK HEADS
BRUNSWICK
BLACK
RED
BLUE
GREEN
Marshalls Creek
Golf Course
Sewage Treatment Works
Boat Harbour
Caravan Park
PILGRAM MEMORIAL PARK
Planing Fields
SADDLE ROAD
Pt.154

3.1 BEACON Coastal Wildlife Survey

A coastal wildlife survey of Byron Shire was undertaken by the Byron Environmental and Conservation Organisation from March to November 1985 (BEACON 1986). This survey included several sites along the Brunswick River, the most relevant being site 44M located amongst mangroves near the junction of Marshalls and Brunswick River (Fig 1).

This 1 ha site was laid out in accordance with fig 1 (with the exception of pit traps). Elliott traps were wired to the stems of the mangrove trees so as to avoid swamping by the higher tides. Eight 20 m three-shelf tetoron mist nets were used to trap birds. On four consecutive mornings these nets were set at ground level to a height of about 2.5 m and operated from dawn for about 5 hours. In addition, random searching for vertebrates was carried out continually while working within the study site.

No amphibians, reptiles or mammals were recorded from this site. A total of 9 bird species were captured and banded and an additional 14 were observed.

3.1.1 The implications of the BEACON survey to route selection

The absence of amphibians, reptiles or mammals from the BEACON site provide strong evidence that it is unlikely that these species would occur in similar mangrove communities near the bypass routes. Furthermore, the BEACON results justified a decision not to trap in similar communities near the bypass routes.

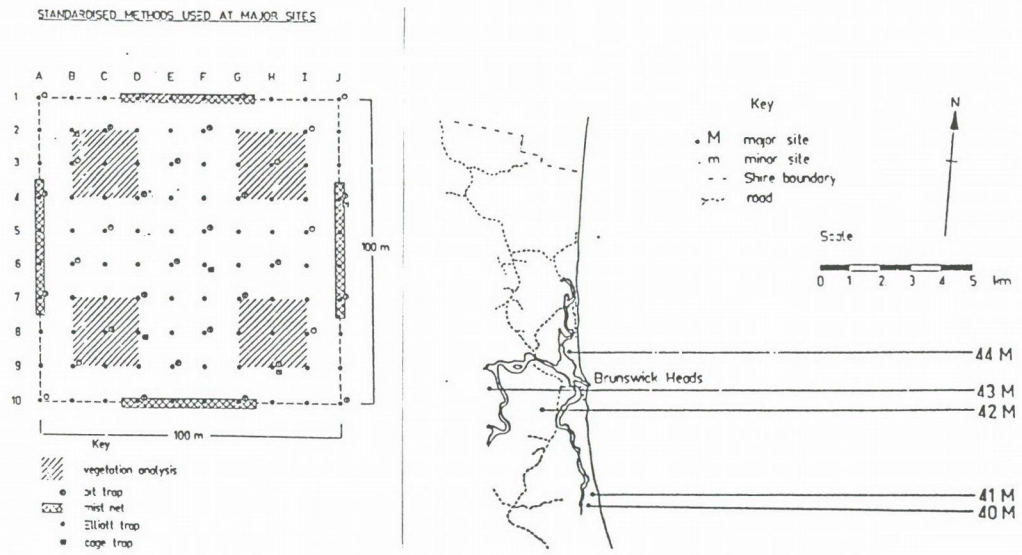


Fig 1: Beacon Site 44M and layout of traps

3.2 The vegetation and flora of Brunswick Heads Nature Reserve

This survey (Williams *et. al.* 1979) highlights the State and regional importance of the Brunswick Nature Reserve and provides a good comparative floristic inventory for other surveys.

This survey examined a small area of vegetation focusing on the mouth of the Brunswick River. It identified 6 rare and 7 uncommon trees as well as 6 rare climbers. The unusual species combination found within the Nature Reserve related to the underlying soil types. The Reserve's

Palaeozoic slates and phyllites contrast with the basalts characteristic of the nearby Big Scrub region.

3.2.1 The implications of the Brunswick Nature Reserve survey to route selection

The survey establishes the national, State and regional importance of the Nature Reserve. It is also the basis of a recommendation that any bypass route should avoid comprising such an important area.

3.3 A flora and fauna assessment of the northern part of the Tyagarah Nature Reserve

This survey mapped the vegetation associations and provided inventories of vascular plants for the northern portion of Tyagarah Nature Reserve (Parker 1991). It relied on the BEACON study for information on wildlife.

It discussed the regional and local importance of the 7 vegetation associations encountered. Small areas of grey and river mangroves were recorded from wetlands near Simpsons Creek. Only 2 mangrove species were recorded, although an additional 3 species have been recorded further south of the study area (pers. obs). These additional species are the orange mangrove *Brugiera gymnorrhiza*, the milky mangrove *Excoecaria agallocha* and the stilt mangrove *Rhizophora stylosa.*

3.3.1 The implications of the Tyagarah survey to route selection

This survey highlighted the extent of mangroves within Simpson Creek. The absence of milky mangroves and orange mangroves within the Tyagarah survey area is relevant. These species may be more common within the north and main arms of the Brunswick River.

3.4 Birds in the Harrys Hill Area, North Head Brunswick River

This inventory (Salter 1983) details 124 species of terrestrial and shore birds for the Harrys Hill and Brunswick River estuary. These observations would have taken some years to compile as many species are seasonal or occasional visitors.

Salter lists 6 species that are described as vulnerable or rare in Schedule 12 under the NSW National Parks and Wildlife Act, 1974. These are:

*	*Xenorhynchus asiaticus*	black-necked stork
*	*Pandion haliaetus*	osprey
*	*Haliastur indus*	brahminy kite
*	*Gallinula olivacea*	bush hen
*	*Haematopus longirostris*	pied oyster catcher
*	*Haematopus fuliginosus*	sooty oyster catcher

3.4.1 The implications of the Harrys Hill survey to route selection

Salter's records arise from extensive observations over many years. They reveal that many species of endangered, cryptic and common birds visit the site.

Wildlife managers can extrapolate from this data the importance of habitat components to avifauna. As many of the requirements of such species are not well understood, the prudent manager would conserve every available habitat.

Salter's inventory demonstrates that endangered shorebirds may at times be found within any of proposed routes. It is important to:

* Minimise habitat disturbance during construction phases;
* Avoid any hydrological alteration of the River; and
* Liaise with the NPWS in order to minimise construction effects if they occur during the breeding period of endangered shorebirds.

3.5 Wildlife survey of the vertebrate fauna of the Brunswick Heads Nature Reserve, NSW

This report (Cathcart 1991) was undertaken as part of undergraduate studies at the University of New England, Northern Rivers. Cathcart used Elliott traps (small mammals), pitfall traps (small mammals and reptiles), cage traps (mammals), mist nets (birds and bats), harp nets (bats) and spotlighting.

The most interesting of Cathcart's records included the bush rat *Rattus fuscipes*, as a "common species" and the sighting of a koala *Phascolarctos cinereus*. The bush rat was recorded by BEACON only in the northern part of the Shire where it was trapped in low numbers.

Cathcart's harp nets recorded the Queensland blossom bat *Syconycteris australis* and the little bent wing bat *Miniopterus australis*. The Queensland blossom bat extends from Cape York to just south of the study site and the little bent wing bat has an Australian distribution from Cape York to central coastal NSW (Cronin 1991).

3.5.1 The implications of this survey to route selection

While some of Cathcart's records would require confirmation, his survey provided detailed lists of vertebrates found within the Brunswick Heads area. As with the Williams' survey, Cathcart's work verifies the importance of the Brunswick Heads Nature Reserve (to fauna) and supports the recommendation that any bypass route should avoid comprising this area.

4.0 VEGETATION

4.1 Survey methods

Vegetation below the spring high tide mark was surveyed on January 22. All terrestrial and aquatic vegetation was recorded using transects spaced at approximately 10 m intervals.

Wetland 62, Wetland 64 and river bank sites were accessed by means of a small motor boat. Some vegetation was recorded on the river bank and above spring high tide but below peak flood heights. These species included paperbarks, bloodwoods, redgums, ironbark wattles, cassias, umbrella trees and saw sedges (see Appendix 1).

4.1.1 Mapping and classification

Vegetation was mapped to a scale of 1:6000 (Map V). The coloured aerial photo (NSW Coastal Wetlands: 3512/157; April 3, 1986) was used as a base map to assist with association boundaries.

Classification of vegetation was based on a scheme developed by Walker *et. al.* (1984). Walker's scheme complements the dominant or diagnostic species with an expression of the growth form, height and cover of the vegetation. For example, the first species is the most abundant or physically predominant species in the tallest stratum; if another upper stratum species is always present and conspicuous it is also selected. A third species may be selected from any stratum if

it is a species of known environmental preference or an extremely abundant species. Thus classification is described as follows:

Vegetation Name= tallest stratum dominant (eg. *Casuarina glauca)* + lower dominant stratum

(eg. Sporobolus virginicus) + structural formation (mid-high sparse to mid-dense open forest)

For further ease of understanding, the associations are listed under the popular names of Beadle (1952).

4.2 Vegetation Associations

Swamp sclerophyll forest

Casuarina glauca, Sporobolus virginicus mid-high sparse to mid-dense open forest.

Mangrove forest

Avicennia marina var. australasica, Aegiceras corniculatum, mid high open woodland to woodland.

Avicennia marina var. *australasica*, *Aegiceras corniculatum*, low open to closed forest.

Excoecaria agallocha mid-high open to closed forest.

Saltmarsh complex

Juncus krausii closed sedgeland.

Sporobolus virginicus closed sod grassland.

4.2.1 Swamp sclerophyll forest

This association is dominated by swamp oak, a salt tolerant species found along coastal NSW and Queensland and in swamps and soaks of the western slopes of NSW (Jacobs *et. al.* 1981; Broadbent *et. al.* 1986). Swamp oaks are an important component of the marine estuarine food web, and as such they are commonly protected under the Coastal Wetlands Policy.

These associations are relatively small and found on more elevated sites than mangroves communities. Sites on Wetland 62 and 64 show little disturbance. Some litter and several exotic plants can be found on the outer margins of these areas. Saltwater cooch on the western bank of the Brunswick River is grazed by stock.

***Casuarina glauca, Sporobolus virginicus* mid-high sparse to mid-dense open forest.**

Structure:

Tallest stratum: 12 m touching to slight separation

Swamp oak Casuarina glauca

Mid stratum:

Casuarina glauca with isolated tuckeroo *Cupaniopsis anarcardioides*.

Ground cover:

Sporobolus virginicus, Suaeda australis, Tetragonia tetragonioides, Fimbryistylis ferruginea and woodland species such as *Dianella caerulea, Lantana camara, Smilax glyciphera, Ghania clarkei, Melaleuca quinquenervia and Callistemon salignus* on nearby higher ground.

4.2.2 Mangrove forest

Mangroves are well recognised for their important role in the marine food chain. They provide homes for marine organisms, stabilise the seabed and contribute large amounts of organic material to the marine environment. Mangroves grow best between mean sea level and spring high tides. The grey mangrove *Avicennia marina* var. *australasica* is usually found on the seaward side of the river mangrove Aegiceras corniculatum. The orange mangrove *Brugiera gymnorrhiza* and the milky mangrove *Excoecaria agallocha,* have also been located within the study area. The orange mangrove occurs as isolated trees amongst the grey mangroves whereas the milky mangrove is usually found landward of the river mangrove.

A dense association of milky mangrove on the southern bank in the vicinity of the green route (Map V) is of local interest. It is unusual in this area to have a mangrove forest with this species as a dominant, especially with a such a well developed canopy. On the south bank in the vicinity of the green route some natural physical damage was observed on very old mangroves.

Mangrove dominated wetland islands are increasing in area. This increase is due to sediment deposition and therefore the provision of appropriate habitat. It occurs largely on the long axis of the islands.

***Avicennia marina* var. *australasica*, *Aegiceras corniculatum*, mid high open woodland to woodland.**

Structure: Tallest stratum 10 m well separated to clearly separated

Grey mangrove Avicennia marina var. australasica.

Midstratum:

Grey mangroves and river mangroves to 4 m; some milky mangroves landward.

Ground cover:

Sporobolus virginicus in elevated areas within Wetland 62.

***Avicennia marina* var. *australasica*, *Aegiceras corniculatum*, low open to closed forest.**

Structure: Tallest stratum 6 m slight separation to touching or overlapping

Grey mangrove *Avicennia marina* var. *australasica*.

Midstratum:

Grey mangroves, river mangroves, several specimens of orange mangrove and cottonwood hibiscus.

Ground cover:

A small area of the salt marsh species Suaeda australis was located in the vicinity of the swamp oak association on the shoreline of Wetland 62

***Excoecaria agallocha* mid-high open to closed forest.**

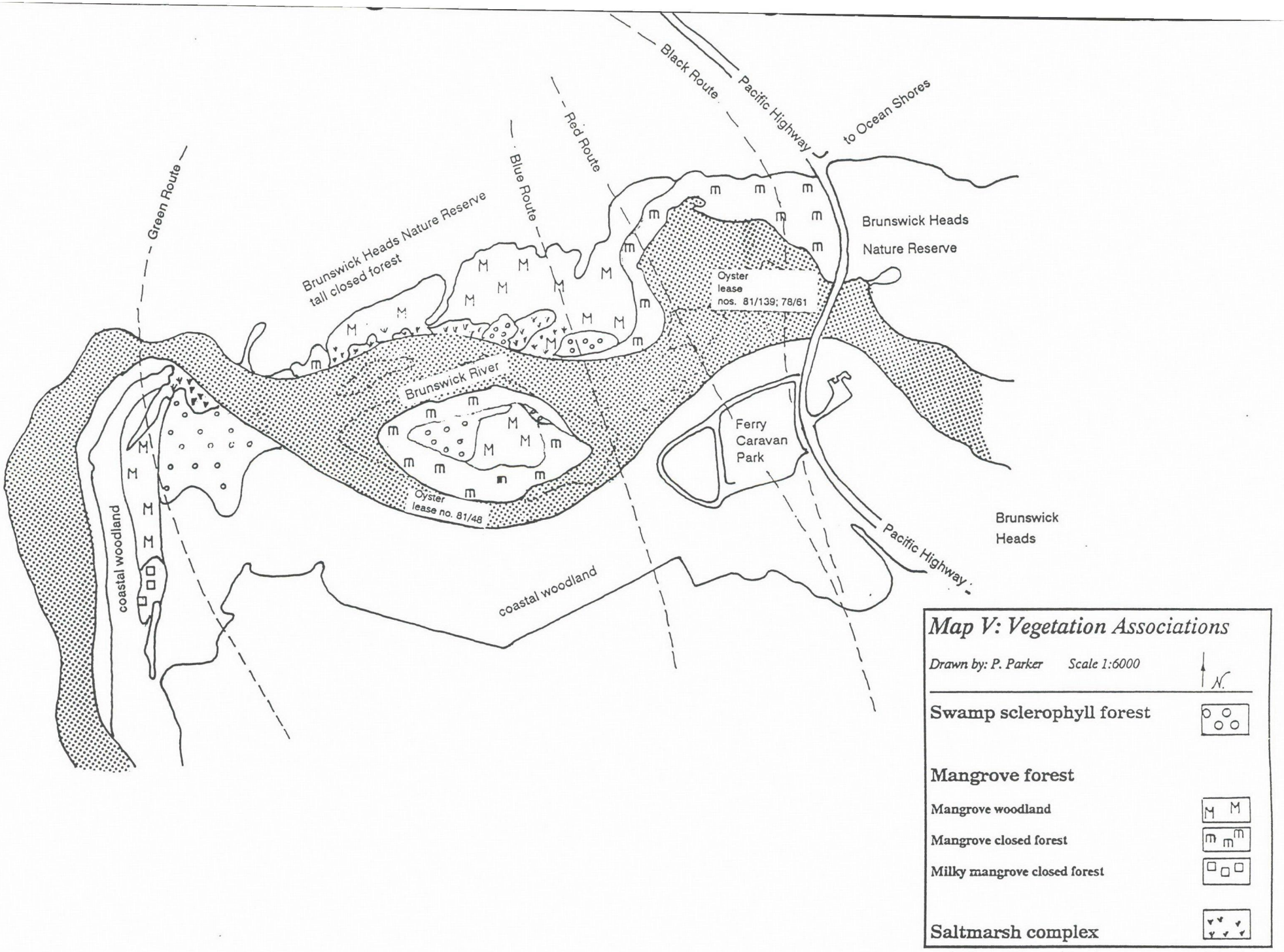
Structure: Tallest stratum 12 m slight separation to touching or overlapping

Milky mangrove *Excoecaria agallocha*.

Midstratum:

River mangroves.

Ground cover: Mangrove fern *Acrostichum speciosum*, swamp lily *Crinum pedunculatum* and *Fimbryistylis ferruginea*. Saw sedge, paperbarks, whip vine and ferns on nearby higher ground.


Black Route
Pacific Highway
to Ocean Shores
Red Route
Blue Route
Green Route
Brunswick Heads Nature Reserve
tall closed forest
Brunswick Heads
Nature Reserve
Oyster
lease
nos. 81/139; 78/61
Brunswick River
Ferry
Caravan
Park
Oyster
lease no. 81/48
coastal woodland
coastal woodland
Pacific Highway
Brunswick
Heads
Map V: Vegetation Associations
Drawn by: P. Parker
Scale 1:6000
N.
Swamp sclerophyll forest
Mangrove forest
Mangrove woodland
Mangrove closed forest
Milky mangrove closed forest
Saltmarsh complex

4.2.3 Saltmarsh complex

Saltmarsh plants are found on higher ground to the landward side of mangroves. These salt tolerant plants have adapted to occasional inundation by high tides. They are highly productive components of the marine food web as well as important bird feeding grounds. Saltmarsh communities may be assigned to three main groups: the shrublands, the sedge and rush swamps and the grasslands (Adam 1981).

Chenopod shrubland and sedge swamps were represented by a small area of 0.005 and 0.01 ha respectively. In contrast, swamp cooch along the fringe of Wetland 62 was well established and more extensive. Some cattle grazing was observed in the salt marsh areas near the green route.

***Juncus krausii* closed sedgeland.**

Structure: Tallest stratum 0.5 m touching to overlapping.

Located on lower ground than the swamp oaks in the vicinity of the green route. *Fimbryistylis ferruginea* contingent with *J. krausii* and grading into swamp oak association.

***Sporobolus virginicus* closed sod grassland.**

Structure: Grass as compact tussocks in close contact at their base

Some isolated grey mangroves in Wetland 62.

4.3 Plants of conservation importance

There is growing concern amongst scientists, land managers and the community that an ever increasing number of native plants are becoming rare or are being threatened with extinction. This concern has lead to a number of publications which are continuously revised. The most authoritative of these is the publication *Rare or Threatened Australian Plants* (Briggs *et. al.* 1988). The current edition has added 1549 species and deleted 426 species since it was first published in 1981.

When placing conservation criteria on species some subjective judgements have been made by the authors. For example, a plant species is considered to be under threat once the plant numbers drop below 1000.

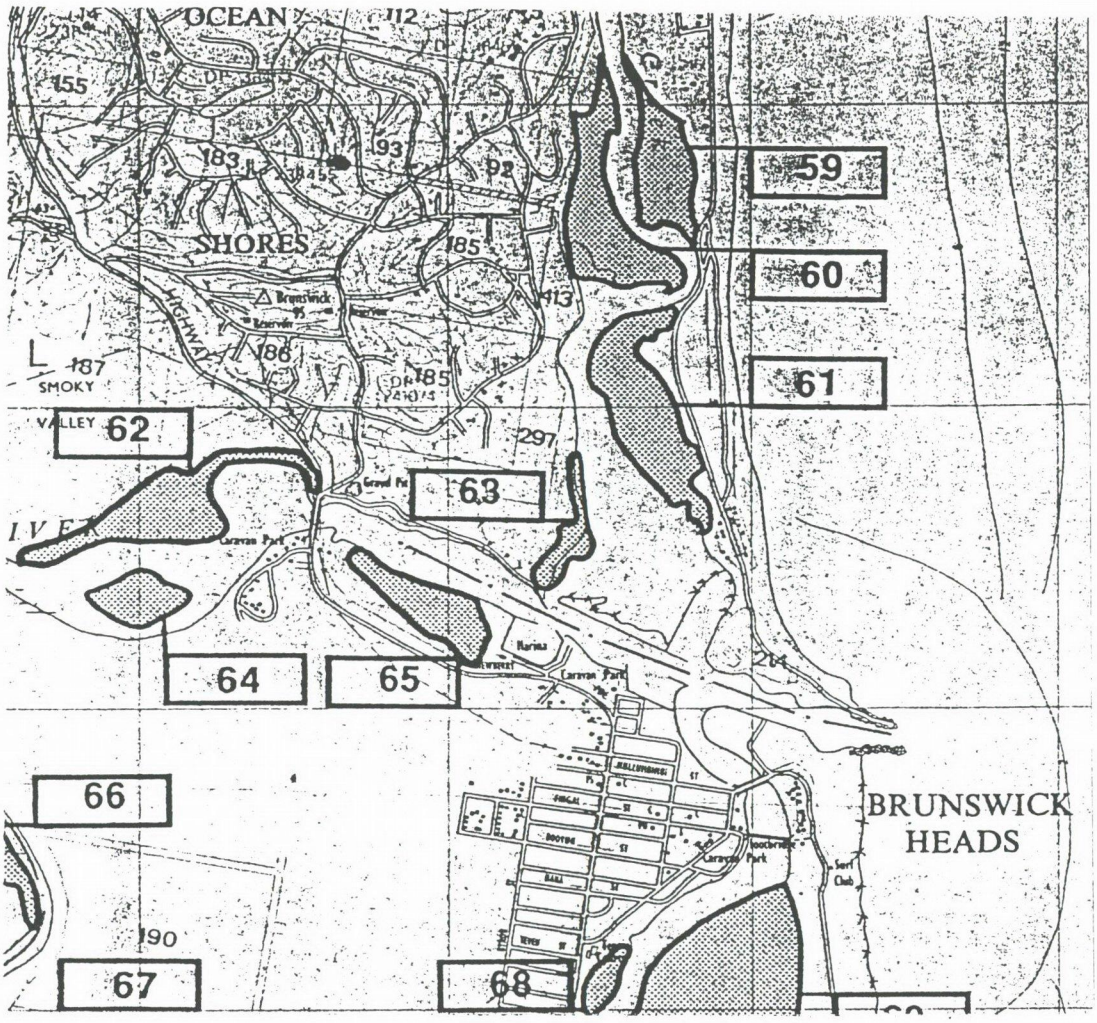
No rare or threatened plants were recorded from the intertidal areas. This is not surprising as the most likely habitats for endangered species would be within the subtropical and littoral rainforests of the Brunswick Nature Reserve (see Williams *et. al.* (1979) s. 3.2).

4.4 Associations of conservation importance

Freshwater or saline wetlands, saltmarsh and mangrove flats are well recognised components of the marine food web. Within the Brunswick River some of these are of State importance and are mapped under the Coastal Wetlands Policy (SEPP no. 14: Map W).

An area consisting of mangroves and swamp oaks (Map V) was located contingent with the southern bank of the River in the vicinity of the proposed green route (plate 1). This area should be investigated by the Department of Planning for possible mapping under the Coastal Wetlands Policy. It contains a significant stand of old river and grey mangroves and a most noteworthy stand of milky mangroves further landward. These milky mangroves are unusual in both their size and concentration. Trees are 8-12 m in height and cover an area of approximately 1 ha.

Few monospecific stands such as this exist in NSW; they are more common in tropical climates especially New Guinea (Alex Floyd pers. comm.).



Map W: Coastal Wetlands (Mapped under SEPP No. 14) Scale 1:25 000

4.5 Impact of the proposed bypass routes on various plant communities: the preferred alternative

4.5.1 Green route

On the southern approach to the Brunswick River the proposed green bypass route passes through old growth grey and river mangroves. It also passes near an unusual stand of milky mangroves (see s 4.3). The moist forest ecotone between the mangrove community and adjacent woodland is uncommon within the Brunswick estuary.

Slopes on the northern bank rise rapidly and therefore few wetland species are affected. This vegetation is discussed in White (pers. comm.).



Plate 1:Brunswick River, north bank; Red route

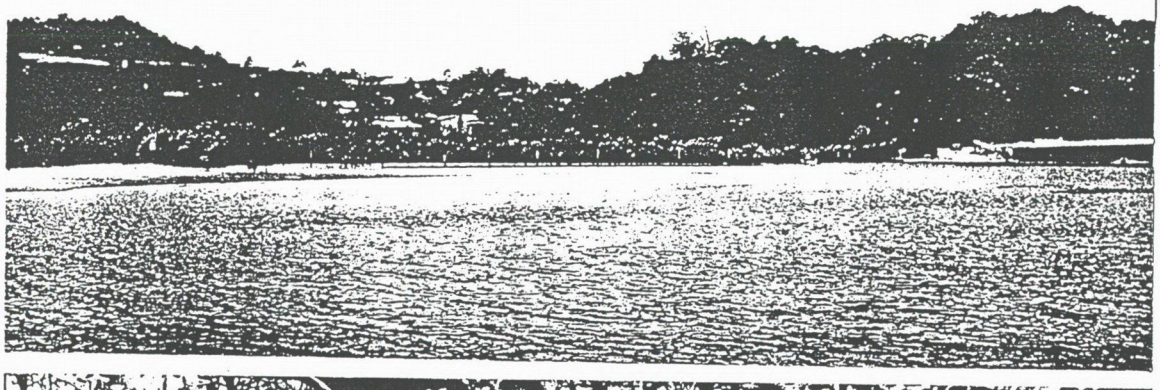


Plate 2: Brunswick River, north bank; Black route

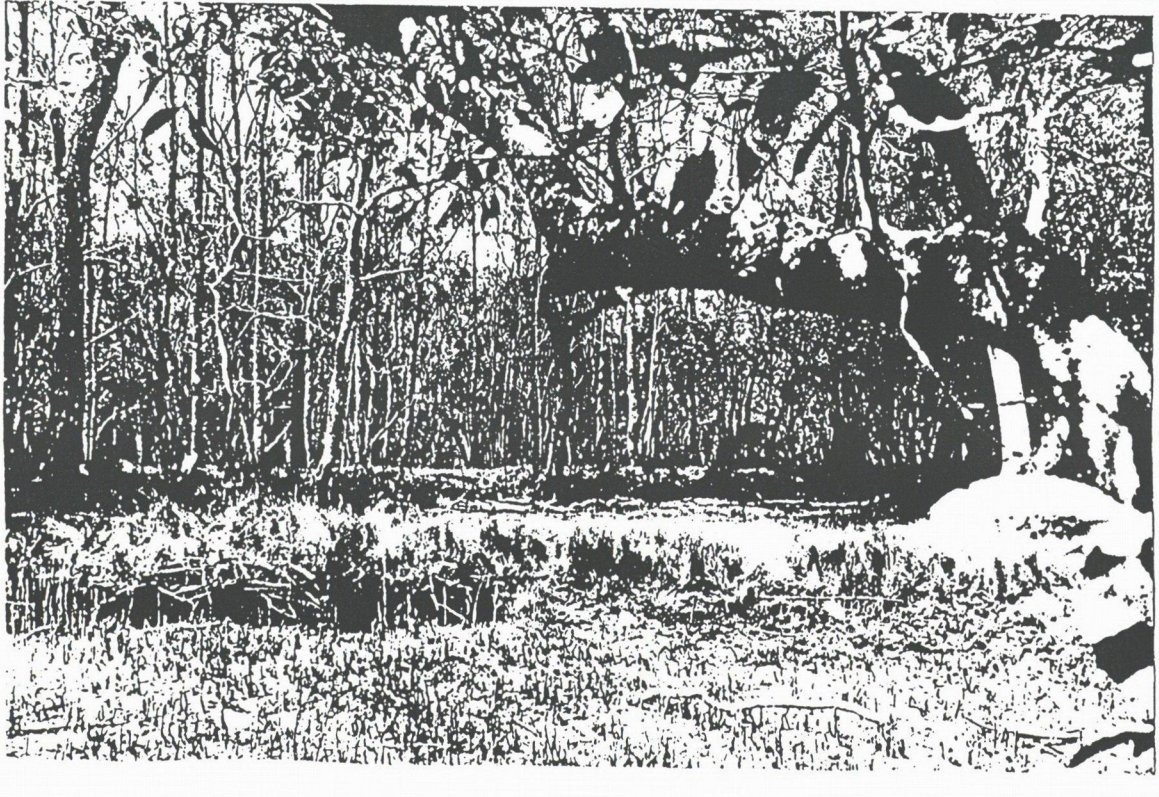


Plate 3: Brunswick River, south bank; Green route

4.5.2 Blue route

Vegetation on the southern bank is comprised of woodland species including forest red gums, bloodwoods, ironbark wattles, lantana and ground covers (Appendix 1). The ground covers includes matrush, midgeonberry, bracken and herbs.

On the northern bank the proposed bypass passes through Coastal Wetland no. 62. Vegetation includes swamp oaks and saltmarsh and mangroves further landward. Subtropical rainforest is encountered north of these mangroves on higher ground.

4.5.3 Red route

There is little vegetation of importance on the southern bank.

On the northern bank the proposed bypass cuts through Coastal Wetland no. 62 (Plate 2). The area of mangroves that would be disturbed is smaller than that of the blue route and about equivalent to that of the black route (see Map V).

4.5.4 Black route

There is little vegetation of importance on the southern bank.

On the northern bank the proposed bypass also bisects Coastal Wetland no. 62 (Plate 1).

Mangroves regenerating around the northern banks of the Brunswick River and on islands within the River are of various age classes. Usually the younger mangroves are found on the margins with the older, larger mangroves found further landward. The mangroves on the northern banks near the existing bridge are about 25 years old. The mangroves previously colonising this site were destroyed around 1964-65 by a land slip associated with the construction of the Ocean Shores Estate (Frank Kirkham pers. comm.).

This route provides the least impact on vegetation communities.

5.0 VERTEBRATE FAUNA

Records of vertebrates were collated from field observations on January 17, 22 and 28 and from the surveys of BEACON (1986) and Cathcart (1991). No trapping within the mangroves or swamp oak wetlands was completed due to the poor results of the extensive trapping undertaken in nearby sites by BEACON.

5.1 Mammals

BEACON failed to record any mammals despite three nights of trapping in mangrove wetlands near the junction of the Brunswick River and Marshalls Creek (Fig 1).

Mammals likely to visit these sites include the water rat *Hydromys chrysogaster* and the swamp rat *Rattus lutreolus*. The water rat is the largest Australian placental rodent. It is found close to waterways including beaches and urban rivers. It will eat fish, crustaceans, molluscs, frogs, waterbirds, bats and aquatic insects (Cronin 1991). The swamp rat is well distributed through Byron Shire (BEACON 1966) favouring coastal swamps, heathland, sclerophyll forests, rainforests and sedgelands.

5.2 Birds

All birds roosting or flying in the vicinity of the proposed bypass routes were recorded. The location of the record and where relevant the number of birds were also noted (Appendix 2).

A total of 43 species were recorded between the green route and the groynes seaward of the existing bridge. Additional species were observed but not recorded due to their terrestrial habitat which is the subject of an other report (White pers. comm.).

Some birds such as the mangrove gerygone and striated heron are obligatory mangrove species; others including herons, egrets, cormorants and whimbrels utilise the estuary for most or part of their needs. Many are forest or open country species observed flying or heard calling near the subject sites.

Birds use different parts of the estuary at different times of the day or tide. For example, whimbrels were observed on the mud flats near oyster lease 78.61 on the low tides and on higher tides used roosts within Wetland 64.

Birds also utilise the estuary or adjacent rainforest and woodlands seasonally. Blakers *et. al.* as reported in BEACON (1986) points out :

* Southern breeding species migrate to northern NSW and Qld in autumn and winter;
* Locally breeding species migrate to northern Qld and New Guinea in autumn and winter;
* Inland breeding birds migrate to the coast in autumn and winter; and
* Northern hemisphere breeding birds migrate to Australia during the southern hemisphere's spring and summer.

Examples of these species are provided in BEACON (1986). They include locally breeding species such as dollarbirds and cicadabirds which migrate northwards during winter. Northern hemisphere breeding species that migrate to Australia during the southern hemisphere winter include whimbrels and grey-tailed tattlers.

During this survey the pied oyster catcher was the only species recorded that is listed as vulnerable or rare in Schedule 12, National Parks and Wildlife Act, 1974. Two pairs of oyster catchers were recorded roosting on the rocky groynes seaward of the Pacific Highway bridge.

5.2.1 International agreements

The Australian government is a signatory to 3 international agreements that protect shorebirds and shorebird habitats. These are the:

* Convention on Wetlands of International Importance (Ramsar Agreement);
* Japan/Australia Migratory Birds Agreement (JAMBA); and
* China/Australia Migratory Birds Agreement.

The Brunswick wetlands are too small to fulfil the *Criteria of International Significance* outlined in annex 2 of the 5th International Conference on the Conservation of Wetlands and Waterfowl, Heiligenhafen, 1974. Nevertheless, they support numerous species of shorebirds that are included within the international treaties.

5.3 Reptiles and amphibians

The BEACON surveys recorded few reptiles or amphibian species using standardised methods in Byron Shire. No reptiles were recorded by BEACON in site 44M (amongst the mangroves) or were observed in the mangroves or wetlands during this assessment.

6.0 INVERTEBRATE FAUNA

In estuaries, the invertebrate community found in the unconsolidated sediments is an ideal subject for baseline studies. Such studies are important for describing ecosystems, assessing

variability in space and time and relating biological and physiochemical variables to human impact (Jones *et. al.* 1986).

The reasons why invertebrates are ideal for monitoring estuarine vitality are (after Boesch *et. al.* 1976):

* A large variety of species may be found within estuaries;
* Species utilise a variety of feeding adaptations;
* Species lack mobility and are therefore unable to evade impacts; and
* Some species are long lived and persistent.

Estuarine sediments can also concentrate nutrients and toxins by adsorbtion (Odum 1970).

This assessment surveyed the invertebrates of the intertidal zones amongst the mangrove pneutamatophores and the subtidal sediments of the estuary. Results of such sampling provide:

* A one-off assessment of the invertebrate infauna;
* An evaluation of the potential impact on invertebrates during construction; and
* A measurement of the relative variability of invertebrates within the intertidal and subtidal sediments found within the subject routes.

6.1 Survey methods

Bottom sediments were sampled with a 1 mm sieve and a 0.025 m^3 benthic grab on January 17. Sampling was undertaken at midtide to allow easy access to sites. Sieve samples involved collecting and washing 5 replicates of approximately 0.007 m^3 of sediment from all four proposed bypass routes. Samples for the blue route were taken on the southern side of Wetland 64, slightly westward of the proposed bypass route. This provided a better representation of the invertebrate fauna of this Coastal Wetland than would a sample taken from other sites (Map L).

Five replicate grab samples were taken for all routes except red, seaward of the sieve sample sites (Map L). Due to their close proximity and similar bottom sediments only one set of grab samples were taken for the black and red routes. Samples were collected in 1.5 m of water and all specimens retained on a 1 mm grid were preserved in 70% isopropanol for later identification. Specimens of polychaetes, crustaceans and molluscs were identified under a stereomicroscope with selected "type" specimens forwarded to the Queensland Museum for specialist verification.

Observations of epifauna were restricted to random searches around sieve sites.

6.2 Results

A total of 16 species in 15 families of macrobenthic infauna were collected from the sieve and grab samples (Appendix 3). Crabs, gastropod and bivalve molluscs represented 31,19 and 19% of the species and 60, 7 and 26 % of individuals respectively. The five species *Nemphtys australis*, *Hymenosoma hodgkini, Mictryis platycheles, Heloecius cordiformes* and *Glanconome* cf. *cerea* accounted for 93% of all individuals (Appendix 3). This is not considered unusual as it is consistent with benthic surveys in other estuaries (Jones 1987).

Only four species of macrobenthic infauna provided reasonable data on distribution. These were polychaete worms *N. australis*; crabs *H. hodgkini* and *H. cordiformis;* and the bivalve mollusc *Glanconome* cf. *cerea*. The numbers of species collected have been plotted against the respective route (Fig 2).

6.2.1 Distribution patterns of macrobenthic infauna

The infauna sampled have distinct patterns of distribution that are related to bottom sediments, water depth, the presence of mangroves or rotting logs, to estuarine sandy beaches and to physiochemical factors (Jones *et. al.* 1986).

For example, Wetland 64 is an important location for the bivalve mollusc *Glancome* cf. *cerea*. This is most likely due to the stability and type of sediments found in this location. Semaphore *H. cordiformis*, and fiddler crabs *Uca*. sp. are abundant on mudflats at lower tides. The soldier crabs *Mictryis platycheles* can be found on the more sandy sediments towards the estuary mouth.

It is worth noting that as well as variations in fauna along the length of the estuary, considerable seasonal and annual patterns have been recorded (Jones 1987 and Jones *et. al.* 1986).

Most of the species in the Brunswick River Estuary are widespread in the estuaries of south-eastern Australia (see Jones 1987 and Jones *et. al.* 1986 and references quoted within) and are reasonably common within the estuaries of south-eastern Queensland (Jones pers. comm).

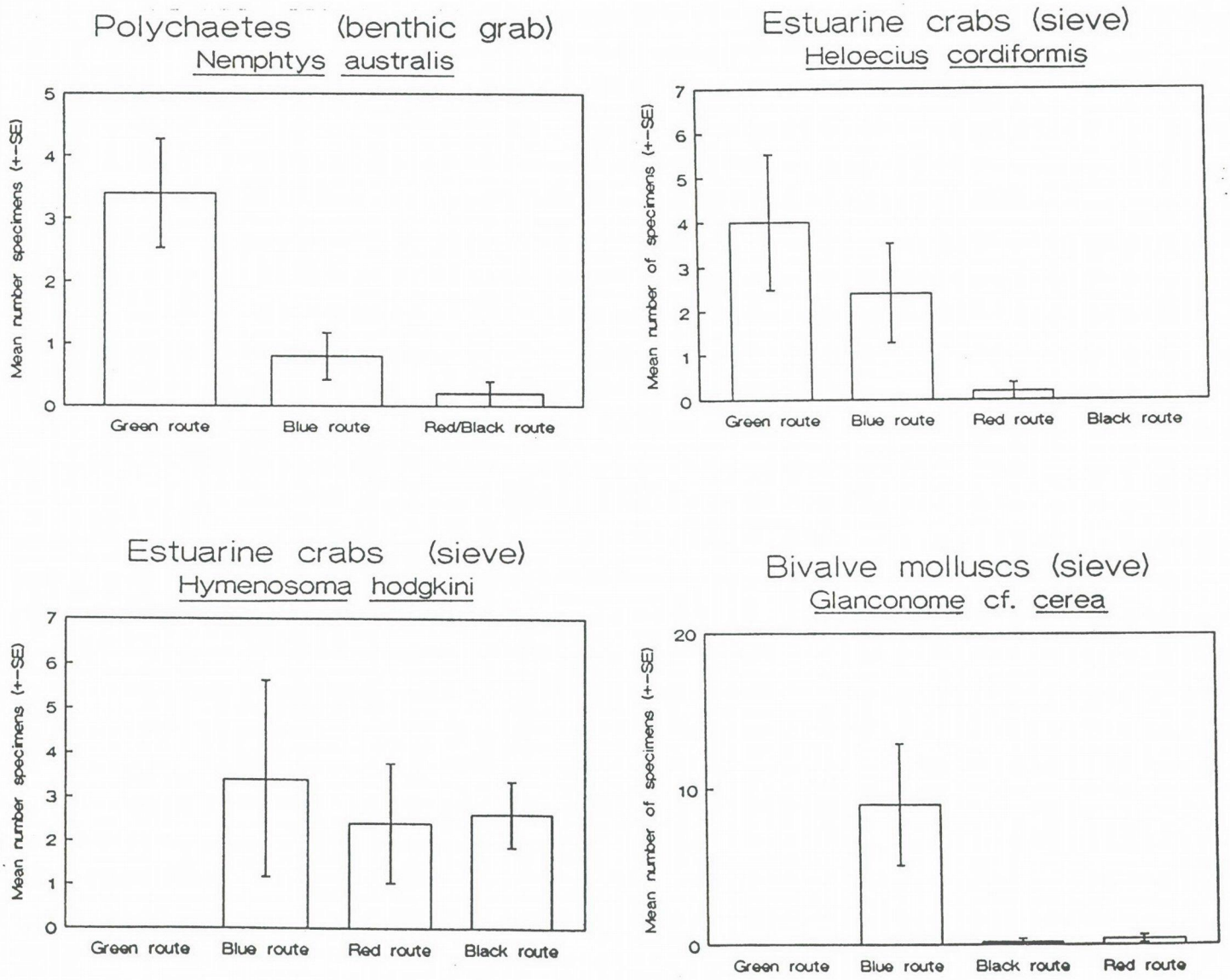


Fig 2: Dominant invertebrates

6.3 Impact of the proposed bypass routes on animal communities: the preferred alternative

This survey and other research establish that the Brunswick River estuary is of importance to:

* Rare and endangered shorebirds; and
* Shorebirds subject to international treaties.

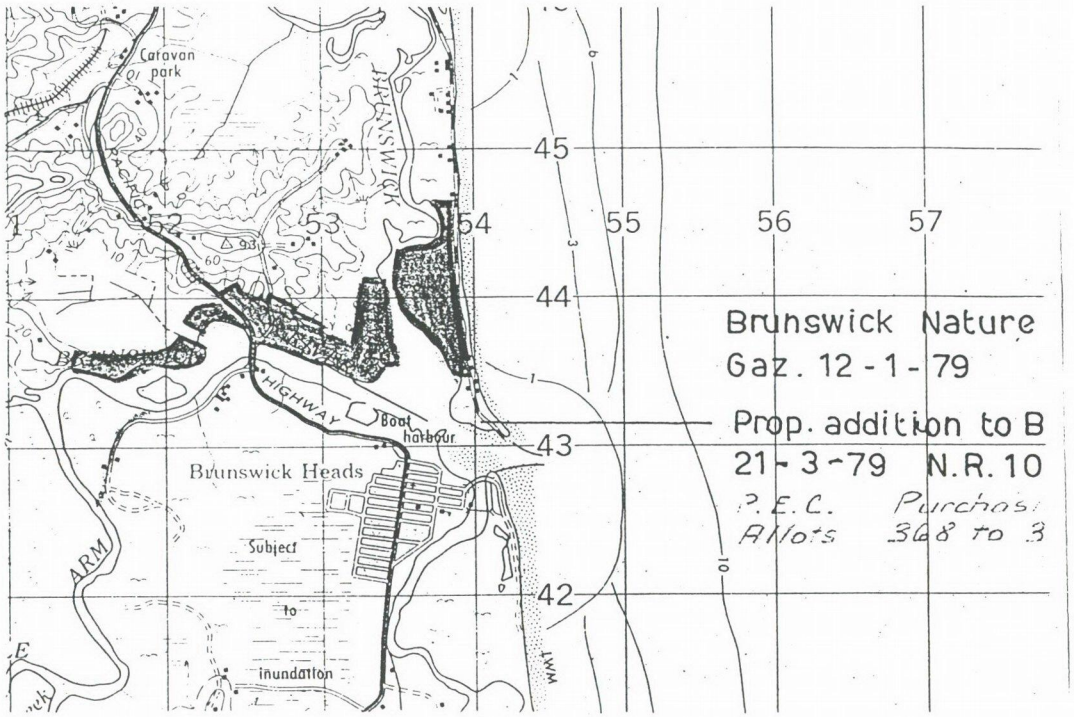
These species utilise a variety of habitats that range from estuarine flats at low tides to mangrove roosts at higher tides. Feeding on a variety of invertebrates and small vertebrates they are somewhat dependent on productive intertidal and subtidal areas both upstream and seawards of the recorded sitings.

In relation to fauna and in accordance with the criteria detailed in S 2.1 the preferred highway bypass route should:

* Not impact on rare or threatened species;
* Where possible, be confined to disturbed areas;
* Minimise the "edge" effect.

Again the black route best satisfies these criteria; the red route being the next most reasonable alternative. Although the black route passes through Coastal Wetlands (described in S 4.5.4), these wetlands are some of the youngest within the Brunswick River. It is recommended that no fill be introduced into these wetlands thus allowing for re-establishment after any disturbance.

The recommendation not to adopt the green or blue routes is based on the quality of habitat encountered (Plate 3). The green route contains old stands of mangroves and moist forests of great value to wildlife. The impact of "opening up" these sites or increasing the edge to area ratio is known as the edge effect. Wildlife managers should always aim to minimise the edge to area ratio of small natural areas.



Map R: Brunswick Nature Reserve (Source NPWS)

7.0 COMMERCIAL OYSTER GROWING

The Brunswick River is of great importance to oyster farmers from the northern rivers district. The value of the area can be quantified in a variety of ways. These include revenue generated from farming and the potential of the estuary as a "warehouse" of spat should disease or other impacts affect oysters from other estuaries.

The economic importance is in the order of several million dollars per year (S. Brinsley pers. comm.). This revenue is generated from the sale of spat, or young oysters *Saccostrea cucullata*. Oysters are either sold to grow-out farms or used by the Brunswick farmers in grow-out farms in other estuaries.

The Brunswick River is favoured by farmers due to:

* Good flushing; On average the tide will rise and fall approximately 2 m. This contrasts with around 1.5 m in the Tweed River or less than 1 m in the Tweed backwaters;
* Sites are generally protected from flood flows and therefore physical damage from logs and debris is minimised;
* In contrast to most other estuaries there have been no recorded oyster kills. Such kills in south coast rivers have been attributed to winter mortality while in north coast estuaries the disease known as QX has been prevalent;
* Three crops of spat are obtained each year. In comparison, spat growing regions at Port Stevens have 2 crops although in some years there is only one crop; and
* The estuary is free from the Pacific oyster *Crassostrea gigas*. This species was introduced into Tasmanian waters during the 1940's and has since spread along the Victorian and NSW coastline. The Pacific oyster does not compare in edible quality with the rock oyster.

7.1 Affected growers

The black and red routes may affect leases no. 81.139 and 78.61 (Map V). These leases are owned by L. and B. Perandis and Mr F. Kirkham respectively.

7.1.1 Consultation

On site discussions were held between this consultant and the Tweed Fisheries Inspector, Mr Steve Brinsley (6 January) and the above growers (28 January). These discussions drew attention to the value of the estuary and the following recommendations were proposed:

* If bridge construction works results in a decrease in the area of the subject leases then growers should be offered the short term option of an equal area in the vicinity of Wetland 65. Similarly, if the new highway bypass causes a reduction in area of the subject leases then growers should be provided with an equal area in the vicinity of Wetland 65;
* Contractors constructing the proposed bridge will consult with the relevant oyster farmers. Consultations will include the best time of the year to drive piles and the most suitable tides for any sediment discharge;
* Any fill necessary for bridge approaches will conform with the existing bank contours. If necessary, approaches should be constructed with extra piers so as to minimise any variation of River flows; and
* Suitable access to the River for the purposes of oyster farming will be retained.

7.2 Impact of the proposed bypass routes on commercial oyster growers: the preferred alternative

The black and red routes will only effect commercial oyster farmers. The black route may effect the lease 78.61, while the red route will effect lease 78.61 and 81.139. These proposed bypass routes are acceptable to the growers concerned providing consideration is given to their requirements detailed in 7.1.1.

7.2 Fishing

With the exception of oyster farmers the Brunswick River estuary is closed to professional fishers. Recreational fishers enjoy fishing from the rocky groynes and from boats anchored within the River. In addition, bait gatherers pump for the ghost nipper *Callianassa australiensis* from sandy spits (pers obs.).

With the possible exception of bait gathering from the sandy spit east of Wetland 64, recreational fishing activities will be largely unaffected by any of the proposed highway bypass routes.

7.3 Boating, swimming and picnicking

Other popular activities include boating, swimming and picnicking. Boating is popular on the higher tides especially towards the River mouth. Swimming is enjoyed adjacent to the caravan park and picnicking is enjoyed on boats and along the river banks.

These recreational activities will be somewhat affected by the bypass. The most accessible swimming sites lie close to the black and red routes while the most popular boat picnicking areas appear to in the vicinity of the blue and green routes. Swimmers, boaters and picnickers have accepted the present highway and it is reasonable to assume that they will continue to do so if the black route is chosen.

8.0 Conclusion

This report examined four potential highway bypass routes around the village of Brunswick Heads. It concluded that the black route provided the least impact to aquatic flora and fauna and recommended that either this or the red route be adopted. Development of either the green or blue routes will have the greatest impact on the environment. The green route passes through important stands of old growth mangroves. While the blue route passes close to the Wetland island (No. 64), through mangrove Wetlands (No. 62) and saltmarsh areas on the northern bank of the Brunswick River.

9.0 Acknowledgements

I acknowledge the kind assistance of the following staff from the Queensland Museum: Mr Daryl Potter (molluscs) and Mr Peter Davies (estuarine crabs). I also wish to thank Mr Alex Floyd for his comments on estuarine vegetation.

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Appendix 1: Vegetation

Scientific name	*Common name*	*Abund*
FERNS		
ADIANTACEAE		
Acrostichum speciosum	mangrove fern	u
LINDSAEACEAE		
Pteridium esculentum	bracken	o
POLYPODIACEAE		
Platycerium superbum	stag-horn fern	u
Pyrrosiaconfluens	horse-shoe felt fern	u
GYMNOSPERMS		
CUPRESSACEAE		
Callitris columellaris	sand cyprus	u
ANGIOSPERMS (Flowering plants)		
Monocotyledons		
AMARYLLIDACEAE		
Crinum pedunculatum	swamp lily	o
COMMELINACEAE		
Commelina cyanea	wandering jew	u
CRASSULACEAE		
# Kalanchoe tubiflora		
CYPERACEAE		
Fimbristylis ferruginea	a sedge	o
Ghania clarkei	sawsedge	o
FLAGELLARIACEAE		
Flagellaria indica	whip vine	u
JUNCACEAE		
Juncus krausii	a rush	o
LILIACEAE		
Dianella caerulea	Paroo lily	u
POACEAE		
Sporobolus virginicus	saltwater cooch	vc
SMILACACEAE		
Smilax australis	austral sarsparilla	u
XANTHORRHOEACEAE		
Lomandra longifolia	matrush	u

Scientific name	*Common name*	*Abund*
Dicotyledons		
ARALIACEAE		
Schefflera actinophylla	umbrella tree	u
CAESALPINIACEAE		
Cassia coluteoides	winter senna	u
CASUARINACEAE		
Casuarina glauca	swamp oak	c
CHENOPODIACEAE		
Suaeda australis	seablite	u
CONVOLVULACEAE		
* *Ipomea cairica*	coast morning glory	u
DILLENIACEAE		
Hibbertia scandens	guinea flower	u
EUPHORBIACEAE		
Excocaria agallocha	milky mangrove	c
MALVACEAE		
Hibiscus tiliaceus	cottonwood hibiscus	o
MIMOSACEAE		
Acacia aulacocarpa	brush ironbark wattle	o
MYOPORACEAE		
Myoporum acuminatum	mangrove boobialla	u
MYRSINACEAE		
Aegiceras corniculatum	river mangrove	vc
MYRTACEAE		
Callistemon salignus	pink-tipped bottlebrush	u
Eucalyptus intermedia	pink bloodwood	o
Eucalyptus tereticornis	forest red gum	o
Melaleuca quinquenervia	broad-leaved paperbark	u
RHIZOPHORACEAE		
Bruguiera gymnorrhiza	orange mangrove	u
SAPINDACEAE		
Cupaniopsis anarcardioides	tuckeroo	u
VERBENACEAE		
Avicennia marina	grey mangrove	vc
* *Lantana camara*	lantana	u

Appendix 1: Vegetation

Scientific name	*Common name*	*Abund*

* intoroduced or naturalised

U= uncommon within an association

O = occasional or restricted to a vegetation association

C= common or found in several associations;

VC= very common in several associations

Appendix 2: Birds

Scientific name	*Common name*	*record*	*site*
Pelicanus conspicillatus	Australian pelican	PP: common in river	B;R
Anhinga melanogaster	darter	PP: occ. downstream	G;Bl
Phalacrocorax melanoleucos	little pied cormorant	PP: occ. downstream on rocky groynes	
Phalacrocorax fuscescens	pied cormorant	PP: in flocks	all
Phalacrocorax sulcirostris	little black cormorant	PP: occ. downstream on rocky groynes	
Ardea novaehollandiae	white-faced heron	PP: occ. along river flats	R;B;G
Egretta alba	great egret	PP: roosting in Wetland no. 62	
Egretta garzetta	little egret	PP: 1 sighted on southern bank	B
Butorides striatus	striated heron	PP: 1 sighted on southern bank	B
Threskiornis aethiopica	sacred ibis	PP: small flocks amongst mangroves	B;G
Threskiornis spinicollis	straw-necked ibis	PP: flocks over site	G
Platalea regia	royal spoonbill	PP: near oyster lease 78.61	B
Anas superciliosa	Pacific black duck	Beacon site 44M	B
Haliaeetus leucogaster	white-bellied sea-eagle	PP: calling from Nature Reserve near Wetland 62	
Haematopus ostralegus	pied oystercatcher	PP: 2 pr. downstream on rocky groynes	
Vanellus miles	masked lapwing	PP: several observed over wetland 64	B
Numenius phaeopus	whimbrel	PP: small flocks on mudflats	Bl;R
Tringa breviceps	grey-tailed tattler	PP: small flocks on mudflats	Bl;R
Larus novaehollandiae	silver gull	PP: common along sand flats and in water	all
Sterna bergii	crested tern	PP: small flocks resting on sand flats	R
Geopelia cuneata	bar-shouldered dove	PP: call recorded wetland 64	B
Ocyphaps lophotes	crested pigeon	PP: Ferry Caravan Park	Bl; R
Cacatua galerita	suphur-crested cockatoo	PP: flocks on southern bank	B
Trichoglossus chlorolepidotus	scaley-breasted lorikeet	PP: flocks feeding on bloodwoods	B
Ceyx azurea	sacred kingfisher	PP: in vicinity of oyster lease 78.61	Bl;R
Dacelo novaeguineae	laughing kookaburra	Beacon site 44M	
Eurystomus orientalis	dollarbird	PP: common along banks & in mangroves	B;G
Hirundo neoxena	welcome swallow	PP: nesting under existing bridge	Bl
Coracina tenuirostris	cicadabird	PP: calling from Nature Reserve and Wetlands 62 &64	
Lalage leucomela	varied triller	PP: calling from Wetland 64	
Myiagra cyanoleuca	leaden flycatcher	Beacon site 44M	
Rhipidura fuliginosa	grey fantail	Beacon site 44M	
Rhipidura leucophrys	willy wagtail	PP: near bridge	Bl
Malurus cyaneus	superb fairy-wren	PP: Wetland 62	
Malurus melanocephalus	red-backed fairy wren	Beacon site 44M	
Gerygone laevigaster	mangrove gerygone	PP: common among mangroves	R;B;G
Anthochaera chrysoptera	little wattlebird	PP: common along southern river bank	B
Meliphaga lewinii	Lewin's honeyeater	PP: occ. along southern river bank	B
Lichmera indistincta	brown honeyeater	Beacon site 44M	
Emblema temporalis	red-browed firetail	Beacon site 44M	
Oriolus sagittatus	olive-backed oriole	PP: Nature Reserve on northern river bank	
Corvus orru	torresian crow	PP: near caravan park	Bl;R

Sites: B=Black; R=Red; Bl=Blue; G=Green

Appendix 3: Invertebrates

		Sieve 5 samples (no/sample)				Grab 5 samples (no/sample)			
Scientific name	*Common name*	Green	Blue	Red	Black	Green	Blue	Red	Black
Class Annelida									
AMPHINOMIDAE									
Amphinosome complanta	bristle worm						1		
Class Polychaeta									
NEPHTYIDAE									
Nemphtys australiensis	polychaete worm			1	1;	2;4;4;6;1	2;1;1	1	
Class Crustacea									
Order Amphipoda									
COROPHIIDAE									
Corophium cf. volutator	amphipod			1					
Order Decapoda									
PENAEIDAE									
Penaeus sp.	prawn		1	1	1;1				
Order Brachyura									
GRAPSIDAE									
Paragrapsus laevis			1						
HYMENOSOMATIDAE									
Hymenosoma hodgkini			11;6	1;7;4	3;2;4;4				
MICTRYDAE									
Mictryis platycheles	soldier crab			6;22;2;9	3;				
OCYPODIDAE									
Heloecius cordiformis	semaphore crab	5;7;9;6;7	3;4;8;1;2	1;1	5;9;5;10				
Uca polita	fidler crab		1						
Phyllum Mollusca									
Class Gastropoda									
LITTORINIDAE									
Bembicium sp.			3	2					
NASSARIIDAE									
Nassarius burchardi			8			1;1	1;1;1	1	
NERITIDAE									
Neritina sp.				1			1		
Class Nudibranchia									
ONCHIDIIDAE									
Onchis cf. chameleon			1		1				
Class Bivalvia									
GLYCYMERIDAE									
Glanconome cf cerea			18;17;10;	1	1;1				

Appendix 3: Invertebrates

		Sieve 5 samples (no/sample)				Grab 5 samples (no/sample)			
Scientific name	*Common name*	Green	Blue	Red	Black	Green	Blue	Red	Black
Class Bivalvia									
MACTRIDAE									
Notospisula trigonella							2;1	2;2	1
TELLINIDAE									
Tellina deltoidalis								2;2;1	

APPENDIX L

Brunswick Heads EIS - Economic Analysis of Options

Project Development Section, RTA 1992

Consulting Services Bureau

PROJECT DEVELOPMENT

Technical Services Directorate

Roads and Traffic Authority
New South Wales





Roads and Traffic Authority
New South Wales

BRUNSWICK HEADS BYPASS

Economic Analysis of Options

BRUNSWICK HEADS BYPASS

Economic Analysis of Possible Routes

The following notes outline the results of an analysis of traffic, accidents and economic justification of the four bypass alternatives for the Pacific Highway at Brunswick Heads. The analysis builds on that already undertaken for a shorter length of one of the original alternatives, and uses the results of traffic surveys previously conducted.

1. TRAFFIC ANALYSIS

(a) Existing Data

The three RTA traffic counting stations on SH10 in the vicinity of Brunswick Heads display the following historical traffic volume data:

STATION	LOCATION	1967	1970	1974	1978	1982	1986	1990
04.070	S OF MR524 STHN LEG. MULLUMBIMBY RD	3000	3640	5320	5540	7510	9317	10372
*04.270	BRUNSWICK HDS-1.6 KM S OF PO	3200	4010	5120	6880	8818	10763	12944
04.073	BILLINUDGEL-N OF MR524 NORTHERN LEG	2790	3690	4340	5310	7430	8526	10005

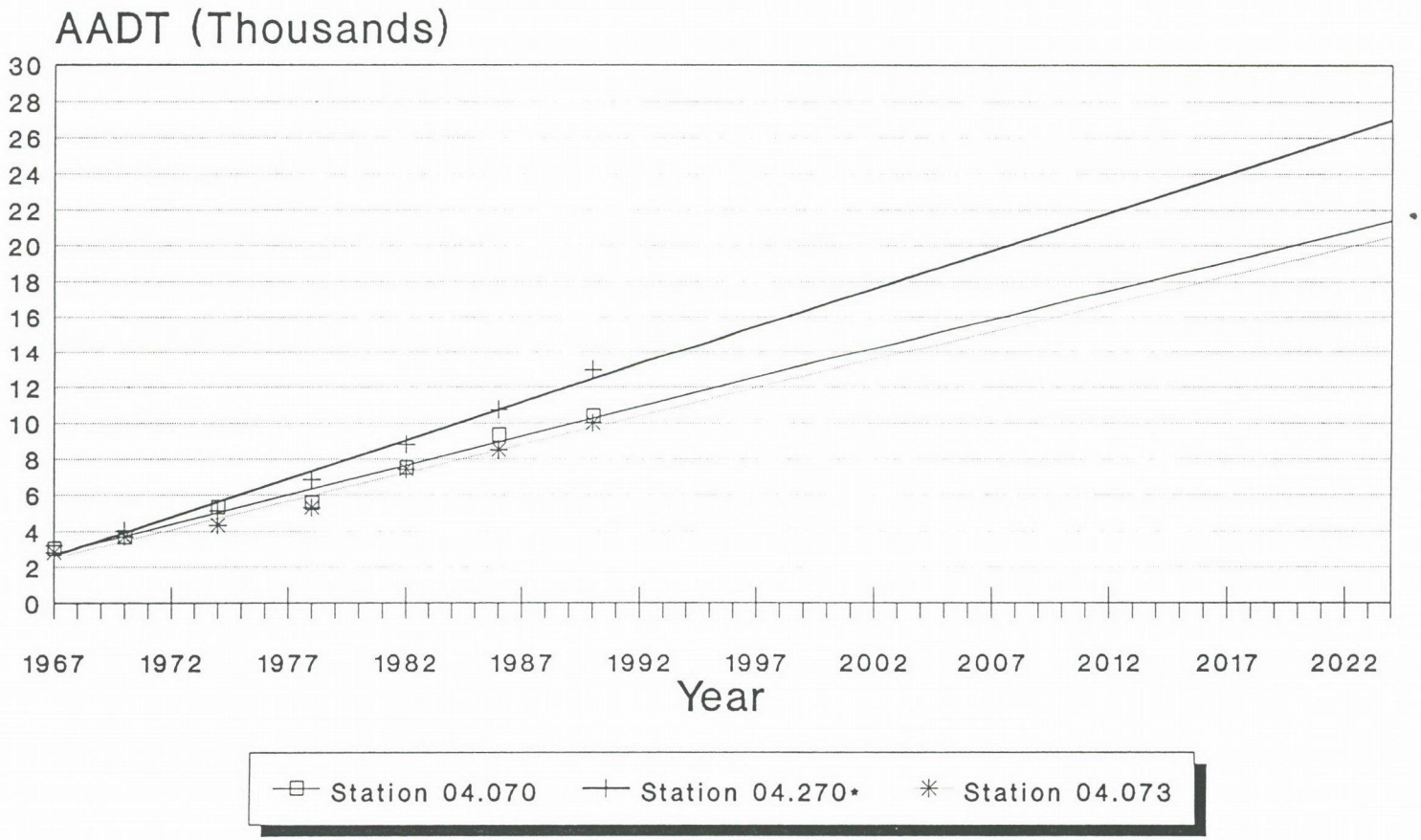
These figures are shown graphically in Figure 1. Of particular note is the general linearity of the traffic growth, which is consistent with observations at other locations around the State. Note also that the figures relate to axle-pairs per day, not vehicles per day. In this situation, 1,000 AADT is equivalent to approximately 900 vehicles per day.

(b) Projections

After analysis of the above data and comparison with forecasts produced using a population-based traffic model (as used in the North Coast Road Strategy Study), a figure of **3.9%** traffic growth was assumed. For the purpose of sensitivity testing, a lower rate of 3.0% p.a. and a higher rate of 5.0% p.a. were also evaluated in the economic evaluation, in conjunction with high and low diversion rates to the bypass route.

Fig 1 BRUNSWICK HEADS BYPASS

SH10 Traffic Growth Trends



Stn 04.070: South of MR 524 (Sthn leg)
Stn 04.270: 1.6 km sth of Brunswk Hds PO
Stn 04.073: North of MR 524 (Nthn leg)

The 3.9% p.a. linear growth rate yielded the following estimates of future corridor traffic volumes:

Year	Traffic (vpd)
1995	13,890
2000	16,160
2005	18,430
2010	20,700
2015	22,970
2020	25,240

(c) Traffic Origin and Destination

A traffic origin and destination survey was carried out on 18 July 1991, involving a 20% sample recorded for the four hours 9.00am - 11.00am and 3.00pm - 5.00pm. The purpose of the survey was to analyse average trip duration, to ascertain the potential demand for a through vehicle bypass based on the number of vehicles stopping in Brunswick Heads.

The survey indicated that 49% of current traffic would be attracted to the (shorter) Red Line bypass proposal then under investigation. The present bypass options are all longer, and rejoin the existing route north of the Rajah Road access to Ocean Shores (and north of the traffic counting location used in the survey). As a result, it is not possible to determine the degree to which Ocean Shores residents would be attracted to the bypass, or more inclined to stay on the existing route; some may merely switch to the more northerly Orana Road access, thereby allowing use of the bypass.

In the absence of this data, it was decided to continue with the 49% bypassable traffic as previously calculated; the sensitivity testing covers the scenarios of 1,000 vpd more and 1,000 vpd less vehicles on the bypass. These would be likely to encompass any variation attributable to the effect of the residents of Ocean Shores (1986 population: 1,826 persons).

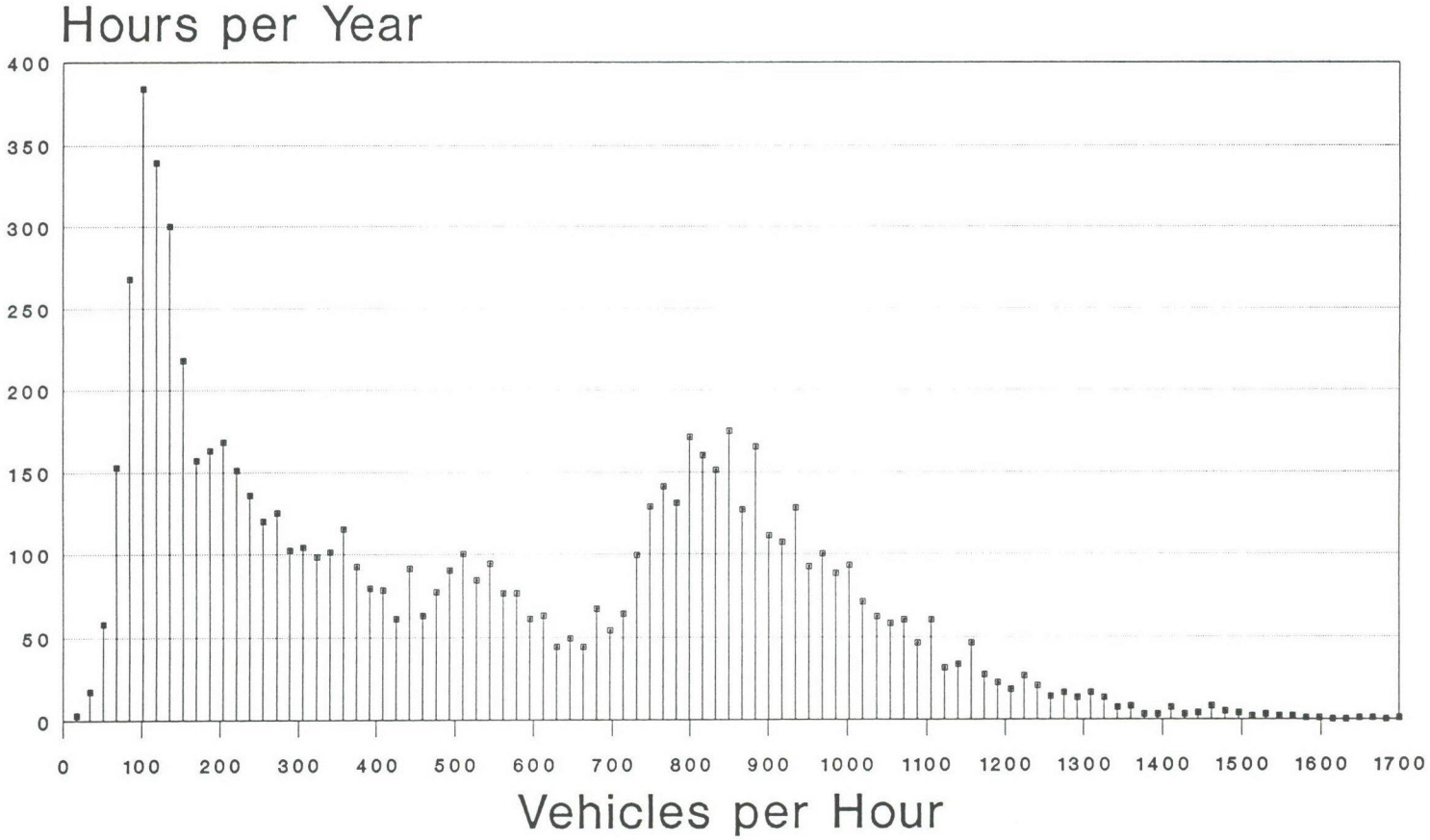
(d) Annual Traffic Distribution

The most recent annual hourly volume data was for the year 1988 at permanent station 04.270, as shown in **Figure 2.** This indicates the usual bi-modal distribution, but with a long tail indication a few hours in the year with very high traffic volumes, typical of areas with high holiday and seasonal usage. The peak hour was 1684 vehicles per hour, or 13.8% of AADT. The 30th highest hour was 1432 vehicles per hour, or 11.7% of AADT. There are 155 hours in the year with volumes greater than 10% of AADT.

The most recent annual daily traffic data at this site (1990) indicates that the peak day (Friday January 5th) accounted for 20,080 vehicles, or 55% above the AADT of 12,950. The first four weeks of the year together accounted for 24% above the average monthly figure. Christmas Day, with only 9,920 vehicles (77% of AADT) detected, was the quietest day of the year.

Fig 2 Annual Traffic Distribution

Permanent Station 04.270



(1988 data)

(e) Weekly Traffic Distribution

A classification survey undertaken in March 1990 indicated that heavy vehicles represented 14.4% of the traffic detected. The survey further indicated a substantial reduction in heavy vehicle numbers during Friday and Saturday nights, and an increase in traffic overall on Friday, Saturday and Sunday, a reflection of the strong recreational demand.

(f) Travel Speeds

Travel times surveyed on Friday 11 October 1991 indicated that the average trip duration of the length of highway to be superseded by the original 3.56 km Red Line was 3 minutes and 33 seconds, an average of 71 km/h. This contrasted with an assumed travel time on the bypass of 2 minutes and 8 seconds (at 100 km/h), a saving of 1 minute 21 seconds.

These figures have been used as the basis for the extension of the analysis to cover the four Options now under investigation. Due to the lengthening of the routes and the steeper grades to be eliminated north of Brunswick Heads, the average travel time saving for light vehicles has been increased to around 2 minutes 30 seconds.

2. ACCIDENT ANALYSIS

All accident records for the period 1983-1990 inclusive on Section 87 of the Pacific Highway were extracted from the ROADACCS database. While this data set yielded 239 accidents over the period, the accidents occurring over the length of Highway to be superseded by the bypass options had to be manually extracted by reference to the exact accident location data. This analysis yielded the following results:

	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
Total Accidents	8	19	21	9	18	17	11	13	116
Total Accident Rate (/mvkm)	0.39	0.89	0.94	0.39	0.74	0.67	0.42	0.48	0.61
Serious Casualty Accidents*	3	6	3	2	4	4	3	2	27
Serious Casualty Accident Rate (/mvkm)	0.15	0.28	0.13	0.09	0.16	0.16	0.11	0.07	0.14
Number Killed	1	0	1	0	2	0	1	0	5
Number Injured	7	13	16	5	16	9	8	13	87

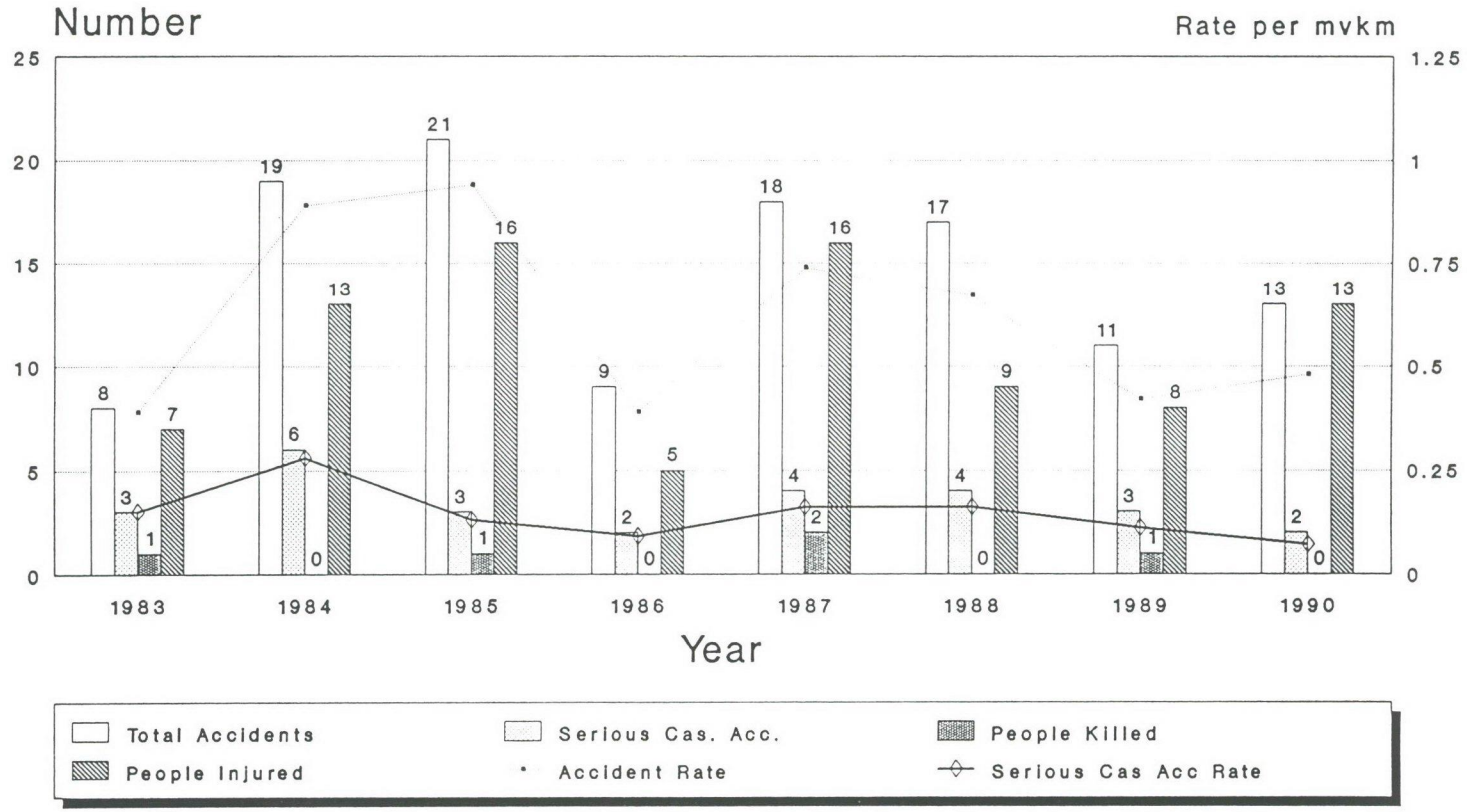
* A Serious Casualty Accident is one involving a fatality and/or an injury which requires hospital admission.

The results are shown graphically in **Figure 3.**

Fig 3 BRUNSWICK HEADS BYPASS

Accident Analysis

1983 - 1990



For the period 1983-1990...
Accident Rate = 0.61 per mvkm
Serious Cas. Acc. Rate = 0.14 per mvkm

3. ECONOMIC ANALYSIS

The REVS (Rural EValuation System) program was used to evaluate the four proposals. The assumed opening date for all options was 1993. All unit values for items such as fuel time and accident costs are as outlined in the March 1991 Authority Circular C91/3: "Parameters for Use in Economic Evaluation", and include:

Petrol Cost (resource price)	=	32.6 cents/litre
Average Accident Cost	=	$38,000 per accident
Value of Private Time	=	$7.12 per hour
Value of Commercial Time	=	$13.23 - $26.89 (depends on vehicle type)
Car occupancy	=	2 people per vehicle
Discount Rate	=	7.00% per annum
Analysis period	=	30 years (from 1993)

REVS works by comparing the difference between costs (vehicle operating costs, travel time, accident costs and road maintenance and resealing costs) in the existing situation (termed the "Base Case") and those in the situation which would occur if the given project were undertaken (termed the "Improved Case"). It analyses these costs on a year-by-year basis over the analysis period, and takes into account the effects of both pavement deterioration and increasing traffic volumes on the road user cost profile. All costs are then appropriately discounted and summed to allow comparison with the discounted construction and pre-construction costs, to produce the various economic indicators used for ranking purposes.

The speed limit on the existing road through Brunswick Heads was adjusted in the program to more accurately reflect the prevailing traffic conditions and travel times. In addition, items HIST(1), HIST(2), HIST(3) and HIST(4) in parameter file AWIDE were calibrated to reflect the annual hourly traffic distribution data derived from the permanent counter south of Brunswick Heads. This data is used by the program to model vehicle speed (and hence the resultant operating costs) during periods of differing traffic volume levels. The data used was:

Variable Name	Description	Old Value	Revised Value
HIST(1)	No. of hours pa with flow between 0 and 4% of AADT	4400	4923
HIST(2)	No. of hours pa with flow between 4% and 8% of AADT	3980	2950
HIST(3)	No. of hours pa with flow between 8% and 12% of AADT	380	866
HIST(4)	No. of hours pa with flow between 12% and 16% of AADT	0	21
		8760	8760

This revised distribution is a more accurate reflection of the strong holiday traffic flows which exist within the region, and will provide a better indication of road user benefits during these periods. Road roughness data was extracted from survey results collected in February 1991, and geometric data for the existing road was derived from RGDAS (Road Geometry Data Acquisition System) data. The RGDAS plots of gradient, advisory speed and horizontal radius are included as an Appendix for information.

The results of the economic analysis and sensitivity testing are listed in **Table 1** following, and shown graphically in **Figures 4** and **5**.

TABLE 1: Results of Economic Analysis

	Red	Blue	Green	Red/Black
Construction Cost ($m)	32.0	33.4	31.5	32.6
P.V. of Construction Cost ($m)	30.0	31.3	29.5	30.5
Length (km)	5.68	5.55	5.70	5.70
Benefits				
▪ litres of fuel/year (m)	5.48	5.57	5.51	5.45
▪ accidents/year	7	7	7	7
▪ hours of vehicle travel/year (m)	1.26	1.27	1.26	1.26
P.V. of Benefits @7% ($m)	219.0	221.2	218.6	218.6
Economic Analysis (all over 30 years @ 7% discount rate)				
Net Present Value ($m)	189.1	190.0	189.2	188.1
Benefit Cost Ratio	7.3	7.1	7.4	7.2
First Year Rate of Return	14.9%	14.7%	15.1%	14.5%
Internal Rate of Return	13.9%	13.9%	13.9%	13.8%
Payback Period (years)	5	5	5	5
Sensitivities				
BCR @ 4% discount rate	12.3	11.9	12.5	12.0
BCR @ 10% discount rate	4.7	4.5	4.7	4.6
If costs increase 20%:				
NPV ($m)	183.1	183.7	183.2	182.0
BCR	6.1	5.9	6.2	6.0
If costs decrease 10%:				
NPV ($m)	192.1	193.1	192.1	191.1
BCR	8.1	7.9	8.2	8.0
If diversion to Bypass is 1,000 vpd lower:				
NPV ($m)	184.7	185.2	184.7	183.7
BCR	7.2	6.9	7.3	7.0
If diversion to Bypass is 1,000 vpd higher:				
NPV ($m)	192.9	194.1	193.0	191.8
BCR	7.4	7.2	7.5	7.3
If traffic growth is lower (3.0% p.a. linear):				
NPV ($m)	133.0	133.7	133.0	132.0
BCR	5.4	5.3	5.5	5.3

If traffic growth is higher (5.0% p.a. linear):				
NPV ($m)	237.3	238.6	236.7	236.2
BCR	8.9	8.6	9.0	8.7
"Worst" Case (ie low traffic growth + high cost + low diversion):				
NPV ($m)	123.0	123.1	123.2	122.0
BCR	4.4	4.3	4.5	4.3
"Best" Case (ie high traffic growth + low costs + high diversion):				
NPV ($m)	244.8	246.7	244.2	243.7
BCR	10.1	9.8	10.2	9.9

* All fuel, accident and vehicle - hours savings are annual average savings over the 30 years from 1993 to 2022, not first year (ie 1993) savings.

All calculations at 7.0% discount rate unless otherwise specified.

4 COMMENTS

It must be stressed that this report is only concerned with the road user and road authority economic effects of these proposals. No attempt has been made to evaluate the economic effect of variations in, for example, air quality, scenic factors or noise exposure. These important factors will require consideration at difference stages of the decision-making process. Their exclusion from this report must not be construed as a lack of concern for other impacts of road development. Rather, it is a reflection of the fact that road user economic analysis is limited to those factors which can reasonably confidently be given a dollar value, to enable the effects to be compared with the initial community investment.

The Net Present Value is the difference between the present value of road user benefits and the present value of costs (construction, land acquisition, planning, etc). A positive Net Present Value indicates that the project has economic merit.

The Benefit-Cost Ratio represents the present value of benefits divided by the present value of costs. A BCR greater than 1 indicates that the project has economic merit.

The results in Table 1 clearly indicate that all options investigated are economically justified from a road user point of view. All offer superior travel conditions for through travellers, and in addition relieve conditions for local traffic within Brunswick Heads.

The reduction in length afforded by the routes (ranging from 850m to 1.0km over the existing route) and the improved alignment and subsequent vehicle travel speed combine to produce large travel time savings. In fact, travel time savings account for 79% of the total road user cost savings of the Red Option. This result was fairly consistent across all options, since they only vary in length by 150 metres and in cost by $1.9 million.

BRUNSWICK HEADS BYPASS

Economic Analysis of Possible Routes

The following table outlines the results of an analysis of the economic justification of the two revised bypass alternatives for the Pacific Highway at Brunswick Heads (Routes "A" and "G").

	Route "A"	Route "G"
Construction Cost	$12.0m	$13.0m
P.V. of Construction Cost	$12.0m	$13.0m
Length (km)	3.30	3.50
Benefits		
▪ litres of fuel/year (m)	2.34	2.22
▪ accidents/year	5	5
▪ hours of vehicle travel/year (m)	0.50	0.50
▪ vehicle-kms travelled (m)	2.64	1.94
P.V. of Benefits @7%	$108.8m	$105.1m
Economic Analysis (all over 30 years @ 7% discount rate)		
Net Present Value	$96.7m	$92.1m
Benefit Cost Ratio	9.0	8.1
First Year Rate of Return	22.0%	18.8%
Internal Rate of Return	14.3%	14.1%
Payback Period (years)	4	5
Sensitivities		
BCR @ 4% discount rate	15.2	13.6
BCR @ 10% discount rate	5.7	5.1
If costs increase 20%:		
NPV	$94.3m	$89.5m
BCR	7.5	6.7
If costs decrease 10%:		
NPV	$97.9m	$93.4m
BCR	10.1	9.0
If diversion to Bypass is 1,000 vpd lower:		
NPV	$92.7m	$88.6m
BCR	8.7	7.8
If diversion to Bypass is 1,000 vpd higher:		
NPV	$100.3m	$95.1m
BCR	9.3	8.3

If traffic growth is lower (3.0% p.a. linear):		
NPV	$71.3m	$66.9m
BCR	6.9	6.1
If traffic growth is higher (5.0% p.a. linear):		
NPV	$112.5m	$105.9m
BCR	10.4	9.1
"Worst" Case (ie low traffic growth + high cost + low diversion):		
NPV	$65.2m	$61.2m
BCR	5.5	4.9
"Best" Case (ie high traffic growth + low costs + high diversion):		
NPV	$117.9m	$110.9m
BCR	11.9	10.5

* All fuel, accident and vehicle - hours savings are annual average savings over the 30 years from 1993 to 2022, not first year (ie 1993) savings.

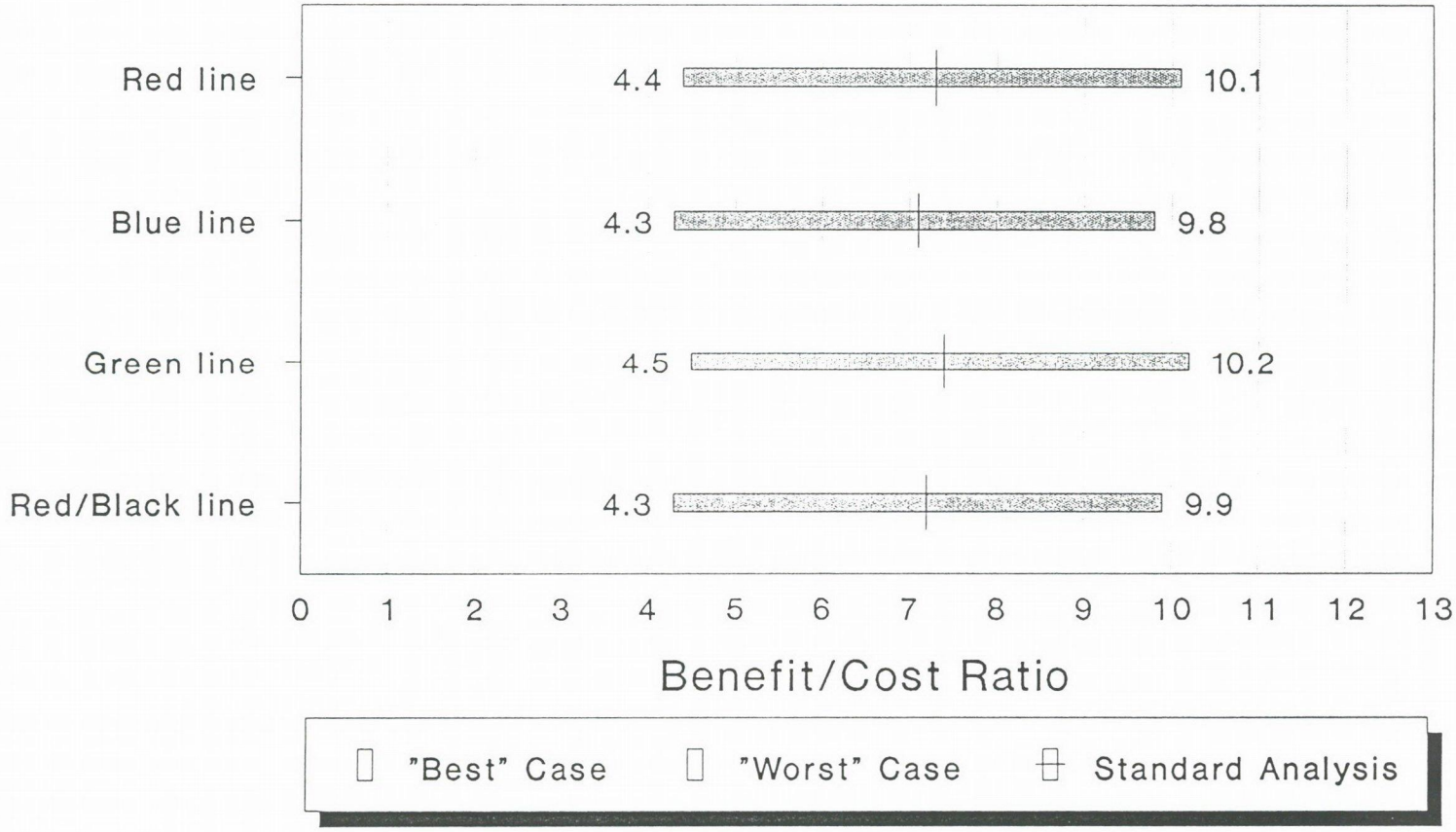
All calculations at 7.0% discount rate unless otherwise specified.

Both these options are attractive from a road user cost point of view. The economic indicators remain robust under all sensitivity tests, with the differences related only to the 200 metre extra distance of the Route "G" alignment, and its additional $1,000,000 cost.

With such sound economic indicators for both options, environmental and social factors may be more significant as the determining factor for route selection.

Fig 4 BRUNSWICK HEADS BYPASS

Range of BCR Results

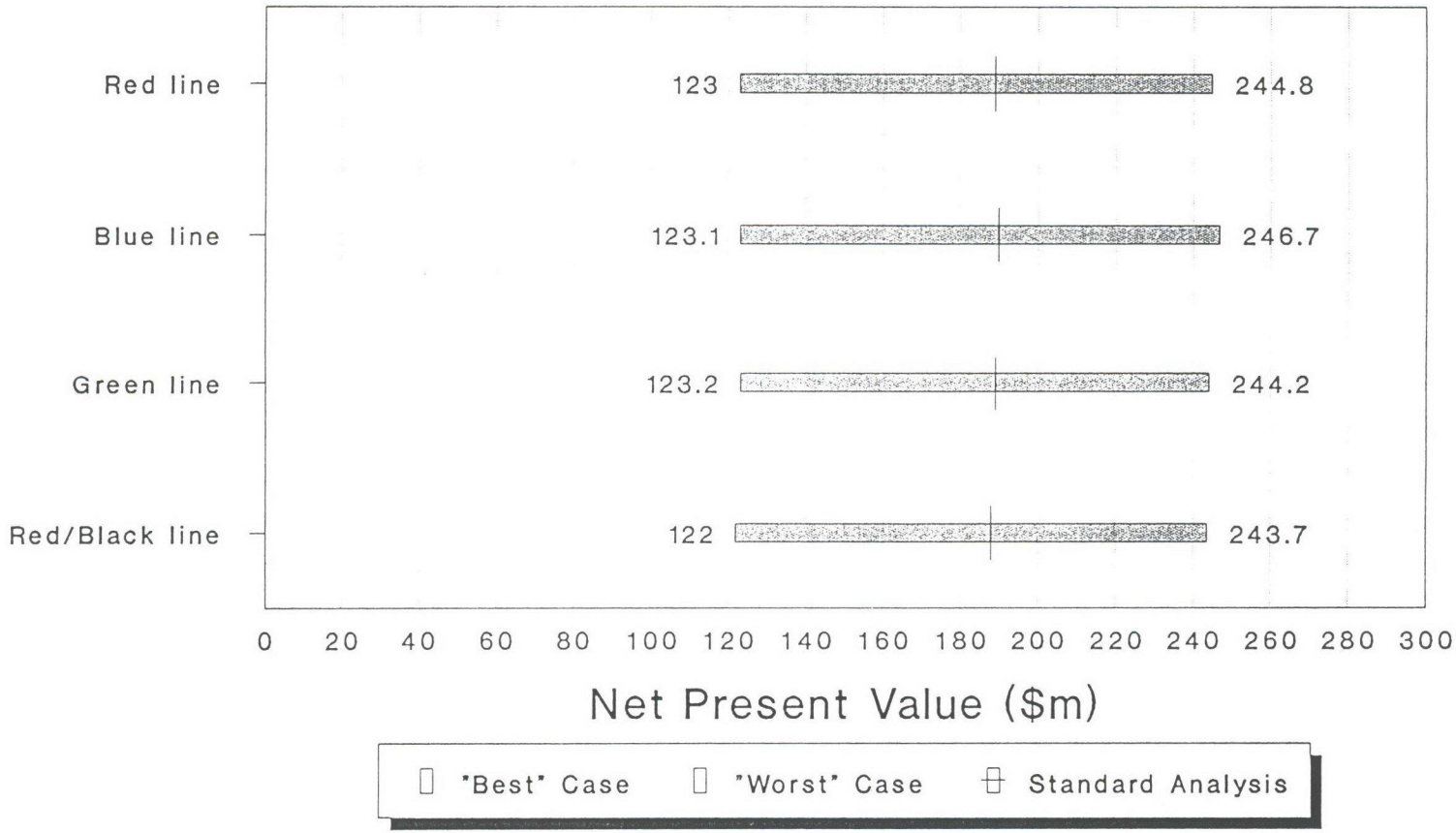


ROADS & TRAFFIC AUTHORITY
HEAD OFFICE
LIBRARY

For definitions of terms used, see Table 1 in text.

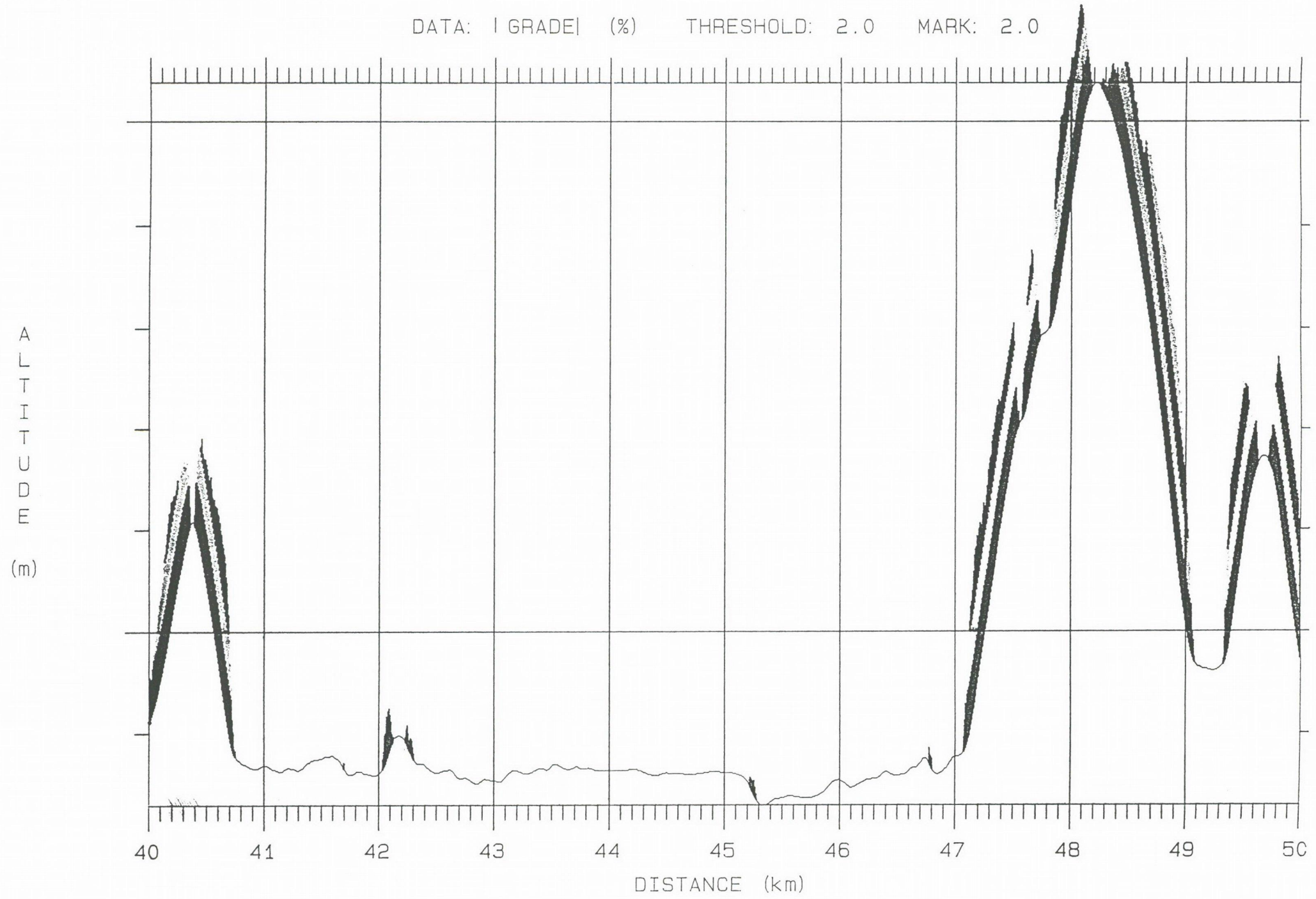
Fig 5 BRUNSWICK HEADS BYPASS

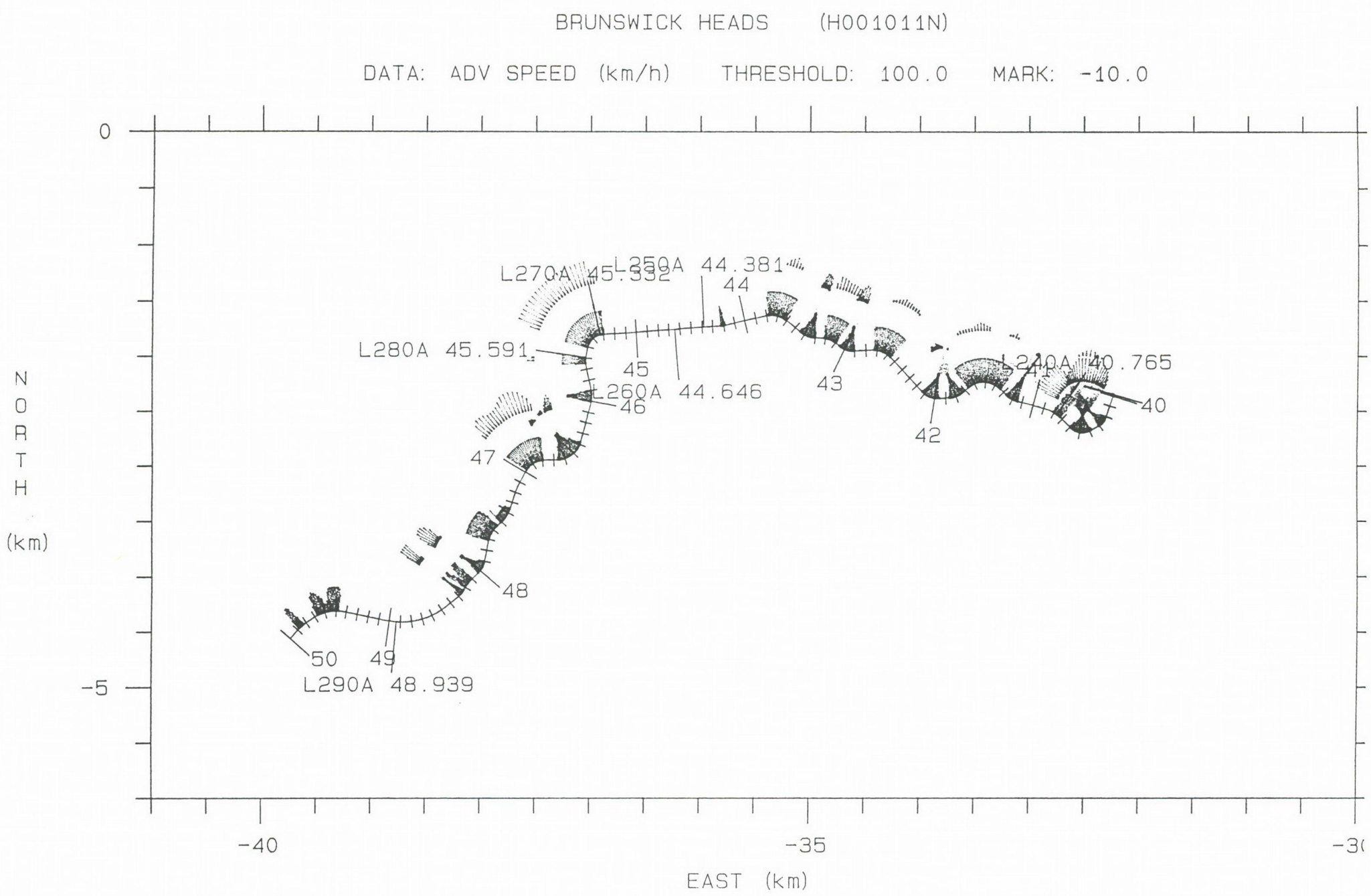
Range of NPV Results

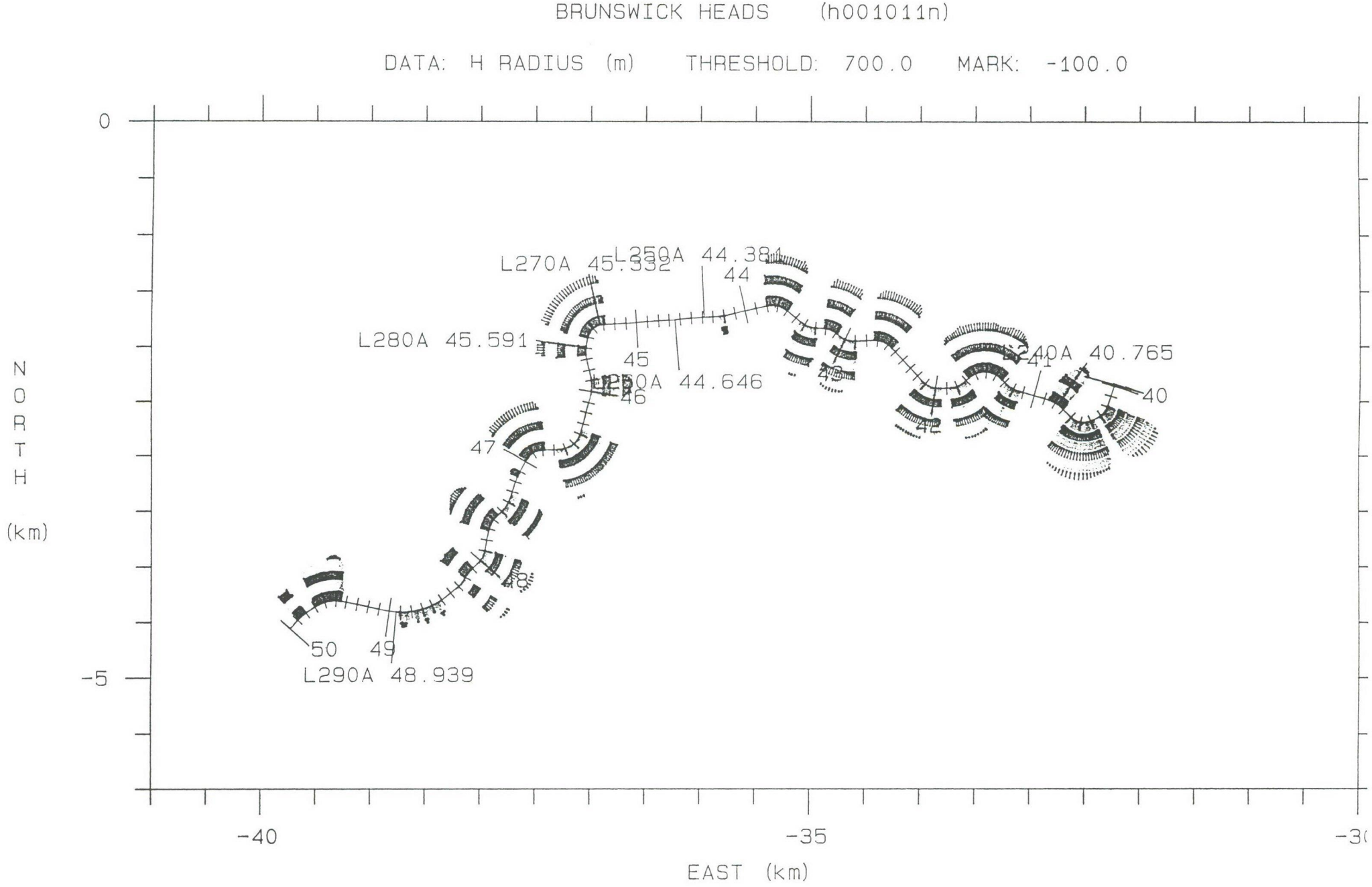


For definitions of terms used,
see Table 1 in text.

Since the options under investigation are mutually exclusive, the appropriate indicator to use for ranking purposes is Net Present Value. However, in the present situation, the minor difference in economic indices across the options is not significant. All that can be reliably inferred from this analysis is that all options are clearly economically justified, given the inputs as stated.


DATA: | GRADE| (%) THRESHOLD: 2.0 MARK: 2.0
ALTITUDE (m)
40
41
42
43
44
45
46
47
48
49
50
DISTANCE (km)


BRUNSWICK HEADS (H001011N)
DATA: ADV SPEED (km/h) THRESHOLD: 100.0 MARK: -10.0
0
-5
NORTH (km)
-40
-35
EAST (km)
L270A 45.332
L250A 44.381
44
L280A 45.591
45
L260A 44.646
46
43
L240A 40.765
40
42
47
48
50
49
L290A 48.939


BRUNSWICK HEADS (h001011n)
DATA: H RADIUS (m) THRESHOLD: 700.0 MARK: -100.0
0
-5
NORTH (km)
-40
-35
EAST (km)
L270A 45.332
L250A 44.381
L280A 45.591
L260A 44.646
L240A 40.765
44
45
46
47
48
49
50
40
41
42
L290A 48.939

APPENDIX M

Visual Landscape Report

Environmental Planning Section, 1992

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2.	Landscape and Visual Significance
3.	Landscape Sensitivity
4.	Extent of Alteration
5.	Assessment of Visual Impact

1. EXECUTIVE SUMMARY

The visual and landscape study described in this report is based upon the analysis of the existing visual resource and the alteration to that resource which will occur if the proposed development is to proceed.

The proposed Bypass route comprises 3.5km of two of three lane roadway. The road reserve is of sufficient width (90.0m) to allow the possible future duplication of the Bypass.

The findings of the study are summarised below.

- The landscape character of the study area encompasses a combination of natural, rural and urban landscape types. However natural bushland components dominate the majority of the Bypass route. The river precinct and heathland community are visually and ecologically significant on a regional scale.

- Views both from and to the proposed Bypass are limited due to the enclosing nature of existing vegetation and level terrain.

- The proposed Bypass will:

* Remove approximately 0.5ha of riverplain forest vegetation deemed high conservation value in a district significance.

* Remove copses of casuarina woodland assessed to be of local significance on the rural floodplain.

* Alter existing natural landform character by cut earthworks of up to 20.0m near Saddle Road and fill banks of up to 2.0m over the riverplain.

- The proposal will not adversely affect the visual quality of the Brunswick River precinct as the Bypass will connect into the existing bridge crossing.

- The Bypass will have a relatively high impact on views for two residences which will have existing idyllic bushland settings severely diminished by the proposed corridor. Views from these residences will now include a road swathe through the riverplain forest/woodland.

- The proposed alignment does not provide a visual/physical margin to the future growth and development of Brunswick Heads township unless strict landuse controls are enforced to ensure conservation of the heath and forest communities.

  Ocean Shores residents orientated to the south will be exposed to mid-distant/distant views of the Bypass particularly through the floodplain.

- However the visibility of the Bypass for residents located on the western edge of Brunswick Heads township will be inhibited by the existing heathland and eucalyptus forest margin.

- The landscape mitigation guidelines have been developed to minimise long term visual impacts and to improve the existing visual amentiy of the landscape as a whole. The recommendations include:

  - Revegetation through a combination of direct native seeding and use of established plant stock. Revegetation will take into account the existing vegetation transitions along the Bypass route with locally collected seed.

  - Landscape treatments to screen the Bypass from local population.

  - Feature tree planting at the northern and southern gateways to reinforce the visual image of the township.

2. INTRODUCTION

This report is a landscape and visual study for the proposed Brunswick Heads Bypass. The study forms part of an EIS prepared by the RTA on the proposal.

The proposed Bypass is situated approximately 700m - 1000km west of Brunswick Heads township, beginning south of the Pacific Highway/Saddle Road intersection and rejoining the highway prior to the existing Brunswick River Bridge.

The purpose of this study is to describe and evaluate the existing visual environment, determine the visual impacts that will occur as a result of Bypass constuction, and to recommend strategies to minimise any adverse visual impacts and improve the visual amentiy of the roadway.

The proposal has been developed as a preferred option following previous route selection studies. Therefore only this preferred alignment is subject to a more detailed investigation in this report.

The report is divided into the sections outlined below:

- Description and evaluation of the existing visual environment including landscape character, visual quality and significance of existing views and vistas.
- The alteration to the existing visual environment which will occur as a result of the Bypass construction.
- Assessment of the proposal's impact on the existing visual environment.
- Proposed guidelines and recommended landscape treatments to minimise the impact of the proposal and improve the visual amenity of the road environment.
- Landscape concept plan which adopts the proposed guidelines and recommended landscape treatments.

3. EXISTING VISUAL ENVIRONMENT

3.1 Regional/Broad Context

The study area is situated within a broad river/coastal plain bordered by the Brunswick River to the north and west, Brunswick Heads township to the east, and hillslopes to the south.

The landscape pattern of the region surrounding the Bypass corridor has been assessed by identifying and describing the landscape components of topography, vegetation and cultural modifications.

Topography: The study area is located within a expansive low lying coastal floodplain adjacent to the Brunswick River which is visually defined by hillslopes situated to the south.

The landform is generally below 4.0 m ASL throughout the entire coastal river plain, rising to over 40 m ASL on the hillslopes north of Saddle Road. These elevated areas provide panoramic views across the floodplain, Brunswick township and Coral Sea horizon.

Vegetation: As a result of landform, soil types, climate, hydrology and landuse activities, the study area displays a range of vegetation communities with distinctly contrasting characteristics. (Figure) These include:

- Wetland Vegetation

This vegetation type alongside the Brunswick River includes Avicennia marina (Mangrove) along the estaurine margin and Casuarina glauca and Melaleuca quinquenervia on the more elevated ground.

- Semi Rural Grassland/Open Woodland

Open woodland used for rural grazing occurs throughout the low lying floodplain situated north west of Brunswick Heads township. The floodplain contains scattered remnant trees particularly along property boundaries and natural depressions. Species include Casuarina glauca, Melaleuca quinquenervia and occasional Eucalyptus robusta of up to 15.0 m in height.

- Heath Vegetation

The poor sandy soil found in the low lying areas of the coastal plain supports a vast area of heath vegetation. A rich variety of species up to 3.0m in height was identified including Banksia ericifolia, Banksia integrifolia, Acacia longifolia and Leptospermum species.

- Forest/Woodland Vegetation

  Eucalypt forest communities occur adjacent to the western margin of Brunswick Heads township and the heathland, within the flora reserve and along the margin of the Brunswick River. A portion of the river margin forest has been classified as a SEPP 14 Wetland (67). A number of tall Eucalypt species (up to 20.0m in height) are identified, namely Eucalyptus tereticornis, Eucalyptus pilularis and Eucalyptus robusta.

  In more sheltered environments along Saddle Road, and within the Flora Reserve remnant littoral rainforest species such as Tristania conferta and Elaeocarpus reticulatus are identified.

Cultural Modifications: Clearing of vegetation to support rural grazing and residential development is the major cultural modification the region has incurred since settlement.

However, apart from some minor tracks and a transmission line easement, the vast area of heathland is relatively undisturbed. The forest and woodland areas at the northern and southern end of the study area have undergone extensive clearing to support grazing activities. An area of remnant forest has been retained as a flora reserve. Built features within the region include Brunswick Heads township, Bayside Way residential development and a caravan park/residential area located west of the existing Brunswick River bridge crossing. On the elevated land north of the Brunswick River is situated the Ocean Shores residential development.

3.2 Landscape Character of the District

Within the broad context, the landscape character consists of a combination of natural, rural and cultural landscape types which are outlined in the table below.

TABLE 1._ - LANDSCAPE CHARACTER OF THE DISTRICT

LANDSCAPE TYPE	COMMENT
Natural Landscape	. Heathland, forest, woodland and wetland vegetation communities provide a variety of characters and transitions reflecting the regions topography, hydrology and landuse patterns. Natural bushland is the dominant landscape type of the Bypass corridor and surrounding environs. . Brunswick River is a significant natural feature with well preserved wetland/ forest vegetation defining its margins.
Rural	Cleared grazing land north and south of the Bypass corridor provides a contrast to the areas of natural bushland. In combination with remnant areas of natural vegetation, these rural lands add variety to the landscape resource of the region.
Urban	Urban/built development is contained in specific areas rather than uniformly spread over the locality. The built environment does not dominate the landscape due to its low scale and containment by the surrounding vegetation.

3.3 Bypass Corridor and Surrounding Environs

The landscape and scenic quality surrounding the Bypass Corridor is attributable to the composition and juxtaposition of natural and landuse elements such as topography, vegetative patterns, hydrology and cultural modifications.

The natural, rural and urban landscape types contained within these elements combine to create distinct landscape character units. (Figures 1-4). These include:

UNIT A - River Precinct
UNIT B - Rural Floodplain
UNIT C - Riverplain Woodland
UNIT D - Riverplain Forest
UNIT E - Wooded Hillslopes
UNIT F - Heathland

The landscape quality and visual significance of the Landscape Character Units are summarised in Table 2.

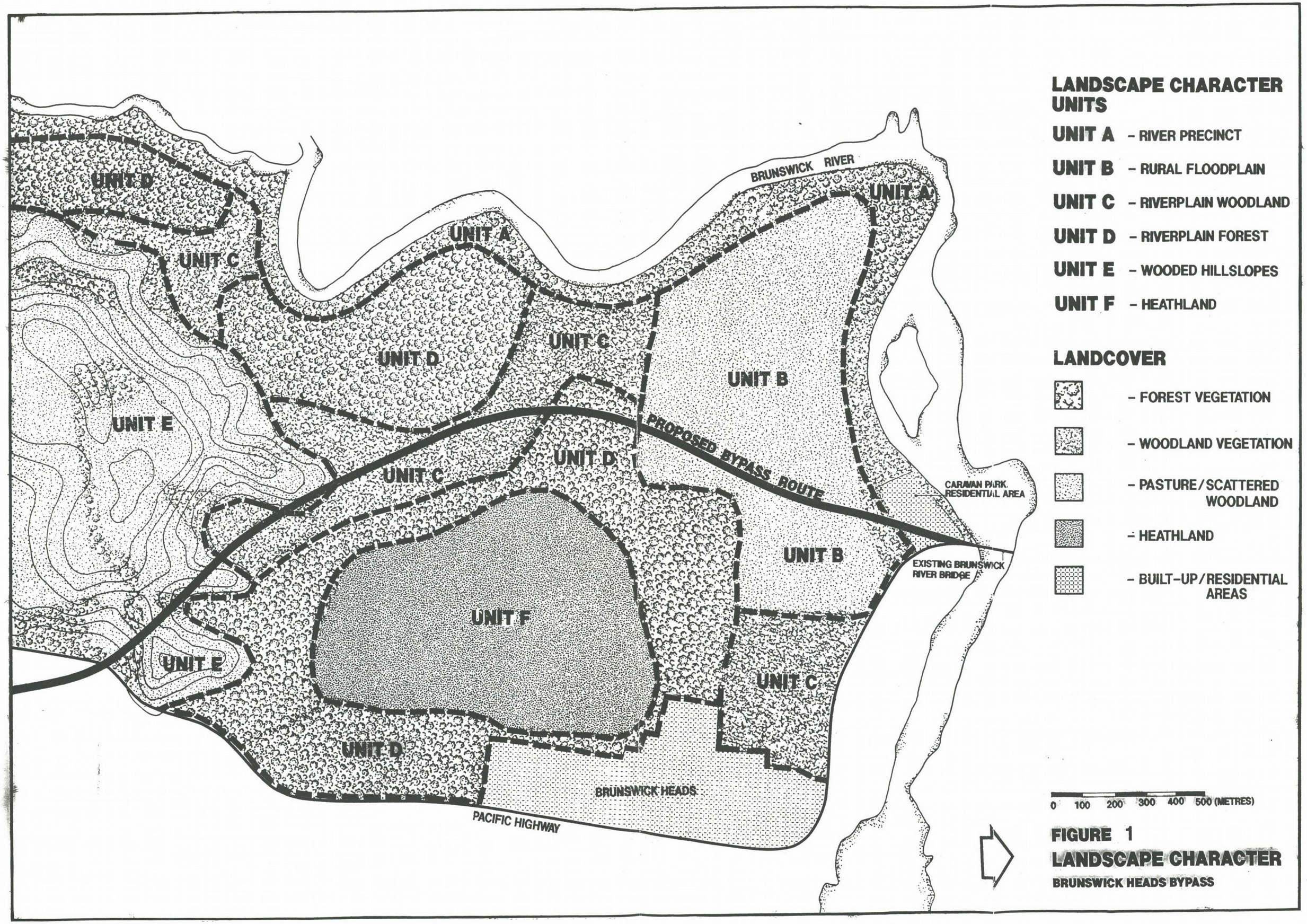
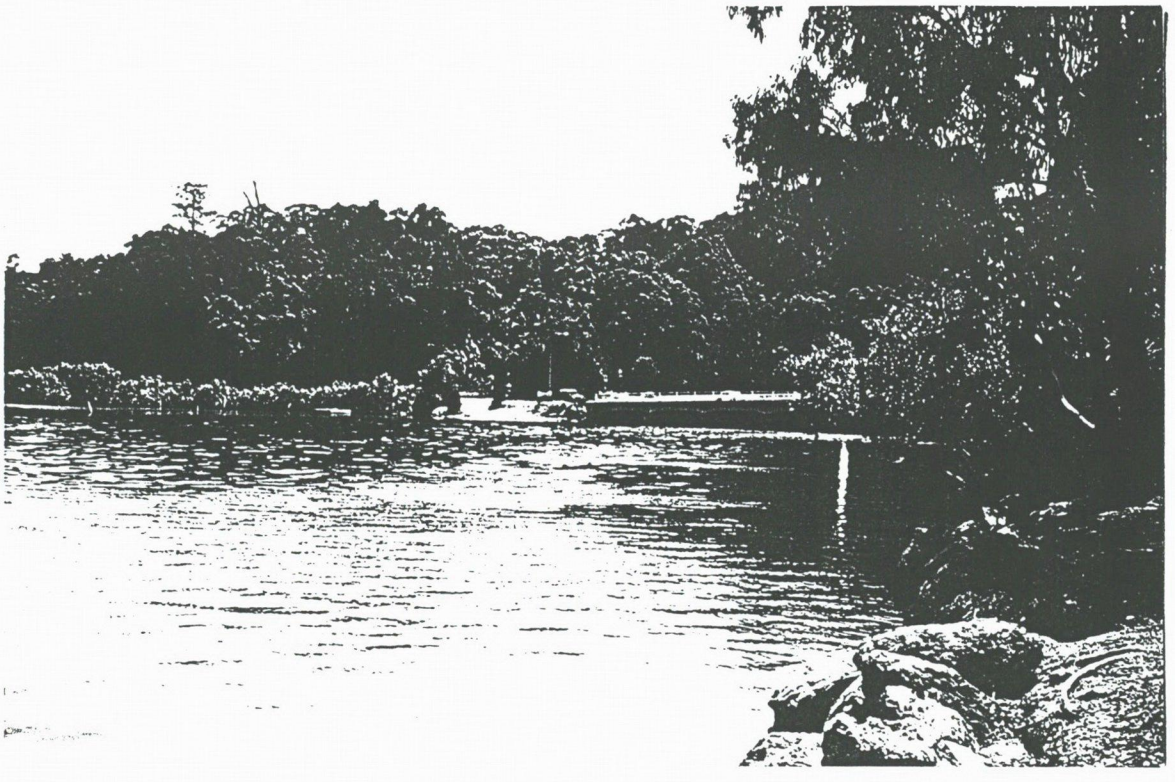


FIGURE 1

LANDSCAPE CHARACTER

BRUNSWICK HEADS BYPASS



LANDSCAPE CHARACTER UNIT A – RIVER PRECINCT

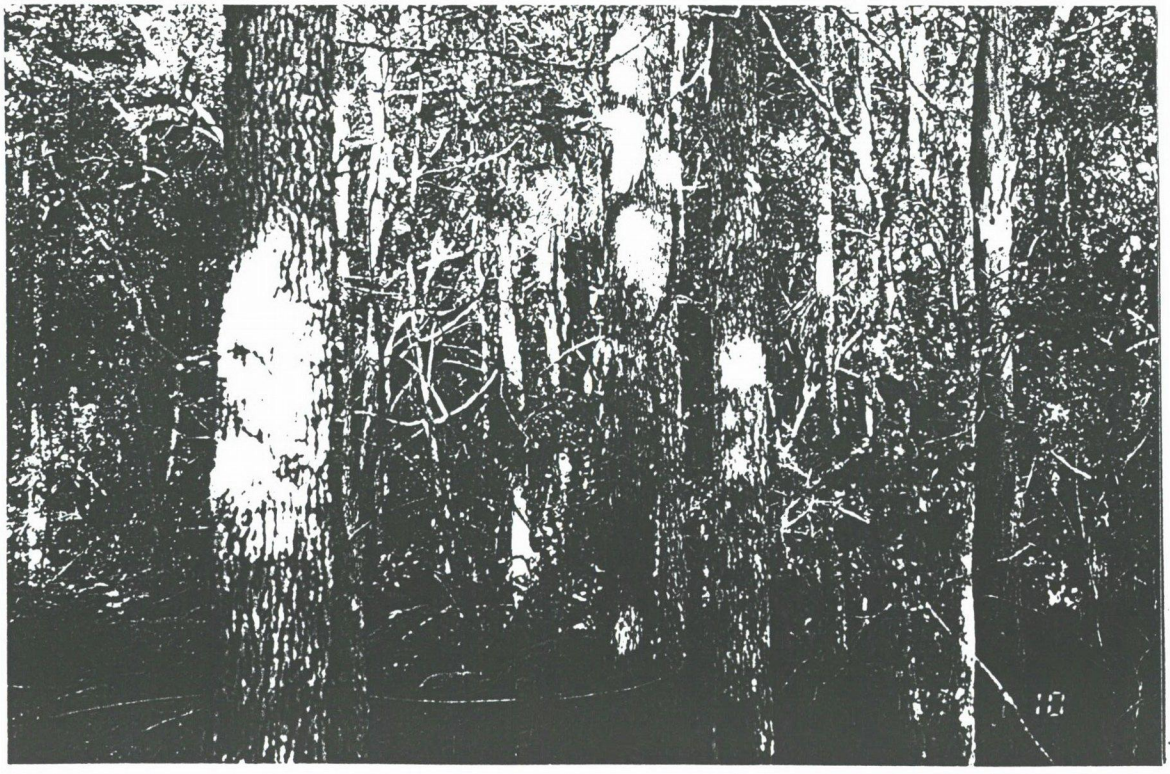


LANDSCAPE CHARACTER UNIT B – RURAL FLOODPLAIN

FIGURE 2



LANDSCAPE CHARACTER UNIT C – RIVERPLAIN WOODLAND



LANDSCAPE CHARACTER UNIT D – RIVERPLAIN FOREST

FIGURE 3

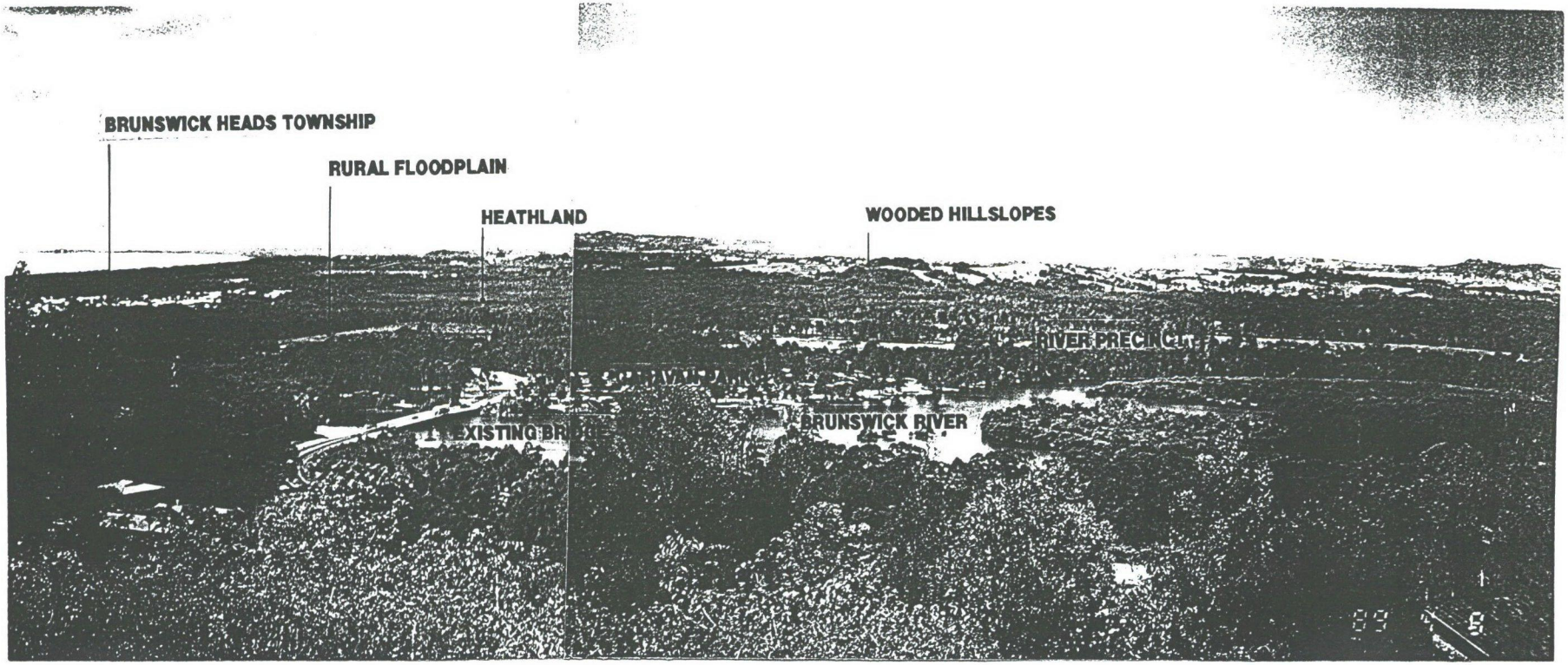


LANDSCAPE CHARACTER UNIT E – WOODED HILLSLOPES



LANDSCAPE CHARACTER UNIT F – HEATHLAND

FIGURE 4



PANORAMIC VIEW FROM OCEAN SHORES LOOKOUT

FIGURE 5

TABLE 2 - LANDSCAPE AND VISUAL SIGNIFICANCE

ANDSCAPE HARACTER UNIT	COMMENT	LANDSCAPE TYPE	LANDSCAPE SIGNIFICANCE	VISUAL SIGNIFICANCE
NIT A - River Precinct	The Brunswick River Precinct is characterised by wetland/forest communities defining sections of the river margin and a caravan park located west of the existing bridge crossing.	Natural	High	Regional
NIT B - Rural Floodplain	This area is characterised by scattered remnant Casuarina glauca and occasional Melaleuca quinquenervia on low lying level terrain which is subjected to seasonal water-logging.	Rural	Moderate	Local
IIT C - Riverplain Woodland	Modified from forest to woodland by previous clearing to support grazing activities.	Rural/ Natural	Moderate	Local/ District
IIT D - Riverplain Forest	This area is characterised by tall Eucalypt/Melaleuca forest with shrub understorey. A strong sense of visual containment is created with views limited to the immediate foreground.	Natural	Mod/High	District
IT E - Wooded Hillslopes	This area is characterised by elevated woodland & contrasting open grazing land on gentle hillslopes. The designated Flora reserve is also contained within this unit. The remnant forest and elevated landform provides a strong visual contrast to the adjoining level topography.	Natural/ Rural	High	District
IT F - Heathland	The expanse of natural heathland provides a landscape detail and pattern which creates a distinctive landscape character through a combination of flat terrain and uniform vegetation density and variety.	Natural	High	Regional

3.4 Views/Spatial Quality

Depending on landform and vegetation characteristics the study area offers a variety of spatial experience ranging from enclosed to open surroundings.

A strong sense of enclosure is experienced within the floodplain forest where a combination of level terrain and dense tall tree cover restricts views within the corridor to the immediate foreground.

The boundary of the floodplain woodland community is defined by the floodplain forest which restrict views through the woodland copses to the mid-foreground/mid distance.

Views across the **rural floodplain** are usually confined to the mid foreground by copses of casuarina, however occasional glimpses of the distant ranges are available from this location. The open spatial quality contrasts strongly with the enclosing nature of the forest communities.

The wooded **hillslopes** near Saddle Road offers good panoramic views of the surrounding hills, residential lots, floodplain and Coral Sea in the background. However, within the forested areas of the Bypass corridor, views are restricted to the immediate foreground.

Excellent foreground views of the river precinct can be obtained along the existing bridge and river banks. The river margin provides a high quality view through the contrast of the expansive water body and the wetland vegetation along the river edge.

North of the Brunswick River, the elevated hillslopes of the Ocean Shores development provide excellent panoramic views encompassing the river, heathlands, riverplain forest/woodland, Brunswick Heads township, wooded hillslopes and ocean shoreline (Figure 5).

4.0 PROPOSED ALTERATION TO THE EXISTING VISUAL ENVIRONMENT

This section will describe the sensitivity of the different landscape components to disturbance by roadworks, the extent of disturbance to each of the different landscape character units and alteration to existing views and vistas that will occur as a result of implementation of the proposal.

The proposed Brunswick Heads Bypass comprises a 3.5km length of two to three lane high standard rural road.

The corridor is situated 700m-1000m west of Brunswick Heads township beginning south of the Pacific Highway/Saddle Road Junction and linking back to the existing highway just prior to the river crossing.

The proposal consists of the following elements:

- 14.5m carriageway width (overall)
- Fill batter formation with average 4:1 gradient. Fill batter height range from 0.5m to 2.00m.
- One major cut of 20.0m in height north of Saddle Road.
- Viaduct construction to traverse riverplain forest for a length of 100.0m.
- Intersection treatments leading to Brunswick Heads township to comprise of rural right turn lanes.

4.1 Landscape Sensitivity

The sensitivity of the landscape character units to the proposed roadworks are to a great extent determined by existing topography and vegetative cover.

TABLE 3 LANDSCAPE SENSITIVITY

				SENSITIVITY TO DISTURBANCE			
LANDSCAPE CHARACTER UNIT	**LANDSCAPE TYPE**	**VEGETATIVE COVER**	**TOPOGRAPHY**	**CUT**	**FILL**	**GRADE**	**VIADUCT**
River Precinct	Natural	Dense cover	Flat	High	High	Mid/ high	Mid
Rural Floodplain	Rural	Medium/ sparse cover	Flat	Mid/ High	Low	Mid	Low
Wooded Hillslopes	Natural/ Rural	Medium/ sparse cover	Undulating	Mid/ high	Mid	Low	Mid
Riverplain Forest	Natural	Dense	Flat	Mid/ high	Mid/ high	Mod	Mid
Riverplain Woodland	Rural/ Natural	Medium cover	Flat	Mid	Mid	Mid	Mid/ low

4.2 Alteration to Landscape Character

Generally the bypass will traverse on low fill over the river/costal floodplain. The width of disturbance and hence proximity of mature vegetation along the bypass will vary according to the depth of these fill embankments.

Fill bank averages 0.5m to 2.0m high with a 35m wide corridor.

The only area of major cut earthworks, up to 20.0m in height is located on the hillslopes north of Saddle Road.

The extent of alteration by cut and fill earthworks to the existing landscape character units is summarised in the Table below.

4.3 Alteration to Views and Vistas

- The proposal traverses a mixture of forest/woodland for over half its length. View availability to the corridor is inhibited by natural bushland.

- Major residential suburbs, namely Brunswick Heads township and Bayside Way will be screened from views to the Bypass by existing forest/heathland vegetation.

- However, a number of rural-residential properties will have existing views altered by the Bypass.

  These include:

  - one residence located on lower Saddle Road footslopes and one residence/nursery will incur severe foreground exposure to the Bypass corridor. The existing scenic bushland/rural outlook from these residences will be diminished by the proposal.

  - Residence/piggery will incur mid-foreground views to the cut face. Northern views over the riverplain will now include a road swathe extending to the mid distance view.

  - Three rural residential properties located off Saddle Road will also have northern outlooks altered by the road proposal. However existing vegetative cover surrounding these residences will limit these views to glimpses rather than existing panoramic views.

- Views over the level rural floodplain will be interrupted by vertical fill batters of up to 2.0m in height. The use of gentle batter gradients (say 6:1) would minimise the visual disruption to views over the floodplain. However this would invariably extend the corridor width and generate more impact on vegetation.

- Residences with a southern outlook from the Ocean Shores development have a superior viewing position over the Brunswick river/coastal plain. This broad vista may be fragmented and diminished by a major roadway, the break in continuous forest vegetative cover will also increase the visual impact of the bypass alignment to middle distance views from this locality.

5.0 ASSESSMENT OF IMPACTS

The assessment of the proposed bypass on the existing visual environment has been based on the degree of alteration, the sensitivity of the landscape to disturbance and the relative visual significance of the landscape.

Assessment of the visual impact on the landscape character is summarised in Table 5:

5.1 Impact on Landscape Character

. The introduction of an urban element to a predominantly natural/rural environment will have a detrimental visual impact on the existing landscape character.

. Generally in terms of conserving existing natural landscape character, the alignment would have the least impacts on the natural environment for the following reasons:

- the ecologically sensitive heathland unit and designated flora reserve would remain intact and free from disturbance.

- from north of the Saddle Road hillslopes to the Rural floodplain, the alignment mainly traverses river plain and woodland that has been modified by previous clearing/agricultural practices.

- 0.5ha of high conservation value forest will be removed, however the majority of Eucalypt forest that fringe the heathland will be retained.

. Potential adverse impacts on landscape character that need to be considered include:

- the proposed alignment would not provide a visual/physical margin to the future growth and development of Brunswick Heads township unless strict landuse controls are enforced to ensure conservation of the heath and forest communities.

- the introduction of weeds during and after construction.

- the alignment could become a major impediment to faunal movements from the heathland to forest/woodland communities. The use of low viaduct structures as recommended by project team ecologist should be considered to facilitate faunal movements.

- the proposal will require a cut embankment of up to 20.0m in depth at Saddle Road. This will have a significant visual impact on the ridgeline and form an undesirable silhouette against the skyline. Terracing and revegetating the cut faces will reduce the impact of landform alteration at this locality (Figure 6).

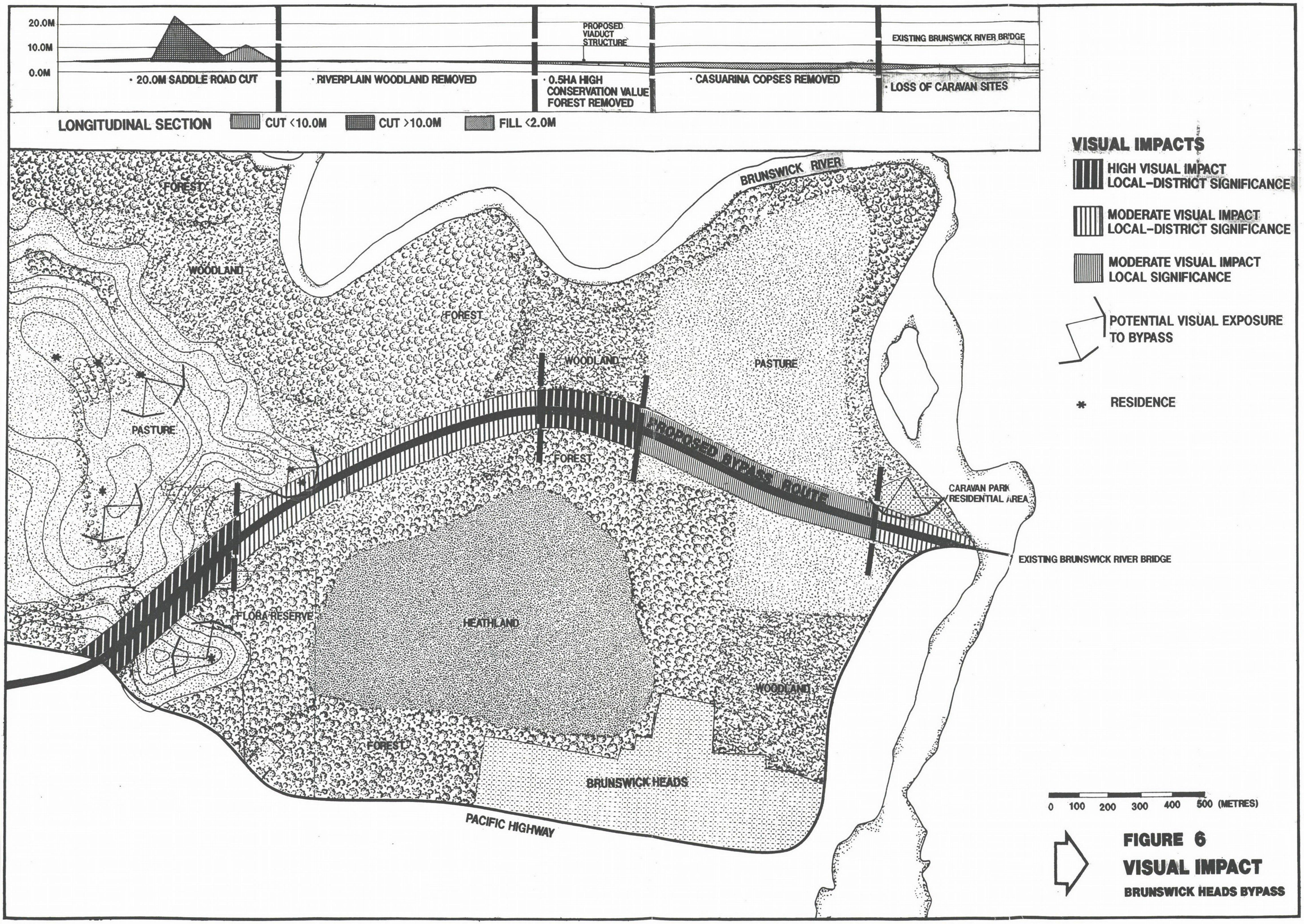


FIGURE 6
VISUAL IMPACT
BRUNSWICK HEADS BYPASS

TABLE 5

LANDSCAPE CHARACTER UNIT	PROPOSED ALTERATION	LANDSCAPE SIGNIFICANCE	VISUAL IMPACT SIGNIFICANCE
River Precinct	Bypass reconnects to Pacific Highway prior to the existing bridge crossing. This will retain all riverbank vegetation.	Regional	Moderate
	The Bypass will visually intrude onto the property of the Caravan Park.	Local	Moderate/High
Rural Floodplain	Removal of Casuarina woodland located on the southern boundary of the Caravan Park.	Local	Moderate
	Fill will visually impose upon and disrupt the natural level of the floodplain.	Local	Moderate
Floodplain Forest	Approximately 0.5ha of forest vegetation of high conservation value will be traversed by the Bypass. The proposed viaduct structure will reduce will reduce required width of swathe disturbance.	District	Mid
Riverplain Woodland	Approximately 1.1ha of Eucalypt woodland with cleared understorey of moderate to high conservation will be removed by corridor.	Local/ District	Mid
Wooded Hillslope	Forest areas on the southern section of Saddle Road removed by cut earthworks.	District	High
	20.0m cut at Saddle Road will alter existing rural hill slope character of the locality	Local	High

5.2 Impact on Local Residents

- The alignment will cause negligible visual intrusion for Brunswick Heads township residents due to containment provided by surrounding vegetation and distance from the development.

- The residents of Brunswick Heads will generally benefit from the Bypass as it will reduce congestion by diverting traffic away from the present village centre. The viewer population of local residents overlooking the busy highway will be reduced significantly as the highway through the township reverts to a local main street.

- However a number of rural residential properties located on the Saddle Road hillslope and adjoining river plain will have views altered by the proposal. In particular the residence/nursery and adjoining residential property located on the northern Saddle Road footslopes will incur immediate foreground visual exposure to the Bypass corridor unless effective visual screening/mitigation measures are implemented. The present idyllic bushland/rural setting these two residences presently enjoy will be significantly diminished by the Bypass (Figure 6).

- The four residences located on the Saddle Road hillslopes will now experience glimpses through the existing vegetative cover of the proposed Bypass. Landscape revegetation treatments in combination with retention of adjoining forest/woodland communities will visually contain the development and reduce the impact of the swathe in views from these residences.

- Residential area adjoining the Brunswick River caravan park will be screened from the Bypass by the existing Casuarina woodland located to the south of the development.

- The eastern boundary of the caravan park will be encroached upon by the proposal resulting in the loss of a number of caravan sites. Appropriate landscape treatments to visually separate the Bypass and caravan park would be required in mitigating this impact.

- Bayside Way residential development will incur minimal visual exposure due to the screening effect of intervening vegetation and landform.

The visual impact of the Bypass on residences at night will mainly be confined to glare from vehicle headlights moving along the local corridor. However the majority of this glare will be contained by the surrounding vegetative cover and roadside landscape treatments

Fixed lighting stands will be located at the northern and southern intersections with the existing Pacific Highway. These intersection are located a considerable distance away from residential areas to pose a glare problem. The use of specially painted lanterns or the attachment of buffles and visors should be considered as a mitigation measure if future residential development is located in close proximity to these intersections.

5.3 Impact on Pacific Highway Motorists

. The corridor will traverse a variety of landscape characters, thus allowing motorists to experience the diverse surroundings of the Brunswick Heads locality.

. Elevated views will not be possible as the alignment offers little variety in grade. Cut earthworks at Saddle Road will reduce the road vertical alignment to the level of the adjoining riverplain.

. The enclosing nature of the tall forest/woodland communities situated between the rural floodplain and Saddle Road hillslopes will restrict views to the foreground. The Saddle Road cut will also restrict lateral views to the foreground.

Across the rural floodplain landscape treatments will allow controlled view breaks for extended enframed views across the floodplain.

. The southern "gateway" into Brunswick Heads is inadequately addressed. It provides motorists with poor visual orientation and anticipated sense of arrival to the township. The use of a rural right turn land rather than a roundabout reduces the significance of the intersection as a major "gateway" to the township. Unless the turn off is adequately signposted and visually denoted by landscape treatment, motorists may miss the entry to Brunswick Heads township.

The northern "gateway" provides a good sense of visual orientation and arrival as motorists are exposed to distant glimpses of the township and rural floodplain from the elevated areas north of the river.

6. LANDSCAPE MITIGATION MEASURES TO REDUCE VISUAL IMPACT

The following landscape recommendations should be considered during the planning, design and construction stages to minimise adverse visual impacts and to improve the visual environment of the project.

6.1 Planning and Design Stage

. Cut Batter

In order to visually minimise the impact of the Saddle Road cut, terrace cut face at 1.0m intervals to reduce the apparent height of the cut and to encourage future regeneration for erosion control purposes (Figure 11).

The top of cut batters should also be rounded to create a more natural transition of landform character.

. Fill batters through forest/woodland communities should be a maximum 3:1 to reduce swathe width and increase the proximity of mature vegetation along the Bypass corridor.

Fill batter gradients across the level rural floodplain should be 6:1 or flatter to visually integrate the road structure with the undulating landform.

It is important to keep clearing for road proposal to an absolute minimum in order to maximise screening provided by existing vegetation.

Areas to be protected from clearing or damage by earthworks machinery should be clearly delineated in the contract documents.

. Utilise Byron Council LEP to restrict possible future westward expansion of Brunswick Heads township and to ensure the high conservation status of the heathland. This will maintain an adequate buffer zone and screening of the Bypass for township residents.

. To increase the significance of the 'gateway' entries into Brunswick Heads township, the introduction of roundabout treatments to reinforce the node should be considered instead of proposed rural right turn lanes.

. Advance preparation of landscape documents will be required to allow time for on site collection of native seed and propagation of local plant material.

6.2 Construction Phase

- To minimise the area to be disturbed at any one time, excavation works should be staged to allow progressive stabilisation by native seed/grass seed revegetation.

  Erosion control techniques such as sedimentation ponds be incorporated as per State Pollution Control Commission recommendations.

- All native vegetation cleared be woodchipped for re-use as a mulch material and seed source in revegetation works.

- All site topsoil and leaf mulch be stripped prior to road construction and stockpiled to retain native seed content. To retain landscape value of native seed content, each stockpile is to be replaced in the vegetation zone from which it was stripped. If available stockpiles of logs/root stumps should be provided for re-use as fauna habitats.

- To facilitate an effective revegetation programme, ensure that acid or potential acid sulphate soils used for fill embankment construction are placed as the lower layers of fill. Minimise the time of exposure to air by reburying the excavated soil as quickly as possible, prefably on the same day.

- All soil stockpiles should be located within the corridor swathe so as to minimise additional disturbance.

- All topsoil infested with weeds and exotic grass species should be removed from the site. Weed contaminated topsoil should not be used in the revegetation works.

- Machine and employee access to be properly managed within the road reserve to avoid an unnecessary clearing. Construction tracks should be kept to within 3.0 m of the top or toe of the batter.

- Construction compounds should be located on level ground in previously disturbed areas or within the cleared swathe. The rehabilitation of construction compounds shall incorporate landscape works in accordance with the overall landscape theme.

6.3 Landscape Treatments/Recommendations

6.3.1 General Landscape Design Theme

The landscape design theme is based on the following objectives:

- Recognise and reinforce the natural qualities of the study area by retaining existing indigenous species and establishing additional plantings of species endemic to the Brunswick Heads locality. However, rather than implement a uniform revegetation theme along the Bypass reserve, the landscape proposal will recognise the existing character transitions of forest, heathland, woodland and wetland.

- Provide wildlife habitats and discourage the movement of native fauna onto the roadway.

- Reduction, control and management of existing and potential weed invasion.

- Minimise the visual impact on residential properties in close proximity to the proposal through the provision of suitably located screen planting.

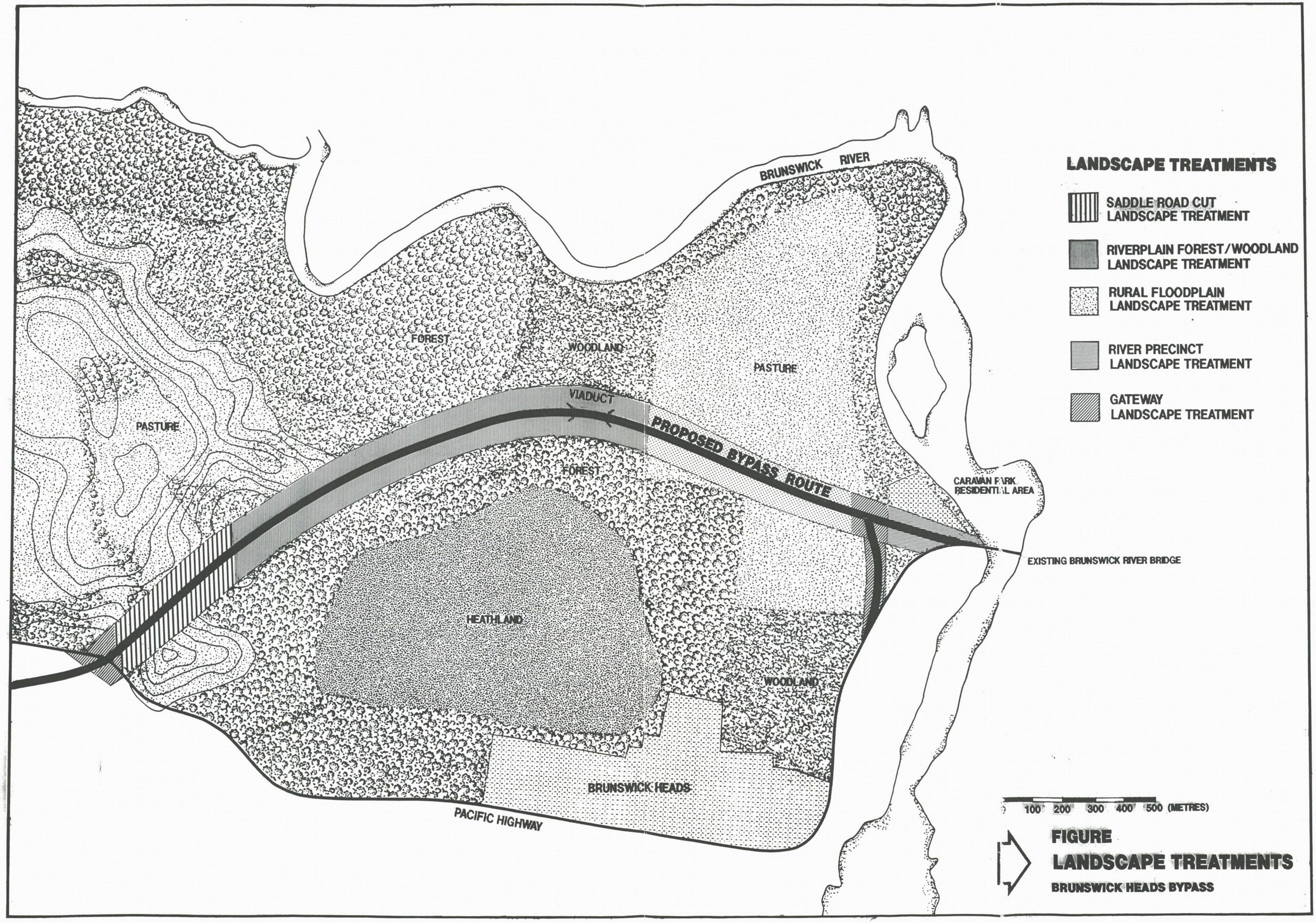
- Town entry gateways to be visually denoted by a composition of exotic and native feature tree groups and shrub understorey.

6.3.2 General Landscape Recommendations

- Revegetation to involve a combination of native seeding and use of established plant stock. The majority of planting shall comprise of suitably hardened semi-advanced and tube stock sized plants. At more sensitive locations such as town gateways, super advanced or semi-mature stock would also be utilised.

- Depth of clean top soil material for planting should be at least 100 mm placed over a ripped subbase. All planting areas need to be mulched with a hardwood chip to a depth of 100 mm.

- To discourage roadside feeding on grassed areas by native animals, shrub planting should be established up to the road verge. Native animal control devices such as perimeter fencing, fence breaks and fauna culverts should be implemented as per the ecologist's EIS report. Chain mesh fencing to control ground fauna movement will require measures to reduce visual impact such as height control, grey or black colouring and vegetative screening.



FIGURE

LANDSCAPE TREATMENTS

BRUNSWICK HEADS BYPASS

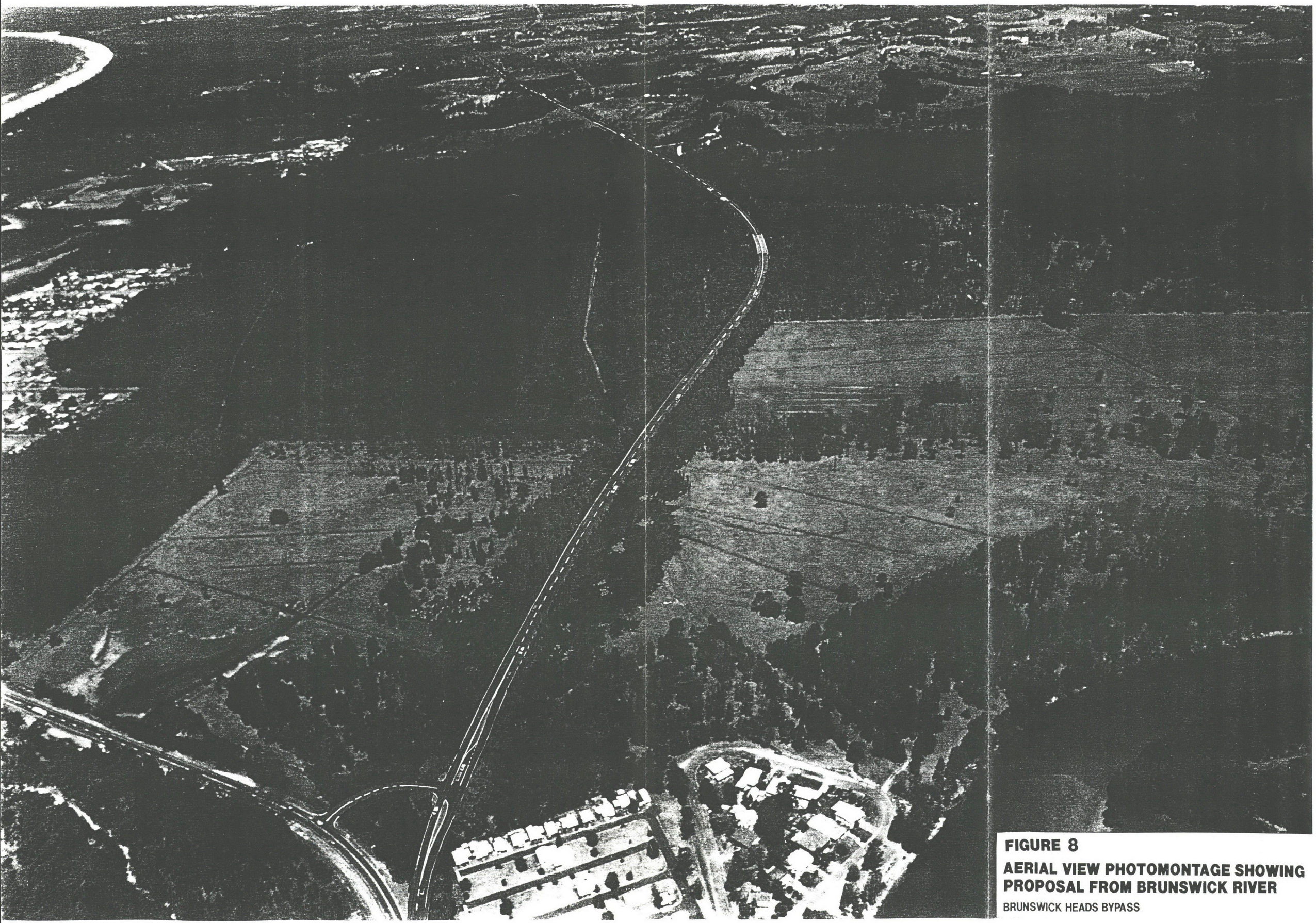


FIGURE 8

AERIAL VIEW PHOTOMONTAGE SHOWING PROPOSAL FROM BRUNSWICK RIVER

BRUNSWICK HEADS BYPASS

- Indigenous species incorporated into the scheme are to be drawn from the natural plant communities around the study area. Species listings and vegetation mapping contained in the EIS flora report is to be consulted during the detailed landscape design stage of the project to ensure that proposed landscape treatments match the adjacent vegetation communities.

- Seed collection for propagation/revegetation purposes will be a necessary component of the landscape works. Provision should be made for this work to be undertaken not less than two years prior to construction.

6.3.3 Specific Landscape Treatments

. Rather than develop a uniform revegetation treatment along the Bypass reserve, it is recommended that a thematic landscape approach be developed that recognises the existing vegetation transitions landscape character, residential screening requirements, and major intersection nodes (Figure 7 and 8).

These landscape themes have been described for each section as follows:

River Precinct

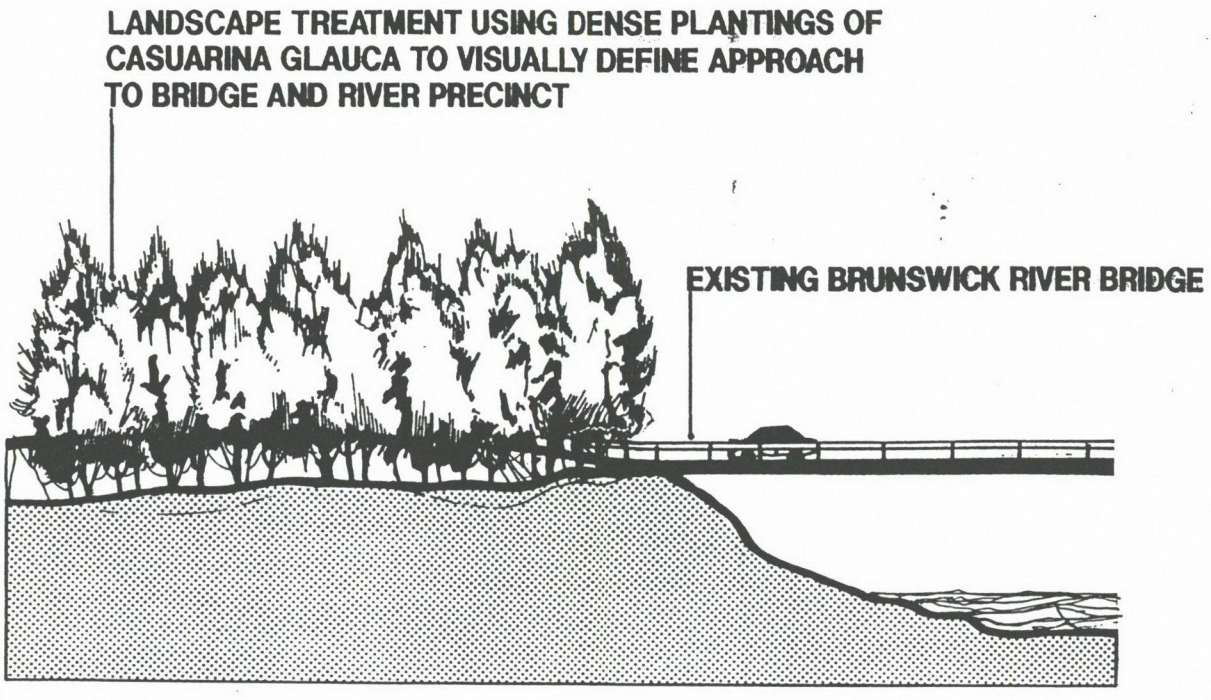
The proposed Bypass re-joins the Pacific Highway prior to the existing bridge crossing. Vegetation presently located on the river margins will remain intact. However, additional pure stand planting of Casuarina glauca and Melaleuca quinquenervia would match the existing riverine character and reinforce the bridge crossing connection (Figure 9).

Dense Casuarina planting will also visually separate and screen the Bypass from the adjacent caravan park development (Figure 9).

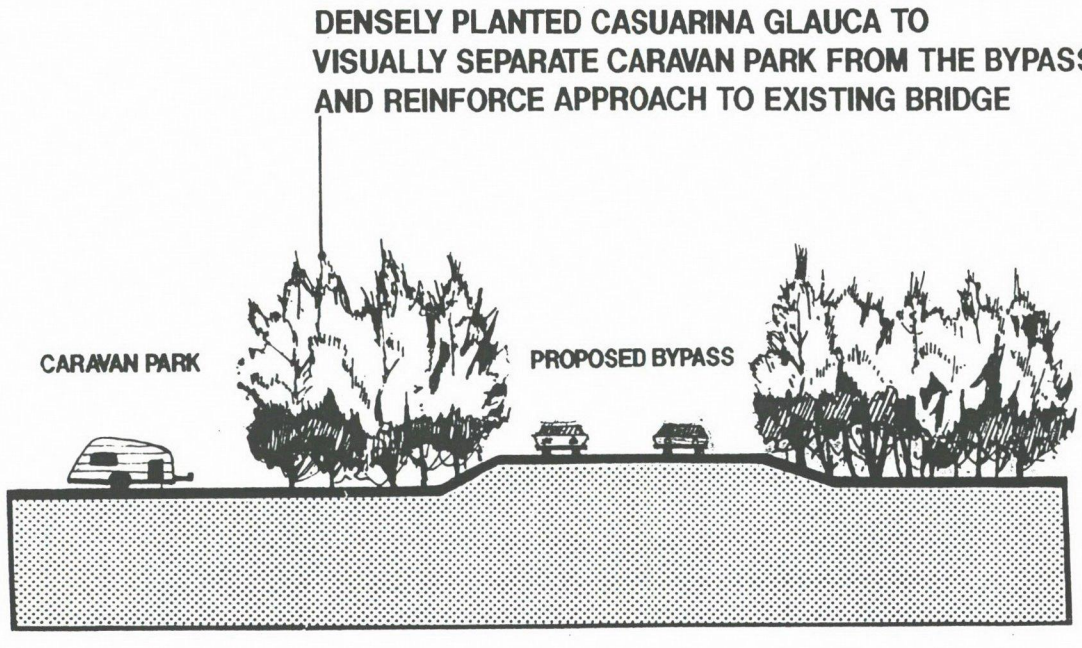
Semi-Rural Grassland/Open Woodland Treatment

This treatment is applicable to the floodplain area north-west of the township that is currently used for grazing activities.

Landscape treatments will involve the strategic planting of trees, shrubs and groundcovers to reduce the impact of the fill batter across the level floodplain and allow controlled viewbreaks over the floodplain landscape. This will provide a visually contrasting experience to the foreground enclosure of the riverplain forest (Figure 10).

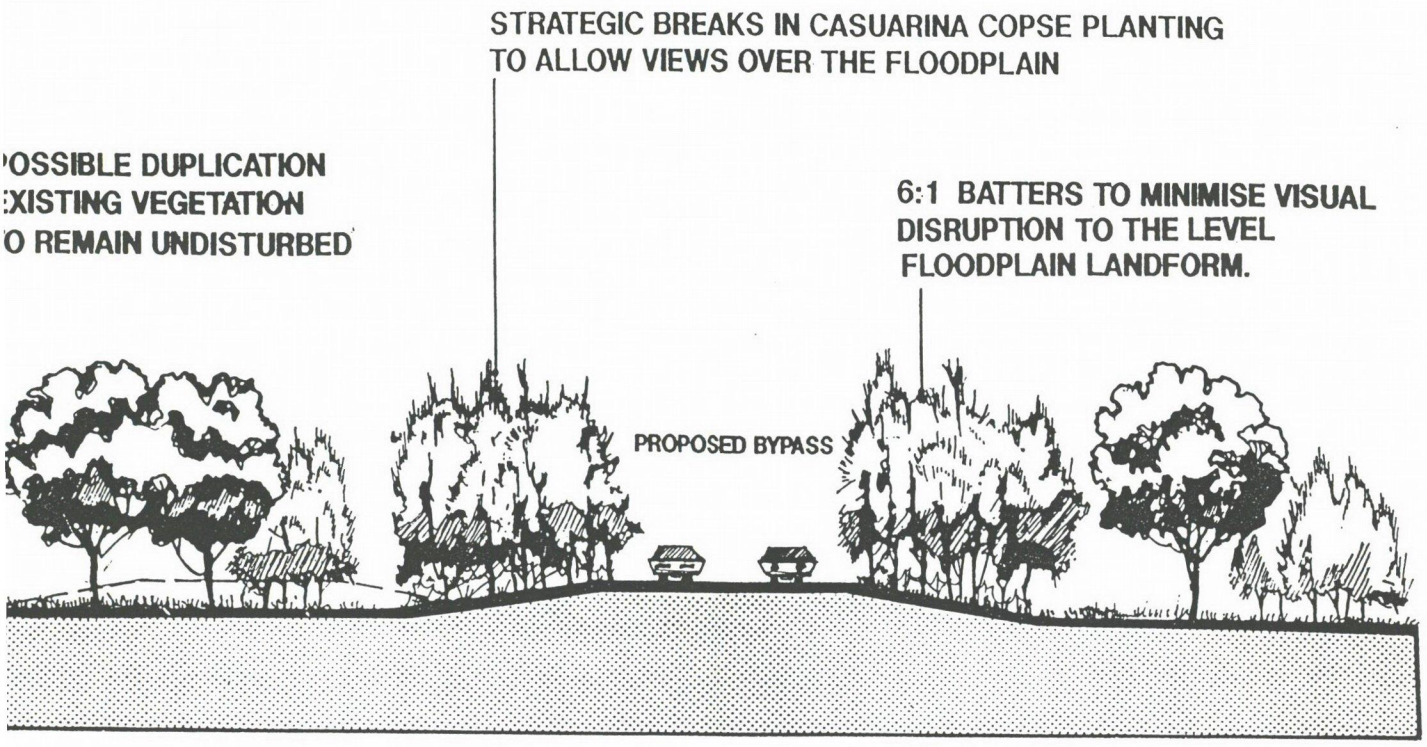


LANDSCAPE TREATMENT – RIVER PRECINCT

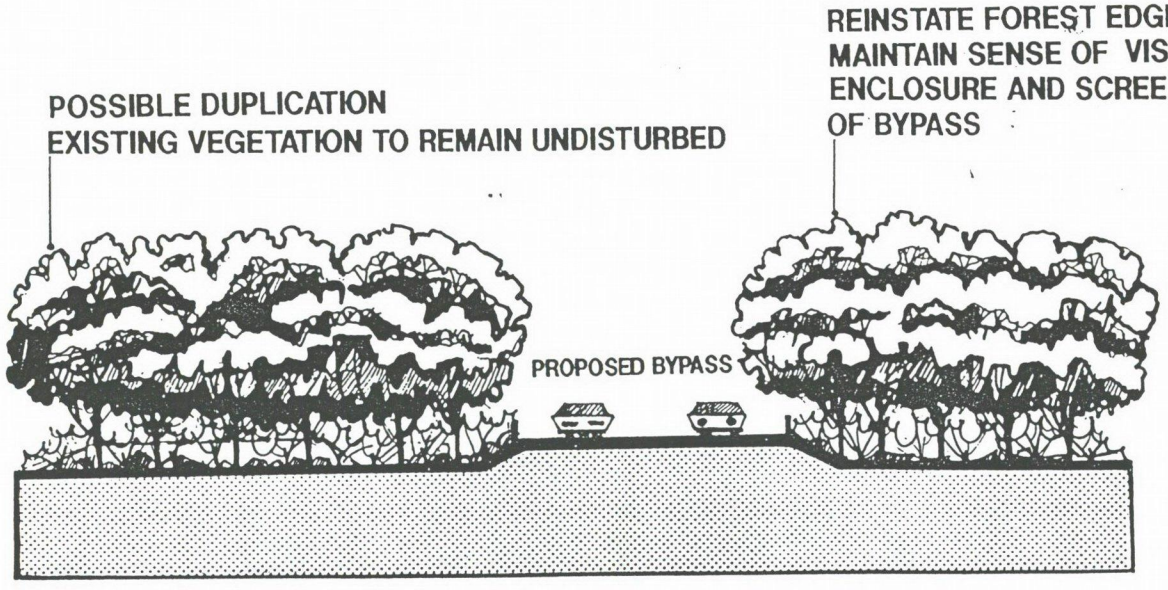


LANDSCAPE TREATMENT –CARAVAN PARK BOUNDARY

FIGURE 9
LANDSCAPE TREATMENTS
BRUNSWICK HEADS BYPASS



LANDSCAPE TREATMENT –RURAL FLOODPLAIN ON FILL



LANDSCAPE TREATMENT – RIVERPLAIN FOREST/WOODLAND

FIGURE 10
LANDSCAPE TREATMENTS
BRUNSWICK HEADS BYPASS

Reinforcement of the existing casuarina woodland along the southern boundary of the Caravan park will ensure that these viewers are effectively screened from the Bypass.

Recommended species include:

TREES	Casuarina glauca
	Melaleuca quinquenervia
	Eucalyptus robusta
SHRUBS	Callistemon salignus
	Leptospermum attenuatum
	Banksia ericifolia
	Acacia avlacocarpa
	Callistemon citrinus
GROUNDCOVER	Hibbertia scanden
	Bracken fern
	Lomandra longifolia

Riverplain Forest/Woodland

This treatment is recommended for areas located on the riverplain bounded by the Saddle Road hillslopes and rural floodplain.

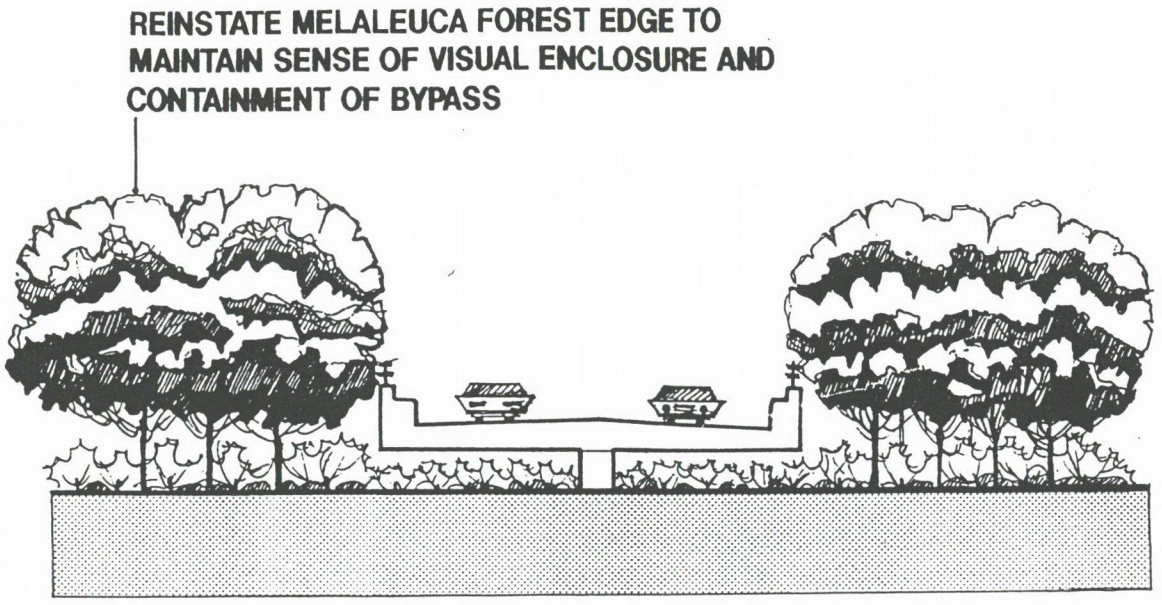
Landscape treatments shall involve dense Eucalypt/Melaleuca planting to visually contain the roadway and to minimise views of the Bypass from Saddle Road (Figure 10).

Species selection for landscape treatments will be determined by the site drainage pattern.

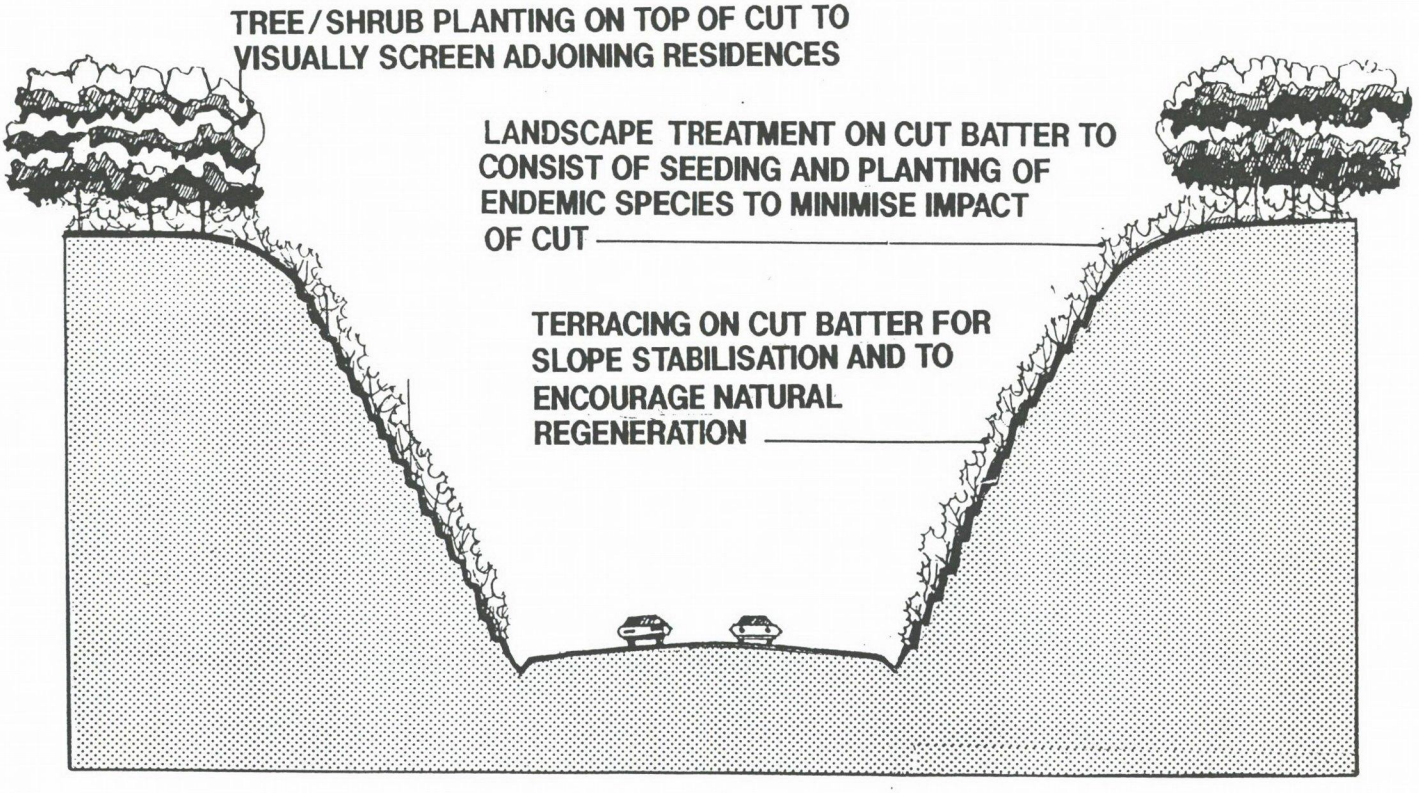
Recommended species for areas with adequate drainage includes:

TREES	Eucaluptus pilularis
	Eucalyptus robusta
	Eucalyptus intermedia
SHRUBS	Banksia aemula
	Leptospermum polygalifolium
	Acacia aulacocarpia
	Dodonaea triquetra
GROUND COVER	Lomandra longifolia

On moist sites, such as adjacent to the viaduct structure, landscape treatments using dominant stands of Melaleuca quinqueneria would be compatible to the surrounding vegetation character (Figure 11).



LANDSCAPE TREATMENT – VIADUCT STRUCTURE



LANDSCAPE TREATMENT – SADDLE ROAD CUT

FIGURE 11
LANDSCAPE TREATMENTS
BRUNSWICK HEADS BYPASS

Recommended species include:

TREES	Melaleuca quinquenervia
	Eucalyptus robusta
	Casuarina glauca
SHRUBS	Leptospermum whitei
	Leptospermum polygalifolium
	Backea stenophylla
	Callistemun salignus
GROUND COVER	Restio tetraphyllus
	Gahnia sieberana

Gateway Treatments

Landscape treatment at gateways shall involve a distinctive planting scheme which serves as a visual signal to motorist wishing to enter the township.

Theme plantings of Syzygium coolminianum (Blue Lillypilly) will visually denote the intersection as well as display the floral emblem of the Brunswick Heads locality.

APPENDIX N

Geotechnical Study

Grafton Zone Office, RTA 1992

SH10 - PACIFIC HIGHWAY

SHIRE OF BYRON

BRUNSWICK HEADS BYPASS

* * * * * * * *

GEOTECHNICAL INPUT FOR

ENVIRONMENTAL IMPACT STUDY

1. Geology and Soils

The geology of the area traversed by the proposed Brunswick Heads Bypass is shown on the Tweed Heads 1:250,000 Geological Map.

Most of the route corridor is located on Quaternary age sediments consisting primarily of estuarine and/or marine deposits of sand. However, a portion of the Bypass towards its southern end will pass through Palaeozoic metasediments of the Neranleigh - Fernvale Group. Main rock type in this area is a phyllite.

A map showing the geology of the area is shown on figure 1.

Geotechnical Investigation

A geotechnical site investigation was carried out in August and September, 1991 to obtain more detailed information on geology and soil type. This consisted of excavator dug test holes in the low lying sandy areas and bore holes using a drilling rig in the proposed cutting where the phyllite rock will be excavated. Schedule sheets of the investigation and drilling logs of the two bore holes are included in Appendix 1.

The investigation has shown soils along the proposed corridor - other than over the cutting - consist almost entirely of sands. These soils have generally a uniform sandy textured profile and are poorly graded i.e. fairly uniform in grain size. A dark brown sand or silty sand topsoil with some organic or vegetable matter occurs to depths of 100mm to 200mm and generally overlies a clean white or grey sand. The colour of the sand becomes a darker grey or brown colour with depth and some shells were detected in places indicating a marine source of deposition for the sands at that depth. A dark brown relatively hard indurated sand layer was detected in three of the four test holes at a depth of 800mm or deeper and a thickness of 300mm or more.

Bore holes within the elevated area proposed for excavation showed the rock is mostly a weathered phyllite material of low strength. A phyllite is a foliated metamorphic rock of sedimentary origin i.e. it was originally most probably a shale but has undergone change due to pressure of overlying material to develop a foliated clearage and become a phyllite. It is mostly highly or moderately weathered within the proposed cutting forming clays, silts and clayey gravel type materials. However in places it is slightly weathered or fresh but should still be able to be easily excavated by ripping due to the closely spaced foliation developed.

This material is proposed for use as fill for the embankment along the length of the Bypass. Quantities of material proposed for excavation are sufficient and quality is similar to that used in many other roadworks projects along the Pacific Highway.

No significant mineral resources or quarry materials are known to exist within the proposed route corridor.

Testing and Analysis of Soil Samples

Laboratory testing has been carried out on the sand samples obtained in the investigation. Test results are shown in Appendix 2. These results show the sand is cohesionless and is mainly fine to medium grained.

In order to assess any potential for acidic soil conditions which may affect runoff water, samples of the soils and standing freshwater were taken for testing. The samples were analysed at the Centre for Coastal Management at the University of new England - Northern rivers. Results of this analysis are included in Appendix 3.

The results indicate there is significant acid sulphate soil potential and that the presence of actual acid sulphate soils is likely.

The NSW Soil conservation Service (now Department of Conservation and Land Management) have produced a "Soil Note" (Veness and Thompson, 1990) which describes these materials and their occurrence and discusses management options. A copy of this document is included in Appendix 3. Also, guidelines have been developed by Tweed Shire Council - just to the north of the Brunswick area - in land use practices for the management of acid sulphate soils. A copy of these guidelines are also included in Appendix 3.

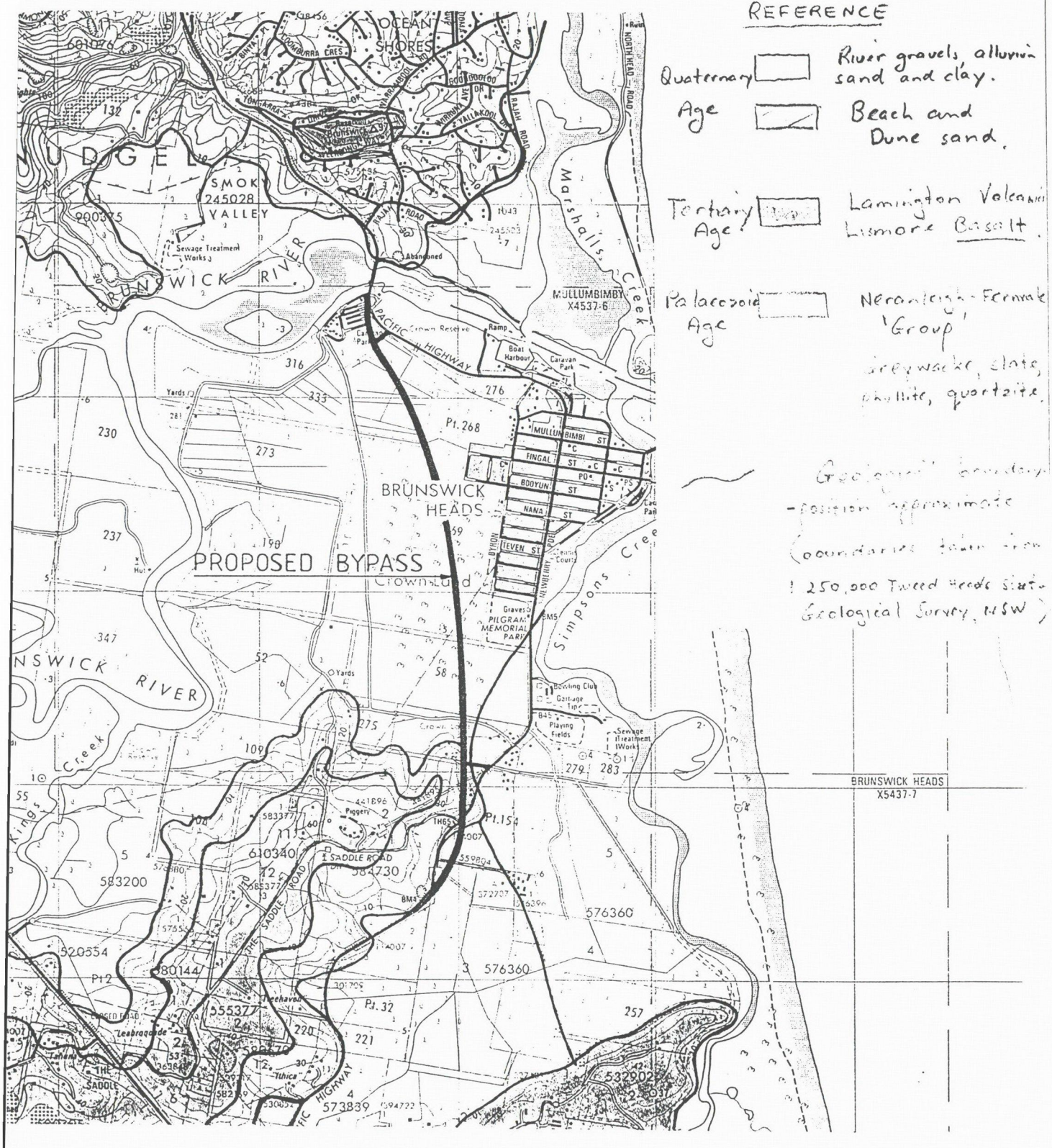
Due to this potential problem being recognized, procedures can now be implemented to prevent any adverse environmental effects, both on and off the sites. A more detailed soils survey will be carried out to determine the extent of the actual acidic soil conditions and potential for acidic soil conditions. The management procedures as documented in the Tweed Shire guidelines and Soil Conservation "Soil Note" will be implemented as required to ensure protection of any area, structures or aquatic fauna that could be affected.

STATE HIGHWAY No. 10 - PACIFIC HIGHWAY. SHIRE OF BYRON

PROPOSED BRUNSWICK HEADS BYPASS

GEOLOGICAL MAP OF THE BRUNSWICK HEADS AREA

~~Sketch showing the proposal for a bypass of Brunswick Heads.~~



"CROWN COPYRIGHT - REPRODUCED FROM
CMA 1:25000 TOPOGRAPHIC MAP OF BRUNSWICK HEADS
WITH PERMISSION OF THE LAND INFORMATION CENTRE, NSW DEPARTMENT OF
CONSERVATION AND LAND MANAGEMENT."

Fig 1

2. *Existing Environment and Landform Characteristics*

The area traversed by the Bypass corridor is mostly a flat and low lying coastal plain consisting of estuarine or marine sand deposits associated with the Brunswick River floodplain and also with pre-existing tidal flats or beach zones.

To the south-west, the country rises to ridges which are associated with much older rock units of the Neranleigh - Fernvale Group. The proposed route intersects these units at just one location towards the southern end.

Except for that area proposed for a cutting the whole route location is shown on the Brunswick Heads topographic map to be less than 10m ASL in elevation. Due to this low lying landform, the route will be situated on a low fill embankment - except where it passes through the cutting.

The existing visual environment comprises open grassed paddocks with scattered timber in the north , revegetated areas of low growth native plants - described on the Brunswick Heads Topographic map as scrub - in the central portions and taller dense uncleared native vegetation to the south. Much of the area gives the impression of being rather unproductive, low lying, swampy ground which would have expansive areas of saturated ground or be covered in water throughout most of the year.

3. *Foundation Conditions*

Foundation for the proposed roadway along its full length - with the exception of where it passes through the cutting - is on sands. A description of these sands is included in part 1 above.

It is well acknowledged that sands generally provide an excellent foundation material. This is because they have excellent drainage properties and practically no shrinkage or swelling characteristics. Any settlement that may occur due to the weight of the overlying embankment is usually small in size and relatively quick, occurring as the embankment is placed.

However, the site investigation showed the sands are fairly uniformly graded, making them of low relative density. This means that when saturated they could tend to be prone to a type of behaviour known as thixotrophy where they may behave like mobile thick liquids when subjected to shearing forces. Signs of this behaviour were noted in some of the excavated saturated sands in the site investigation carried out.

Such foundation conditions and potential difficulties would be fully assessed in a detailed investigation and appropriate engineering construction techniques implemented to ensure stability e.g. the use of geofabric layers. It is not considered likely that any deep excavation and replacement of foundation material will be necessary at any point. However it will probably be necessary to remove the grass and top soil layer. Where this is done, such material may be useful for spreading on embankment batters to aid vegetation growth.

4. *Groundwater and Drainage*

The proposed route for most of its length traverses flat, low lying land associated with the Brunswick River floodplain.

The area usually has a high water table which exists in sand aquifers. At the time of the investigation, the water table was at a depth of 800mm to 1200mm. However, this investigation was carried out after a prolonged dry period. In more normal wet seasons the water table level would be expected to be at a much higher level, at or near the ground surface.

Surface water runoff is assisted in some areas by a series of excavated open drains to aid the natural drainage. However surface water can lie over parts of the area even in dry periods, particularly at the northern end where elevation is slightly lower.

Samples of standing surface water were collected at a number of places including excavated drains and natural low lying areas. Two of these samples were analysed at the Centre for Coastal Management-U.N.E. and results are included in Appendix 3 (2nd page of report from the Centre for Coastal Management).

The Bypass construction would not significantly alter drainage patterns in the area. Drainage structures would be provided at existing channels and flow paths that are crossed by the proposed route. Careful attention to drainage during the construction phase and minimisation of the extent of vegetation clearing would help to protect surface waters from siltation.

The groundwater occurring in the sand aquifers would be protected as far as possible from contamination. The potential for groundwater contamination exists because of the high hydraulic conductivity of the sands in the area. Even though the groundwater is of little use because of its salinity, a strategy for the protection of the groundwater will be adopted to ensure construction activities and their effects do not have adverse affects. The following precautionary measures would be implemented:-

* The contractors plant, equipment and materials compounds are to be bunded to prevent oils, greases or otherwise contaminated water from discharging into the natural drainage system or groundwater recharge areas.

* The contractors would be required to dispose of all domestic garbage and industrial waste in proper industrial bins for collection by others. No open on ground rubbish areas are to be permitted.

* Wastewater from the contractors amenities would be piped to the local sewerage system. No septic tanks are to be permitted.

These measures implemented for protecting groundwater would also ensure that surface waters are not contaminated by construction activities. In addition, road design would include provision for drainage to control runoff and revegetation of cleared areas would be carried out as soon as possible after construction.

5. *Construction Materials*

Material for fill required for embankment construction along the route is proposed to come from the one large cutting near the southern end of the Bypass. As discussed, this material is a weathered phyllite rock which when excavated would consist primarily of clays, clayey gravels and some rock pieces of an overall quality suitable for fill.

Quantities of materials with regard to fill requirements and available material in the cutting are planned to be balanced. This means there will be no need to borrow additional fill material from off the job site or a need to dispose of any leftover material.

Pavement materials however, would need to be imported to the job site. Final determination of pavement type is yet to be made, but will either be concrete or flexible, the latter being layers of crushed rock or natural gravel compacted to form the pavement. Pavement materials would come from existing resources in established quarries or gravel pits of a quality necessary to meet required specifications.

Construction activities and materials storage would be confined to the Bypass road reserve or adjacent areas of severed RTA land. The road reserve would be fenced prior to the commencement of roadworks.

Should the pavement be concrete, a concrete batching plant may be temporarily established. This would be located either on or adjacent the construction site. The Cement and Concrete Association have set out guide-lines to provide measures to control noise and dust emanating from batching plants.

The use of concrete as a possible pavement type would be confirmed during the detailed design stage.

6. *Earthworks and Erosion Safeguards*

Construction within the proposed road reserve would require clearing of a width sufficient only to establish the road formation.

Except for material within the proposed cutting, existing soils are primarily sands. Due to their topographic position, these soils generally represent a low erosion hazard. an exception would be those soils exposed adjacent to drainage channels which may be subject to bank erosion. Detailed investigation of localised flow patterns and velocities and suitable scour protection measures would be undertaken.

Temporary erosion controls would be developed to suit each stage of construction activity.

The main environmental consideration for the embankment is that of the potential for groundwater contamination during construction. In low lying areas of the Brunswick coastal area the groundwater level is close to the surface. Also the sand deposits in this area are generally of high hydraulic conductivity making the area sensitive to infiltration of contaminates.

When the construction site is cleared, graded contour drains, or diversion channels, would be formed to divert runoff from outside the site around the works. The aim of this technique is to keep potential sediment laden runoff away from undisturbed areas. This would maintain the water quality of nearby watercourses, especially the Brunswick River.

Haul roads and access tracks within the road reserve associated with the construction activities would be planned with special attention to erosion control. All roads would be properly constructed with gravel so that the transport of sediment by vehicle wheels is minimised.

Sediment which does reach the boundary of the construction site would be collected by sediment traps, which could include silt fences, hay bales and filter trenches. The sediment traps would be retained after construction ceases until such time as restoration works such as landscaping treatments (seeding, tube plantings etc) have become effective. To determine the time when the structures can be safely removed, a monitoring program would be developed by the RTA and staff would routinely check stream sedimentation levels, water quality and quality of runoff during and after the construction phase. This monitoring would include testing for pH to ensure acidic water (pH less than 4) does not leave the site.

Piped diversion drains would also be constructed through the proposed development so that natural runoff passes through the site. This would have the effect of maintaining relatively dry conditions on the road surface in periods of wet weather, and would prevent backwater flows developing, particularly during floods.

To stabilise soil around the road reserve area in the longer term a program of re-vegetation would be established. This landscaping program would also be aimed at establishing as quickly as possible a protective grass cover on embankment batters so that silt and clay washed off in runoff in the early months after completion is minimised.

Potential for erosion and scouring on the face of the large exposed cutting during and after excavation would be considered in the design and construction phases. The face of the cutting would be laid well back at an angle which ensures stability and reduces velocity of water flow. In addition, suitable protection measures on the face of the cutting would be implemented, such as seeding and grassing, assisted by a hessian blanket if required.

Appendix 1.

Investigation Schedule and Drilling Logs

SCHEDULE OF PAVEMENT AND SUBGRADE INVESTIGATION					H.O FILE No. 10/62.1153 D.O FILE No. 10/62.1153 W.O FILE No. LAB. No. B3802 DATE 25/09/91 LABORATORY AT BALLINA W.O
WORK SH10 Shire of Byron Investigation for E.I.S of the proposed bypass for Brunswick Heads					
HOLE, CHAINAGE AND OFFSET	PAVEMENT DESCRIPTION AND DISTRESS MECHANISMS	MATERIAL DESCRIPTION	SAMPLE No.	DEPTH (MM)	REMARKS
Hole 1 Northern End	Flat area, with surface drainage, grassland.	Topsoil Dark Brown Sand with Vegitation.	-	0-100	
		White/ Grey Sand	1A	100-550	Field Moisture = 13.1% * Water Table at 1200mm.
		Dark Grey Sand	1B	550-3300+	Field Moisture = 24.3% * Hole ceased at 3300mm due to cave in.
SIGNATURE R Cormick		DESIGNATION TESTING OPERATOR			DATE 30/09/91

SCHEDULE OF PAVEMENT AND SUBGRADE INVESTIGATION

H.O FILE No. 10/62.1153
D.O FILE No. 10/62.1153
W.O FILE No.
LAB. No. B3802
DATE 25/09/91
LABORATORY AT BALLINA W.O

WORK SH10 Shire of Byron
Investigation for E.I.S on the proposed bypass for Brunswick Heads

HOLE, CHAINAGE AND OFFSET	PAVEMENT DESCRIPTION AND DISTRESS MECHANISMS	MATERIAL DESCRIPTION	SAMPLE No.	DEPTH (MM)	REMARKS
Hole 2	Flat area, with surface drainage, grassland.	Topsoil Dark Brown Sand with Vegitation.	-	0-200	
		White/ Grey Sand	2A	200-500	Field Moisture = 22.8%
		Dark Grey Clayey/Sand with Shells	2B	500-3200 *	Water table at 1100mm Field Moisture = 28.5%
		Dark Brown Indurated Sand	-	* 3200+	* Approximate depth Couldn't get exact measurement due to cave in. # Hole ceased due to cave in.

SIGNATURE R Cormick DESIGNATION TESTING OPERATOR DATE 30/09/91

SCHEDULE OF PAVEMENT AND SUBGRADE INVESTIGATION					H.O FILE No. 10/62.1153 D.O FILE No. 10/62.1153 W.O FILE No. LAB. No. B3802 DATE 25/09/91 LABORATORY AT BALLINA W.O
WORK SH10 Shire of Byron Investigation for E.I.S on the proposed bypass for Brunswick Heads					
HOLE, CHAINAGE AND OFFSET	PAVEMENT DESCRIPTION AND DISTRESS MECHANISMS	MATERIAL DESCRIPTION	SAMPLE No.	DEPTH (MM)	REMARKS
Hole 3	Heath Vegitation	Topsoil Dark Brown Sand with Vegitation.	-	0-100	
		Brown Sand	3A	100-1300	Field Moisture = 12.2% * Water table at 1000mm
		Grey Sand	3B	1300-1800	Field Moisture = 25.0%
		Dark Brown Indurated Sand	3C	1800-2100	
		Dark Brown Sand	3D	2100-2800+	Field Moisture = 24.3% # Hole ceased due to cave in.
SIGNATURE R. Cormick		DESIGNATION TESTING OPERATOR			DATE 30/09/91

SCHEDULE OF PAVEMENT AND SUBGRADE INVESTIGATION

H.O FILE No. 10/62.1153
D.O FILE No. 10/62.1153
W.O FILE No.
LAB. No. B3802
DATE 25/09/91
LABORATORY AT BALLINA W.O

WORK SH10 Shire of Byron
Investigation for E.I.S on the proposed bypass for Brunswick Heads

HOLE, CHAINAGE AND OFFSET	PAVEMENT DESCRIPTION AND DISTRESS MECHANISMS	MATERIAL DESCRIPTION	SAMPLE No.	DEPTH (MM)	REMARKS
Hole 4 (Near power lines)	Heath Vegitation	Topsoil Dark Brown Sand with Vegitation.	-	0-200	
		White Sand	4A	200-800	Field Moisture = 19.8%
		Dark Brown Indurated Sand	4B	800-1900+	* Water table at 800mm

SIGNATURE R Cormick DESIGNATION TESTING OPERATOR DATE 30/09/91

NON-CORE DRILL HOLE-GEOLOGICAL LOG

HOLE NO : 1
FILE / JOB NO : 10/62.1153
SHEET 1 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.

POSITION : SOUTHERN SECTION E=52969.2 N=39856.5 SURFACE ELEVATION : 28.49 ANGLE FROM VERTICAL : 0°

RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : S WATTS

DATE STARTED : 15.8.91 DATE COMPLETED : 20.8.91 DATE LOGGED : 20.8.91 LOGGED BY : J.L. CHECKED BY : G K

DRILLING						MATERIAL					
DEPTH	DRILLING & CASING	DRILLING FLUID TYPE & LOSS	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES, TESTS, ETC	RL(m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary & Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & other observations
0	AUGER		E					CL	SILTY CLAY : YELLOW, PINK-PHYLLITE.	D	St	
1												
			E						AS ABOVE.			
2												
3									2.80m END NON-CORE DRILLING.			
4									SEE CORED DRILL HOLE SHEETS 2,3,4,5 OR 5 FOR INFORMATION			
5												
6												
7												

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

GS 562-1288

CORED DRILL HOLE LOG

HOLE NO : 1
FILE / JOB NO : 10/62.1153
SHEET 2 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : SOUTHERN SECTION E=52969.2 N=39856.5 SURFACE ELEVATION : 28.49 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : S. WATTS
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 15.8.91 DATE COMPLETED : 20.8.91 DATE LOGGED : 15.8.91 LOGGED BY : J.L. CHECKED BY : GK

DRILLING					MATERIAL			FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS / RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	RL (m)	GRAPHIC LOG	DESCRIPTION — ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	EST STRENGTH I_s (50) MPa: EL — 0.03 / VL — 0.1 / L — 0.3 / M — 1 / H — 3 / VH — 10 / EH	NATURAL FRACTURE SPACING (mm): 20 / 60 / 100 / 300 / 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
DEPTH 0						SEE NON-CORE DRILL HOLE SHEET 1 OF 5 FOR INFORMATION.					
						2.80m START CORING					
NMLC CORING	100% RETURN					PHYLLITE: YELLOW, RED, WHITE THINLY LAMINATED. OCCASIONAL HARD LAYERS.	MW SW MW SW MW SW MW				SOFT WHITE CLAY WHITE CLAY FRIABLE, SOFT
						3.80 CORE LOSS 0.85m (3.80 - 4.65)					
		4.65				4.65 PHYLLITE: YELLOW, WHITE, THINLY LAMINATED.	MW				WHITE CLAY, SOFT FRIABLE, SOFT
		5.40				5.13 CORE LOSS 0.27m (5.13-5.40) 5.40 PHYLLITE: YELLOW, WHITE, THINLY LAMINATED	MW				
		6.15				5.55 CORE LOSS 0.60 (5.55 - 6.15) 6.15					
					Qz	PHYLLITE: YELLOW, WHITE, RED, ISOLATED QUARTZ SEAM. 6.61	MW				QUARTZ SEAM
		6.75				6.75 CORE LOSS 0.14m (6.61 - 6.75) 6.91 CORE LOSS 0.16m (6.75 - 6.91)					SOFT
		7.63				PHYLLITE: YELLOW, WHITE, RED, THINLY LAMINATED. 7.75 PHYLLITE: RED, YELLOW, THINLY LAMINATED.	MW SW				

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

QS-563-1269

CORED DRILL HOLE LOG

HOLE NO : 1
FILE / JOB NO : 10/62.1153
SHEET 3 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : SOUTHERN SECTION E=52969.2 N=39856.5 SURFACE ELEVATION : 28.49 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : P.S.
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 15.8.91 DATE COMPLETED : 20.8.91 DATE LOGGED : 19.8.91 LOGGED BY : J.L. CHECKED BY : GK

DRILLING					MATERIAL				FRACTURES		
DEPTH	PROGRESS: DRILLING & CASING	PROGRESS: WATER	CORE LOSS (%) / RUN DRILL DEPTH	SAMPLES & FIELD TESTS	RL (m)	GRAPHIC LOG	DESCRIPTION: ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	EST STRENGTH I_s (50) MPa: EL – 0.03, VL – 0.1, L – 0.3, M – 1, H – 3, VH – 10, EH	NATURAL FRACTURE SPACING (mm): 20, 60, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
9	NMLC CORING	80% RETURN	8.60				PHYLLITE: RED, YELLOW, THINLY LAMINATED.	SW				
							8.91					
							PHYLLITE: RED, THINLY LAMINATED.	HW				SOFT SOFT
							9.45 CORE LOSS 0.65 (9.45 - 10.10)					
10			10.10				10.10					
							PHYLLITE: YELLOW, BROWN, WHITE.	SW MW				FRACTURED
							10.85 CORE LOSS 0.35 (10.85 - 11.20)					
11			11.20				11.20					
							PHYLLITE: RED, YELLOW, THINLY LAMINATED	SW HW				FRACTURED
12							12.10 CORE LOSS 0.30 (12.10-12.40)					
			12.40				12.40					
							PHYLLITE: YELLOW, BROWN, THINLY LAMINATED.	MW				
13			13.40				AS ABOVE	MW				SOFT
14												
							14.51 CORE LOSS 0.58 (14.51-15.09)					
15			15.09				15.09					
							PHYLLITE: RED, BROWN, YELLOW	HW				BLACK SEAM SOFT SEAM

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

GS-563-1289

CORED DRILL HOLE LOG

HOLE NO : 1
FILE / JOB NO : 10/62.1153
SHEET 4 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : SOUTHERN SECTION E=52969.2 N=39856.5 SURFACE ELEVATION : 28.49 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : P.S.
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 15.8.91 DATE COMPLETED : 20.8.91 DATE LOGGED : 20.8.91 LOGGED BY : JL CHECKED BY : GK

DRILLING | MATERIAL | FRACTURES

DEPTH (m)	PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING: (CORE LOSS / RUN %) DRILL DEPTH	DRILLING: SAMPLES & FIELD TESTS	DRILLING: RL (m)	MATERIAL: GRAPHIC LOG	MATERIAL: DESCRIPTION (ROCK TYPE: Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	MATERIAL: WEATHERING	MATERIAL: EST STRENGTH I_s (50) MPa (EL – 0.03, VL – 0.1, L – 0.3, M – 1, H – 3, VH – 10, EH)	FRACTURES: NATURAL FRACTURE SPACING (mm) (20, 60, 100, 300, 1000)	FRACTURES: VISUAL	FRACTURES: ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
16	NMLC CORING	80% RETURN	16.00				16.00 CORE LOSS 0.59 (16.00-16.59)					
			16.59				16.59 PHYLLITE : RED, BROWN, YELLOW, THINLY LAMINATED.	HW				
17												
18			18.19				AS ABOVE.	HW				SOFT BLACK SEAM
19							19.20 CORE LOSS 0.80 (19.20 - 20.00)					
20			20.00				20.00 PHYLLITE : BROWN, GREY, HARD.	MW SW MW				QUARTZ SEAM
21							21.14 CORE LOSS 0.86 (21.14 - 22.00)					
22							22.00 PHYLLITE : BROWN, YELLOW, THINLY LAMINATED.	HW				
23			23.50				23.07 CORE LOSS 0.43 (23.07 - 23.50) 23.50 PHYLLITE : BROWN, YELLOW, THINLY LAMINATED	MW				FRACTURED
24												

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

QS-563-1288

CORED DRILL HOLE LOG

HOLE NO : 1
FILE / JOB NO : 10/62.1153
SHEET 5 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : SOUTHERN SECTION E 52969.2 N=39856.2 SURFACE ELEVATION : 28.49 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : P.S.
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 15.8.91 DATE COMPLETED : 20.8.91 DATE LOGGED : 20.8.91 LOGGED BY : JL CHECKED BY : GK

DRILLING					MATERIAL			FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	CORE LOSS (CORE LOSS / RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	RL (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	EST STRENGTH I_s (50) MPa: EL – 0.03, VL – 0.1, L – 0.3, M – 1, H – 3, VH – 10, EH	NATURAL FRACTURE SPACING (mm): 20, 60, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC CORING	80% RETURN	25.00				PHYLLITE : BROWN GREY, HARD LAYERS.	MW SW MW				FRACTURED
						24.77 CORE LOSS 0.23 (24.77 - 25.00)					
						25.00m END BH1					

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

GS-563-1269

NON-CORE DRILL HOLE-GEOLOGICAL LOG

HOLE NO : 2
FILE / JOB NO : 10/62.1153
SHEET 1 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : NORTHERN SECTION E=52975.9 N=39879.4 SURFACE ELEVATION : 28.11 ANGLE FROM VERTICAL : 0°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : S WATTS
DATE STARTED : 21.8.91 DATE COMPLETED : 26.8.91 DATE LOGGED : 21.8.91 LOGGED BY : J.L. CHECKED BY : GK

DRILLING						MATERIAL					
DEPTH	DRILLING & CASING	DRILLING FLUID TYPE & LOSS	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES, TESTS, ETC	RL (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary & Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & other observations
0	AUGER		E					CL	SILTY CLAY: YELLOW, RED BROWN PHYLLITE.	M	St	
1			E					CL	AS ABOVE.	M	St	
2									2.25m END NON-CORE DRILLING.			
3									SEE CORED DRILL HOLE SHEETS 2,3,4,5 OF 5 FOR INFORMATION			
4												
5												
6												
7												

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

GS-582-1288

CORED DRILL HOLE LOG

HOLE NO : 2
FILE / JOB NO : 10/62.1153
SHEET 2 OF 5

PROJECT : SHIO. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : NORTHERN SECTION E=52975.9 N=39879.4 SURFACE ELEVATION : 28.11 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : P. S.
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 21.08.91 DATE COMPLETED : 26.8.91 DATE LOGGED : 22.8.91 LOGGED BY : J L CHECKED BY : GK

DRILLING

PROGRESS: DRILLING & CASING; WATER

CASING

NMLC CORING

80% RETURN

CORE LOSS / RUN %) DRILL DEPTH

2.97
4.07
4.47
5.68
6.48

SAMPLES & FIELD TESTS

RL (m)

MATERIAL

GRAPHIC LOG

DESCRIPTION
ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)

SEE NON-CORE DRILL HOLE SHEETS 1 OF 5
FOR INFORMATION.

2.25 START CORING

PHYLLITE :
BROWN, RED, YELLOW

2.72
2.97 CORE LOSS 0.25 (2.72 - 2.97)

PHYLLITE :
RED, WHITE, HARD LAYERS

3.57
CORE LOSS 0.50 (3.57 - 4.07)
4.07

PHYLLITE :
RED, GREY BROWN, THINLY LAMINATED
4.39
4.47 CORE LOSS 0.08 (4.39 - 4.47)

PHYLLITE
YELLOW, GREY, THINLY LAMINATED

5.60
5.68 CORE LOSS 0.08 (5.60 - 5.68)

PHYLLITE :
BROWN, RED, GREY

6.38
6.48 CORE LOSS 0.10 (6.38 - 6.48)

PHYLLITE :
BROWN, RED, GREY THINLY LAMINATED

7.34
CORE LOSS 0.74 (7.34 - 8.08)

WEATHERING

HW
MW
HW
MW
HW

EST STRENGTH I_s (50) MPa
EL 0.03 | VL 0.1 | L 0.3 | M 1 | H 3 | VH 10 | EH

FRACTURES

NATURAL FRACTURE SPACING (mm)
20 60 100 300 1000

VISUAL

ADDITIONAL DATA
(joints, partings, seams, zones, etc)
Description, orientation, infilling or coating, shape, roughness, thickness, other

SOFT

WHITE CLAY

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

QS-563-1289

CORED DRILL HOLE LOG

HOLE NO : 2
FILE / JOB NO : 10/62.1153
SHEET 3 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.

POSITION : NORTHERN SECTIO E=52975.9 N=39879.4 SURFACE ELEVATION : 28.11 ANGLE FROM HORIZONTAL : 90°

RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : P S

CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD

DATE STARTED : 21.8.91 DATE COMPLETED : DATE LOGGED : 22.8.91 LOGGED BY : J L CHECKED BY : GK

DRILLING | MATERIAL | FRACTURES

DEPTH	PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS / RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	RL (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	EST STRENGTH I_s (50) MPa (EL – 0.03, VL – 0.1, L – 0.3, M – 1, H – 3, VH – 10, EH)	NATURAL FRACTURE SPACING (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
	NMLC CORING	80% RETURN	8.08				8.08 CORE LOSS 0.74 (7.34-8.08)					
							PHYLLITE: RED, BROWN, YELLOW GREY THINLY LAMINATED.	HW				SOFT
9			9.18				AS ABOVE.	HW				
10							9.92 CORE LOSS 0.46 (9.92-10.38)					
			10.38				10/38					
							PHYLLITE: BROWN, YELLOW, RED, GREY. THINLY LAMINATED. SOFT LAYERS.	HW				SOFT SOFT SOFT
11												
			11.58				AS ABOVE.	HW				
12												SOFT
			12.98									
13							12.98 CORE LOSS 0.32 (12.98 - 13.30)					
			13.30				13.30					
			13.45				PHYLLITE: BROWN, YELLOW SOFT.					SOFT
14							13.70 CORE LOSS 1.02 (13.70-14.72)					
			14.72				14.72					
15							PHYLLITE: BROWN, YELLOW, RED. THINLY LAMINATED.					
							15.65 CORE LOSS 0.26 (15.65-15.91)					
16			15.91				15.91					

See Standard Sheets for details of abbreviations & basis of descriptions.

RTA ROADS AND TRAFFIC AUTHORITY, NSW

GS-563-1269

CORED DRILL HOLE LOG

HOLE NO : 2
FILE / JOB NO : 10/62.1153
SHEET 4 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : NORTHERN SECTION E=52975.9 N=39879.4 SURFACE ELEVATION : 28.11 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : P.S.
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 21.8.91 DATE COMPLETED : 26.8.91 DATE LOGGED : 26.8.91 LOGGED BY : J L CHECKED BY : GK

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS / RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	RL (m)	GRAPHIC LOG	DESCRIPTION — ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	EST STRENGTH I_s (50) MPa: EL – 0.03, VL – 0.1, L – 0.3, M – 1, H – 3, VH – 10, EH	NATURAL FRACTURE SPACING (mm): 20, 60, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC CORING	80% RETURN					PHYLLITE: BROWN, RED, THINLY LAMINATED.	SW				SOFT
		17.40									
						PHYLLITE: BROWN, BLACK, THINLY LAMINATED.	F				
							SW				
							F				
		19.90									
						PHYLLITE: BROWN, YELLOW, RED, THINLY LAMINATED.	SW				FRACTURED
		20.76									
							SW				FRACTURED
		22.64				CORE LOSS 0.36m (22.64 - 23.00)					
		23.00									
						PHYLLITE: BROWN, BLACK, THINLY LAMINATED.	F				

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

QS-563-1289

CORED DRILL HOLE LOG

HOLE NO : 2
FILE / JOB NO : 10/62.1153
SHEET 5 OF 5

PROJECT : SH10. SHIRE OF BYRON.
LOCATION : BRUNSWICK HEADS BY PASS - CUTTING.
POSITION : NORTHERN SECTION E=52975.9 N=39879.4 SURFACE ELEVATION : 28.11 ANGLE FROM HORIZONTAL : 90°
RIG TYPE : PIONEER MOUNTING : TRAILER CONTRACTOR : R T A DRILLER : S WATTS
CASING DIAMETER : NW BARREL (length) : 3.0m BIT : DIAMOND BIT CONDITION : GOOD
DATE STARTED : 21.8.91 DATE COMPLETED : 26.8.91 DATE LOGGED : 27.8.91 LOGGED BY : J.L. CHECKED BY : GK

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS /RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	RL (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	EST STRENGTH I_s (50) MPa EL – 0.03 – VL – 0.1 – L – 0.3 – M – 1 – H – 3 – VH – 10 – EH	NATURAL FRACTURE SPACING (mm) 20 60 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC CORING	80% RETURN	25.56				PHYLLITE: BLACK, BROWN, THINLY LAMINATED.	F				FRACTURED
						25.56m END BH 2					

See Standard Sheets for details of abbreviations & basis of descriptions.

ROADS AND TRAFFIC AUTHORITY, NSW

QS-563-1269

Appendix 2

Test Results from Soils Investigation

(Refer schedule in Appendix 1)

ROADS AND TRAFFIC AUTHORITY
BALLINA WORKS OFFICE TESTING LABORATORY
CANAL BRIDGE, PACIFIC HIGHWAY, BALLINA, 2478.

D.O. FILE No.: 10/62·1153
W.O. FILE No.:
LAB. No. : B3802
DATE : 25/09/91

TEST REPORT : DYNAMIC CONE PENETROMETER | **TEST METHOD : T161**

WORK : SH10 Shire of Byron
Brunswick Bypass

HOLE No.	Hole 1		Hole 2		
SAMPLE No.	1		1		
LOCATION (km)	Refer Sampling Schedule		Refer Sampling Schedule		
OFFSET (m)					
LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)	LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)
200-1200	0.475	3	200-600	0.125	<2
1200-1450	0.000	<2	600-1025	0.294	<2
1450-1875	0.176	<2	1025-1200	0.143	<2
1875-2200	.231	<2	1200-1700	0.100	<2
-------	-----	---	1700-2200	0.200	<2

HOLE No.	Hole 3		Hole 3 (con)		
SAMPLE No.	1		1		
LOCATION (km)	Refer Sampling Schedule		Refer Sampling Schedule		
OFFSET (m)					
LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)	LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)
100-200	0.25	<2	600-1100	1.90	18
200-250	1.00	8	1100-1300	0.00	0
250-400	0.33	2	1300-1625	0.23	<2
400-500	0.75	6	1625-1700	0.66	4
500-600	1.75	16	1700-1725*	2.00	17.5

NOTE: * ESIMATED C.B.R. VALUE NOT COVERED BY N.A.T.A. CERTIFICATION.

REMARKS : * Refusal

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SIGNATURE : [signature]
R Cormick
DESIGNATION : Testing Operator

DATE : 30/09/91

ROADS AND TRAFFIC AUTHORITY
BALLINA WORKS OFFICE TESTING LABORATORY
CANAL BRIDGE, PACIFIC HIGHWAY, BALLINA, 2478.

D.O. FILE No.: 10/62.1153
W.O. FILE No.:
LAB. No. : B3802
DATE : 25/09/91

TEST REPORT : DYNAMIC CONE PENETROMETER | **TEST METHOD : T161**

WORK : SH10 Shire of Byron
Brunswick Bypass

HOLE No.	Hole 4				
SAMPLE No.	1				
LOCATION (km)	Refer Sampling Schedule				
OFFSET (m)					
LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)	LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)
200-525	0.23	<2			
525-750	1.00	8			
750-900	2.17	20			
900-1050	4.67	46			
1050-1150	11.00	>50 *			

* Refusal

HOLE No.					
SAMPLE No.					
LOCATION (km)					
OFFSET (m)					
LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)	LAYER DEPTH [B.S.L.] (mm)	RESISTANCE (BLOWS PER 25mm PENETRATION)	* ESTIMATED C.B.R. VALUE (%)

NOTE: * ESIMATED C.B.R. VALUE NOT COVERED BY N.A.T.A. CERTIFICATION.

REMARKS :

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SIGNATURE : R Cormick
DESIGNATION : Testing Operator
DATE : 30/39/91

BALLINA 2478

M.R. Form No. 404
(Revised February, 1983)

DEPARTMENT OF MAIN ROADS, N.S.W.

F.71

TEST REPORT: SUBGRADE SOIL, ROAD GRAVEL, ETC.

H.O. File
D.O. File 10/62.1153
W.O. File
Lab. No. B3802
Laboratory at Ballina

WORK:
SH10 SHIRE OF BYRON
BRUNSWICK BY-PASS

NO. OF SAMPLES: 8 | SUBMITTED BY: R. CORMICK | DATE RECEIVED: 25-09-91

SOURCE OF MATERIAL (Location or name of deposit)
Insitu - Refer Sampling Schedule

DATE AUTHORISED (M.R. Form No. 150)
NA

SAMPLE NO.:			1A	1B	2A	2B	3A	3B
DEPTHS BETWEEN WHICH SAMPLES TAKEN			100 550	550 3300	200 500	500 3200	100 1300	1300 1800
CHAINAGE (in case of samples ex road)			Hole 1	Hole 1	Hole 2	Hole 2	Hole 3	Hole 3
PRE-TREATMENT (See reverse side of form)			Nil	Nil	Nil	Nil	Nil	Nil
TEST	PORTION Passing	Ret. 19.0 mm sieve %	100	100	100	100	100	100
T106	19.0 mm sieve	Pass 9.50 mm sieve %	100	100	100	100	100	100
		Pass 4.75 mm sieve %	100	100	100	100	100	100
		Pass 2.36 mm sieve %	100	100	100	100	100	100
T107	2.36 mm sieve	Pass 425 μm sieve %	99	99	99	99	99	98
		Pass 75 μm sieve %	12	10	15	10	3	5
		Less than 13.5 μm %	7	5	9	7	2	4
T 108 T109	425 μm sieve	Liquid Limit	*	*	*	*	*	*
		Plastic Limit	*	*	*	*	*	*
		Plasticity Index	N.P	N.P	N.P	N.P	N.P	N.P
T113	2.36 mm sieve	Linear Shrinkage %	-	-	-	-	-	-
T110	4.75 mm sieve	Max. dry density (t/m^3)						
		Opt. moist cont. %	-	-	-	-	-	-
T114	19.0 mm sieve	M.D.C.S. (MPa)	-	-	-	-	-	-
			-	-	-	-	-	-
CALCULATIONS AS PER M.R.Form No. 76		RATIOS R	0	0	0	0	0	0
		A	99	99	99	99	99	98
		B	12	10	15	10	3	5
		C	58	50	60	70	67	80
T. VALUE (D + E + F + 0.5 P.I. – 0.25 R)			-	-	-	-	-	-
CBR BY GRADING RULE %			-	-	-	-	-	-
CBR BY SMR RULE %			-	-	-	-	-	-

REMARKS: (Presence of micaceous or porous particles, organic matter, flocculated clay, etc. to be noted)

* Not Obtainable.

National Association of Testing Authorities, Australia

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SIGNATURE R Cormick

DESIGNATION Testing Operator

DATE 5 November 1991

M.R. Form No. 404
(Revised February, 1983)

DEPARTMENT OF MAIN ROADS, N.S.W.

BALLINA WORKS OFFICE
CANAL BRIDGE PACIFIC HWY
BALLINA 2478

F.71

TEST REPORT: SUBGRADE SOIL, ROAD GRAVEL, ETC.

H.O. File
D.O. File 10/62.1153
W.O. File
Lab. No. B3802
Laboratory at Ballina

WORK:

SH10 SHIRE OF BYRON
BRUNSWICK BY-PASS

NO. OF SAMPLES: 8 | SUBMITTED BY: R CORMICK

DATE RECEIVED: 25-09-91

SOURCE OF MATERIAL (Location or name of deposit)

Insitu - Refer Sampling Schedule

DATE AUTHORISED (M.R. Form No. 150)

NA

SAMPLE NO.:			3D	4A	
DEPTHS BETWEEN WHICH SAMPLES TAKEN			2100 2800	200 800	
CHAINAGE (in case of samples ex road)			Hole 3	Hole 4	
PRE-TREATMENT (See reverse side of form)			Nil	Nil	
TEST	PORTION Passing	Ret. 19.0 mm sieve %	100	100	
T106	19.0 mm sieve	Pass 9.50 mm sieve % Pass 4.75 mm sieve % Pass 2.36 mm sieve %	100 100 100	100 100 100	
T107	2.36 mm sieve	Pass 425 μm sieve % Pass 75 μm sieve % Less than 13.5 μm %	95 3 3	98 4 2	
T 108 T109	425 μm sieve	Liquid Limit Plastic Limit Plasticity Index	* * N.P	* * N.P	
T113	2.36 mm sieve	Linear Shrinkage %	–	–	
T110	4.75 mm sieve	Max. dry density (t/m^3) Opt. moist cont. %	–	–	
T114	19.0 mm sieve	M.D.C.S. (MPa)	–	–	
			–	–	
CALCULATIONS AS PER M.R.Form No. 76	RATIOS	R	0	0	
		A	95	98	
		B	3	4	
		C	100	50	
T. VALUE (D + E + F + 0.5 P.I. – 0.25 R)			–	–	
CBR BY GRADING RULE %			–	–	
CBR BY SMR RULE %			–	–	

REMARKS: (Presence of micaceous or porous particles, organic matter, flocculated clay, etc. to be noted)

* Not Obtainable

National Association of Testing Authorities, Australia

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SIGNATURE R.Cormick

DESIGNATION Testing Operator

DATE 5 November 1991

M.R. Form No. 386 (Metric)
(Revised December, 1973)

DEPARTMENT OF MAIN ROADS, N.S.W.

BALLINA WORKS OFFICE
CANAL BRIDGE PACIFIC HWY
BALLINA 2478

TEST REPORT: FINE AGGREGATE

H.O. File
D.O. File 10/62.1153
W.O. File
Lab. File
Laboratory at Ballina
Report No. B3802

WORK:
SH10 SHIRE OF BYRON
BRUNSWICK BY-PASS

No. of samples: 8
Submitted by: R Cormick

Date received: 25-09-91
Date testing authorised: (M.R. Form No. 150) NA

Source and description of material (location or name of deposit):
Insitu - Refer Sampling Schedule

Supplier: NA
Proposed use: NA

Quantity represented: NA

Test Method	Specification:			Sample Number 1A	1B	2A	2B
T201	Passing 9·50 mm sieve	%					
	Passing 6·70 mm sieve	%					
	Passing 4·75 mm sieve	%					
	Passing 2·36 mm sieve	%					
	Passing 1·18 mm sieve	%		100	100	100	100
	Passing 850 µm sieve	%		-	-	-	-
	Passing 600 µm sieve	%		96	96	93	99
	Passing 300 µm sieve	%		66	70	71	79
	Passing 150 µm sieve	%		9	9	12	12
	Passing 75 µm sieve	%		4	4	5	4
T202	Presence of clay lumps	%		-	-	-	-
T203	Material finer than 75 µm sieve:	%		-	-	-	-
T260	Organic impurities (Colour Test)	Pass/fail		-	-	-	-
T264	Soluble salts	%		-	-	-	-
				-	-	-	-
				-	-	-	-

REMARKS:

Specification: M.R. Form No. NA

National Association of Testing Authorities, Australia

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Signature R Cormick

Designation Testing Operator

Date 05 November 1991

I.R. Form No. 386 (Metric)
Revised December, 1973)

DEPARTMENT OF MAIN ROADS, N.S.W.

BALLINA WORKS OFFICE
CANAL BRIDGE PACIFIC HWY
BALLINA 2478

TEST REPORT: FINE AGGREGATE

H.O. File
D.O. File 10/62.1153
W.O. File
Lab. File
Laboratory at Ballina
Report No. B3802

WORK:
SH10 SHIRE OF BYRON
BRUNSWICK BYPASS INVESTIGATION

No. of samples: 8

Submitted by: R Cormick

Date received: 25-09-91

Date testing authorised: (M.R. Form No. 150) NA

Source and description of material (location or name of deposit):
Insitu - Refer Sampling Schedule

Supplier: NA

Proposed use: NA

Quantity represented: NA

Test Method	Specification:			Sample Number 3A	3B	3D	4A
T201	Passing 9·50 mm sieve	%					
	Passing 6·70 mm sieve	%					
	Passing 4·75 mm sieve	%					
	Passing 2·36 mm sieve	%					
	Passing 1·18 mm sieve	%		100	100	100	100
	Passing 850 µm sieve	%		-	-	-	-
	Passing 600 µm sieve	%		100	100	100	100
	Passing 300 µm sieve	%		84	79	59	78
	Passing 150 µm sieve	%		8	6	2	5
	Passing 75 µm sieve	%		2	2	2	2
T202	Presence of clay lumps	%		-	-	-	-
T203	Material finer than 75 µm sieve:	%		-	-	-	-
T260	Organic impurities (Colour Test)	Pass/fail		-	-	-	-
T264	Soluble salts	%		-	-	-	-
				-	-	-	-
				-	-	-	-

REMARKS:

Specification: M.R. Form No. NA

Signature R Cormick

Designation Testing Operator

Date 5 November 1991

National Association of Testing Authorities, Australia

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Appendix 3

Results of Analysis of Soils and Water Samples for Acid Sulphate Soils Potential

Centre for Coastal Management
P.O. Box 125
East Lismore 2480

Tel. (066) 203632

8 November 1991

Mr John Lyons
Roads and Traffic Authority
PO Box 425
Ballina 2478

Dear Mr Lyons,

Herewith are the complete results of the pH/ sulphur analysis of the 14 soil and 2 water samples supplied on the 18 October 1991. The water analysis results were not included in the fax of the 8 November. I have also enclosed a copy of various reports on acid sulphate soils and their field analysis.

If you have any queries, please dont hesitate in contacting me on the above phone no.

ANALYSIS RESULTS

Parameter	pH (1:5 reaction water)	Sulphur Water Soluble ppm or mg/L (S)	Sulphur Total ppm or mg/L (S)	Sulphur Oxidisable ppm (S)
Soils/ Sediments				
1A	4.3	22	31	9
1B	2.6	*964	9195	**8231
2A	5.6	28	34	6
2B	5.4	310	5087	**4777
3A	3.7	29	93	64
3B	3.7	101	3293	**3192
3C	3.8	187	1809	**1622
3D	4.3	29	324	295
4A	3.3	25	869	**844
4B	2.6	53	913	**860
A1	2.7	42	1275	**1233
A2	3.4	34	42	8
B2	4.4	*1148	3678	**2530
CI	4.4	*855	1035	180

Key and Notes
* Actual acid sulphate soils likely
** Significant acid sulphate soil potential

The water extractable sulphur was determined as sulphate after extraction in water (1 soil: 5 water).
The total sulphur was determined from digestion in hydrogen peroxide (H_2O_2).
Oxidisable sulphur is the difference between the extractable and total sulphur.

Parameter	pH	TSS	TOC ppm or mg/L	COD ppm or mg/L
Waters				
A3	4.1	274 mg/L	33 mg/L OC	2692 mg/L O2
BI	7.1	2053 mg/L	287 mg/L OC	---

--- high chloride concentration (> 2000 ppm) prohibits this test
TSS= total suspended solids
TOC= total organic carbon
COD= chemical oxygen demand
OC= organic carbon

Yours faithfully,

G. J. Lancaster

Graham Lancaster

Note: i) For sample locations 1A to 4B - refer to investigation schedule, Appendix 1.

ii) Sample No's A1, A2, A3, B1, B2, C1 and C2 located as follows:-

A1, A2, A3 - Approx. 100m north of test hole 4

B1, B2 - Approx. 100m south of test hole 1

C1, C2 - Approx. 20m north of test hole 2.

Soil Conservation Service of New South Wales

soil note

ACID SULPHATE SOILS

Ruth Veness
Soil Conservationist, Coffs Harbour
David Thompson
Investigations Officer, Grafton

Introduction

Acid sulphate soils are highly acid soils found along the east coast of Australia in low-lying areas with saline or brackish waters. They are also found in inland iron-rich swamps and peat bogs and in some mine spoils or in quarries.These soils can cause serious land use problems.

This Soil Note describes acid sulphate soils, outlines the problems they cause, and suggests some measures to avoid the problems.

What are acid sulphate soils?

Acid sulphate soils, formerly known as cat clays, are soils which, when exposed to the air, form free sulphuric acid and show straw-yellow mottles of a complex sulphate mineral called jarosite.

On the scale by which soil acidity/alkalinity is measured, acid sulphate soils have a pH value less than 4, which is very acid (a pH value of 7 is neutral). On the coast these soils can also be highly saline.

Potential acid sulphate soils are poorly drained and rich in pyrite (iron sulphide) but are nearly neutral or only slightly acid in the field. They become acid sulphate soils **only** when exposed to the air after drainage.

What is the problem?

Acid sulphate soils can cause problems in both agricultural and urban environments. They may restrict or prevent the growth of agricultural crops, pastures and garden plants. In coastal areas this restriction may be due to the combined effects of salinity and acidity as well as toxic levels of aluminium and iron. The acid also causes corrosion of the concrete, iron and steel used for structures. Acidification of water bodies may damage aquatic life and prevent recreational or commercial use.

Recognition of acid sulphate soils in Australia has been relatively recent. CSIRO soil surveys in the early 1960s first identified the development of acid sulphate soils following drainage of backswamp areas to relieve excess floodwaters on the Macleay and Clarence River floodplains. Problems arise when watertables fall to low levels, thereby exposing potential acid sulphate soils to the air.

Acid attack of underground water and sewerage pipes in coastal areas became evident in the 1970s. Acid sulphate soils have caused the collapse of pier and bridge pylons in the Sydney area. When used as fill in an urban subdivision, not even weeds or grasses can grow unless special measures are taken.

Areas most likely to contain potential acid sulphate soils either have not been developed or have only recently been developed. These areas are being increasingly used for urban and resort subdivision, aquaculture and mining. Therefore, the recognition of both potential and existing acid sulphate soils is improving.



Even after 6 years the acid sulphate soils used as fill in this subdivision will not accommodate vegetation without special measures.

Where are they found?

The occurrence of coastal acid sulphate soils is related to past rising sea-levels when grey clays containing sulphur and iron were deposited from seawater in mangroves and estuarine environments. Likely low-lying coastal environments would include areas with saline or brackish water such as deltas, coastal flats and backswamps and seasonal or permanent freshwater swamps which were formerly brackish.

Such landscapes are relatively extensive along parts of the east coast of Australia, so encountering acid sulphate soils is highly likely. It is more often

ISSN 0811-2622

AVOID PROBLEM AREAS

If soil surveys identify potential problem areas, the most sensible approach is to leave these soils in their undisturbed state. However, if disturbance has occurred or is planned, follow these management steps to alleviate or prevent the problem.

MANAGE LAND USES

Excavation and Land Fill. Ensure that acid or potential acid sulphate soils used for land fill in urban, industrial or mining developments are used as only the lower layers of the fill. Minimise the time of exposure to air by reburying the excavated soil as quickly as possible, preferably on the same day.

Building. Special preventative measures should be used if building is to disturb potential acid sulphate soils (e.g., foundations and pipelines). Advice is available from the Cement & Concrete Association of Australia at 100 Walker Street, North Sydney.

Agriculture. Ensure that the bottom level of surface drains designed to remove excess floodwaters is *above* the dry season watertable. This reduces both the amount of soil aeration through surface cracking and decaying root channels and the depletion of fresh swamp waters. Applying agricultural lime to reduce soil acidity is unlikely to be economic.

Aquaculture. Do not build ponds in potential or actual acid sulphate soil layers. If the ponds are drained and the soil is exposed to oxidation, severe problems may arise.

Landscaping. Areas where acid sulphate soil is to be used as fill (e.g., urban subdivisions and golf courses) will require the addition of topsoil to establish and maintain vegetation. The depth of soil needed will depend on the types of plants to be grown.

Further Information

For further information on acid sulphate soils, contact your nearest office of the Soil Conservation Service of NSW.

TWEED SHIRE COUNCIL

LAND USE GUIDELINES FOR ACID SULPHATE SOILS

GUIDELINES FOR CHANGE OF LAND USE

BACKGROUND

Tweed Shire Council has developed these guidelines following severe environmental damage in the Tweed River and other water bodies. Of particular concern was the 1987 fish kill which left approximately 15 kilometres of the Tweed River devoid of all gilled aquatic life. These incidents are continuing and Cudgen Lake was subject to extreme acid conditions in 1991.

Acid conditions and high soluble aluminium levels (toxic to aquatic life) were recorded in the Tweed River and other watercourses after low lying areas affected by potential acid sulphate soils with available aluminium were subject to drying due to both natural conditions and drainage works. A chemical reaction occurred, in the soils with sulphuric acid being formed. Flooding of these soils released this acid and dissolved aluminium into surrounding waterbodies with resultant impacts on all forms of aquatic life.

With proposals before Council to develop in areas affected by these soils a need was seen to co-ordinate the expertise available to draft guidelines to prevent adverse environmental conditions arising from any development or change of land use in the future.

AIMS

The aims of the guidelines are to ensure that if potential acid sulphate conditions are present on development sites, they be correctly identified and managed. The aims for management of these materials are to prevent adverse environmental effects, both on and off site. The environmental aspects apply to the amelioration of existing problems if they are sufficiently serious in their effects on water quality, as well as any possible effects of the development activity.

These guidelines are intended to act as a guide to both developers, who will ultimately be controlled by Council's Development Control Process and to existing primary producers in the Tweed, who may as a result of farming activities, have cause to disturb potential acid sulphate soils. These agricultural activities do not generally come under the control of Council, however, this document is intended to act as a guide to hopefully alleviate problems that could occur when working in potential acid sulphate soil areas.

These guidelines are restricted to environmental quality and do not include engineering problems for which there are existing guidelines and set procedures.

ACID SULPHATE MATERIALS

Potential acid sulphate sediments (ie. they contain pyrite) were formed under very restricted conditions between about 3,000 and 6,000 years ago, in the geological period referred to as the Holocene. The special conditions required the presence of iron-rich sediments from a river, sulphate from sea water, the presence of sulphate reducing bacteria and a plentiful supply of organic matter (usually mangroves).

These materials are therefore only found in low lying parts of the flood plains of rivers and creeks.

Actual acid sulphate materials are formed when pyrite in sediments is exposed to oxidation. Pyrite (FeS_2) is unstable in the presence of specialised bacteria and oxygen from the air, and it decomposes to form ferrous iron and sulphuric acid.

Pyrite remains stable under anoxic conditions and does not cause acidity if kept free of oxygen. Oxygen admission can occur naturally or can be caused by human disturbance. Common causes of disturbance and admission of oxygen are lowering of the natural water table (for example by drainage works), or excavation or pyritic materials and their dumping at the surface.

Materials that have not been oxidised but contain pyrite are referred to as "potential acid sulphate soils". These materials are not acidic, but become acidic if exposed to oxygen.

Soils which have been oxidised and become strongly acidified are called "actual acid sulphate soils". The word "actual" is often omitted and can cause confusion. The New South Wales Soil Conservation Service has a "Soil Note" (Veness, 1990) which describes these materials and their occurrence in New South Wales.

The environmental effects of oxidation of pyrite are related to severe acidification. Acidification causes the dissolution of clay minerals and the release of aluminium to waters. The aluminium may remain in the water in forms that are highly toxic to gilled animals and aquatic plants. In addition, the acid conditions permit iron to remain in solution, rather than form solid compounds. Iron in solution can also be toxic to aquatic life and can cause unsightly stains and slimes. Sulphate is produced by pyrite oxidation and can contribute salinity to non-marine waters.

In summary, actual acid sulphate materials are highly undesirable because they cause severe acidification of natural waters and soils. If acidity is sufficiently intense, aquatic life may be damaged. Plant growth in the soils is very poor or impossible. In addition to impacts on aquatic environments, engineering constraints can also be imposed by acid sulphate soils. These can include poor foundation qualities, concrete corrosion and general corrosion of engineering structures. These problems both require special consideration in the management of land use in potential acid sulphate areas.

The acidity may not develop if the potential acid sulphate material contains sufficient lime ($CaCO_3$) to neutralise it. Lime is commonly found in the form of shells. In the long term (hundreds of years) the attack on the clay minerals will eventually neutralise the acidity.

IDENTIFICATION

Definitions of acid sulphate materials vary within the scientific literature and have not been formally defined in Australia. The following descriptions can be made from Dutch and American soils classifications:

Potential acid sulphate soils can be defined as waterlogged materials that contain 0.75% or more sulphur on a dry weight basis, mostly in the form of sulphides and have less than three times as much carbonate ($CaCO_3$ equivalent) as sulphur.

Actual acid sulphate soils are defined as materials that have both a Ph value less than 3.5, jarositic mottles and at least 0.05% water soluble sulphate.

Chemical analyses can be used to identify these materials.

In the field, actual acid sulphate soils can be identified by the distinctive straw-yellow colour of jarosite in a dark or pale grey matrix. Their texture is usually silty clay or clay. They occur at a depth of the fluctuating water table.

Potential acid sulphate materials are more difficult to identify in the field. They are usually dark grey clay, sometimes with a blue tinge. They are often peaty and may contain preserved fragments of mangroves. They are always below the water table and often below an actual acid sulphate layer containing the distinctive colour of jarosite.

SOILS REGISTER

There are a number of environments in which potential acid sulphate soils occur. Using this information, details provided by the New South Wales Sugar Milling Co-operative and knowledge of problem areas, Council has begun the compilation of a Potential Acid Sulphate Soils Register. This Register, in the form of mapped areas, is to be updated as further information becomes available.

The map of the Shire indicates those areas affected by potential acid sulphate soils. Any change of land use in the area shown which includes:

- drainage works
- excavation
- irrigation using groundwater

MUST comply fully with the guidelines.

QUANTIFICATION

The volumes of acid sulphate materials can be determined by soil surveys. As these materials required special circumstances to form, they also occur in particular parts of the landscape of coastal flood plains. Only low lying regions of superficial sediments need be surveyed if the only purpose of the survey is to delineate acid sulphate soils.

The design of the survey depends on the proposed development. The depth of soil and sediment to be examined may depend on the depth of proposed excavations, and on any influence excavation or drainage during the development may have on the water table nearby. The frequency of coring will depend on the continuity of any acid sulphate strata, and on the area that will be disturbed.

Existing conditions both on and off site need to be recorded, and baseline data established to gauge any change. (eg. depth of water table, characteristics of water courses, etc.)

Normally the area that is to be disturbed will required surveying. Particular attention with denser sampling may be warranted for areas that are to be excavated. Field descriptions of the soil will frequently be sufficient to allow mapping of acid sulphate strata. Occasional chemical analyses will be required for checking of the field observations.

The total reserves of acidity can be determined by chemical analyses of oxidisable sulphur.

Quantification of materials may require excavation and monitoring of materials over an extended period of time to determine what the pH characteristics the soil and potential runoff will develop.

Council's preferred strategy for survey design is included in the attached flowchart.

MANAGEMENT OF ACID SULPHATE MATERIALS

Any management procedures must be detailed with all calculations including:

- hydrological and geological characteristics of the site
- depth of any excavation
- quantities of materials excavated
- storage of excavated material
- leachate collection systems
- discharge characteristics including flow, pH and time of discharge
- characteristics of existing watercourses including tidal regime.

If potential acid sulphate soils are identified, all engineering details submitted must note that the design is able to withstand aggressive conditions and low bearing values encountered in these soils.

Management procedures should also allow for adequate safeguards and alternative management strategies should the predictions and calculations regarding the management of these soils prepared in statements preceding the development be inaccurate.

Principles for managing these materials are:

1. Prevention of Oxidation and Associated Acidification:

   This may be achieved by avoiding excavation of the material and preventing lowering of water tables. Soil survey results can be used to identify areas that are not to be disturbed.

   Excavated potential acid sulphate materials can be disposed of by returning and consolidating the material to an anoxic environment, usually below the water table. Significant oxidation and acidification can occur after two weeks' exposure to the air. The materials must therefore be placed below the water table and saturated within two weeks.

2. Neutralisation and Containment of Acidity:

   If soil analyses show that lime exceeds the oxidisable sulphur content by a factor of three (on a mass basis), then the soil has sufficient capacity to neutralise all the acidity that will be produced.

   Lime can be added to the soil to neutralise the acidity. Because the pyrite is finely divided and dispersed throughout the sediment, lime must also be finely divided and well mixed throughout the material. Normal agricultural lime is satisfactory.

   As pyrite may occur in pockets at high concentrations, it is advisable to retain any leachate or runoff to ensure any escapes of acidic waters are contained and neutralised. Effluent from such areas should be monitored to ensure adverse quality water does not leave the site. Water acidity of less than pH4 should not be allowed to leave the site because of potential impacts on aquatic life.

   The main product of neutralisation is gypsum ($CaSO_4.2H_2O$) which is innocuous.

MONITORING

All developments dealing with the disturbance or modification of potential acid soils should include details of monitoring programmes. These programmes should include the details of parameters to be monitored and monitoring scheduled.

Generally monitoring will be required until a suitable and stable water quality in waterbodies and/or runoff from the site has been achieved.

TECHNICAL EXPERTISE

Council strongly urges that appropriately qualified experts be consulted in regard to development and activities in areas of potential acid sulphate soils. Suitably qualified experts will be invaluable in the identification of potential acid sulphate soil environments, survey design, qualification and formulation of management procedures.

The following list comprises suitably qualified experts known to Council.

References for Further Reading:

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Acid Sulphate soils. Soil Note 22/90
Soil Conservation Service of New South Wales

APPENDIX O

SH No. 10 - Pacific Highway
Proposed Brunswick Heads Bypass

Flooding and Water Quality Assessment
for an Environmental Impact Statement
ROUTE G

Webb McKeown & Associates P/L 1992

STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
SHIRE OF BYRON - PROPOSED BRUNSWICK HEADS BYPASS
42.5km TO 46.7km NORTH OF BALLINA
FLOODING AND WATER QUALITY ASSESSMENT
FOR AN ENVIRONMENTAL IMPACT STATEMENT

ROUTE G

NOVEMBER, 1992

Prepared for:

THE ROADS & TRAFFIC AUTHORITY
ENVIRONMENTAL PLANNING SECTION
260 ELIZABETH STREET
SURRY HILLS NSW 2010

WEBB, McKEOWN & ASSOCIATES PTY. LTD.
CONSULTING ENGINEERS

STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
SHIRE OF BYRON - PROPOSED BRUNSWICK HEADS BYPASS
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EXECUTIVE SUMMARY

This report provides an assessment of the likely impacts of the proposed construction by the Roads & Traffic Authority of a bypass (Route G) at Brunswick Heads from 42.5km to 46.7km north of Ballina. The following issues are considered herein:

- water quality,
- sedimentation,
- tidal impacts,
- flooding impacts.

The analysis of water quality impacts concluded that there is likely to be a net reduction in pollution and sedimentation from the road environs providing that recommended controls and monitoring are undertaken. In the absence of such controls, the re-location of sources of pollution from their present positions may produce localised threats to water quality in previously undisturbed areas.

The proposed bypass crosses the floodplain of the Brunswick River west of the township of Brunswick Heads and joins at its northern end with the existing bridge over the Brunswick River. The road would be constructed at or above the 1% flood level on an earthen embankment. Within this embankment it is proposed that several waterway openings would be provided as wildlife corridors and to minimise flooding impacts. The effects of including 100m wide, 200m wide and 400m wide openings were evaluated.

The bypass will have no impact upon the tidal regime of the Brunswick River, but will impact upon the flooding regime. A detailed analysis of alternatives was undertaken. The results are indicative as no ground survey of the proposed bypass alignment is currently available and survey data along the route were obtained from 1:4000 orthophoto maps and other data sources. The following conclusions have been drawn:

- changes in flood levels will occur for all floods. The magnitude of the affectation is dependent upon the size of the waterway openings. Results for the 100m wide openings show that 1% flood levels will rise by up to 0.06m,
- for 11 of the 12 flood liable dwellings at Riverside Crescent, the increase in flood level is unlikely to significantly increase flood damages. For the

remaining dwelling, the impact may be significant, as the depth of inundation under existing conditions is relatively shallow,

- flood levels are not increased at the eastern limits of Mullumbimby,
- the location and size of the openings should be evaluated at the design stage to ensure that minimal affectation occurs.

Results for an Extreme Flood have also been provided for the 100m wide opening.

Possible mitigation measures for the affected properties at Riverside Crescent include:

- house raising/protection,
- levees,
- voluntary purchase.

STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY

SHIRE OF BYRON - PROPOSED BRUNSWICK HEADS BYPASS

42.5km TO 46.7km NORTH OF BALLINA

FLOODING AND WATER QUALITY ASSESSMENT

FOR AN ENVIRONMENTAL IMPACT STATEMENT

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1. INTRODUCTION

1.1 General

This report forms part of an Environmental Impact Statement (EIS) for the proposed Brunswick Heads Bypass (42.5km to 46.7km north of Ballina) which is being prepared by the Roads & Traffic Authority (RTA). The report also contains an overview of the likely water quality and flooding impacts of the Section from 46.7km to 51.0km north of Ballina, which includes the river crossing of the Brunswick River. The latter section is outside the scope of the present EIS, but issues covered in this report will provide the basis for the future EIS to be undertaken for that section at a later date.

The proposed route and the extent of study area are shown in the main body of the EIS. The bypass involves construction of a 3 lane carriageway from the existing Highway near Saddle Hill to the existing southern approach to the bridge over the Brunswick River. Approximately 2.5km of the 3.5km length of deviation is across the Brunswick River floodplain which lies to the west of Brunswick Heads and south of the Brunswick River. This report provides an assessment of the water quality, sedimentation, tidal and flooding impacts of the proposed bypass.

A route selection investigation was undertaken previously. This recommended that Route G be the preferred option, and this route has been addressed herein.

1.2 Previous Studies

A number of previous investigations into flooding (References 1 to 4) have been undertaken within the study area. Their results are summarised in Appendix A.

1.3 Site Description

A longitudinal section along the proposed bypass route showing ground levels and proposed road levels is provided in the main body of the EIS. The road pavement is to be constructed on an embankment at or above the 1% flood level (which varies from 2.5m AHD at the bridge to 3.0m AHD near the Saddle). The embankment will be up to 2m above the existing ground level.

Under present conditions in a major flood, floodwaters cross the floodplain west of Brunswick Heads, passing both under the Pacific Highway bridge and across the existing Highway between the bridge and boat harbour. The approximate 1% flood level at the bridge is 2.5m AHD. A detailed survey of the existing Pacific Highway showed that the lowest point along the crest of the road is at approximately 2.2m AHD. No ground survey of the proposed bypass alignment is currently available.

The topography of the land along the proposed route north of the Saddle is generally flat at around 1m to 3m AHD. Approximately 1.5km of the route is through semi-cleared grazing land. The remaining 1.0km to the bridge is across largely cleared grazing land with only scattered stands of trees. The bypass will join with the existing Pacific Highway approximately 200m south of the bridge. It will encroach upon the south-east corner of the Caravan Park and it has been assumed that the Caravan Park will be resumed.

The river is largely in its natural state with no major existing sedimentation or water quality problems. Immediately upstream of the bridge there are oyster leases and SEPP 14 Wetlands Nos. 62 and 64.

1.4 Usage of the Floodplain

The majority of the floodplain is used for cattle grazing with little arable farming. There are also extensive stands of high quality heathland vegetation. Further upstream near Mullumbimby, there is some sugar cane farming. A survey of the buildings located within the floodplain has been undertaken by the RTA and the following areas are known to be flood liable in a 1% flood:

- the Caravan Park situated on the west side of the southern approach to the Highway bridge, including the Manager's Residence and Kiosk,
- Riverside Crescent adjoining the Caravan Park. All 12 residences are flood liable,
- the township of Mullumbimby, which includes approximately 70 flood liable buildings to the east of the railway line and approximately 50 buildings to the west of the railway line (Reference - Mullumbimby Floodplain Management Study - December 1989),
- Sawmill, Football Club, isolated houses and a commercial development located along Football Club Road extending northwards from MR524,
- eight or more houses in Fingal and Cudgen Streets, Brunswick Heads,
- isolated farm buildings and yards.

1.5 Report Structure

The assessment of the impacts of the proposed bypass (for the 42.5km to 46.7km route) has been presented in two sections:

- Water Quality (Section 2),
- Tidal and Flooding (Section 3).

Section 4 provides an overview of the possible impacts of upgrading the Highway from 46.7km to 51.0km (Caravan Park to Billinudgel).

2. WATER QUALITY ASSESSMENT

2.1 General

A detailed water quality survey was not undertaken as part of this study, but the following possible pollutant sources were identified:

- two Sewage Treatment Works located at Mullumbimby and on the northern bank of the Brunswick River upstream of the Pacific Highway bridge,
- stormwater runoff from Mullumbimby and the Caravan Park/Riverside Crescent, including runoff from the existing Pacific Highway,
- stormwater runoff from agricultural land (which has probably been sprayed by chemicals) and from grazing land.

These sources would not appear to have a large impact on the normal quality of the river water, which is understood to be reasonably good. No measurements of water quality were undertaken as part of this study.

The proposed bypass could affect the quality of the runoff from the road environs to the local area in the following ways:

- increased turbidity during the construction stage (due to removal of vegetation, stockpiles, and importation of fill to raise the proposed bypass above the design flood level),
- increased turbidity during early operational/establishment stage (due to high erosion potential),
- lead from motor vehicle exhausts may be removed from the atmosphere by rain and washed off in the subsequent stormwater runoff after settling on to roads and other surfaces,
- leakage of fuel, lubricants, hydraulic fluids and coolants from motor vehicles,
- particulate matter deposited on to the road, such as tyre rubber, and linings from brakes and clutches, then being washed off in the subsequent stormwater runoff,

- deposits on vehicle under-carriages (such as dirt, rust and decomposing coatings) being left behind by traffic,
- the road surface of the bypass itself is a pollutant source as it breaks down under traffic wear. The severity of this is dependent on the type of road surface which is used,
- localised increase in litter sourced from traffic.

The consideration of water quality can be sub-divided into Design/Construction and Operation Stages. These are discussed in the following sections together with steps that can be taken to mitigate the potential impacts of the bypass.

2.2 Stage 1 - Design and Construction Stage

The potential for discharge of large quantities of sediment into the Brunswick River is at its greatest during this stage. Removal of vegetation, excavation, stockpiling of topsoil and importation of fill to raise the proposed bypass above the design flood level, all increase the potential sediment load. To minimise this problem it is proposed that the RTA consider the following points during design and initiate a construction management programme which could include an appropriate combination of the following:

- protecting the road embankments at culvert openings against erosion by providing wing walls and aprons at each end,
- designing culverts to ensure that velocities in large floods are kept below scouring velocity after exiting from the culvert structures. Alternatively, erosion protection measures need to be continued downstream until velocities are reduced below scouring velocity,
- evaluation of alternative types of road pavement. Reference 9 states that asphalt contains varying amounts of heavy metals depending on the type of aggregate used. Blast furnace slag and fly ash have high metal contents, sand and river gravel is fairly inert, and blue metal has a high phosphorous content. Concrete road surfaces may yield high concentrations of lead and zinc, but this is once

again dependent on the aggregate type. Also, lane-stripping paint may contain chromium or titanium dioxide, depending on the colour used,

- ensuring embankments are graded so that they are stable against erosion, and providing drainage channels at crests and toes to control runoff,
- planning haul roads and construction access tracks for minimal erosion potential,
- consultation with the local Soil Conservation Service Officer prior to construction,
- undertaking a water monitoring programme during construction which would include tests for: turbidity (secchi depth), oil and grease, pH, conductivity, salinity and chlorinated hydro-carbons,
- minimising the disturbed area at any one time,
- use of geotextile silt retention fences around the construction areas,
- testing of fill material for chlorinated hydro-carbons (pesticides such as PCB and DDT) and dewatering of fill prior to moving onto site if dredged material is used,
- providing bunds around stockpiles,
- directing runoff from the construction site to a series of sedimentation ponds,
- ensuring outflow from sedimentation ponds is passed through a filter pond before discharge to the river,
- employing erosion control measures as illustrated on Figure 1,
- following appropriate guidelines in the design of sedimentation basins. The State Pollution Control Commission suggests that sedimentation basins should be designed to store runoff resulting from a storm of between 2yr ARI and 5y ARI. Normally, a minimum length to width ratio of 2:1 is required. Further guidelines can be found in Reference 8,
- conveying flow through the site in temporary culverts and channels or re-directing floodwaters away from the construction area during the construction period,
- undertaking a re-vegetation programme aimed at establishing, as quickly as possible, a protective cover on disturbed areas in order to minimise silt being washed off in the early operations period,

- hydromulching of batters, or the use of biodegradable protective matting to promote uniform grass growth and reduce scouring potential. Subject to consultation with the Soil Conservation Service and landscape assessment, native trees should be planted at a rate of (say) 6/100m^2,
- leaving geotextile silt fences in place until after re-vegetation has commenced,
- monitoring of the construction process to ensure that oil/diesel spills are minimised and that the other proposed measures are implemented.

A further concern is the possible impacts of the construction activities on SEPP14 Wetland No. 62. Whilst the potential impacts can largely be mitigated by the above measures, the presence of this wetland may require revised construction procedures in areas that ultimately drain to this location.

Provided that suitable measures are implemented and monitored, the effects of construction activities on water quality will not be a significant constraint to the work.

2.3 Stage 2 - Operation Stage

On completion of the bypass the potential impacts on water quality would be:

- increase in turbidity due to erosion from areas disturbed by construction, and from road embankments and cuttings which have not been satisfactorily re-established,
- increase in fine sediment, heavy metals and rubber particles due to the abrasive nature of the road surface,
- localised increase in litter, oil, grease, lead and other heavy metals emanating from vehicles,
- spillages due to accidents.

These potential impacts can largely be controlled using appropriate measures. The following sections discuss each of the issues in turn.

2.3.1 Turbidity

Sources of erosion can be identified by post-construction inspections and stabilised by turfing, reno mattresses or concrete protection. Additional controls may be required to ensure minimal impacts upon SEPP14 Wetland No. 62.

2.3.2 Sediment, Rubber, Litter, Oil, Grease and Heavy Metals

Increases in sediment, rubber, litter, oil, grease and heavy metal pollutants will generally occur in proportion to increases in traffic. Heavy metals emitted by cars include cadmium, antimony, lead, copper, barium and zinc. Of these, lead is the most significant.

It is anticipated that the use of the bypass will provide a reduction of the above pollutants compared to the existing route for a given level of road traffic. This results from the removal of three tight bends, the shortening of the route, and the reduction in acceleration and deceleration requirements. Also, the introduction of unleaded fuel will further reduce lead emissions in the longer term. Reference 9 states that unleaded petrol use has steadily increased from 18% of total petrol consumed in 1988 to 36% in 1991.

Lead concentrations of less than 5ug/L are typical of natural freshwater streams compared with highway runoff concentrations of more than 1000/ug/L. Thus the bypass has the potential to increase lead concentrations in the surrounding natural surface waters. Lead particles emanating from vehicle emissions may settle on the road surface and then be washed off together with oil, grease, rubber and sediment to the minor drainage routes, and ultimately to the Brunswick River.

It has been found (Reference 9) that leaded fuel has approximately 3 times as much particulate material in the exhaust as unleaded fuel at room temperature. The major portion of emitted lead in cars is exhausted as particulate matter.

Generally it is the "first flush" of runoff which has the highest concentrations of pollutants. Subsequent runoff is much cleaner. Reference 9 suggests that up to 90% of the pollutant load is carried in the first flush, which consists of 30-50% of the total storm runoff volume. Mitigation measures should therefore be designed to ensure that they adequately control the initial runoff. The following mitigation measures should be considered:

- **Gross Pollutant Traps (GPT's)**

  GPT's may be effective in intercepting litter from traffic, including rubbish and broken vehicle components (glass, plastic, metals, etc.). They could be constructed by upgrading sediment traps installed at the construction stage. Design guidelines can be found in Reference 8.

- **Sedimentation Basins**

  After construction of the bypass has been completed, sedimentation basins should be permanently retained for water quality control. The basins normally develop wetland flora which act as an efficient filter for some of the heavy metals originating from the bypass. Alternatively, geotextile or other materials may be used to filter the runoff. In dry weather these basins could act as emergency storage areas for spills caused by road users. Contaminants could then be removed or neutralised before entering the natural watercourses.

  The sizing and location of these basins should be determined at the design stage in conjunction with advice from the State Pollution Control Commission. Consideration needs to be given to possible overtopping of the basins in long duration storms or by floodwaters originating from the Brunswick River.

- **Grass-lined Channels**

  Reference 9 indicates that grass-lined channels can be effective in removing particulate pollutants from runoff, but they need regular maintenance to remove sediment build-up. It has been reported that channels of 20, 40 and 60 metre lengths can remove 40-60%, 60-80% and 80-100% respectively of the initial lead concentration.

- **Effective Maintenance Programs**

  It is suggested that an ongoing maintenance and inspection program be implemented once the bypass is operational. Items should include periodic inspection of culverts and embankments for blockages and erosion damage. Regular cleaning out of the GPT's and monitoring of water quality control ponds will also be required. If required, a water quality sampling program could be implemented to monitor the impacts of the bypass and highlight any areas of deficiency which could then be addressed. This could be a continuation of the program undertaken during the construction stage. A suitable waste disposal site for the residue of the basins would also need to be established.

Studies have shown that lead from exhaust emissions stays in the atmosphere for between 1 and 5 days before being deposited and entering the biosphere through water, soil or vegetation. During this time it may be transported some distance away depending upon the wind velocity and local barriers (forests, hills, etc.). Higher concentrations will be found in the immediate area adjoining the bypass. During rainfall events, contaminated water sprayed into the atmosphere by passing vehicles may be blown some distance from the bypass. It is unlikely that any viable preventative measures can be incorporated to reduce this impact.

Whilst the future total pollutant load to the Brunswick River originating from the bypass is likely to be less than the existing load, the localised point discharge sources will change significantly. At present, runoff and pollutants from the Highway mainly enter the river downstream of the bridge. The construction of the bypass will re-locate the

point sources to an area which is presently natural or semi-natural forest or grazing land. While it is expected that the proposed measures will minimise the pollution from the road, some pollutants will inevitably reach those areas beyond the road easement. The consequences for the existing flora and fauna should be evaluated.

2.3.3 Spillages

Accidental spillages on the bypass could have a greater impact on river water quality and the local flora and fauna than pollutants washed off during storm events. Accidental spillages are however infrequent events, and mopping up procedures in conjunction with permanent water quality measures (e.g. filter ponds) would largely nullify any adverse impacts.

The risk of accidental spillages is mainly related to the transportation of hazardous goods. These are primarily flammable and combustible liquids, gases and toxic materials. The risk of accidental spillages of hazardous goods is a function of road conditions and traffic volumes. The design of the proposed bypass would result in improved road and traffic conditions and should therefore bring about a reduction in the risk of spillages. However, the re-location of the transport route to an area which is presently unaffected by spillages means that any spillage has the potential to significantly affect the local environment. An effective spillage control procedure should therefore be implemented.

The potential impacts of spillages on particularly sensitive areas, such as the SEPP14 wetland, should be discussed by the appropriate experts.

2.3.4 Conclusions

There is the potential for adverse impacts on water quality during construction of the proposed bypass. Implementation of appropriate controls, and ongoing monitoring, should ensure that there is only a minimal reduction in overall water quality. Because of the improvements to the road there is likely to be a net reduction in pollution after

construction. Re-location of the sources of pollution may produce localised threats to water quality in previously undisturbed areas. These threats can largely be mitigated by providing appropriate controls and implementing an effective monitoring program.

It is likely that a corridor along the proposed route will be slightly affected by pollutants even if the proposed mitigation measures are implemented. The significance to the local ecology should be addressed by the appropriate ecological experts.

It should be noted that there is currently little information regarding water quality aspects of road runoff in Australia. As noted in Reference 9, most of the available data refers to American conditions which may not apply locally (e.g. differing road and vehicle construction methods and materials). However, the limited available local data generally supports overseas findings.

2.4 Acid Sulphate Soils

It is possible that acid sulphate soils may lie within the bypass route. Should these be disturbed and exposed during the construction phase, they could have a significant impact upon water quality and the local ecology unless appropriate measures are implemented.

Detailed analysis of acid sulphate soils is outside the scope of this report.

2.5 Groundwater

The impact of the proposed bypass on groundwater has not been investigated in this report.

3. TIDAL AND FLOODING ASSESSMENT

3.1 General

The proposed bypass will not impact upon the tidal dynamics of the Brunswick River. However, because it is to be built across the floodplain, it has the potential to change flood behaviour, which could in turn affect other floodplain users.

In a 1% flood event, the floodplain is approximately 2.5km wide, extending from the Brunswick River to the track which runs east-west at the northern limit of Saddle Hill. Under existing conditions floodwaters cross the Pacific Highway in a major flood (approximately 2% event or larger) between the Caravan Park and the Boat Harbour. Any restriction to the flow of floodwaters across the Highway has the potential to raise flood levels upstream and consequently increase flood damages.

The factors which affect the amount of flood damages are:

- depth of inundation,
- duration of inundation,
- frequency of inundation,
- extent of inundation,
- velocity of flow.

The calibrated computer models (WBNM model (Reference 6) and Cell Model (Reference 7)) adopted in the Brunswick River Floodplain Management Investigation (Reference 4) were used in this study to assess the impact of the bypass on flood behaviour. The Cell Model layout was amended within the area of interest to provide for better definition of flows across the existing Pacific Highway route. A revised layout within the area of interest is given on Figure 2.

Hydraulic analyses were undertaken for the 1%, 2% and 5% AEP flood events as described in Reference 4 and for the flood of May 1987. The 1% event is the designated flood adopted by Byron Shire Council for examination of flood behaviour. The May 1987 flood has also been considered, as it is the largest flood in recent times, and there is a good flood database available. This flood is also fresh in the minds of the local community.

A modelled peak height profile for the May 1987 flood is compared to the observed data points on Figure 3. A reasonable match to the observed data has been obtained, which confirms that the model is accurately replicating flood levels along the Brunswick River in major floods and thus can be adopted with confidence for design purposes.

3.2 Impacts of Bypass Construction on Flooding

The impacts of the bypass on flooding will depend on the size of the waterway openings under the embankment across the floodplain relative to the flow area cut off by the embankment itself. It has been assumed for modelling purposes that the road pavement would be constructed on an earthen embankment (up to 2m above natural surface) and would be flood free in a 1% flood. Initially the hydraulic model was run for existing conditions and the peak flood levels at the centre of each cell (Figure 2) are provided in Table 1.

Construction of the bypass will affect flood behaviour in two ways which will be reflected in a change in flood levels:

- loss of access to the floodplain storage areas located between the bypass and Brunswick Heads,
- reduction in flow across the existing Pacific Highway.

The model was modified to account for the construction of the bypass, but without any waterway openings underneath the embankment, thereby eliminating all the flow across the floodplain and the existing Pacific Highway. This effectively simulated a "worst

case" situation. The results showed that flood levels in a 1% event would increase by up to 0.09m at Riverside Crescent.

The RTA advised that the Caravan Park would be resumed prior to the construction of the bypass. Therefore the impacts upon the Caravan Park have not been considered in this analysis.

TABLE 1

Peak Flood Levels (m AHD)

BRUNSWICK BYPASS ROUTE-G

1987 FLOOD		Openings		
	Exist.	100m	200m	400m
CELL 23	3.20	*	*	*
CELL 26	3.17	*	*	*
CELL 27	3.26	*	*	*
CELL 30	2.95	*	*	*
CELL 31	2.88	*	*	*
CELL 32	2.17	-0.24	-0.07	*
CELL 33	2.47	0.05	0.03	*
CELL 34	2.51	0.03	0.02	*
CELL 36	2.22	0.03	*	*
CELL 37	2.09	-0.05	-0.07	-0.04
CELL 38	2.21	0.03	*	*
CELL 39	2.10	0.02	*	*
CELL 41	1.95	*	*	*
CELL 42	2.11	-0.18	-0.02	0.05
CELL 43	1.76	0.02	*	*
CELL 44	1.64	0.02	*	*

1% FLOOD		Openings		
	Exist.	100m	200m	400m
CELL 23	3.39	*	*	*
CELL 26	3.34	*	*	*
CELL 27	3.44	*	*	*
CELL 30	3.19	0.02	*	*
CELL 31	3.19	0.02	*	*
CELL 32	2.75	-0.27	-0.16	-0.07
CELL 33	2.93	0.06	0.04	0.02
CELL 34	2.97	0.05	0.03	*
CELL 36	2.82	0.04	0.02	*
CELL 37	2.70	0.03	*	*
CELL 38	2.79	0.04	0.02	*
CELL 39	2.73	0.03	0.02	*
CELL 41	2.65	0.03	*	*
CELL 42	2.69	-0.22	-0.12	-0.05
CELL 43	2.52	*	*	*
CELL 44	2.39	0.02	0.02	*

EXTREME FLOOD	Openings	
	Exist.	100m
CELL 23	4.28	0.10
CELL 26	4.22	0.10
CELL 27	4.29	0.09
CELL 30	4.12	0.12
CELL 31	4.12	0.12
CELL 32	3.85	-0.26
CELL 33	3.95	0.17
CELL 34	3.98	0.15
CELL 36	3.90	0.14
CELL 37	3.80	0.15
CELL 38	3.88	0.15
CELL 39	3.85	0.13
CELL 41	3.80	0.13
CELL 42	3.76	-0.17
CELL 43	3.76	0.07
CELL 44	3.67	-0.09

2% FLOOD		Openings		
	Exist.	100m	200m	400m
CELL 23	3.24	*	*	*
CELL 26	3.20	*	*	*
CELL 27	3.30	*	*	*
CELL 30	3.02	*	*	*
CELL 31	2.99	0.02	*	*
CELL 32	2.48	-0.15	-0.08	-0.02
CELL 33	2.70	0.04	0.02	*
CELL 34	2.73	0.03	*	*
CELL 36	2.55	0.02	*	*
CELL 37	2.43	*	-0.04	-0.02
CELL 38	2.52	*	*	*
CELL 39	2.45	*	*	*
CELL 41	2.36	*	-0.03	*
CELL 42	2.43	-0.11	-0.04	*
CELL 43	2.21	*	*	0.02
CELL 44	2.21	0.02	*	*

5% FLOOD		Openings		
	Exist.	100m	200m	400m
CELL 23	3.13	*	*	*
CELL 26	3.10	*	*	*
CELL 27	3.24	*	*	*
CELL 30	2.91	*	*	*
CELL 31	2.83	*	*	*
CELL 32	2.27	-0.11	*	0.04
CELL 33	2.53	0.04	0.02	*
CELL 34	2.57	0.03	*	*
CELL 36	2.32	*	*	*
CELL 37	2.18	-0.04	-0.03	-0.02
CELL 38	2.30	*	*	*
CELL 39	2.22	*	*	*
CELL 41	2.11	0.02	0.03	0.02
CELL 42	2.20	-0.04	0.06	0.08
CELL 43	2.12	0.02	0.02	0.02
CELL 44	2.14	*	*	*

Notes: Flood levels for existing conditions are shown in m AHD.
Levels following bypass construction (future) are shown as the change in flood level (in m) relative to the existing flood level.
* represents a change in flood level of less than 0.015m. A change of this order is within the sensitivity range of the computer model and can be considered to be negligible.
The results are indicative as no detailed ground survey of the bypass alignment is currently available.

The RTA has advised that a number of openings will be included under the bypass. These openings will be provided in order to:

- act as wildlife corridors,
- reduce the hydraulic impact of the bypass upon flood levels,
- ensure that local drainage lines are maintained.

The size and location of these openings will be determined at the design stage, but it is considered that a minimum waterway opening width of 100m will be provided. The hydraulic analysis has been undertaken for waterway opening widths of 100m, 200m and 400m.

The Cell Model was modified to simulate the effects of including these openings. It was assumed that each opening would be a minimum of 50m wide. Changes were made to the connections between Cells 37 and 42 (Weir 26) and Cells 33 and 32 (Weirs 26 & 20) to simulate these openings. It was assumed that 50% of the total opening was provided within each weir. The results are shown in Table 1 as the change in flood level (in metres) compared to existing conditions. It is recommended that the location and size of the openings be evaluated at the design stage to further minimise the hydraulic impacts of the bypass. A change in flood level of less than 0.015m is within the sensitivity range of the computer model and can be considered to be negligible.

The results indicate that in all the floods examined (1%, 2%, 5% and 1987) there would be a general increase in flood level on the upstream side following construction of the bypass if only a 100m wide waterway opening was adopted. The maximum increase would be 0.06m. For a 400m wide opening there would be a maximum increase of 0.02m for the 1% flood in Cell 33.

The potential increase in flood levels could be minimised by constructing a larger number of openings of greater cumulative width under the Highway. The hydraulic model was used to determine the number of openings required. An opening (or combination of

openings) of approximately 500m total width would be necessary to produce less than 0.015m increase in flood level upstream.

Results for the Extreme Flood for a 100m wide opening are also provided in Table 1.

3.3 Impacts

The flooding impacts of the bypass construction for the various alternatives are summarised below.

3.3.1 Velocities

The peak average velocity under the existing Highway bridge in a 1% flood is approximately 1.9m/s, and this would increase by 10% to 2.1m/s for a 100m wide opening. For a 400m wide opening there would be no increase in peak velocity. An increase of this magnitude would not be expected to significantly increase the rate of scouring or sediment transport capacity. It would also be unlikely to significantly affect the aquatic ecosystem, particularly since this increase would only apply to larger floods. The potential impacts on the aquatic ecosystem should be reviewed by the appropriate consultant.

3.3.2 Extent, Duration and Frequency of Inundation

The floodplain is bounded by steeply sloping land, so that any increase in flood levels would not significantly increase the lateral extent of the floodplain. The bypass is therefore unlikely to significantly affect any building or land user not already affected by flooding.

The duration of inundation would be marginally increased, but would not be sufficient to have any measurable effect on flood damages.

The frequency of inundation of the rural lands is also unlikely to be significantly affected by construction of the bypass as it only has an impact when overbank flooding occurs in major floods. Rural lands are already inundated by relatively minor floods under existing conditions. There are some residences where the frequency of flooding may increase and these are considered in some detail below.

Floor levels for all the buildings in Riverside Crescent were surveyed and existing and future conditions examined for the full range of design floods. The results showed that the existing Highway is only overtopped by a significant amount in floods of 2% or greater magnitude. The Highway therefore blocks the overland flow paths up to this level, and the only effect of the bypass construction is the loss of floodplain storage.

The survey revealed that 11 of the 12 buildings at Riverside Crescent which are flooded in a 1% event are already inundated in a 2% event. The remaining building is 9 Riverside Crescent and for this structure the frequency of inundation will increase slightly after construction of the bypass. For the remaining 11 buildings there may be a marginal reduction in frequency of inundation as the bypass reduces flood levels in Cell 37 for all floods except the 1%. For the flood liable properties in Fingal Street, Brunswick Heads (Cells 32 and 42), it is likely that the frequency of inundation will be marginally reduced.

3.3.3 Change in Flow Patterns

The proposed bypass will reduce the overland flow path across the existing Pacific Highway (between the bridge and the boat harbour), but it will not be eliminated entirely as waterway openings are to be placed under the bypass. More flow will therefore pass under the Highway bridge over the Brunswick River, and the consequences of this change are considered elsewhere in the EIS.

3.3.4 Depths of Inundation

The depths of inundation for flood liable properties will increase as shown in Table 1. The possible impacts upon existing land users therefore requires assessment.

The existing land use upstream of the bypass is predominantly grazing with scattered light to heavy timber. The Crown Land contains a significant stand of well established trees and other vegetation. It is not expected that the change in flood levels will affect the existing natural or rural land use activities or cause a change in the vegetation patterns.

The floor levels, ground levels, depths of inundation (for a 1% event), and description of each building in the residential community at Riverside Crescent is shown in Table 2. These properties are all located within Cell 37 (refer Figure 2) and for a 1% flood the increases in flood level range from 0.03m (100m opening) to nil (200m opening) as shown in Table 1.

No assessment of the potential impacts of the increase in flood level upon the caravans and other users of the caravan park has been undertaken as it is understood that the caravan park will be resumed.

TABLE 2

Flood Liable Buildings
Upstream of the Bypass

	Floor Level (m AHD)	Ground Level (m AHD)	Depth (m) (1% Flood)	House Description	Ground Floor Usage
Riverside Crescent					
House No. 1	1.49	1.49	1.21	2 storey Fibro	Garage/storage.
2	1.55	1.55	1.15	2 storey Brick/board	Garage/storage.
3	1.48	1.48	1.22	2 storey Fibro	Garage/workshop/living/ laundry/bedroom.
4	2.04	1.80	0.66	2 storey Brick	Garage/workshop/living/ laundry/bedroom.
5	2.12	1.59	0.58	1 storey Brick	All uses.
6	1.50	1.50	1.20	2 storey Board	Garage/storage/laundry.
7	2.20	1.35	0.50	1 storey Fibro	All uses.
8	1.65	1.65	1.05	2 storey Fibro	Garage/storage.
9	2.62	1.39	0.08	1 storey Timber	All uses.
10	1.79	1.42	0.91	2 storey Fibro	Garage/bedroom/living.
11	2.20	1.99	0.50	1 storey Brick	All uses.
12	2.07	1.99	0.63	2 storey Board	Entrance/laundry/garage.

Note: The depth refers to the depth of inundation above the indicated floor level in a 1% flood under existing conditions (Cell 37).

Change in Flood Level @ Riverside Crescent (Cell 37)

	1% Flood	2% Flood	5% Flood
Existing	2.70	2.43	2.18
No Openings	+0.09	N/A	N/A
400m Opening	*	-0.02	-0.02
200m Opening	*	-0.04	-0.03
100m Opening	+0.03	*	-0.04

Flood Levels for the Openings are shown in metres relative to Existing Conditions.

In a 2% event (flood level of 2.43m AHD or greater) 11 of the 12 buildings shown in Table 2 would already be inundated (8 were flooded in the May 1987 flood). The remaining building is 9 Riverside Crescent. In floods greater than a 2% event, the depth of inundation would be greater after construction of the bypass, increasing from a negligible amount at the 2% level to 0.03m at the 1% level (100m wide opening). The existing depth of inundation in a 1% event varies from 0.5m to 1.2m for the 11 buildings. An increase of 0.03m at such depths therefore represents a relatively minor change in flood impact.

The potential increase in flood damages which may be caused by an increased depth of inundation depends upon many factors including:

- warning time,
- preparedness of the residents,
- type and location of goods, etc., within the building.

No detailed examination of these factors has been undertaken. It is reasonable to conclude that the change in flood level caused by the bypass for the 11 properties flooded at the 2% level, will have little impact upon the flood damages. For the one building affected by larger floods, any increase in depth of inundation could be significant, as the bypass could be the difference between being, and not being flooded, in a particular flood event.

In addition to the properties described in the above table, there are 3 farm sheds located within the potential impact zone on the east bank of the river approximately 800m south west of the Highway bridge. No detailed survey information is available for these buildings, but levels from orthophotomaps indicate that they would be flood liable in a 1% event. These buildings are located within Cell 38, and would experience a 0.04m increase in a 1% flood (100m opening) following construction of the bypass. A detailed assessment of the impact of this increase in flood level has not been carried out at this stage. However, given the relatively small increase in level, and the fact that there is no impact for floods of 2% or lesser magnitude (except for the 1987-100m opening case of +0.03m), it is unlikely that there would be any measurable increase in flood damages at these locations due to the construction of the bypass.

Flood levels are reduced to the east of the bypass for all events (Cells 32 and 42) except the 5% (200m and 400m opening) and the 1987 (400m opening). A survey of floor levels showed that 8 residential buildings in Fingal and Cudgen Streets, Brunswick Heads, are inundated in a 1% event. Following bypass construction the 1% flood level would be reduced by up to 0.27m (Cell 32 - 100m wide opening). This is a significant reduction in flood level, with 3 of the 8 buildings becoming flood free in a 1% event.

TABLE 2

Flood Liable Buildings
Upstream of the Bypass

	Floor Level (m AHD)	Ground Level (m AHD)	Depth (m) (1% Flood)	House Description	Ground Floor Usage
Riverside Crescent					
House No. 1	1.49	1.49	1.21	2 storey Fibro	Garage/storage.
2	1.55	1.55	1.15	2 storey Brick/board	Garage/storage.
3	1.48	1.48	1.22	2 storey Fibro	Garage/workshop/living/ laundry/bedroom.
4	2.04	1.80	0.66	2 storey Brick	Garage/workshop/living/ laundry/bedroom.
5	2.12	1.59	0.58	1 storey Brick	All uses.
6	1.50	1.50	1.20	2 storey Board	Garage/storage/laundry.
7	2.20	1.35	0.50	1 storey Fibro	All uses.
8	1.65	1.65	1.05	2 storey Fibro	Garage/storage.
9	2.62	1.39	0.08	1 storey Timber	All uses.
10	1.79	1.42	0.91	2 storey Fibro	Garage/bedroom/living.
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12	2.07	1.99	0.63	2 storey Board	Entrance/laundry/garage.

Note: The depth refers to the depth of inundation above the indicated floor level in a 1% flood under existing conditions (Cell 37).

In a 2% event (flood level of 2.43m AHD or greater) 11 of the 12 buildings shown in Table 2 would already be inundated (8 were flooded in the May 1987 flood). The remaining building is 9 Riverside Crescent. In floods greater than a 2% event, the depth of inundation would be greater after construction of the bypass, increasing from a negligible amount at the 2% level to 0.03m at the 1% level (100m wide opening). The existing depth of inundation in a 1% event varies from 0.5m to 1.2m for the 11 buildings. An increase of 0.03m at such depths therefore represents a relatively minor change in flood impact.

The potential increase in flood damages which may be caused by an increased depth of inundation depends upon many factors including:

- warning time,
- preparedness of the residents,

- type and location of goods, etc., within the building.

No detailed examination of these factors has been undertaken. It is reasonable to conclude that the change in flood level caused by the bypass for the 11 properties flooded at the 2% level, will have little impact upon the flood damages. For the one building affected by larger floods, any increase in depth of inundation could be significant, as the bypass could be the difference between being, and not being flooded, in a particular flood event.

In addition to the properties described in the above table, there are 3 farm sheds located within the potential impact zone on the east bank of the river approximately 800m south west of the Highway bridge. No detailed survey information is available for these buildings, but levels from orthophotomaps indicate that they would be flood liable in a 1% event. These buildings are located within Cell 38, and would experience a 0.04m increase in a 1% flood (100m opening) following construction of the bypass. A detailed assessment of the impact of this increase in flood level has not been carried out at this stage. However, given the relatively small increase in level, and the fact that there is no impact for floods of 2% or lesser magnitude (except for the 1987-100m opening case of +0.03m), it is unlikely that there would be any measurable increase in flood damages at these locations due to the construction of the bypass.

Flood levels are reduced to the east of the bypass for all events (Cells 32 and 42) except the 5% (200m and 400m opening) and the 1987 (400m opening). A survey of floor levels showed that 8 residential buildings in Fingal and Cudgen Streets, Brunswick Heads, are inundated in a 1% event. Following bypass construction the 1% flood level would be reduced by up to 0.27m (Cell 32 - 100m wide opening). This is a significant reduction in flood level, with 3 of the 8 buildings becoming flood free in a 1% event.

3.4 Mitigation Measures

Apart from providing additional waterway openings under the bypass embankment, the following measures could be considered for mitigating the effects of increased flood levels at the affected properties.

3.4.1 Flood Proofing of Buildings

It is possible to flood proof brick buildings by providing waterproof doors and windows, and sealing all other openings. This option would be suitable for the five brick buildings in Riverside Crescent, and possibly for the one building which has a brick ground floor and fibro second storey. An indicative cost to carry this out would be $15 000 to $20 000 each if the garages are included. It is generally not appropriate to flood proof the remaining non-brick buildings as house raising normally is a better option.

3.4.2 House Raising

House raising is a viable measure for non-brick buildings and can generally be undertaken at a cost of approximately $20 000 per house. The cost can vary considerably depending on the actual building. Brick houses cannot generally be raised.

3.4.3 Voluntary Purchase

Properties may be purchased at market value if the owner is willing to sell. This option would be expensive and it is unlikely that many residents would be interested in selling.

3.4.4 Levees

Recent Floodplain Management Studies carried out for Byron Shire Council (Appendix A, Reference 3) have not addressed the possibility of a levee in the Riverside Crescent area. However preliminary investigations carried out as part of this present study suggest

that it may be practical to construct an earthen embankment from the bridge along the river bank (or road alignment) and thence eastwards towards the proposed bypass. If the works were undertaken in conjunction with bypass construction, costs could be minimised, and there would appear to be no major construction difficulties.

Matters which need to be considered in constructing such a levee include:

- internal drainage,
- visual impact,
- access to the river,
- temporary loss of vegetation along the river bank.

These issues can be significant to a local community, and considerably more work would be required before a levee could be confidently presented as a viable option.

3.4.5 Measures to Protect 9 Riverside Crescent

The property at 9 Riverside Crescent has been considered separately to the other 11 properties because:

- the increase in depth could be the difference between being flooded and not being flooded in a particular flood. Thus the frequency of flooding will change, although only marginally,
- the 0.03m increase in depth of inundation (100m opening) in a 1% flood caused by the bypass represents a significant relative increase in depth of inundation (refer Table 2).

The property at 9 Riverside Crescent is a single storey timber building on brick piers and could be raised relatively easily. It would require a lift of only 0.2m to make it flood free, although it would be worthwhile to raise it higher and provide say a 0.3m freeboard above the 1% flood level.

3.5 The Greenhouse Effect

The "Greenhouse" effect has become one of the major environmental concerns in recent years. It could impact upon issues encompassed in this study by increasing design flood levels. This could result from an increase in design ocean levels and/or an increase in design rainfalls.

Recent advice from the Bureau of Meteorology indicates that there is no intention at present to revise design rainfalls to take account of the Greenhouse effect, as the possible mechanisms are far from clear, and there is no indication that Greenhouse-type changes would in fact increase design rainfalls for major storms.

Design ocean levels would have to rise substantially to have any significant impact on flood levels within the area being considered, and there is no indication that any revision of existing design ocean levels is imminent.

The possible impacts of the Greenhouse effect do not therefore impose a significant constraint on the construction of the bypass.

4. OVERVIEW OF SECTION 46.7km TO 51.0km

4.1 General

This section provides an overview of the likely impacts which would need to be addressed if the Highway Section from 46.7km to 51.0km north of Ballina was upgraded at some future date. At the time of writing this report, the preferred alignment has not been established, therefore the overview is not specific to any chosen route.

The overview has been sub-divided into the following two sections:

- water quality assessment,
- tidal and flooding assessment.

4.2 Water Quality Assessment

In general the assessment of the present bypass proposal in Section 2 is also applicable for the Section from 46.7km to 51.0km. However an additional concern would be that the terrain is much steeper, and the higher flow velocities could carry higher sediment/silt loads thus increasing the erosion potential. The flow paths would however generally be better defined and thus easier to control. Smaller local drainage catchments would have to be considered in greater detail to ensure that local problems, such as scour, did not develop as a consequence of construction.

The closeness of SEPP14 Wetlands Nos. 62 and 64 may require an upgrading of the sediment control works proposed in Section 2. Runoff directed towards oyster leases in the bay would also have to be carefully controlled.

4.3 Tidal and Flooding Assessment

4.3.1 Tidal

The only possible concern would be with the crossing of the Brunswick River. There is the potential for the tidal dynamics within the estuary to be affected by any changes in the present crossing. This will require careful examination during the full EIS process. It is unlikely that this will significantly constrain the proposed bridge design.

Care will also have to be taken to ensure that local scouring or sedimentation of the river channel is not affected by the bridge construction.

4.3.2 Flooding

It would appear that the proposed alignment through the Caravan Park (which will be removed) would not cause any significant additional flooding concerns other than those detailed above in Section 3.

It has been assumed that the proposed alignment would not change the crossing of the Marshalls Creek floodplain at Billinudgel and there would therefore be no flooding impacts from bypass construction in this area.

5. REFERENCES

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Brunswick Valley Floodplain Management Study - Hydrology Report
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Webb, McKeown & Associates Pty Ltd, April 1987.

4. Brunswick River Floodplain Management Committee
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5. Institution of Engineers, Australia
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Revised Version 1987.

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Water Research Laboratory, Report No. 154, 1979.

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9. Peterson, S M and Batley, G E
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Investigation Report CET/LH/IR076, CSIRO Division of Coal & Energy Technology, Centre for Advanced Analytical Chemistry
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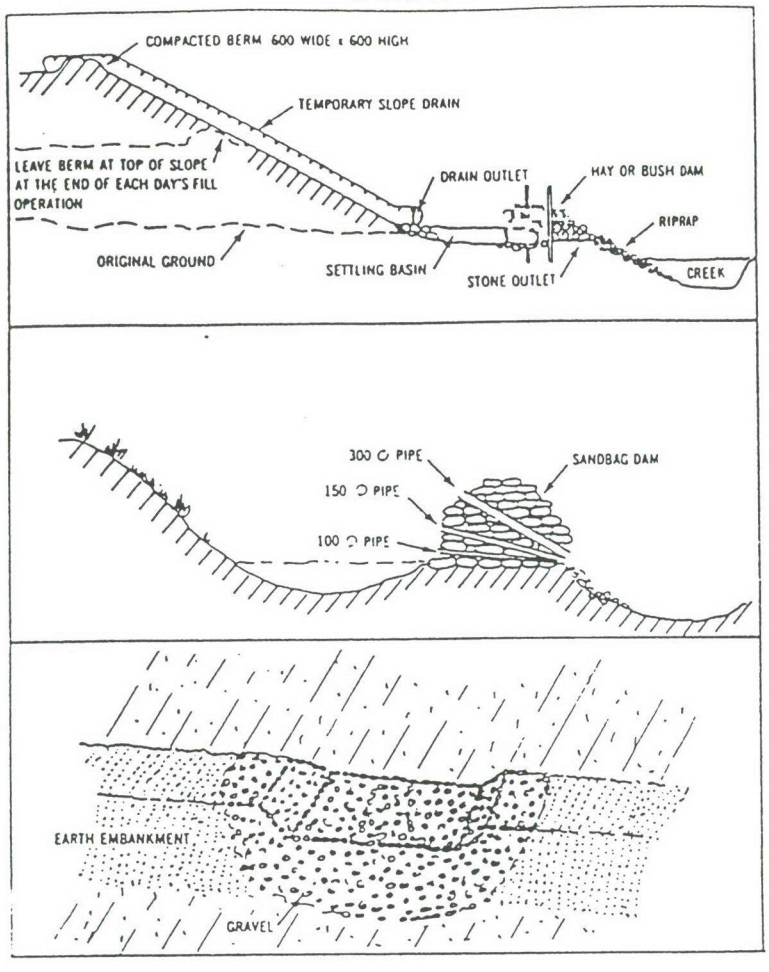
FIGURES

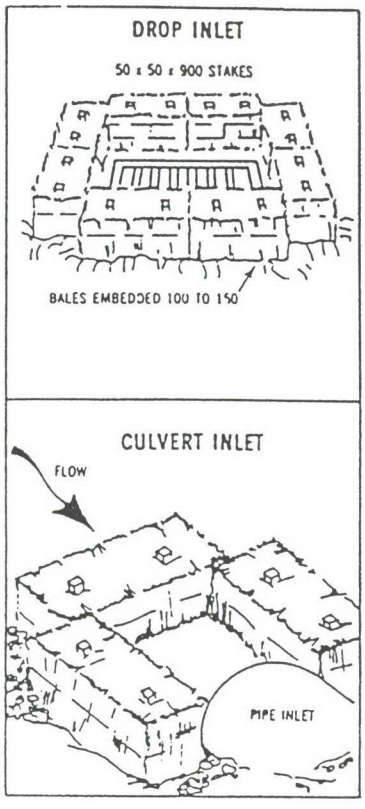
FIGURE 1

EROSION CONTROL MEASURES

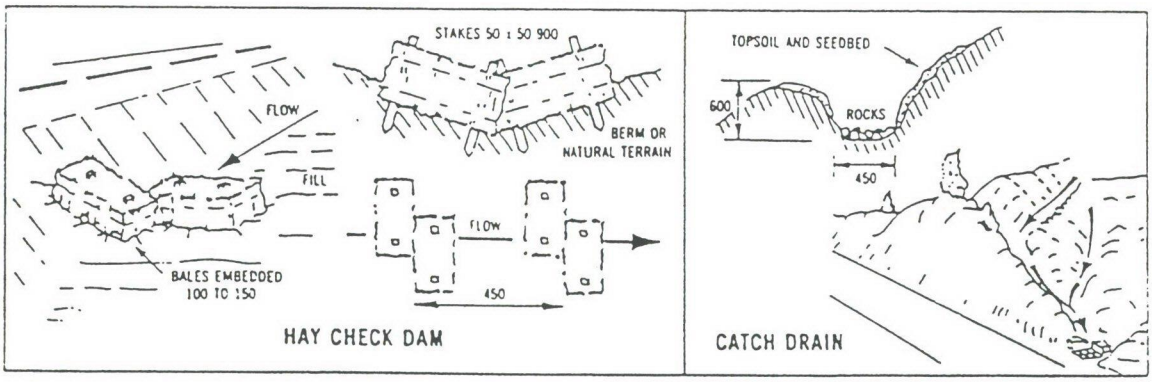
SEDIMENTATION TRAPS



DRAINAGE STRUCTURES



SLOPES



RUNOFF CONTROL STRUCTURES

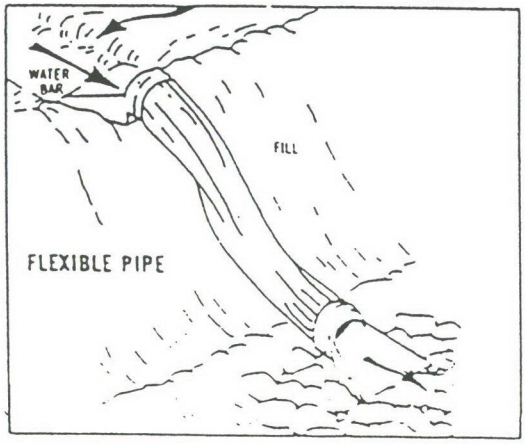


FIGURE 2

HYDRAULIC MODEL
CELL LAYOUT

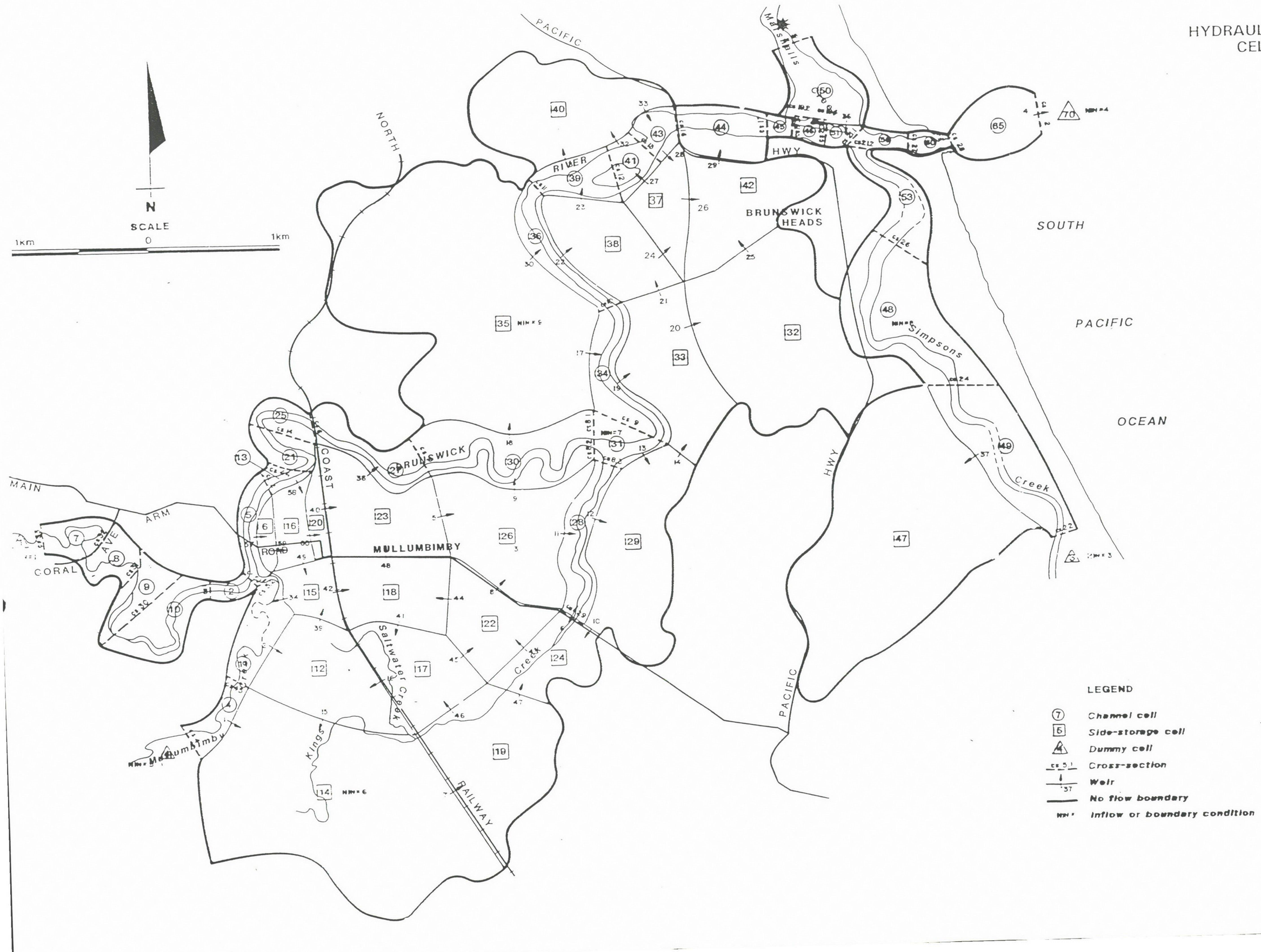
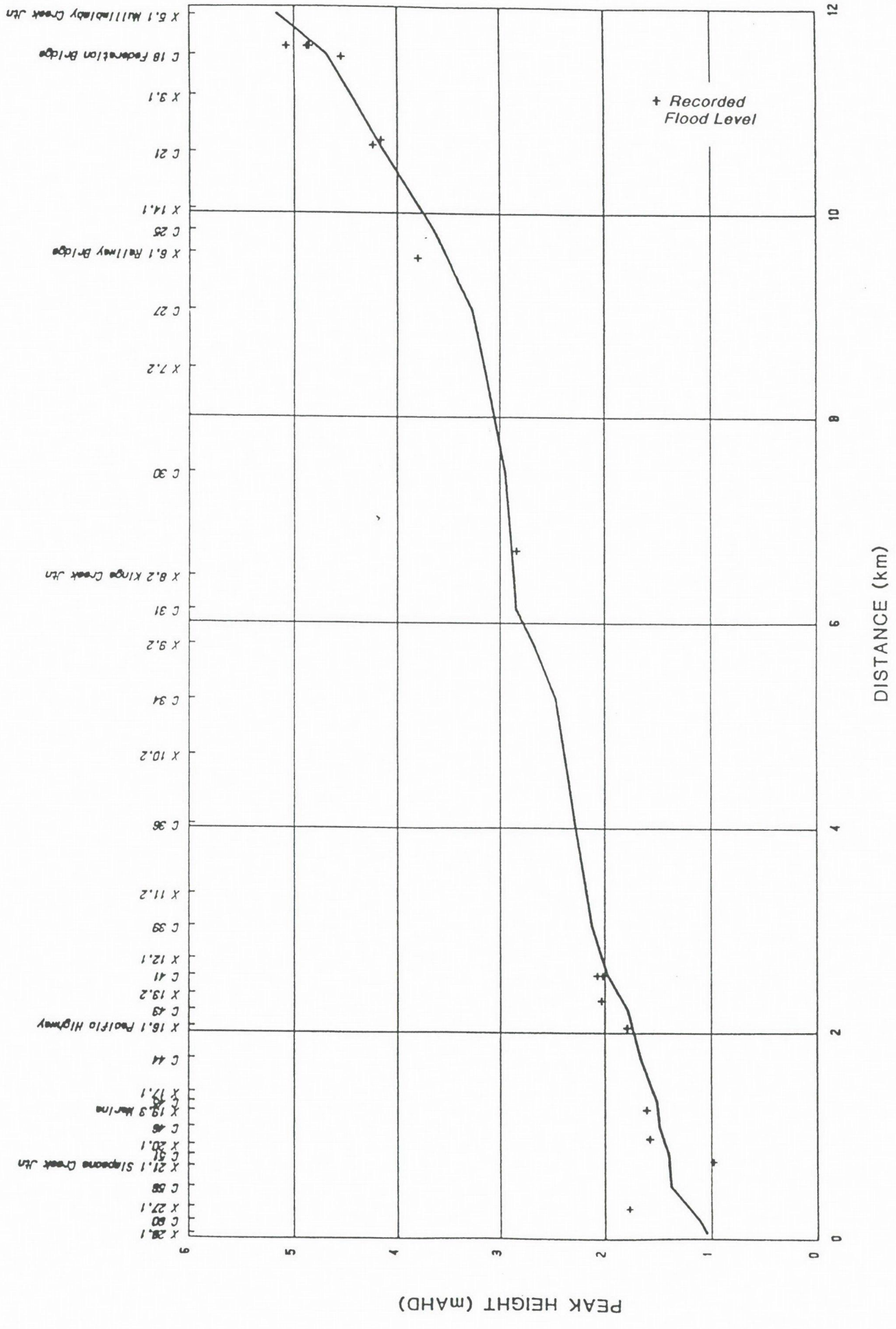


FIGURE 3

PEAK HEIGHT PROFILE
BRUNSWICK RIVER
MAY 1987 FLOOD



APPENDIX A

APPENDIX A
PREVIOUS REPORTS REGARDING FLOODING

Flood studies of relevance to the EIS have been briefly described below (References 1 to 4):

1. **Brunswick Valley Floodplain Management Study - Hydrology Report**
   Prepared for Byron Shire Council in July 1984 by Laurie, Montgomerie & Pettit Pty Ltd and Webb, McKeown & Associates Pty Ltd

   This study undertook a detailed analysis of the rainfall and runoff data for the Brunswick River in order to determine the 5% and 1% Annual Exceedance Probability (AEP) flood hydrographs.

   Peak flows were estimated by two methods: direct frequency analysis of the runoff record at the gauging station at Durrumbul; and a frequency analysis of rainfall records in the area, which were then converted into flows using a calibrated runoff routing model (Watershed Bounded Network Model (WBNM)).

   The effectiveness of the frequency analysis of runoff data was restricted by the limited amount of data available and the method was only used as a check on the order of accuracy of the runoff model results.

   The runoff routing model was calibrated using the well documented records available from several large floods in the 1970's. Rainfall data from five stations near the catchment were analysed to determine the 5% and 1% rainfall patterns for input into the model. Using the calibrated runoff routing model and the design rainfall patterns a series of design hydrographs were derived.

The adopted design rainfall intensities are approximately 20% greater than the design rainfall intensities provided in Australian Rainfall and Runoff -1987 version (AR&R) (Reference 5).

2. **Brunswick River Flood Study**

Prepared for Byron Shire Council in November 1986 by Webb, McKeown & Associates Pty Ltd

In this study a numerical computer model of the Brunswick River floodplain was established. The model is known as the Cell Model (or CELLS or SAMOD). It was used to simulate floodplain flows from Mullumbimby on the Brunswick River, and Billinudgel on Marshalls Creek, to the Pacific Ocean at Brunswick Heads. The channel and floodplain were subdivided into a series of inter-connected cells. A series of cross-sections were used to describe the channel connections and weirs. Flow between the cells was calculated by the computer program and flood levels and velocities determined. The model was calibrated to several historical floods in the 1970's and 1980's.

By including design flow hydrographs obtained from Reference 1, design flood levels, velocities and flows were established.

3. **Brunswick Valley Floodplain Management Study**

Prepared for Byron Shire Council in April 1987 by Webb, McKeown & Associates Pty Ltd

In this study several flood mitigation and development options were examined. One of the options was a possible canal development and flood channel on the east bank of the river approximately 1km south of the Highway bridge over the Brunswick River.

4. **Brunswick River Floodplain Management Investigation**

Prepared for the Brunswick River Floodplain Management Committee in November 1989 by Webb, McKeown & Associates Pty Ltd.

This study was undertaken in order to:

- investigate existing flooding problems along Marshalls Creek,
- consider applications to re-zone and develop flood liable land in the Marshalls Creek floodplain (in particular a proposal by the Ocean Shores Development Corporation Pty Ltd to develop North Ocean Shores).

The hydrologic and hydraulic computer models adopted in Reference 3 were used in these analyses.

A major flood in May 1987 provided a considerable amount of flood and rainfall data. The models were tested against the data from this event and where applicable changes were made in order to more accurately reproduce the recorded data. These changes resulted in a significant reduction in flood levels within the lower reaches of the Brunswick River, Marshalls Creek and Simpsons Creek.

APPENDIX P

Noise Analyst Report

Environmental Planning Section, RTA 1992

TEP:
Mr F Weatherall - 662 5136

SH10. BRUNSWICK HEADS BYPASS. TRAFFIC NOISE INVESTIGATION FOR ENVIRONMENTAL IMPACT STATEMENT. REPORT NO.1.

A. DESCRIPTION OF INVESTIGATION

The following were carried out:

a) Existing noise levels were measured in late November 1991, at three locations along the existing route and at the two properties which will be nearest to the new route. These measured levels are set out in Appendix A, and are summarized in Table A below.

b) Future noise levels were estimated for the nearest house, 140m from the new road for a variety of noise barrier scenarios.

c) Results (a) and (b) are discussed.

B. MEASURED NOISE LEVELS

These are detailed in Appendix A and are summarised in Table A below. Existing noise levels along the highway in Brunswick Heads are about 70 dBA (L10, 18hrs) and residential facade, and along the proposed route were about 47 dBA (free field).
Along the existing highway noise levels are high, traffic being the predominant noise source. At the houses nearest to the new route, the predominant noise is natural, due to wind in the trees, cicadas, etc.

C. RTA CRITERIA

Present RTA environmental goals are:

a) L10 (18hrs) to not exceed 63 dBA

b) Leq (night time) to not exceed 55 dBA.

The measured levels at No 64 Pacific Highway indicate that Leq night is 7.2 dBA below L10 (18hrs), however this difference may be smaller along the new route. L10 (18hrs, estimated) should probably be held below 60 dBA, in order to achieve satisfactory night time noise levels.

TABLE A. Summary of Existing (ie Measured) Noise Levels.
November 1991.

ADDRESS		Leq (18hrs)	Leq (24hrs)	L90 (day)	Leq (night)	(1hr, night max
Sites along the Existing Highway						
64 Pacific Hwy(Usher) Tues 26/11		69.9	65.7	52.9	62.3	63.8
V. Typical house.Mon,Wed25,27/11		69.5	65.2	52.9	62.6	67.2
3m from house.	Av.	69.7	65.5	52.9	62.5	65.5
Lagoon Caravan Park (free field, nearest van sites		64.7	60.5	56	58.4	61.4
Ocean Caravan Park (Free field, nearest van sites		68.5	64.8	52	61.8	64.8
Sites nearest to the Proposed Bypass						
19 Minyon St.		47.9	48.4	44.2	44.3	45.8
(Cnr Byron St,) Owner		47.3	48.2	43.0	44.5	45.6
free field) Mrs Uppgard	Av.	47.6	48.3	43.6	44.4	45.7
12 Cudgen St (Cnr Booyun)		45.2	45.8	40.4	38.7	41.6
Facade		47.8	45.5	40.3	37.6	39.5
	Av.	46.5	45.6	40.4	38.1	40.5

D. FUTURE NOISE LEVELS - EXISTING ROUTE

a) Along the existing highway, there will be a substantial improvement in noise levels principally due to most large trucks and other through traffic using the Bypass. This reduction is estimated to be about 5 dBA. For instance if the traffic volume is halved due to traffic using the new route, and the heavy vehicle content is also halved (from 14% to 7%), then the estimated noise level reduction would be 3.0 dBA plus 1.4 dBA respectively, equivalent to a 64% reduction in traffic volume (ie to 36% of present volumes).

This improvement would be most pronounced at night, when most traffic will be through traffic which will use the new route.

E. FUTURE NOISE LEVELS - PROPOSED RED ROUTE

The estimated noise levels are set out in the table below, and are for the closest house, 140m from the red route. The effect of existing vegetation is conservatively estimated to be between zero and 5.5 dBA. These calculations are based on 9000vpd (18hr), 14% heavy vehicles and 80kph, and take account of the greater noise emission heights of heavy vehicles. Variations from this data can be estimated using the CORTN algorithms in Road Traffic Noise. For example, each 26% of traffic growth will increase noise levels by 1.0 dBA.

Comparative measurements at a straight length, 5km south of Brunswick Heads, at Grays Lane, near the railway overbridge indicated that the model is slightly conservative at Brunswick Heads. Appendix B refers.

TABLE B. ESTIMATED NOISE LEVELS (L10, 18HRS)

Fence and/or mound, 20m from Centreline					
Barrier Height	0m	1m	2m	3m	4m
Normal asphalt	57.9	56.8	54.8	52.9	51.0
Open graded asphalt	55.3	54.4	52.7	50.9	48.8
Shoulder Barrier 7m from Centreline					
Barrier Height	0m	2m	4m	6m	
Normal asphalt	57.9	55.2	50.2	45.9	
Open graded asphalt	55.3	53.2	48.5	43.8	

Along the new (red) route, at the nearest houses, future noise levels will be at least 12 decibels below those along the existing highway, and well below present RTA criteria. At worst, moderate noise mitigation measures will meet existing and possible future criteria, for both day time and night time noise levels.

The first row of houses facing the new road between Minyon Street and Fingal Street are estimated to be up to 4 dBA below the levels estimated above. This will be up to 10 dBA above existing levels, at these sites, but several dBA below the RTA criteria listed above.

Each metre height of earth mound will achieve about 2 dBA of noise reduction, but could cause several additional metres width of ground disturbance.

F. FUTURE NOISE LEVELS, PROPOSED BLUE AND GREEN ROUTES

The alternative blue and green routes are at least 380m and 650m respectively from the nearest houses in Brunswick Heads. Given that there will be significant noise attenuation due to the intervening vegetation, this is estimated to reduce the noise levels at the nearest houses in Brunswick Heads by 6.5 dBA and 10.0 dBA respectively below those described in Section E above.

It is therefore considered that these routes are unlikely to require earth mounding or other noise barrier treatment, other than landscaping, to minimize noise levels, except possibly near isolated farm residences, if any are close to these routes.

G. FUTURE NOISE LEVELS. BLACK ROUTE

The black route follows the red route past Brunswick Heads and then travels within 150m of the existing highway from the Brunswick River north. The black route is likely to improve noise levels at the nearest houses in the Ocean Shore Estate, by moving traffic further west and through improvements to the traffic flow. Nevertheless the higher acoustical standards required along new roads and these houses being above the road could present significant design problems.

H. FUTURE NOISE LEVELS. NORTH OF BRUNSWICK HEADS

North of Coolamon Scenic Drive, all four routes are common.

The acoustical effects will be at isolated rural residences and at the caravan park north of Coolamon Scenic Drive, where noise barriers would have to be considered.

S. Wenthold
Noise Analyst
30.11.92.

MANAGER RESEARCH DEVELOPMENT & NOISE

PROJECT MANAGER

FW04121S

APPENDIX B

Details of Measurements on Friday 29 November 1991, to Calibrate (Check) the CORTN model for local traffic.

Road Side Noise Level (based on 80kph)

Time of Day	Traffic Volume L	M	H	VPH	% HV	%HT	L10 at 13.5m	L10* (1hr,est)	L10 meas	Leq meas	Diff L10	Diff Leq
4.30-4.42	144	9	10	815	11.7	6.1	75.1	66.9	69.2	65.4	+2.2	-1.5
4.45-4.57	167	14	10	955	12.6	6.3	76.1	67.9	68.7	65.5	+0.8	-2.4
5.05-5.17	141	13	7	805	12.4	4.3	75.3	67.1	68.2	64.5	+0.9	-2.6
AV	753	60	45	858	12.2	5.2	75.5	67.2	68.7	65.1	+1.3	-2.2

The microphone was 50m from the road centreline in free field.

*The attenuation due to distance is:

i)	Line source radiation: 10 Log (50/13.5) =	5.7
ii)	Vegetation: 5.2 log (50/(6x3-1.5))	2.5
iii)	Total attenuation with distance.	8.2

The pavement surfacing was a coarse sprayed seal. The apparent correction is +1.3 dBA.

Given that new road is likely to be of asphalt, or open graded asphalt or a fine seal, then no correction would be required.

TEP
Mr F Weatherall - 662 5136

SH10. PACIFIC HIGHWAY. BRUNSWICK HEADS BYPASS TRAFFIC NOISE INVESTIGATIONS. REPORT NO. 2.

A. PURPOSE OF INVESTIGATION

Report No.1 considered the red (preferred) blue, green and black routes being considered to bypass Brunswick Heads.

Two further routes, a pink and red dashed route are now also being considered. The purpose of this report is to consider these latter two routes in relation to the preferred (red) route.

B. RTA NOISE GOALS

Present RTA Draft Policy sets the basic noise goals to be 60 dBA and 55 dBA for Leq (24hrs) and Leq(8hrs, night time) respectively, with the following conditions applying:

i) At a site with significant existing noise, then an expected rise of up to 3 dBA is deemed to be acceptable.

ii) At an existing quiet site, the noise level rise should not exceed 12 dBA.

RTA procedures for estimating future traffic noise levels are based on L10(18hrs) which then needs to be related to Leq(24hrs) and Leq(8hrs, night time). Based on a 48 hour measurement adjacent to the Pacific Highway in Brunswick Heads, Leq (24hrs) is 4.2 dBA below (L10 (18hrs) and Leq(8hrs, night time) is 7.2 dBA below. This indicates that L10 (18hrs estimated) should not exceed 62dBA in order for the base level noise goals to not be exceeded.

C. EXISTING AND FUTURE NOISE LEVELS

At the two homes nearest all the proposed bypass routes, ambient noise levels were measured for 48hrs to be as set out in Table A below.

TABLE A. EXISTING NOISE LEVELS (48HR MIN MEASUREMENTS)

	L10 (18hrs)	Leq (24hrs)	Leq(8hrs night time)
64 Pacific Highway	69.7	65.5	62.5
19 Minyon (Cnr Byron)	47.6	48.3	44.4
12 Cudgen (Cnr Booyun)	46.5	45.6	38.1

At 12 Cudgen St, the most western house, rigorous application of Condition B (ii) would require Leq(8hrs night time) to not exceed 50 dBA and for L10 (18hrs, estimated) to not exceed 57 dBA.

A series of estimated noise levels is set out in Table B of my previous report and below, for a house 140m from the bypass. The red dashed route appears to be approximately 100m from 19 Minyon St, at the south west corner of the town, resulting in noise levels 2dBA higher than Table B. At 12 Cudgen Street, Table B levels would apply.

TABLE B. ESTIMATED NOISE LEVELS (L10, 18HRS)

Fence and/or mound, 20m from Centreline					
Barrier Height	0m	1m	2m	3m	4m
Normal asphalt	57.9	56.8	54.8	52.9	51.0
Open graded asphalt	55.3	54.4	52.7	50.9	48.8
Shoulder Barrier 7m from Centreline					
Barrier Height	0m	2m	4m	6m	
Normal asphalt	57.9	55.2	50.2	45.9	
Open graded asphalt	55.3	53.2	48.5	43.8	

C. THE EFFECTS OF THE VARIOUS ROUTE OPTIONS

1. All three routes are acoustically superior to retaining the existing highway route, due to the diversion of traffic from the town, particularly of heavy trucks and at night.

2. The pink route is acoustically the superior of all the routes under consideration, because traffic is moved further from the town.

3. At 12 Cudgen St, the most western house for total compliance with RTA draft noise goals, L10 (18hrs, estimated) should not exceed 57 dBA. The red and red dashed routes are both 140m away. However, Table B indicates that open graded asphalt or a barrier less than 1m high would achieve this goal.

4. At 19 Minyon St, L10 (18hrs, estimated) should not exceed 62dBA. For the red dashed route 2dBA should be added to the estimated levels in Table B. In any event, a 2dBA minimum margin of compliance is indicated, even with no noise mitigation measures.

5. The following noise alleviation treatments, if considered desirable, would achieve some noise reduction along the eastern roadside past the town:

   a) Landscaping, to partially or completely block vision between the town and the bypass.
   b) Open graded asphalt.
   c) An earth mound would increase the width of ground disturbance and could impede flood flow.
   d) A roadside noise barrier would result in scenery loss for the road user.

6. If the land area between the town and the bypass is rezoned residential or another noise sensitive land use, then further analysis may be required. An industrial zoning would resolve this traffic noise situation.

7. At the southern end of the bypass, the red dashed route is closer to some buildings, which are understood to be the home and business premises of an earth moving contractor. These premises are already affected by traffic noise from the existing highway.

8. At the approaches to the Brunswick River crossing, a noise barrier is likely to be required along the western roadside.

Noise Analyst
30.11.92

FW17AG1S

TEP
Mr Frank Weatherall 662 5318

SH10. PACIFIC HIGHWAY. BRUNSWICK HEADS BYPASS. ROUTE G. NOISE EFFECTS DUE TO ROAD TRAFFIC AND ROAD CONSTRUCTION. REPORT NO 3.

A. PURPOSE OF REPORT

The purpose is to describe the subject noise effects along Route G, to evaluate:

i) whether RTA Noise Goals will be met, and

ii) if necessary to recommend appropriate noise amelioration measures.

My earlier reports, Nos 1 and 2, considered the other route options.

B. NOISE MEASUREMENTS

Measurements adjacent to Route G, additional to those in Report No 1, were carried out during the first week of November 1992. The results are set out below, and are summarised in Table A. Appendix A is a more detailed report.

C. RTA NOISE GOALS

Present RTA Draft Policy sets the basic noise goals for a road project to be 60dBA and 55 dBA for Leq(24hrs) and Leq(8hrs, night time) respectively, with the following conditions also applying:

i) At a site with significant existing noise, then an expected rise of up to 3 dBA is deemed to be acceptable.

ii) At an existing quite site, the noise level rise at a nearby residence should not exceed 12 dBA.

RTA procedures for estimating future traffic noise levels are based on L10 (18 hrs) which then needs to be related to Leq (24hrs) and Leq (8hrs, night time). Based on a 48 hour measurement adjacent to the Pacific Highway (Site 7), in Brunswick Heads, Leq(24hrs) is 4.2 dBA below L10(18 hrs) and Leq(8hrs, night time) is 7.2 dBA below. This indicates L10(18hrs estimated) should not exceed 62dBA in order for the basic night time noise goal to not be exceeded at night.

D. EXISTING NOISE LEVELS

Existing Noise Levels at Sites 1-7 below were measured for 24hours or more. Sites 8 and 9 are short (satellite) measurements which are related to the diurnal pattern at Site 7, which also lies along the existing route of the Pacific Highway.

Table 1 below gives the noise levels in dBA at all nine locations.

TABLE 1. MEASURED NOISE LEVELS

Location	At Wall or in free field	Leq(24hrs)	Leq(8hr, night)	L10 (18hrs)
1 Ch 3200L House near the Lagoon Caravan Park	W	48.5	44.7	49.6
2 Ch1200L	FF	46.3	41.7	47.6
3 Ch500L House on Pig Farm	W	51.8	48.0	48.4
4 House east Ch 700	W	47.8	41.3	49.0
5 19 Mingon St Brunswick Heads	FF	48.3	44.4	47.6
6 12 Cudgen St Brunswick Heads	W	45.6	38.1	46.5
7 64 Pacific Highway Brunswick Heads	FF	65.5	62.5	69.7
8 Ocean Beach Cvan Park nearest site to SH10.	FF	64.8	61.8	68.5
9 Lagoon C'van Park nearest van sites to SH10	FF	60.5	58.4	64.7

Appendix 1 contains a detailed noise measurement report for Sites 1-5.

Appendix 2 contains full tables and graphs of the above noise levels.

Measurements at Locations 1 to 4 were taken early November 1992 adjacent to Route G, whilst Locations 5-9 were measured in late November 1991, in and near Brunswick Heads.

E. FUTURE NOISE LEVELS

a) The property will most likely to be subject to the highest levels of traffic noise is the new two storey house 140m left (west) of Chainage 1100, which is at least 20m above the new road. The estimated noise levels at this property are set out in Table B below.

b) Noise levels at the pig farm west of Ch 600 will be approximately 6dBA lower due to the greater distance and to greater shielding by the natural terrain.

c) The most significant total effect will be at the group of homes behind (west of) the existing Lagoon Caravan Park. The new road will be about 130m away vss approximately 180m away at present. Aside from any effect due to traffic growth, this will theoretically raise noise levels by 5dBA, 2dBA on account of the distance, and 3dBA on account of the road configuration. However RTA Noise Goals will not be exceeded. The estimated noise levels at the first floor (L10,18hrs in dBA) are set out in Table B below.

Table B. Estimated Levels of L10 (18hrs) in dBA.

Height of Barrier above the Road Shoulder (5.5m offset)

Pavement Surface	0m	1m	2m	3m	4m	5m
(i) HOUSE AT CH1100L						
Normal Asphalt	58.0	58.0	56.5	53.6	51.5	48.9
Open Graded Asphalt	56.2	56.2	55.3	52.6	50.6	47.4
(ii) HOUSES NEAR THE LAGOON CARAVAN PARK - SHOULDER BARRIER						
Normal asphalt	57.4	56.8	54.1	51.7	48.9	26.4
Open graded asphalt	55.7	55.3	53.1	50.8	47.9	45.2

(iii) HOUSES NEAR THE LAGOON CARAVAN PARK - EARTH MOUNDS

	Height of Earth mound/fence (20m offset)			
	0m	2m	4m	6m
Normal asphalt	57.4	55.8	52.0	48.5
Open graded asphalt	55.7	54.3	50.7	47.1

All barrier heights are from the road shoulder level.

These barriers are not required to acheive the RTA Noise Goals, however they have been calculated in this report, in order to assess the effect of each 1m increase in barrier height.

These estimates are based on 9000 vehicles per day, 14% heavy vehicles and 80kph. At 100kph, the estimated noise levels will be up to 1.5dBA higher.

F. CONCLUSION

The Brunswick Heads Bypass will significantly reduce noise levels for a large number of residences in Brunswick Heads, particularly at night when almost all heavy trucks will be diverted along the Bypass.

There are a small number of properties along Route G, where noise levels are expected to rise. However, noise alleviation measures will not be required to meet RTA Noise Goals at these properties.

S Wentworth
Noise Analyst
13.11.92.

APPENDIX B

SH10. PACIFIC HIGHWAY.

BRUNSWICK HEADS BYPASS; OPTION G:

MEASUREMENTS OF NOISE LEVELS:

A. EXISTING CONDITIONS

The existing accoustical environment can be classified in various ways. Firstly those locations which have existing traffic noise, and those which have little or no traffic noise. Secondly those locations where the noise level is likely to rise due to the bypass and those where the noise level is likely to fall.

B. LOCATION OF NOISE MONITORING SITES

The locations chosen are representative of both categories. Naturally all possible locations were not monitored, as other sites are an example of the typical accoustical environment which occurs away from the village. Site 2 particularly is an example of a typical environment, which was chosen to be a representative of locations which have little or no traffic noise, but are likely to be affected by the bypass.

The locations are:

No.	Site Description	Classification	Type
1	10 Riverside Cresc.	T, A	Facade
2	Nursery in Bashfords Lane	NT, A	Free field
3	Piggery Farm, off Pacific Hwy	NT, A (Minimally)	Free field
4	House on hill, West of Hwy just before Bashfords lane.	T, A	Free field
5	19 Minyon St. (Cnr Byron St.)	T, B	Free field
6	12 Cudgen St.	T, B	Facade*
7	64 Pacific Hwy, V. Typical House,	T, B	Facade*
8	Ocean Caravan Pk	T, B	Free field
9	Lagoon Caravan Park	T, A	Free field

Where T = Traffic environment
NT = Non traffic environment
A = Traffic noise levels likely to rise
B = Traffic noise levels likely to fall

Measurements of traffic noise, 1m from a building facade (ie a wall), will usually be 2-3dBA higher, due to noise reflections.

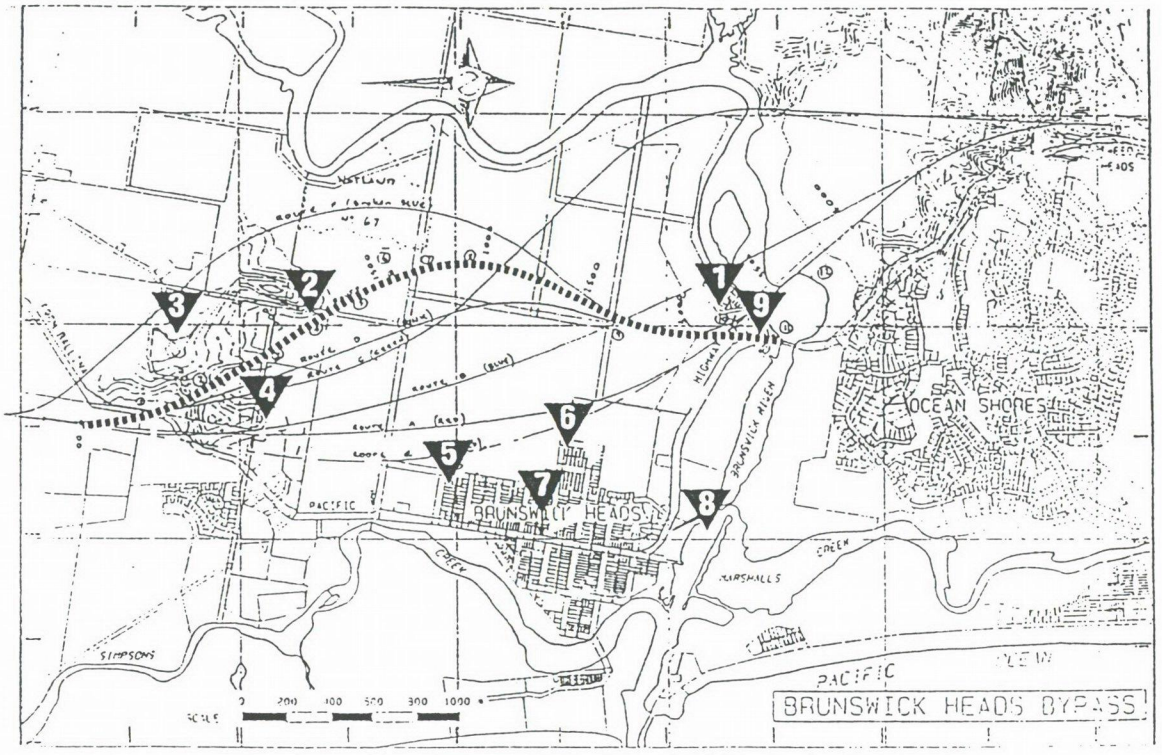


Fig 1: Location of Noise Monitoring sites.

C. EXISTING NOISE LEVELS

Table 2 below gives the noise levels at Sites 1 to 9. The location of these sites is shown in Figure 1.

Noise monitoring at Sites 1 to 7 were performed for 24 hours or more, Sites 8 and 9 are short term measurements of traffic flows, which have been extrapolated, based on the diurnal noise pattern at Site 7.

TABLE 2. MEASURED NOISE LEVELS (IN dBA)

Location	Leq(24 hrs) 00:00-24:00	Leq(night) 22:00-06:00	L10(18hrs) 06:00-24:00
1	48.5	44.7	49.6
2	46.3	41.7	47.5
3	51.3	48.0	48.4
4	47.8	41.3	49.9
5	48.3	44.4	47.6
6	45.6	38.1	46.5
7	65.5	62.5	69.7
8	64.8	61.8	68.5
9	60.5	58.4	64.7

Note: Appendix 1 contains tables and graphs of noise levels measured.

Measurements at Locations 1 to 4 were taken in early November 1992. Locations 5 to 9 were measured in late November 1991.

D. WEATHER CONDITIONS

Adverse weather conditions influenced measurement of noise levels at Locations 1 to 4. Windy and rainy weather tends to increase the noise levels perceived. Periods of fine weather were:

Wednesday	4/11/92	20:00 - 24:00
Thursday	5/11/92	00:00 - 24:00
Friday	6/11/92	00:00 - 18:00
Saturday	7/11/92	20:00 - 24:00
Sunday	8/11/92	00:00 - 11:00

To obtain representative noise levels of the existing traffic conditions, good weather periods were appropriately concatenated, and 24hr measurements of fine weather noise levels were obtained at each site. These are listed in Table 2.

E. TYPICAL ACOUSTICAL NON-TRAFFIC ENVIRONMENT

Location 2 is typical of a non traffic environment in this area. Noise levels 1km or more away from the existing highway, are typically:

Leq(24hrs)	=	45 - 47 dB(A)
Leq(night)	=	41 - 43 dB(A)
L10(18hrs)	=	47 - 49 dB(A)

Any other locations which were not measured and are located at the same distance from the highway (or further), are likely to have the same noise levels as the "environment noise levels" given above. This includes the new double storey house 140 metres west of the proposed bypass G, at approximate chainage: 1100.

Noise Analyst

TABLE A-6

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Dave Richardson, Nursery, Bashfords ln.
DATE/DAY/LOC SUN-MORN (0-11)+ FRIDAY (12-21) + SAT-NIGHT

FILENAME: A:\123R3\BRUNS\NURS.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 0

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	51	45	35	42.5
24	23 - 24	48	45	34.5	43.1
1	24 - 1	47	41.5	34	39.7
2	1 - 2	53	41.5	33	40.9
3	2 - 3	46.5	41.5	33	38.3
4	3 - 4	51.5	49.5	34	44.6
5	4 - 5	47	44.5	33.5	41.2
6	5 - 6	54	43.5	32.5	41.6
7	6 - 7	56.5	42.5	32	44.2
8	7 - 8	53.5	43.5	33	42.1
9	8 - 9	55.5	45.5	34.5	43.9
10	9 - 10	56.5	48.5	35	46.3
11	10 - 11	51.5	43	34	41.6
12	11 - 12	52.5	45	34.5	42.7
13	12 - 13	61	48.5	35	49.5
14	13 - 14	54.5	47.5	34	45.1
15	14 - 15	57.5	51.5	34.5	48.2
16	15 - 16	60	46.5	35.5	49.8
17	16 - 17	56	49.5	38	46.6
18	17 - 18	56.5	51.5	39.5	49.6
19	18 - 19	56.9	48.5	40.5	50.4
20	19 - 20	57.2	48.8	42	50.7
21	20 - 21	58.5	53.5	43	50.9
22	21 - 22	53	44.5	35.5	43.1
23	22 - 23	51	45	35	42.5
24	23 - 24	48	45	34.5	43.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	47.1 dB(A)
Leq (night)	22:00 - 06:00	41.9 dB(A)
L90 (background)	07:00 - 18:00	35.2 dB(A)
Leq (24 hours)	00:00 - 24:00	46.4 dB(A)
1hr Leq max	22:00 - 06:00	44.6 dB(A)

Total Noise Statistics for: BRUNSWICK HEADS
Pig and Cattle Farm

Location no: 3

Totals	Descriptor	Period	Totals
2	L10 (18 hours)	06:00 - 24:00	48.4 DB(A)
2	Leq (night)	22:00 - 06:00	48.0 DB(A)
2	L90 (background)	07:00 - 18:00	40.1 DB(A)
2	Leq (24 hours)	00:00 - 24:00	51.3 DB(A)
2	1hr Leq max	22:00 - 06:00	53.8 DB(A)

Comments

Note: Calculations include concatenated days to ensure "good weather measurements" are represented.

TABLE A-1

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Pig and Cattle Farm
DATE/DAY/LOC: 4/11/92, Wed

FILENAME: C:\123R3\BRUNS\FARM.WK3
WEATHER: FINE
COMMENTS: NONE
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23				
24	23 - 24				
1	24 - 1				
2	1 - 2				
3	2 - 3				
4	3 - 4				
5	4 - 5				
6	5 - 6				
7	6 - 7				
8	7 - 8				
9	8 - 9				
10	9 - 10				
11	10 - 11				
12	11 - 12				
13	12 - 13				
14	13 - 14				
15	14 - 15				
16	15 - 16				
17	16 - 17	69.7	63.2	46.2	59.4
18	17 - 18	65.7	58.2	44.2	54.9
19	18 - 19	61.2	54.7	43.7	51.3
20	19 - 20	62.7	53.7	44.7	52.5
21	20 - 21	61.7	54.7	49.7	54.2
22	21 - 22	59.7	52.7	43.2	51.6
23	22 - 23	48.2	43.7	40.2	42.8
24	23 - 24	51.7	43.2	40	43.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	53 dB(A)
Leq (night)	22:00 - 06:00	0 dB(A)
L90 (background)	07:00 - 18:00	45.2 dB(A)
Leq (24 hours)	00:00 - 24:00	49.1 dB(A)
1hr Leq max	22:00 - 06:00	0 dB(A)

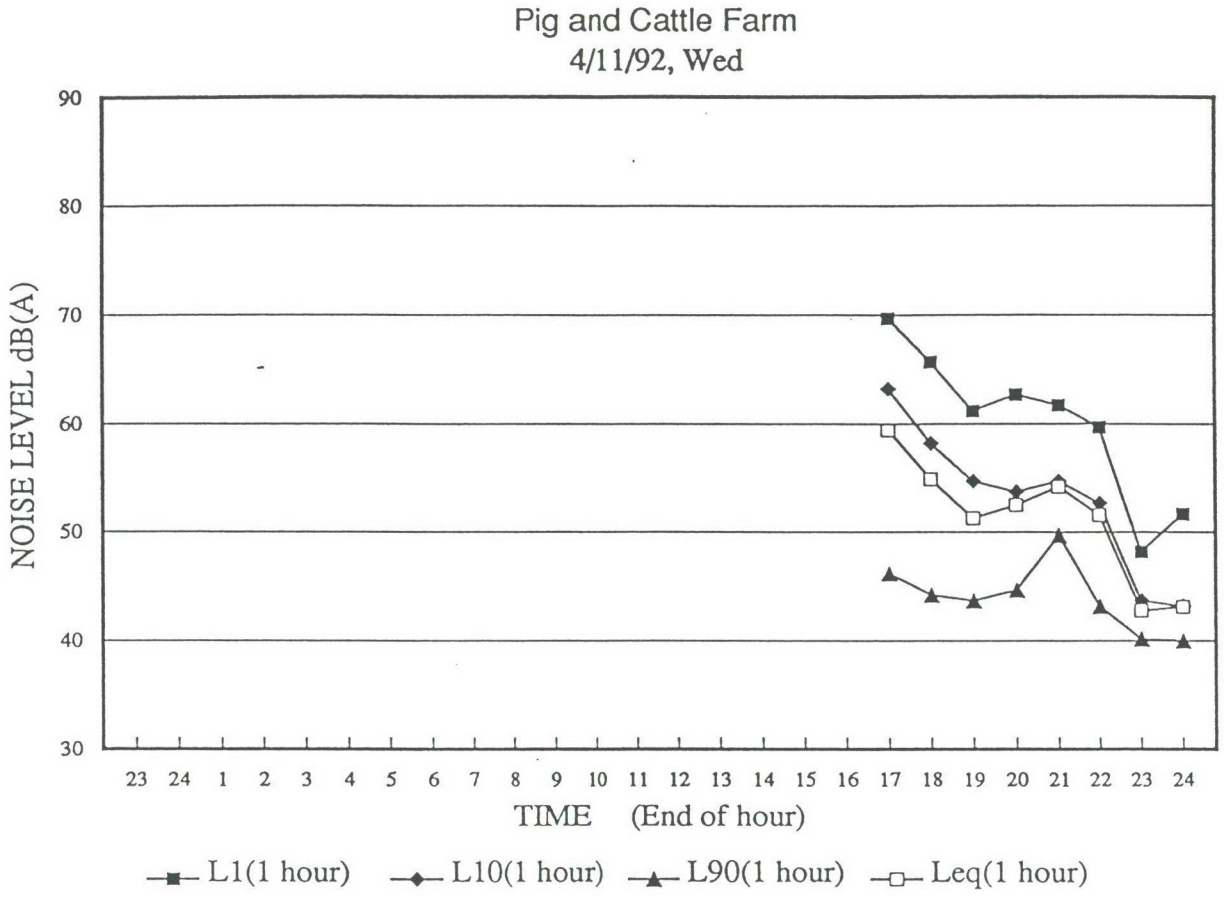

Pig and Cattle Farm
4/11/92, Wed
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-2

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Pig and Cattle Farm
DATE/DAY/LOC 5/11/92, Thu

FILENAME: C:\123R3\BRUNS\FARM.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 0

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	48.2	43.7	40.2	42.8
24	23 - 24	51.7	43.2	40	43.1
1	24 - 1	42.7	40.2	40	40
2	1 - 2	52.7	42.7	40	40.6
3	2 - 3	53.7	45.2	40	43
4	3 - 4	46.7	41.7	40	40
5	4 - 5	51	46.2	40	43
6	5 - 6	54.7	46.7	40	45.7
7	6 - 7	54.7	45.2	40	44.7
8	7 - 8	53.7	45.7	40	44.6
9	8 - 9	59.7	48.2	40	55.5
10	9 - 10	59.7	44.2	40	52.9
11	10 - 11	57.7	45.2	40	48.4
12	11 - 12	59.2	46.7	40	47.1
13	12 - 13	52.2	46.2	40	44.9
14	13 - 14	56.7	46.2	40	49.8
15	14 - 15	57.7	46.7	40.2	50.5
16	15 - 16	67.2	50.7	40	54.8
17	16 - 17	65.2	52.2	40	53.1
18	17 - 18	63.5	50.8	41	52.8
19	18 - 19	60.5	50.3	42	52.3
20	19 - 20	58.7	53.7	43.7	51.8
21	20 - 21	59.7	54.2	51.7	53.2
22	21 - 22	54.7	52.7	45.7	51.9
23	22 - 23	51.7	44.2	40	40.1
24	23 - 24	60.7	43.7	40	47.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	48.2 dB(A)
Leq (night)	22:00 - 06:00	42.7 dB(A)
L90 (background)	07:00 - 18:00	40.1 dB(A)
Leq (24 hours)	00:00 - 24:00	50.2 dB(A)
1hr Leq max	22:00 - 06:00	45.7 dB(A)

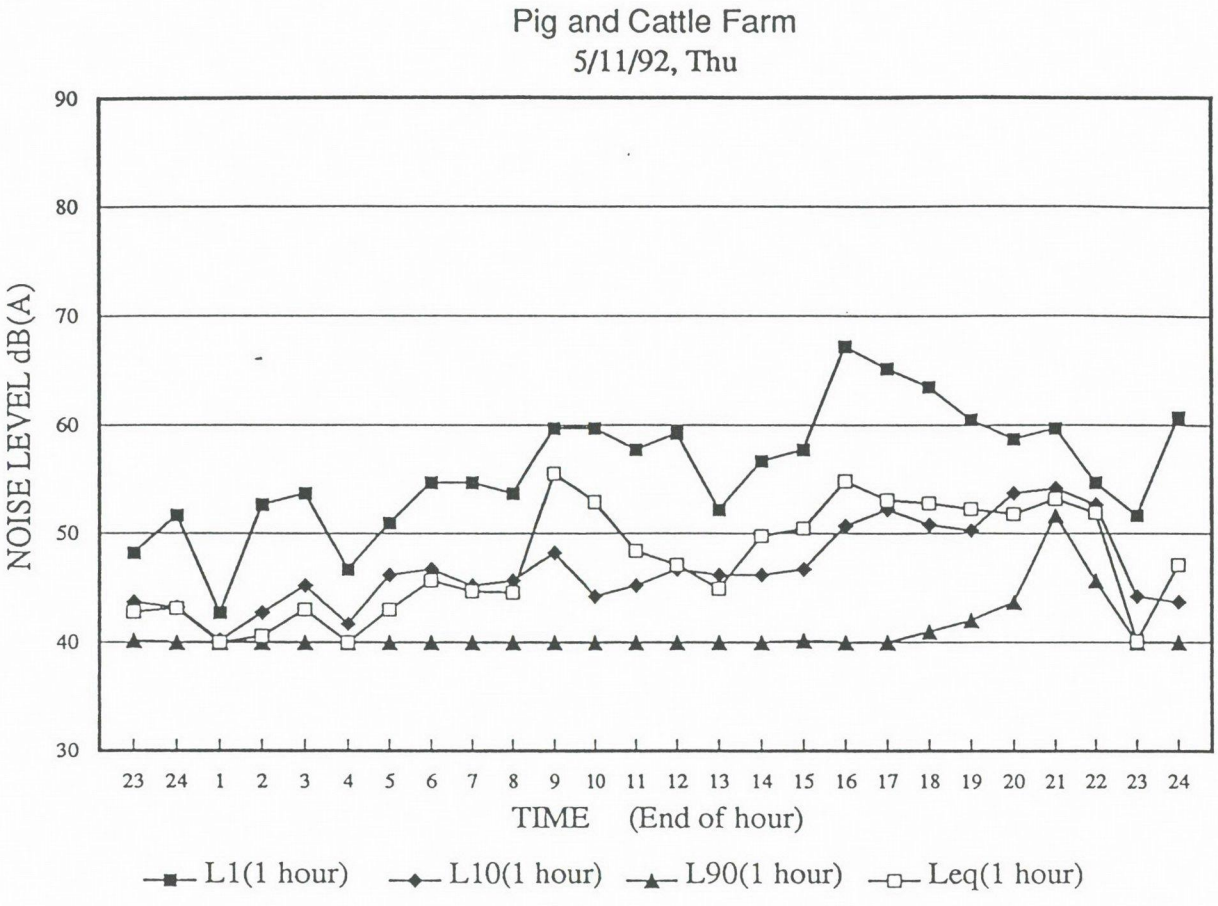

Pig and Cattle Farm
5/11/92, Thu
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

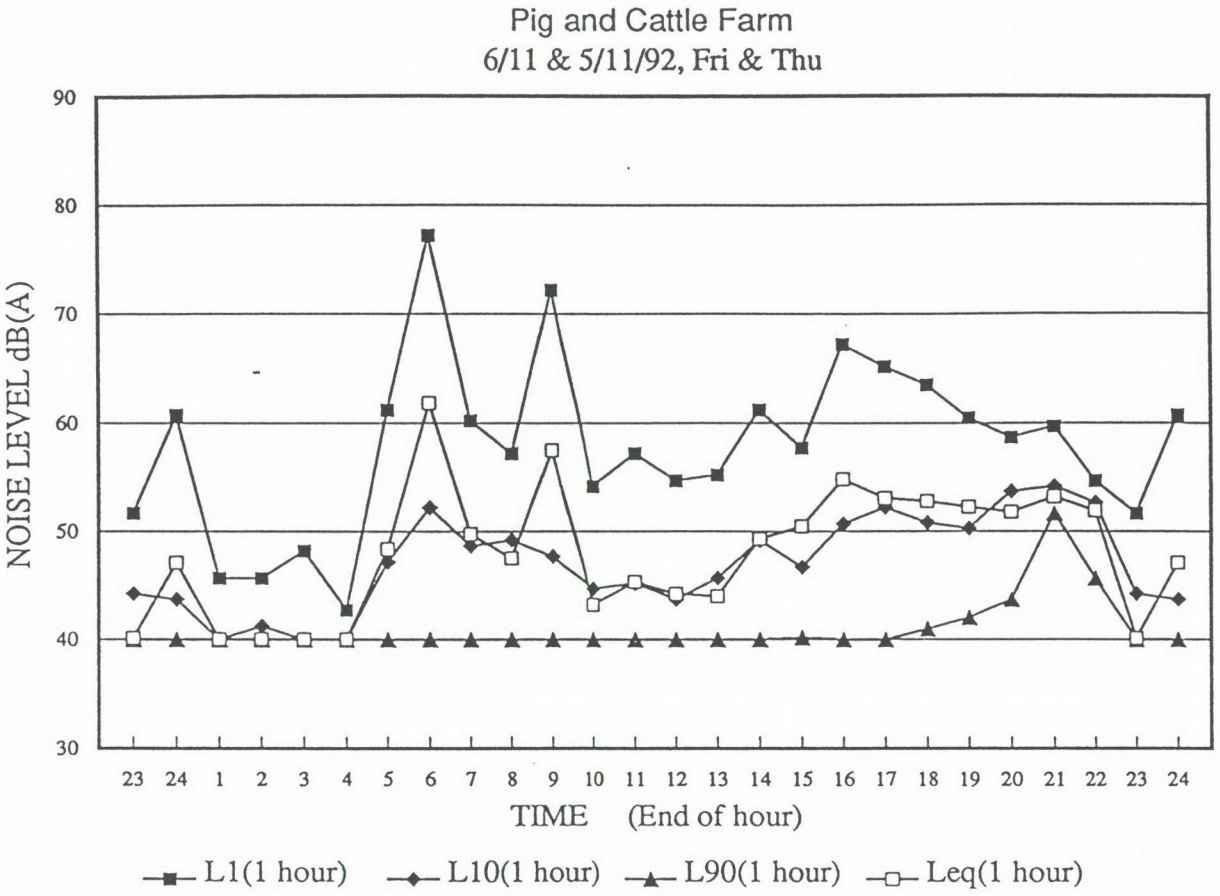
TABLE A - 3

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Pig and Cattle Farm
DATE/DAY/LOC 6/11 & 5/11/92, Fri & Thu

FILENAME: C:\123R3\BRUNS\FARM.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 0

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	51.7	44.2	40	40.1
24	23 - 24	60.7	43.7	40	47.1
1	24 - 1	45.7	40	40	40
2	1 - 2	45.7	41.2	40	40
3	2 - 3	48.2	40	40	40
4	3 - 4	42.7	40	40	40
5	4 - 5	61.2	47.2	40	48.4
6	5 - 6	77.2	52.2	40	61.8
7	6 - 7	60.2	48.7	40	49.8
8	7 - 8	57.2	49.2	40	47.5
9	8 - 9	72.2	47.7	40	57.5
10	9 - 10	54.2	44.7	40	43.2
11	10 - 11	57.2	45.2	40	45.3
12	11 - 12	54.7	43.7	40	44.2
13	12 - 13	55.2	45.7	40	44
14	13 - 14	61.2	49.2	40	49.3
15	14 - 15	57.7	46.7	40.2	50.5
16	15 - 16	67.2	50.7	40	54.8
17	16 - 17	65.2	52.2	40	53.1
18	17 - 18	63.5	50.8	41	52.8
19	18 - 19	60.5	50.3	42	52.3
20	19 - 20	58.7	53.7	43.7	51.8
21	20 - 21	59.7	54.2	51.7	53.2
22	21 - 22	54.7	52.7	45.7	51.9
23	22 - 23	51.7	44.2	40	40.1
24	23 - 24	60.7	43.7	40	47.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	48.5 dB(A)
Leq (night)	22:00 - 06:00	53.2 dB(A)
L90 (background)	07:00 - 18:00	40.1 dB(A)
Leq (24 hours)	00:00 - 24:00	52.3 dB(A)
1hr Leq max	22:00 - 06:00	61.8 dB(A)


Pig and Cattle Farm
6/11 & 5/11/92, Fri & Thu
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

Total Noise Statistics for: BRUNSWICK HEADS
House on hill, closest to existing Hwy

Location no: 4

Totals	Descriptor	Period	Totals
1	L10 (18 hours)	06:00 - 24:00	49.9 DB(A)
1	Leq (night)	22:00 - 06:00	41.3 DB(A)
1	L90 (background)	07:00 - 18:00	42.1 DB(A)
1	Leq (24 hours)	00:00 - 24:00	47.8 DB(A)
1	1hr Leq max	22:00 - 06:00	44.9 DB(A)

Comments

Note: Calculations include concatenated days and weekends to ensure good weather measurements are represented.

TABLE A-1

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: House on hill, closest to existing Hwy
DATE/DAY/LOC: 6/11/92, Fri

FILENAME: C:\123R3\BRUNS\CLOSEHIL
WEATHER: FINE
COMMENTS: NONE
WEEKEND ? NO = 0, YES = 1: 1

	TIME -	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23				
24	23 - 24				
1	24 - 1				
2	1 - 2				
3	2 - 3				
4	3 - 4				
5	4 - 5				
6	5 - 6				
7	6 - 7				
8	7 - 8				
9	8 - 9				
10	9 - 10				
11	10 - 11				
12	11 - 12				
13	12 - 13				
14	13 - 14				
15	14 - 15				
16	15 - 16	58.7	52.7	42.2	49.8
17	16 - 17	58.2	55.2	46.7	52.2
18	17 - 18	64.2	55.7	42.2	52.2
19	18 - 19	60.2	52.2	43.2	49.9
20	19 - 20	64.2	61.7	47.2	55.9
21	20 - 21	61.7	55.7	46.7	52.9
22	21 - 22	60.2	54.2	45.2	51.4
23	22 - 23	58.7	52.7	44.2	50
24	23 - 24	57.7	52.7	44.2	49.7

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	54.8 dB(A)
Leq (night)	22:00 - 06:00	0 dB(A)
L90 (background)	07:00 - 18:00	43.7 dB(A)
Leq (24 hours)	00:00 - 24:00	47.8 dB(A)
1hr Leq max	22:00 - 06:00	0 dB(A)

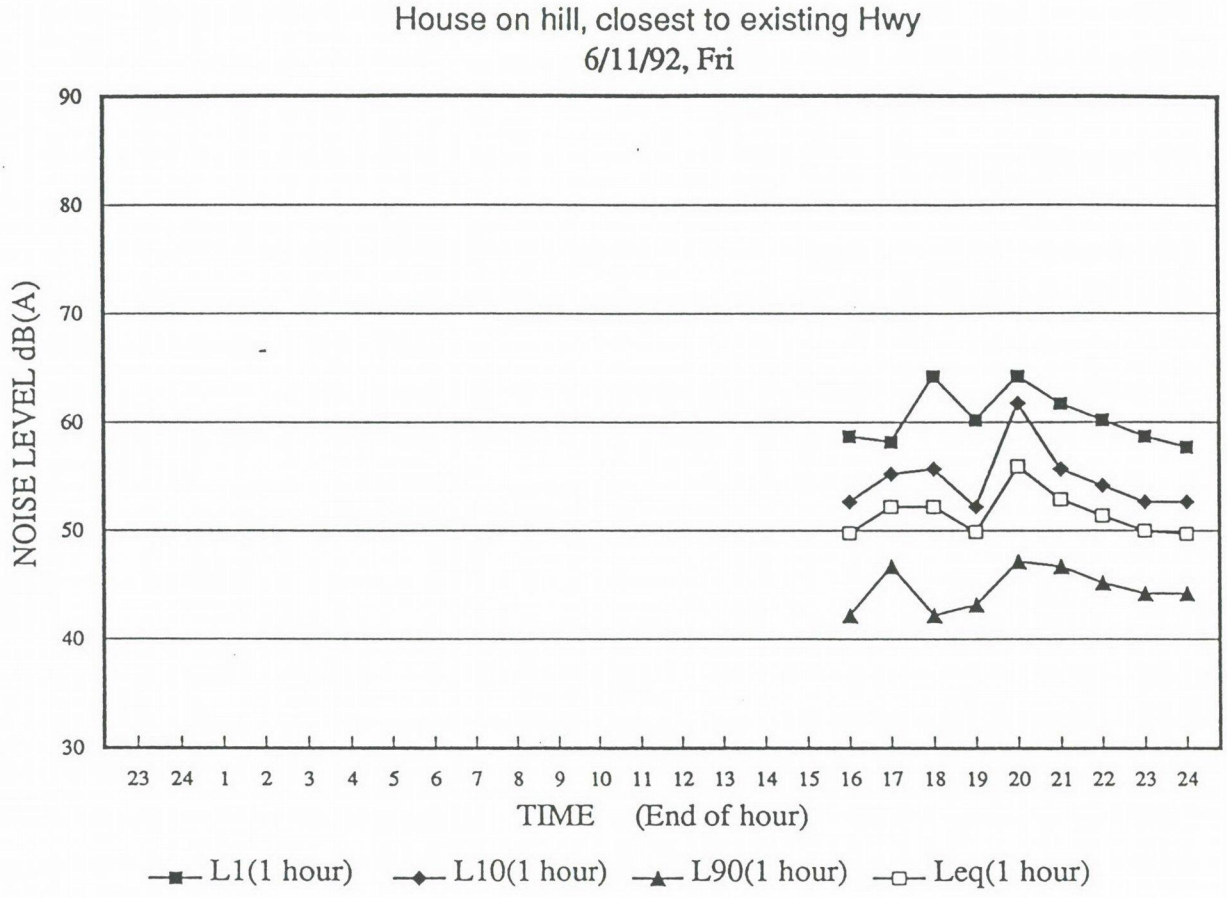

House on hill, closest to existing Hwy
6/11/92, Fri
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-2

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: House on hill, closest to existing Hwy
DATE/DAY/LOC 7/11/92, Sat

FILENAME: C:\123R3\BRUNS\CLOSEHIL
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	58.7	52.7	44.2	50
24	23 - 24	57.7	52.7	44.2	49.7
1	24 - 1	60.7	54.7	44.2	51.5
2	1 - 2	57.7	52.7	43.2	49.3
3	2 - 3	58.2	53.2	43.7	49.8
4	3 - 4	58.2	53.2	43.7	49.7
5	4 - 5	53.7	49.2	40.2	45.9
6	5 - 6	53.2	49.7	40.7	46.4
7	6 - 7	58.2	51.2	40.7	48.9
8	7 - 8	59.7	52.7	42.2	50.4
9	8 - 9	61.7	55.2	45.2	53
10	9 - 10	62.2	55.7	45.7	53.3
11	10 - 11	60.2	54.7	47.2	52.6
12	11 - 12	58.7	54.2	46.7	51.6
13	12 - 13	59.2	54.2	45.7	51.6
14	13 - 14	57.2	52.7	45.2	50.2
15	14 - 15	56.7	51.7	43.7	49.3
16	15 - 16	54.2	50.7	41.2	49.1
17	16 - 17	56.7	51.2	42.2	48.6
18	17 - 18	56.7	52.7	43.2	49.4
19	18 - 19	58.7	49.7	41.2	51
20	19 - 20	60.7	53	42.7	52.3
21	20 - 21	54.2	48.2	41.7	45.9
22	21 - 22	50.2	47.2	41.2	44.8
23	22 - 23	55.7	47.2	40	44.9
24	23 - 24	48.2	44.7	40	40.8

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	51.5 dB(A)
Leq (night)	22:00 - 06:00	49.4 dB(A)
L90 (background)	07:00 - 18:00	44.4 dB(A)
Leq (24 hours)	00:00 - 24:00	50 dB(A)
1hr Leq max	22:00 - 06:00	51.5 dB(A)

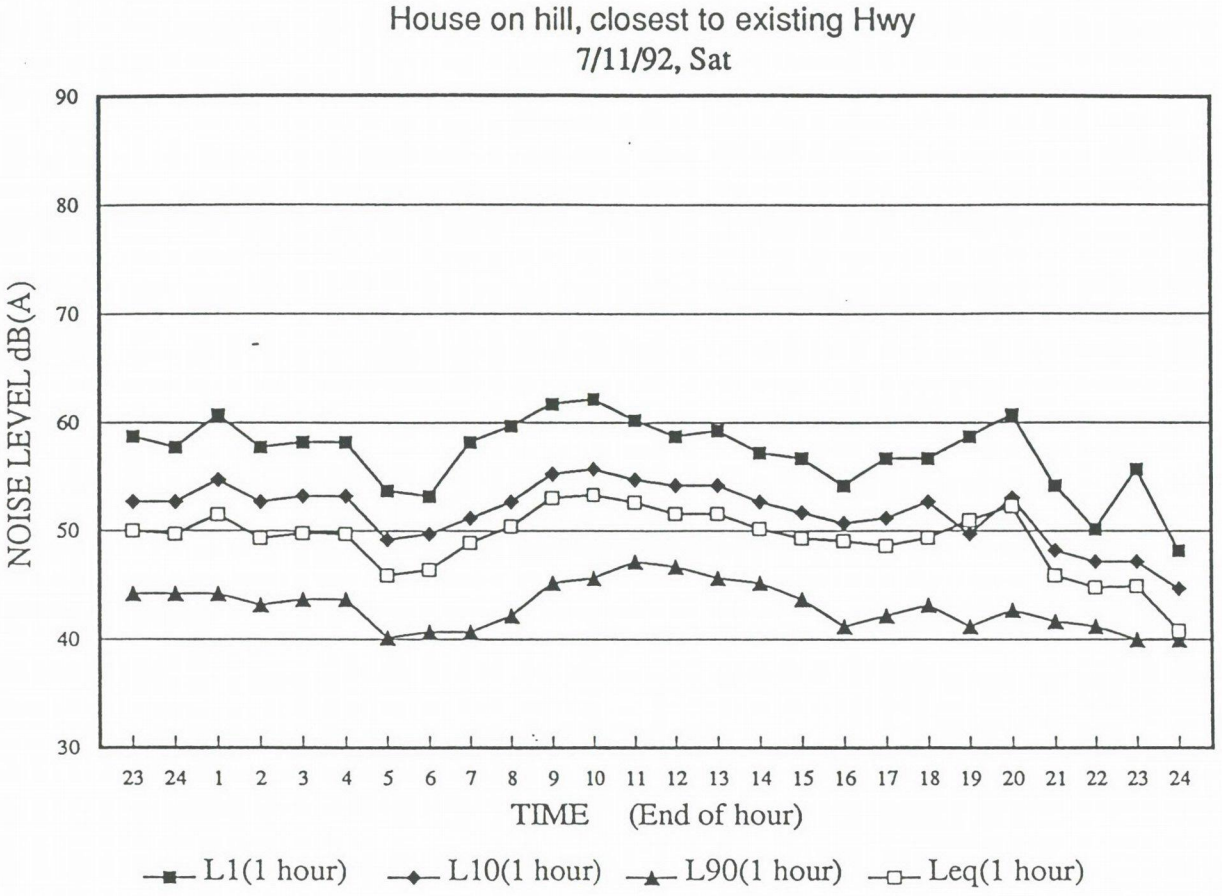

House on hill, closest to existing Hwy
7/11/92, Sat
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-3

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: House on hill, closest to existing Hwy
DATE/DAY/LOC 8/11/92, Sun

FILENAME: C:\123R3\BRUNS\CLOSEHIL
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	55.7	47.2	40	44.9
24	23 - 24	48.2	44.7	40	40.8
1	24 - 1	47.7	42.2	40	40
2	1 - 2	47.2	42.2	40	40
3	2 - 3	49.2	43.2	40	40
4	3 - 4	48.7	43.7	40	40
5	4 - 5	48.7	43.2	40	40
6	5 - 6	49.7	45.2	40	42.1
7	6 - 7	52.7	45.7	40	43
8	7 - 8	54.7	47.7	40	45.6
9	8 - 9	57.7	48.7	40.2	47
10	9 - 10	60.7	51.2	40.7	49.2
11	10 - 11	53.2	47.7	40	45.2
12	11 - 12	60.7	54.2	40.7	52.7
13	12 - 13				
14	13 - 14				
15	14 - 15				
16	15 - 16				
17	16 - 17				
18	17 - 18				
19	18 - 19				
20	19 - 20				
21	20 - 21				
22	21 - 22				
23	22 - 23				
24	23 - 24				

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	49.2 dB(A)
Leq (night)	22:00 - 06:00	41.3 dB(A)
L90 (background)	07:00 - 18:00	40.3 dB(A)
Leq (24 hours)	00:00 - 24:00	43 dB(A)
1hr Leq max	22:00 - 06:00	44.9 dB(A)

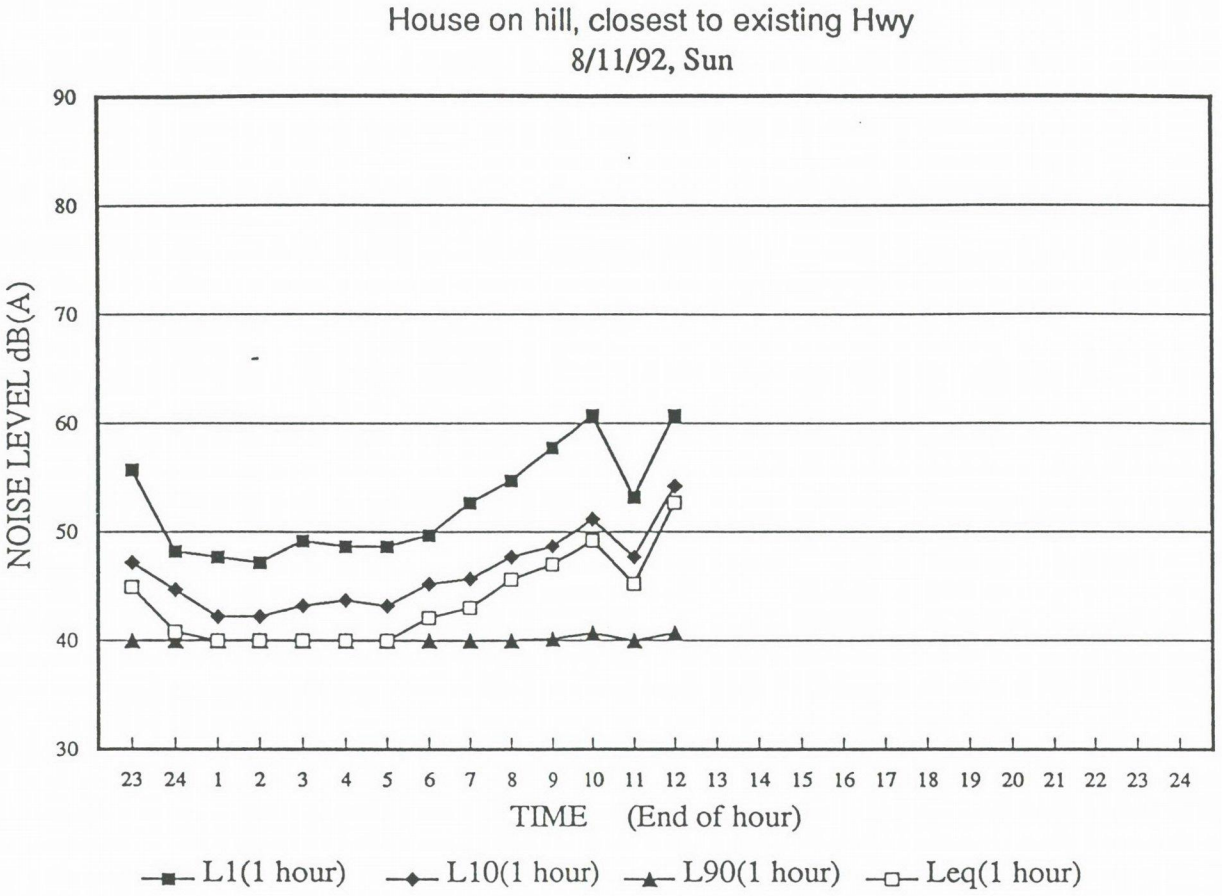

House on hill, closest to existing Hwy
8/11/92, Sun
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-4

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: House on hill, closest to existing Hwy
DATE/DAY/LOC 8/11 & 6/11, Sun & Fri

FILENAME: C:\123R3\BRUNS\CLOSEHIL
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	55.7	47.2	40	44.9
24	23 - 24	48.2	44.7	40	40.8
1	24 - 1	47.7	42.2	40	40
2	1 - 2	47.2	42.2	40	40
3	2 - 3	49.2	43.2	40	40
4	3 - 4	48.7	43.7	40	40
5	4 - 5	48.7	43.2	40	40
6	5 - 6	49.7	45.2	40	42.1
7	6 - 7	52.7	45.7	40	43
8	7 - 8	54.7	47.7	40	45.6
9	8 - 9	57.7	48.7	40.2	46.6
10	9 - 10	60.7	51.2	40.7	49.2
11	10 - 11	53.2	47.7	40	45.2
12	11 - 12	60.7	54.2	40.7	52.7
13	12 - 13	61	55	41	52
14	13 - 14	60	54	42	51
15	14 - 15	59	53	43	50
16	15 - 16	58.7	52.7	42.2	49.8
17	16 - 17	58.2	55.2	46.7	52.2
18	17 - 18	64.2	55.7	42.2	52.2
19	18 - 19	60.2	52.2	43.2	49.9
20	19 - 20	64.2	61.7	47.2	55.9
21	20 - 21	61.7	55.7	46.7	52.9
22	21 - 22	60.2	54.2	45.2	51.4
23	22 - 23	58.7	52.7	44.2	50
24	23 - 24	57.7	52.7	44.2	49.7

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	52.8 dB(A)
Leq (night)	22:00 - 06:00	41.3 dB(A)
L90 (background)	07:00 - 18:00	41.7 dB(A)
Leq (24 hours)	00:00 - 24:00	49.8 dB(A)
1hr Leq max	22:00 - 06:00	44.9 dB(A)

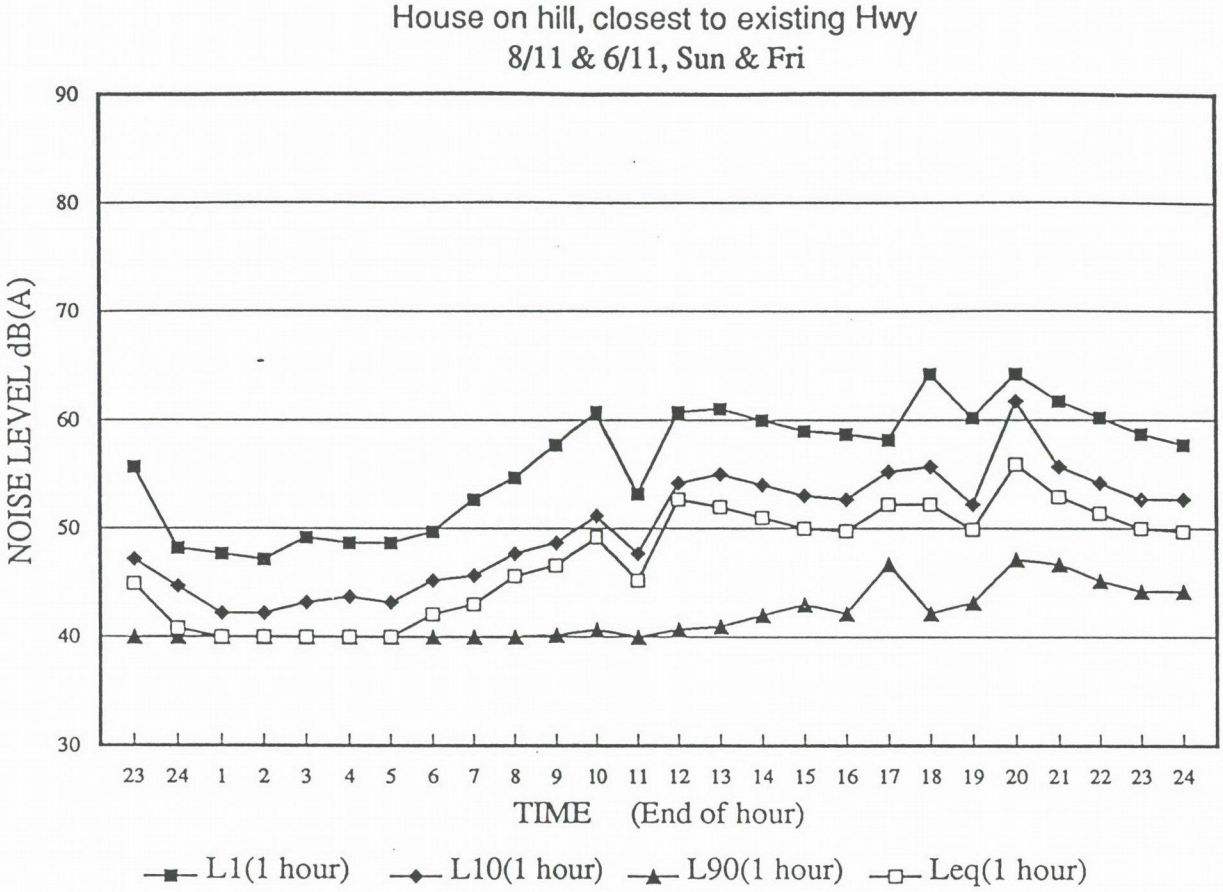

House on hill, closest to existing Hwy
8/11 & 6/11, Sun & Fri
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-5

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: House on hill, closest to existing Hwy
DATE/DAY/LOC 8/11 & Sat 10/11/92, Sun + Sat

FILENAME: C:\123R3\BRUNS\CLOSEHIL
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 0

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	55.7	47.2	40	44.9
24	23 - 24	48.2	44.7	40	40.8
1	24 - 1	47.7	42.2	40	40
2	1 - 2	47.2	42.2	40	40
3	2 - 3	49.2	43.2	40	40
4	3 - 4	48.7	43.7	40	40
5	4 - 5	48.7	43.2	40	40
6	5 - 6	49.7	45.2	40	42.1
7	6 - 7	52.7	45.7	40	43
8	7 - 8	54.7	47.7	40	45.6
9	8 - 9	57.7	48.7	40.2	47
10	9 - 10	60.7	51.2	40.7	49.2
11	10 - 11	53.2	47.7	40	45.2
12	11 - 12	60.7	54.2	40.7	52.7
13	12 - 13	59.2	54.2	45.7	51.6
14	13 - 14	57.2	52.7	45.2	50.2
15	14 - 15	56.7	51.7	43.7	49.3
16	15 - 16	54.2	50.7	41.2	49.1
17	16 - 17	56.7	51.2	42.2	48.6
18	17 - 18	56.7	52.7	43.2	49.4
19	18 - 19	58.7	49.7	41.2	51
20	19 - 20	60.7	53	42.7	52.3
21	20 - 21	54.2	48.2	41.7	45.9
22	21 - 22	50.2	47.2	41.2	44.8
23	22 - 23	55.7	47.2	40	44.9
24	23 - 24	48.2	44.7	40	40.8

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	49.9 dB(A)
Leq (night)	22:00 - 06:00	41.3 dB(A)
L90 (background)	07:00 - 18:00	42.1 dB(A)
Leq (24 hours)	00:00 - 24:00	47.8 dB(A)
1hr Leq max	22:00 - 06:00	44.9 dB(A)

House on hill, closest to existing Hwy
8/11 & Sat 10/11/92, Sun + Sat

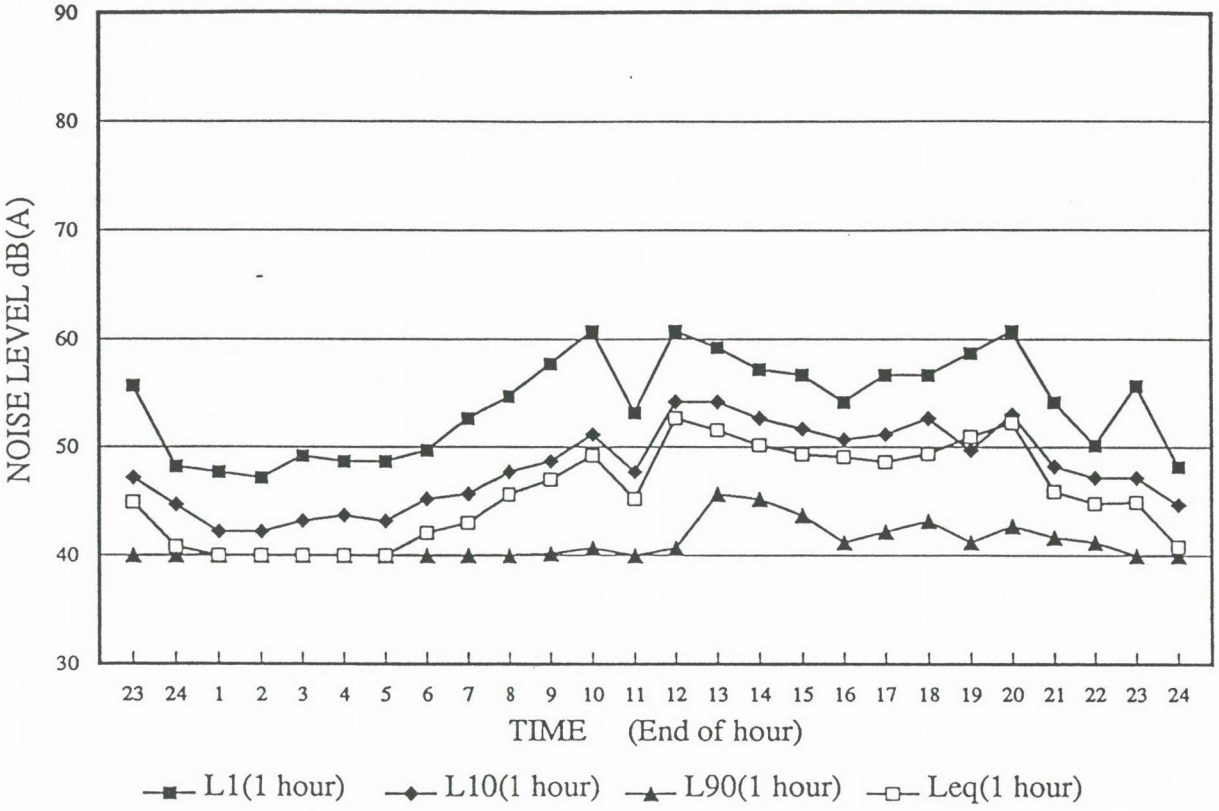


TABLE A-5

Location 5

DATE: THURSDAY 28 NOVEMBER, 1991
ADDRESS: 19 MINYON ST., BRWK HEADS (CR BYRON ST.)
TYPE: FACADE (10:00-15:00 HRS INTERPOLATED)
** MRS UPPGARD

TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
22 - 23	51.3	46.3	38.8	45
23 - 24	48.8	43.8	39.3	44.2
24 - 1	54.3	44.3	39.5	44.6
1 - 2	48.3	44.5	40.8	44.2
2 - 3	49.3	44.8	39.3	43.8
3 - 4	49.5	44.8	38.8	42
4 - 5	50.3	45.3	40	44.1
5 - 6	52.3	47	40.5	45.8
6 - 7	60.3	47.8	41.8	52.1
7 - 8	59.3	47.8	42.5	48
8 - 9	62.3	48.3	42.3	51.3
9 - 10	58.7	46.5	44.8	49.3
10 - 11	54.3	45.8	45	50
11 - 12	56.3	46.5	42	47.3
12 - 13	57.3	47.3	43	48.5
13 - 14	58.3	48	45	50
14 - 15	58.3	48	45	50
15 - 16	58.3	51	46	50.5
16 - 17	62.8	51.3	45.8	51.6
17 - 18	59.3	51.3	45	50.6
18 - 19	55.3	49.8	43.5	48.1
19 - 20	58.3	51.5	43.8	48.8
20 - 21	51.3	46.5	41.5	45
21 - 22	54.3	46.3	40.8	44.8
22 - 23	48.8	45.3	39.8	44.6
23 - 24	48.3	44	39.5	45

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	47.9 dB(A)
Leq (night)	22:00 - 06:00	44.3 dB(A)
L90 (background)	07:00 - 18:00	44.2 dB(A)
Leq (24 hours)	00:00 - 24:00	48.4 dB(A)
1hr Leq max	22:00 - 06:00	45.8 dB(A)

NOISE LEVELS at 19 MINYON STREET, BRUNSWICK HEADS (CORNER OF BYRON STREET)

THURSDAY 28 NOVEMBER, 1991

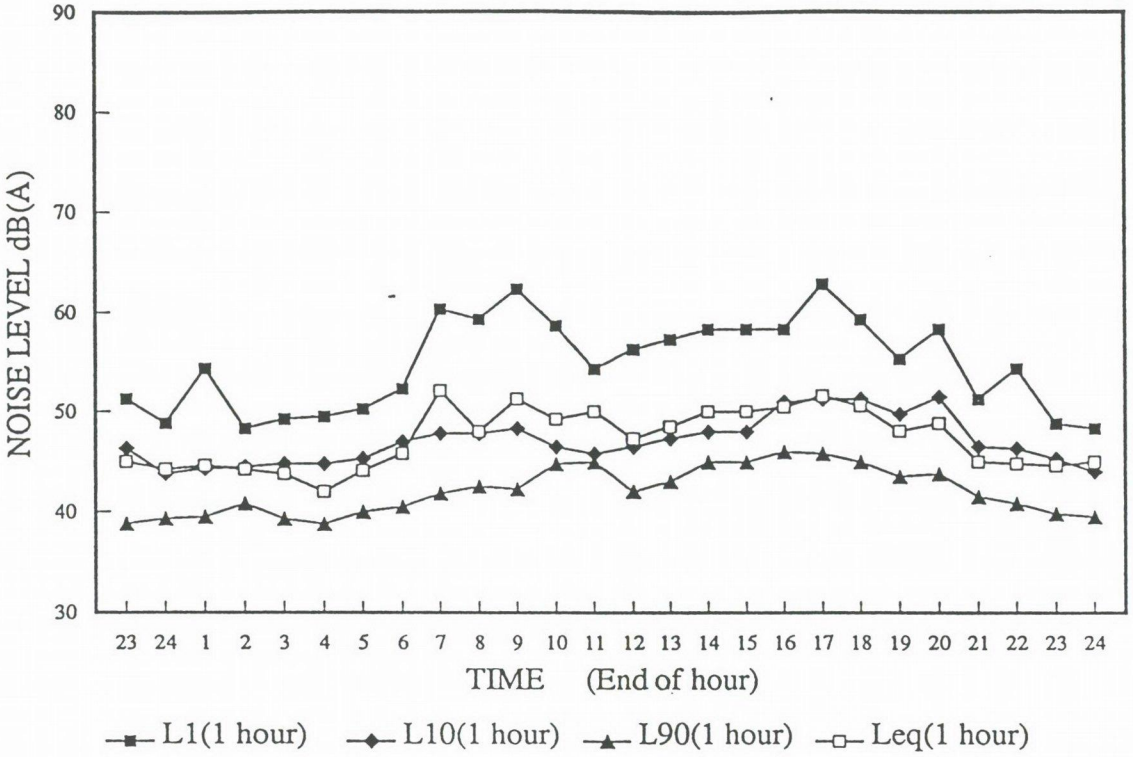


TABLE A-6

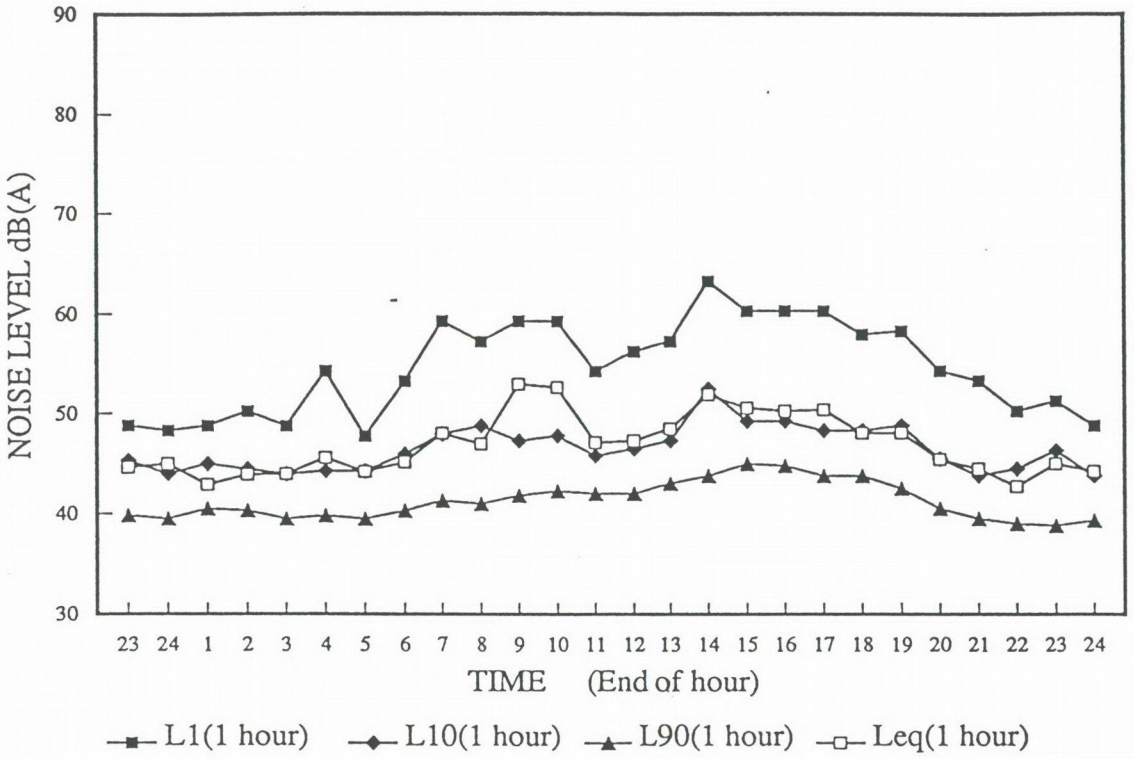
DATE: WED 27 AND FRI 29 NOVEMBER, 1991
ADDRESS: 19 MINYON ST., BRWK HEADS (CR BYRON ST.)
TYPE: FACADE

TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
22 - 23	48.8	45.3	39.8	44.6
23 - 24	48.3	44	39.5	45
24 - 1	48.8	45	40.5	42.9
1 - 2	50.3	44.5	40.3	43.9
2 - 3	48.8	44	39.5	44
3 - 4	54.3	44.3	39.8	45.6
4 - 5	47.8	44.3	39.5	44.2
5 - 6	53.3	46	40.3	45.2
6 - 7	59.3	48	41.3	48.1
7 - 8	57.3	48.8	41	47
8 - 9	59.3	47.3	41.8	53
9 - 10	59.3	47.8	42.3	52.7
10 - 11	54.3	45.8	42	47.1
11 - 12	56.3	46.5	42	47.3
12 - 13	57.3	47.3	43	48.5
13 - 14	63.3	52.5	43.8	51.9
14 - 15	60.3	49.3	45	50.6
15 - 16	60.3	49.3	44.8	50.3
16 - 17	60.3	48.3	43.8	50.4
17 - 18	58	48.3	43.8	48.1
18 - 19	58.3	48.8	42.5	48.1
19 - 20	54.3	45.5	40.5	45.4
20 - 21	53.3	43.8	39.5	44.5
21 - 22	50.3	44.5	39	42.7
22 - 23	51.3	46.3	38.8	45
23 - 24	48.8	43.8	39.3	44.2

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	47.3 dB(A)
Leq (night)	22:00 - 06:00	44.5 dB(A)
L90 (background)	07:00 - 18:00	43 dB(A)
Leq (24 hours)	00:00 - 24:00	48.2 dB(A)
1hr Leq max	22:00 - 06:00	45.6 dB(A)

NOISE LEVELS at 19 MINYON STREET, BRUNSWICK HEADS (CORNER OF BYRON STREET)

WEDNESDAY 27 AND FRIDAY 29 NOVEMBER, 1991



Location 6

TABLE A-2

DATE: WED 27 AND THURS 28 NOVEMBER, 1991
ADDRESS: 12 CUDGEN ST., BRWK HEADS (CR BOOYUN ST
TYPE: FACADE

TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
22 - 23	44.3	38.5	32	40.4
23 - 24	41.5	38.5	31	35.5
24 - 1	43.3	37	31.3	35.4
1 - 2	49.5	45.3	35.5	41.6
2 - 3	47.3	40	32.3	38
3 - 4	43.8	39	31.8	36.2
4 - 5	45.3	41	35.5	38.7
5 - 6	47.3	41.3	35.8	39.6
6 - 7	56.3	44.5	37	51.2
7 - 8	54.3	44	37.5	44.6
8 - 9	54.3	44	38.8	48.2
9 - 10	49.3	43.8	39.8	42.5
10 - 11	53.3	46	41	45.1
11 - 12	58.8	49.5	41	48.6
12 - 13	54.5	49	38.8	45.5
13 - 14	63.3	57	40.3	52.4
14 - 15	53	48.3	40.3	45
15 - 16	54.5	50.5	42.8	47.1
16 - 17	54.3	47.5	42.8	47.1
17 - 18	56.3	47.5	41.5	47.3
18 - 19	49.3	42.8	38.3	41.2
19 - 20	52.8	43.8	37	43.6
20 - 21	52.3	40.8	35	48.7
21 - 22	42.3	37	32.3	35.5
22 - 23	44.3	38.5	32	40.4
23 - 24	41.5	38.5	31	35.5

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	45.2 dB(A)
Leq (night)	22:00 - 06:00	38.7 dB(A)
L90 (background)	07:00 - 18:00	40.4 dB(A)
Leq (24 hours)	00:00 - 24:00	45.8 dB(A)
1hr Leq max	22:00 - 06:00	41.6 dB(A)

NOISE LEVELS at 12 CUDGEN STREET, BRUNSWICK HEADS (CORNER OF BOOYUN ST.)

WEDNESDAY 27 AND THURSDAY 28 NOVEMBER, 1991

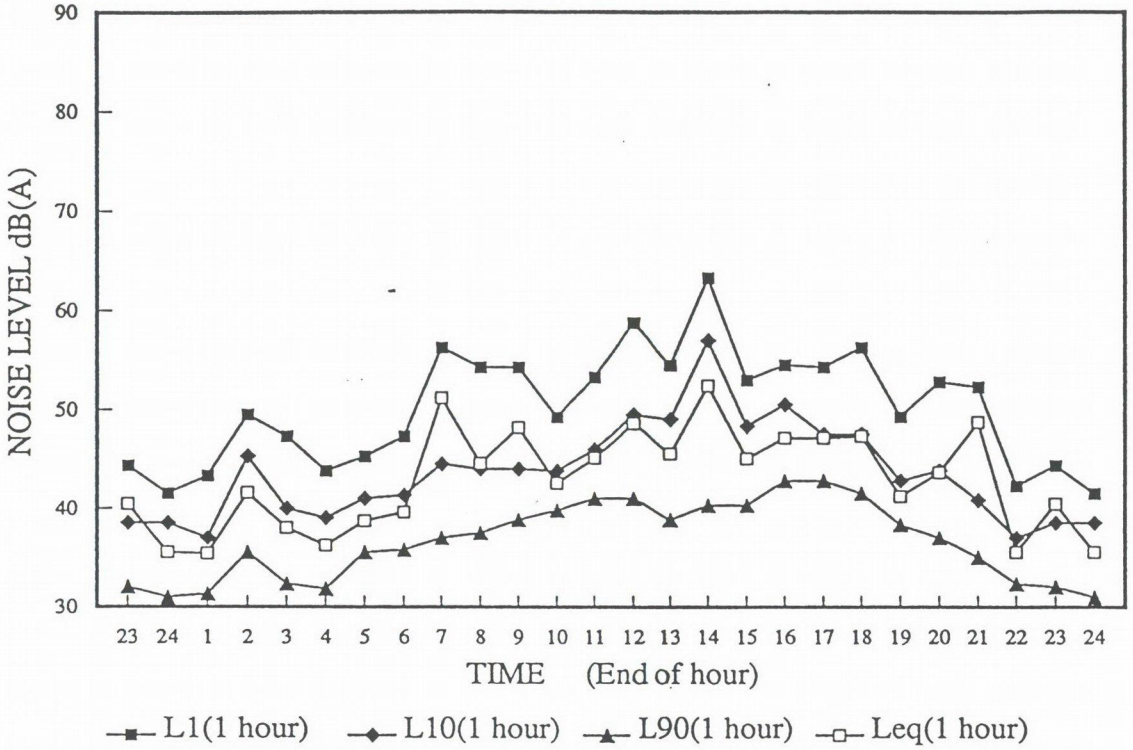


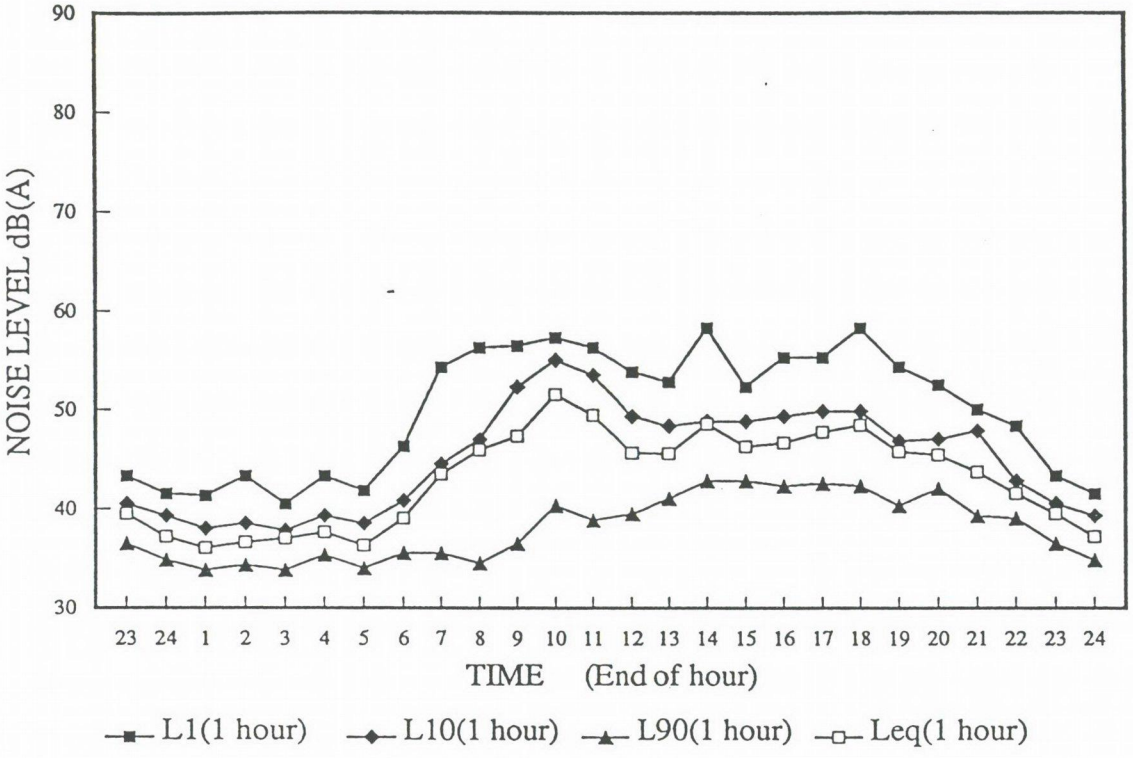
TABLE A-3

DATE: THURS 28 AND FRI 29 NOVEMBER, 1991 Location 6
ADDRESS: 12 CUDGEN ST., BRWK HEADS (CR BOOYUN ST
TYPE: FACADE

TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
22 - 23	43.3	40.5	36.5	39.5
23 - 24	41.5	39.3	34.8	37.2
24 - 1	41.3	38	33.8	36
1 - 2	43.3	38.5	34.3	36.6
2 - 3	40.5	37.8	33.8	37
3 - 4	43.3	39.3	35.3	37.6
4 - 5	41.8	38.5	34	36.3
5 - 6	46.3	40.8	35.5	39
6 - 7	54.3	44.5	35.5	43.5
7 - 8	56.3	47	34.5	45.9
8 - 9	56.5	52.3	36.5	47.3
9 - 10	57.3	55	40.3	51.5
10 - 11	56.3	53.5	38.8	49.4
11 - 12	53.8	49.3	39.5	45.6
12 - 13	52.8	48.3	41	45.5
13 - 14	58.3	48.8	42.8	48.5
14 - 15	52.3	48.8	42.8	46.2
15 - 16	55.3	49.3	42.3	46.6
16 - 17	55.3	49.8	42.5	47.7
17 - 18	58.3	49.8	42.3	48.4
18 - 19	54.3	46.8	40.3	45.7
19 - 20	52.5	47	42	45.4
20 - 21	50	47.8	39.3	43.7
21 - 22	48.3	42.8	39	41.5
22 - 23	43.3	40.5	36.5	39.5
23 - 24	41.5	39.3	34.8	37.2

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	47.8 dB(A)
Leq (night)	22:00 - 06:00	37.6 dB(A)
L90 (background)	07:00 - 18:00	40.3 dB(A)
Leq (24 hours)	00:00 - 24:00	45.5 dB(A)
1hr Leq max	22:00 - 06:00	39.5 dB(A)

NOISE LEVELS at 12 CUDGEN STREET, BRUNSWICK HEADS (CORNER OF BOOYUN ST.)
THURSDAY 28 AND FRIDAY 29 NOVEMBER, 1991



Location 7

TABLE A-2

DATE: TUESDAY 26 NOVEMBER, 1991
ADDRESS: MR. USHER, 64 PAC. HWY, BRWK HEADS
TYPE: ~~FACADE~~ 3m in front of house

TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
22 - 23	75.3	66.8	44	63.1
23 - 24	74.8	63.8	43.5	61.5
24 - 1	76.3	62.8	43.3	63.8
1 - 2	72.3	53.8	42.5	58.3
2 - 3	76.3	60.3	41.5	63.2
3 - 4	75.3	57.8	41.3	61.4
4 - 5	74.8	63.3	41.5	61.7
5 - 6	75.8	67.3	43.3	63.4
6 - 7	77.3	71.3	47.8	66.7
7 - 8	76.3	70.5	47.3	66.5
8 - 9	76.8	71	52.5	68.2
9 - 10	76.8	71	51.5	67.5
10 - 11	75.8	70.8	54.5	67.3
11 - 12	75.3	70.3	54	66.5
12 - 13	75.8	70.5	52.3	66.6
13 - 14	75.8	70.3	53.5	66.6
14 - 15	76.3	70.8	54.5	67
15 - 16	75.8	70.8	54.3	66.9
16 - 17	76.3	70.8	53.5	67
17 - 18	75.8	70.8	53.5	66.9
18 - 19	75.8	70.3	50.8	66.5
19 - 20	76.3	69.5	46	65.4
20 - 21	75.3	68.3	45.8	64.3
21 - 22	74.8	67.5	44	63.3
22 - 23	75.8	69	43.3	67.2
23 - 24	74.3	64	42.3	61

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	69.9 dB(A)
Leq (night)	22:00 - 06:00	62.3 dB(A)
L90 (background)	07:00 - 18:00	52.9 dB(A)
Leq (24 hours)	00:00 - 24:00	65.7 dB(A)
1hr Leq max	22:00 - 06:00	63.8 dB(A)

NOISE LEVELS at 64 PACIFIC HIGHWAY, BRUNSWICK HEADS
TUESDAY 26 NOVEMBER, 1991

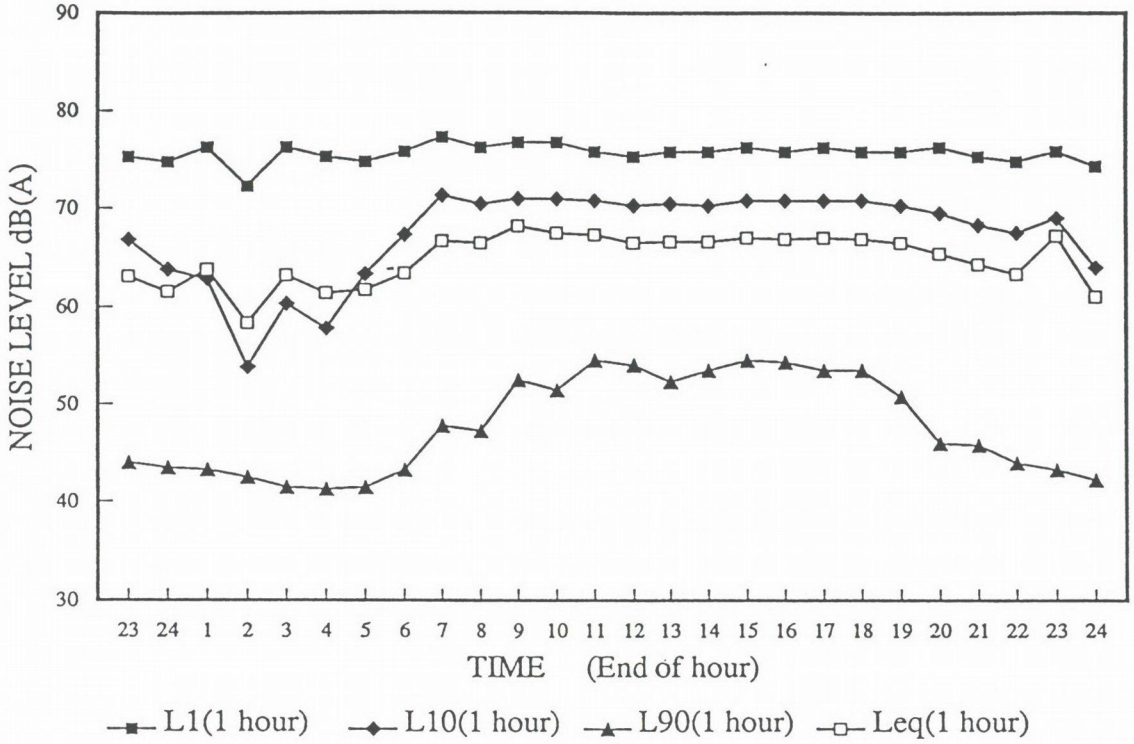


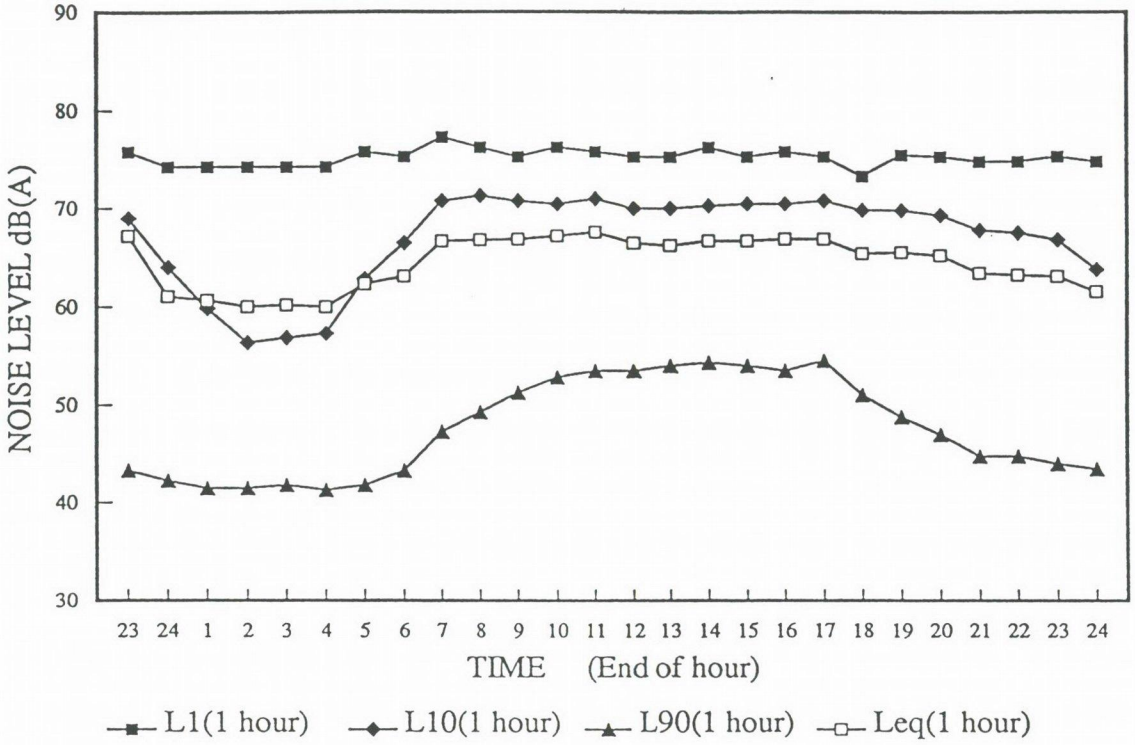
TABLE A-3

DATE: MON. 25 AND WED. 27 NOVEMBER, 1991
ADDRESS: MR. USHER, 64 PAC. HWY, BRWK HEADS
TYPE: ~~FACADE~~ 3m inside of house.

TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
22 - 23	75.8	69	43.3	67.2
23 - 24	74.3	64	42.3	61
24 - 1	74.3	59.8	41.5	60.6
1 - 2	74.3	56.3	41.5	60
2 - 3	74.3	56.8	41.8	60.2
3 - 4	74.3	57.3	41.3	60
4 - 5	75.8	62.8	41.8	62.3
5 - 6	75.3	66.5	43.3	63.1
6 - 7	77.3	70.8	47.3	66.7
7 - 8	76.3	71.3	49.3	66.8
8 - 9	75.3	70.8	51.3	66.9
9 - 10	76.3	70.5	52.8	67.2
10 - 11	75.8	71	53.5	67.6
11 - 12	75.3	70	53.5	66.5
12 - 13	75.3	70	54	66.2
13 - 14	76.3	70.3	54.3	66.7
14 - 15	75.3	70.5	54	66.7
15 - 16	75.8	70.5	53.5	66.9
16 - 17	75.3	70.8	54.5	66.9
17 - 18	73.3	69.8	51	65.4
18 - 19	75.5	69.8	48.8	65.5
19 - 20	75.3	69.3	47	65.2
20 - 21	74.8	67.8	44.8	63.4
21 - 22	74.8	67.5	44.8	63.2
22 - 23	75.3	66.8	44	63.1
23 - 24	74.8	63.8	43.5	61.5

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	69.5 dB(A)
Leq (night)	22:00 - 06:00	62.6 dB(A)
L90 (background)	07:00 - 18:00	52.9 dB(A)
Leq (24 hours)	00:00 - 24:00	65.2 dB(A)
1hr Leq max	22:00 - 06:00	67.2 dB(A)

NOISE LEVELS at 64 PACIFIC HIGHWAY, BRUNSWICK HEADS
MONDAY 25 AND WEDNESDAY 27 NOVEMBER, 1991



RECORD OF SHORT AND SATELLITE TRAFFIC NOISE MEASUREMENTS

SATELLITE STATION ADDI:OCEAN CARAVAN PARK Location B

PERMANENT STATION ADI: 64 PACIFIC HIGHWAY, BRUNSWICK HEADS

DATE: MON 25 NOV, 1991 MEASUREMENT TYPI: FREEFIELD

WEATHER: ~~DRY AND SUNNY~~ FINE, WIND FREE

START TIME	No.OF MIN	SATELLITE STATION MEASUREMENTS (NOISE LEVELS IN dBA) L1	L10	L50	L90	Leq	SIMULT PS LEVELS L10	Leq	DIFFERENCE L10	Leq
16.10	20	74.5	68.5	61	51.5	65	70.3	66.3	-1.8	-1.3
16:40	20	75.5	69	62	52	65.5	70.5	66.7	-1.5	-1.2
17:00	20	78	70	63	53.5	67.2	71	67.2	-1	0
17:30	20	77	69.5	60.3	52.5	66.3	70	66.3	-0.5	0
AVE. (dBA)		76.3	69.3	60.6	52.4	66	70.5	66.7	-1.2	-0.8

PERMANENT STATION:

L10,18hrs (06:00 - 24:00) = 69.7 dBA
Leq,24hrs (00:00 - 24:00) = 65.5 dBA
Leq,night (22:00 - 06:00) = 62.4 dBA

SATELLITE STATION:

L10(18hrs,SS) = L10(18hrs,PS) + ave L10(difference) = 68.5 dBA

Leq(24hrs,SS) = Leq(24hrs,PS) + ave Leq(difference) = 64.7 dBA

Leq(night,SS) = Leq(night,PS) + ave Leq(difference) = 61.6 dBA

L10(18 hrs,short measurement) = ave L10(SS) - 1.0 = 68.3 dBA

REMARKS: NEAREST VAN SITES 10M FROM ROAD CENTRELINE

RECORD OF SHORT AND SATELLITE TRAFFIC NOISE MEASUREMENTS

SATELLITE STATION ~~ADDI~~:LAGOON CARAVAN PARK Location 9.

PERMANENT STATION ADI: 64 PACIFIC HIGHWAY, BRUNSWICK HEADS

DATE: MON 25 NOV, 1991 MEASUREMENT TYPI: FREEFIELD

WEATHER: ~~DRY AND SUNNY~~ FINE, WIND FREE

START TIME	No.OF MIN	SATELLITE STATION MEASUREMENTS (NOISE LEVELS IN dBA) L1	L10	L50	L90	Leq	SIMULT PS LEVELS L10	Leq	DIFFERENCE L10	Leq
16:00	20	71	66	61.5	57	63.3	70.3	66.3	-4.3	-3
16:30	20	70.5	64.3	59.8	55	61.5	70	66.5	-5.7	-5
16:50	20	72.5	66.8	61	56	63.5	70.8	67	-4	-3.5
17:10	20	70.5	64.8	60.3	55.3	61.8	70.5	66.8	-5.7	-5
AVE. (dBA)		71	65.5	60.6	55.8	62.5	70.4	66.7	-5	-4.1

PERMANENT STATION: L10,18hrs (06:00 - 24:00) = 69.7 dBA
Leq,24hrs (00:00 - 24:00) = 65.5 dBA
Leq,night (22:00 - 06:00) = 62.4 dBA

SATELLITE STATION:

L10(18hrs,SS) = L10(18hrs,PS) + ave L10(difference) = 64.7 dBA

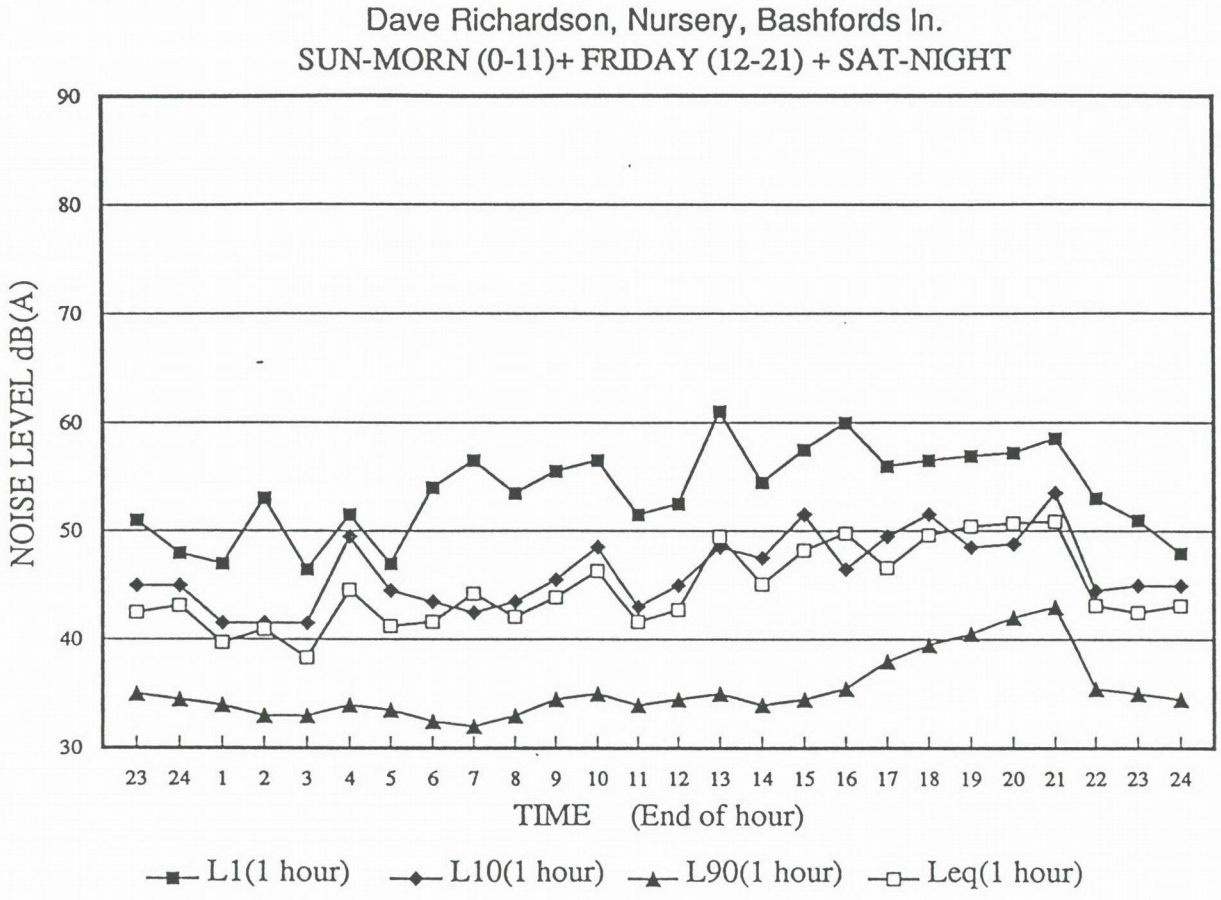
Leq(24hrs,SS) = Leq(24hrs,PS) + ave Leq(difference) = 61.4 dBA

Leq(night,SS) = Leq(night,PS) + ave Leq(difference) = 58.3 dBA

L10(18 hrs,short measurement) = ave L10(SS) - 1.0 = 64.5 dBA

REMARKS: NEAREST SITE 29.5M FROM ROAD LINE

Van


Dave Richardson, Nursery, Bashfords ln.
SUN-MORN (0-11)+ FRIDAY (12-21) + SAT-NIGHT
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

Total Noise Statistics for: BRUNSWICK HEADS
Mrs Morony, 10 Riverside Cresc.

Location no: 1

Totals	Descriptor	Period	Totals
1	L10 (18 hours)	06:00 - 24:00	49.6 DB(A)
1	Leq (night)	22:00 - 06:00	44.7 DB(A)
1	L90 (background)	07:00 - 18:00	42.8 DB(A)
1	Leq (24 hours)	00:00 - 24:00	48.5 DB(A)
1	1hr Leq max	22:00 - 06:00	49.8 DB(A)

Comments

Note: Calculations include concatenated days, but not weekends, to ensure "good weather measurements" are represented.

TABLE A-1

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Mrs Morony, 10 Riverside Cresc.
DATE/DAY/LOC: 4/11/92, WED

FILENAME: A:\123R3\BRUNS\CARPERM.WK3
WEATHER: FINE
COMMENTS: NONE
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23				
24	23 - 24				
1	24 - 1				
2	1 - 2				
3	2 - 3				
4	3 - 4				
5	4 - 5				
6	5 - 6				
7	6 - 7				
8	7 - 8				
9	8 - 9				
10	9 - 10				
11	10 - 11				
12	11 - 12				
13	12 - 13	57.5	54	46.5	51.7
14	13 - 14	60	56.5	50.5	54.2
15	14 - 15	58.5	55.5	49	53.1
16	15 - 16	58	54	48.5	51.8
17	16 - 17	59.5	54.5	48	52.8
18	17 - 18	59.5	54.5	47.5	52
19	18 - 19	59.5	54.5	45.5	51.5
20	19 - 20	64	54	44.5	52.8
21	20 - 21	51	48.5	44	47
22	21 - 22	49.5	46.5	40	44.6
23	22 - 23	48	43.5	37.5	40.9
24	23 - 24	47.5	43.5	36	40.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	51.6 dB(A)
Leq (night)	22:00 - 06:00	0 dB(A)
L90 (background)	07:00 - 18:00	48.3 dB(A)
Leq (24 hours)	00:00 - 24:00	48.1 dB(A)
1hr Leq max	22:00 - 06:00	0 dB(A)

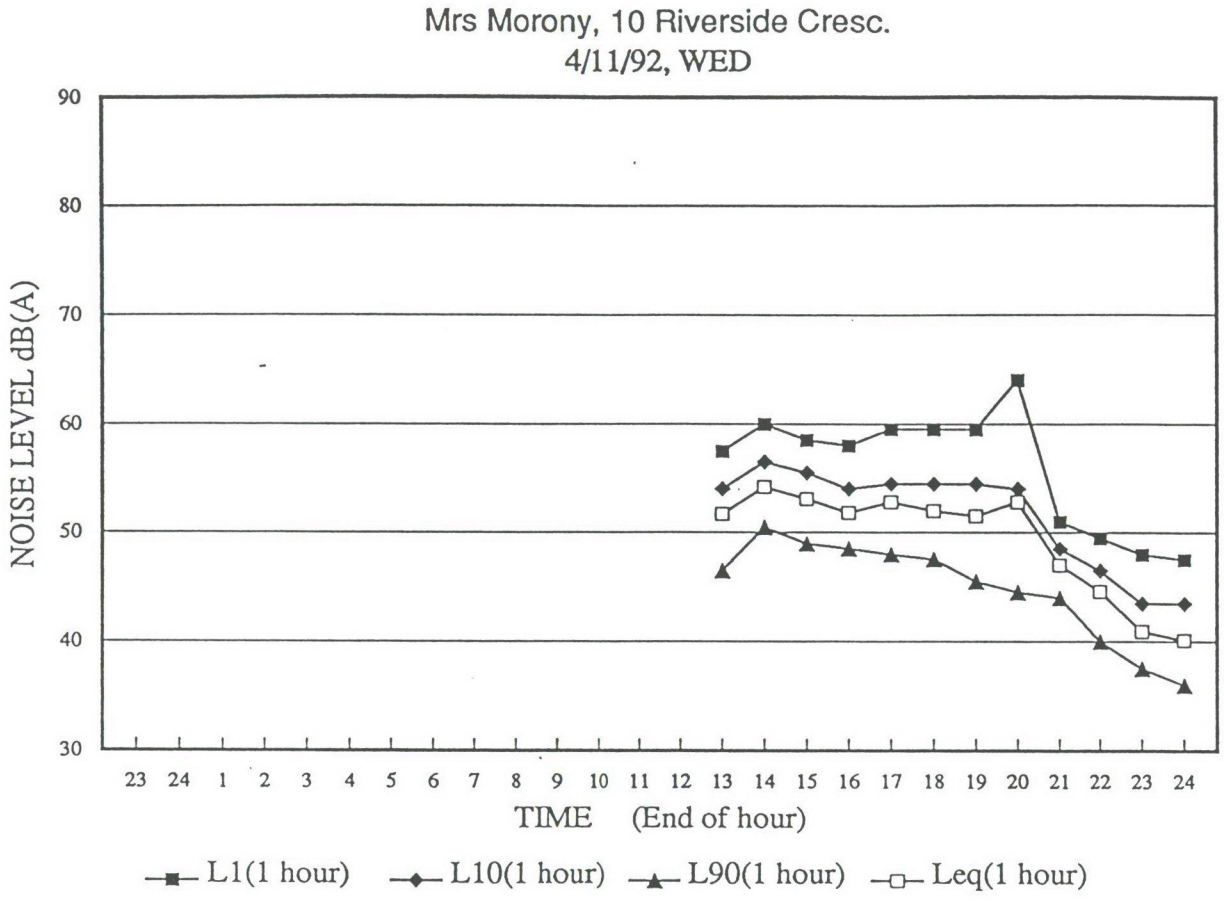

Mrs Morony, 10 Riverside Cresc.
4/11/92, WED
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-2

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Mrs Morony, 10 Riverside Cresc.
DATE/DAY/LOC 5/11/92, THU

FILENAME: A:\123R3\BRUNS\CARPERM.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	48	43.5	37.5	40.9
24	23 - 24	47.5	43.5	36	40.1
1	24 - 1	47.5	43.5	35.5	39.8
2	1 - 2	46.5	42	35.5	39.1
3	2 - 3	50	43.5	36	40.6
4	3 - 4	51	44	36	41.2
5	4 - 5	51	44.5	34.5	48.7
6	5 - 6	61.5	52.5	37	49.8
7	6 - 7	59.5	50.5	41.5	49.5
8	7 - 8	55.5	48.5	41	49.3
9	8 - 9	56	49.5	40	47.3
10	9 - 10	56	48	40.5	46.1
11	10 - 11	61	48.5	40	50.2
12	11 - 12	61.5	53.3	44	51.6
13	12 - 13	54.5	48.9	51.1	47.2
14	13 - 14	58.3	51	43.3	48.9
15	14 - 15	58.3	50.5	42.3	48.7
16	15 - 16	58.3	50.8	42.8	48.7
17	16 - 17	57.3	50.3	42	48.5
18	17 - 18	56.8	50.5	43.5	50.1
19	18 - 19	57.3	51.5	43.3	50.9
20	19 - 20	61.3	56.5	43.5	53.6
21	20 - 21				
22	21 - 22				
23	22 - 23				
24	23 - 24				

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	50.6 dB(A)
Leq (night)	22:00 - 06:00	44.7 dB(A)
L90 (background)	07:00 - 18:00	42.8 dB(A)
Leq (24 hours)	00:00 - 24:00	48.1 dB(A)
1hr Leq max	22:00 - 06:00	49.8 dB(A)

Mrs Morony, 10 Riverside Cresc.
5/11/92, THU

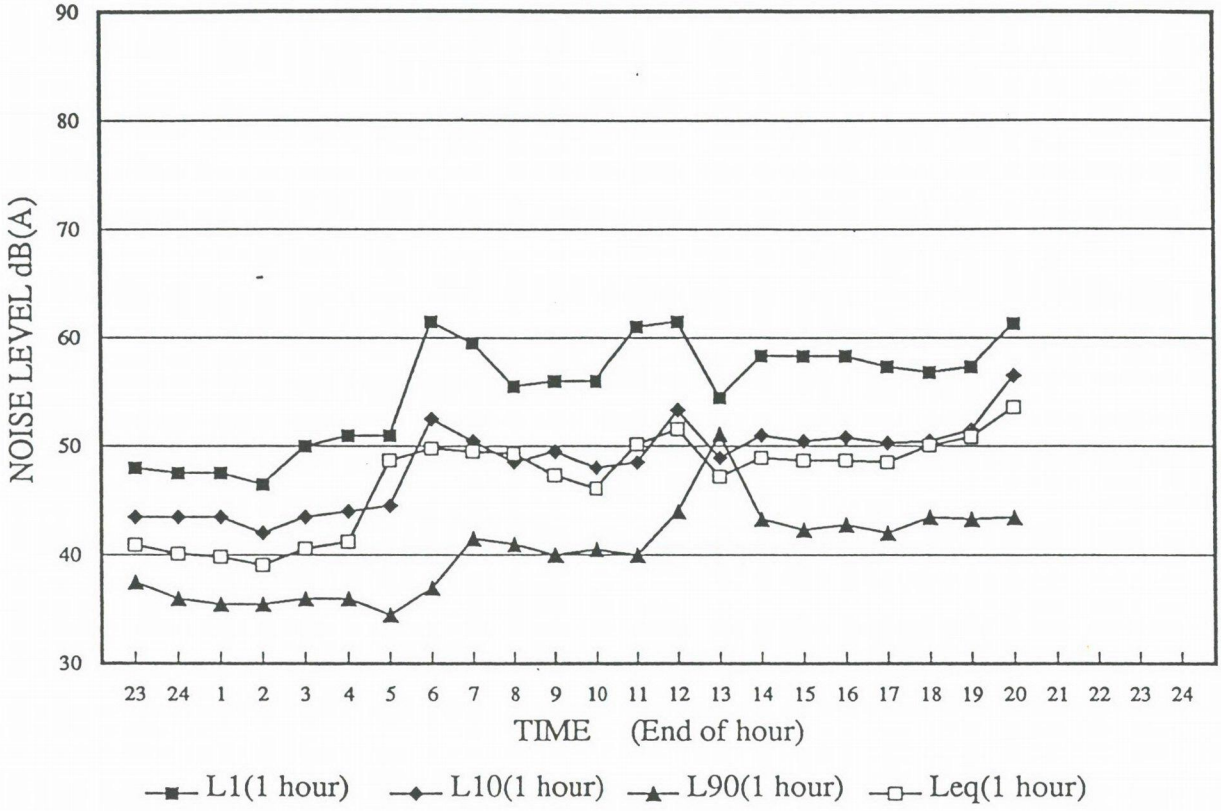


TABLE A-3

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Mrs Morony, 10 Riverside Cresc.
DATE/DAY/LOC 7/11/92, SAT

FILENAME: A:\123R3\BRUNS\CARPERM.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23				
24	23 - 24				
1	24 - 1				
2	1 - 2				
3	2 - 3				
4	3 - 4				
5	4 - 5				
6	5 - 6				
7	6 - 7				
8	7 - 8				
9	8 - 9				
10	9 - 10				
11	10 - 11				
12	11 - 12				
13	12 - 13				
14	13 - 14				
15	14 - 15				
16	15 - 16				
17	16 - 17				
18	17 - 18				
19	18 - 19	64.3	54.3	41.8	52
20	19 - 20	52.8	47.3	41.8	45.1
21	20 - 21	60.3	49.3	40.8	49.4
22	21 - 22	45.8	43.8	40	42
23	22 - 23	45.8	42.8	36.8	40.5
24	23 - 24	45.8	42.8	35	41.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	15.6 dB(A)
Leq (night)	22:00 - 06:00	0 dB(A)
L90 (background)	07:00 - 18:00	0 dB(A)
Leq (24 hours)	00:00 - 24:00	41.2 dB(A)
1hr Leq max	22:00 - 06:00	0 dB(A)

Mrs Morony, 10 Riverside Cresc.
7/11/92, SAT

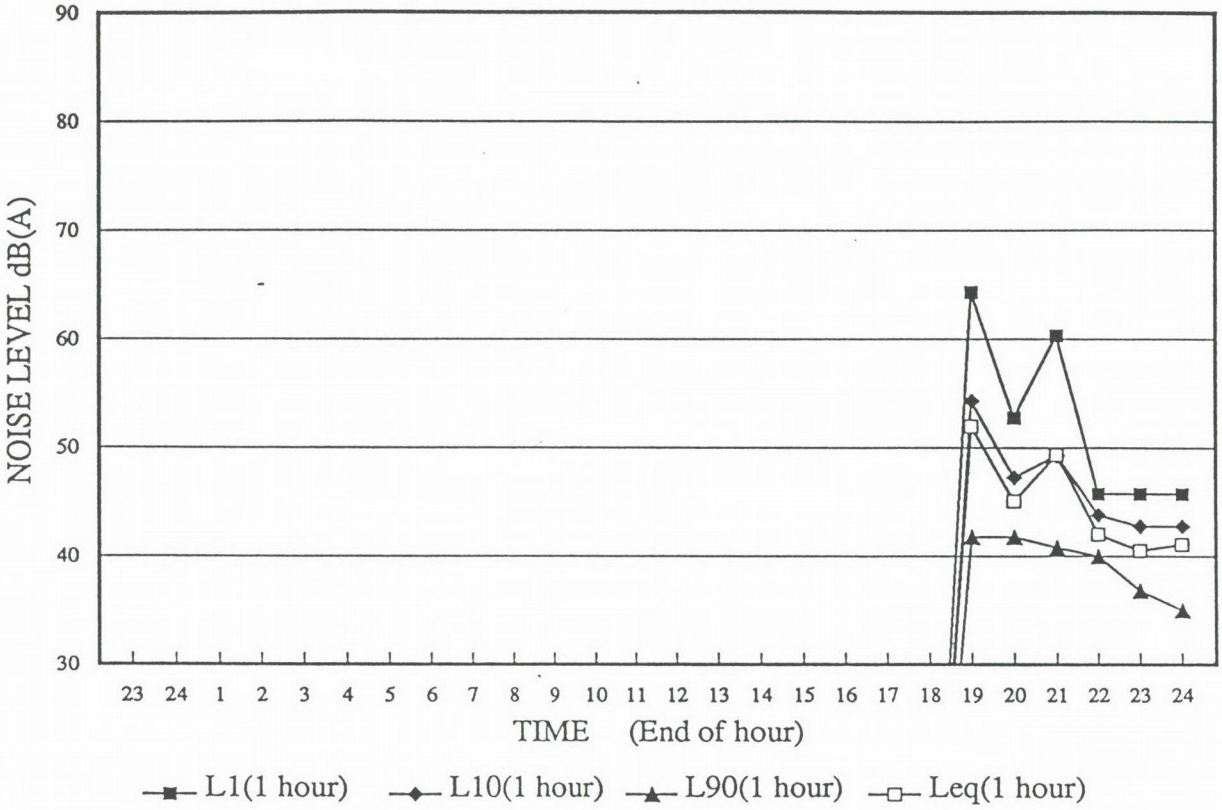


TABLE A-4

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Mrs Morony, 10 Riverside Cresc.
DATE/DAY/LOC 8/11/92, SUN

FILENAME: A:\123R3\BRUNS\CARPERM.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	45.8	42.8	36.8	40.5
24	23 - 24	45.8	42.8	35	41.1
1	24 - 1	45.8	41.3	35.5	38.8
2	1 - 2	42.8	39.5	34.8	37.2
3	2 - 3	45.3	41	36	39.3
4	3 - 4	45.3	41.5	36.5	39.8
5	4 - 5	44.8	41	36.8	39.2
6	5 - 6	60.3	47	38.5	46.9
7	6 - 7	57.3	48.3	38.8	47.2
8	7 - 8	59.3	51.3	41	49.2
9	8 - 9	59.8	51.5	42.8	49.9
10	9 - 10	65.3	56.5	42.5	53.9
11	10 - 11	65.3	52.5	41.3	54
12	11 - 12				
13	12 - 13				
14	13 - 14				
15	14 - 15				
16	15 - 16				
17	16 - 17				
18	17 - 18				
19	18 - 19				
20	19 - 20				
21	20 - 21				
22	21 - 22				
23	22 - 23				
24	23 - 24				

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	52 dB(A)
Leq (night)	22:00 - 06:00	41.5 dB(A)
L90 (background)	07:00 - 18:00	41.9 dB(A)
Leq (24 hours)	00:00 - 24:00	45.3 dB(A)
1hr Leq max	22:00 - 06:00	46.9 dB(A)

Mrs Morony, 10 Riverside Cresc.
8/11/92, SUN

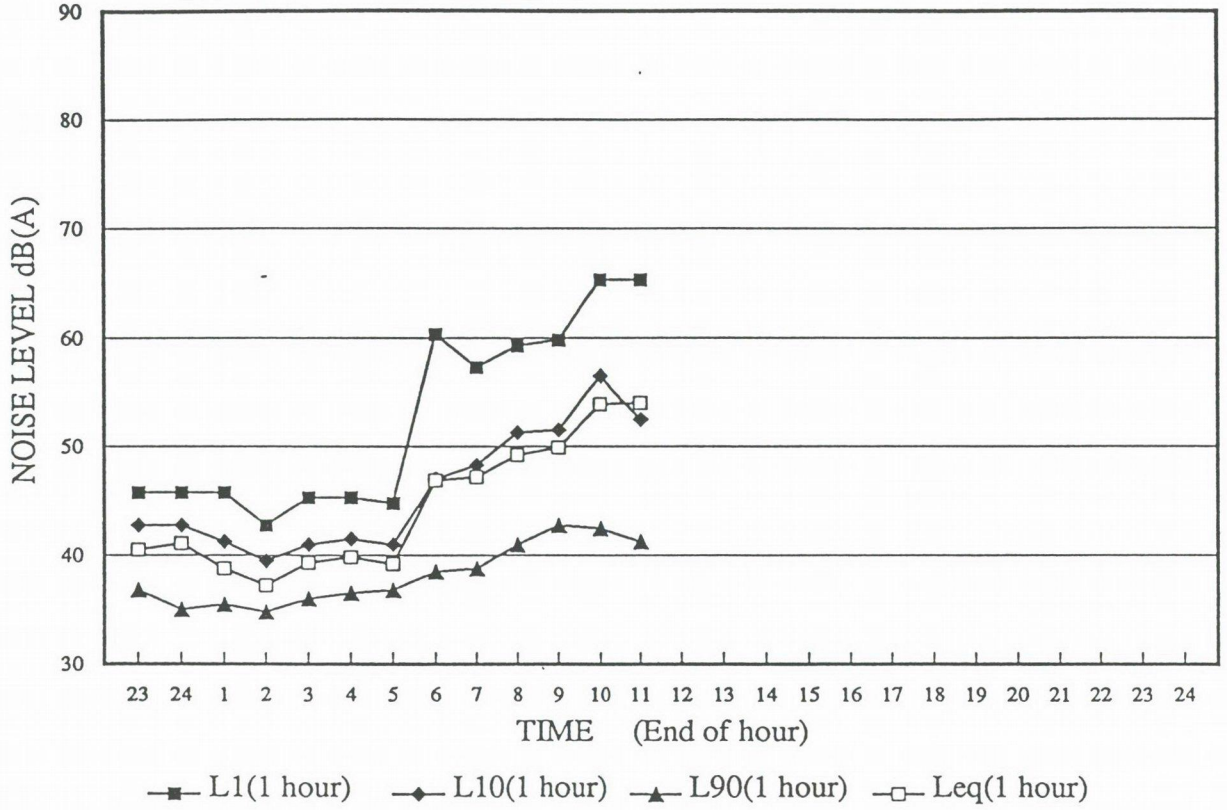


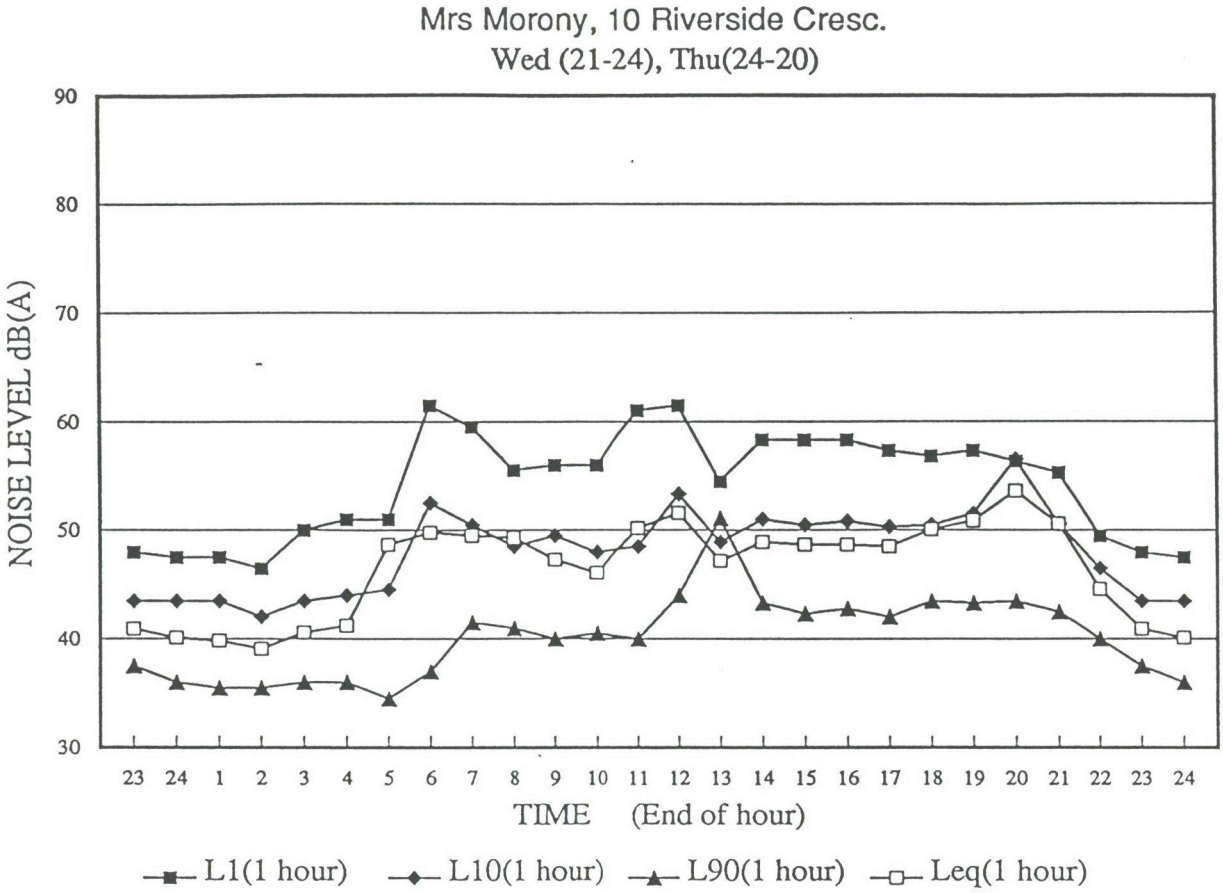
TABLE A-5

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Mrs Morony, 10 Riverside Cresc.
DATE/DAY/LOC Wed (21-24), Thu(24-20)

FILENAME: A:\123R3\BRUNS\CARPERM.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 0

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	48	43.5	37.5	40.9
24	23 - 24	47.5	43.5	36	40.1
1	24 - 1	47.5	43.5	35.5	39.8
2	1 - 2	46.5	42	35.5	39.1
3	2 - 3	50	43.5	36	40.6
4	3 - 4	51	44	36	41.2
5	4 - 5	51	44.5	34.5	48.7
6	5 - 6	61.5	52.5	37	49.8
7	6 - 7	59.5	50.5	41.5	49.5
8	7 - 8	55.5	48.5	41	49.3
9	8 - 9	56	49.5	40	47.3
10	9 - 10	56	48	40.5	46.1
11	10 - 11	61	48.5	40	50.2
12	11 - 12	61.5	53.3	44	51.6
13	12 - 13	54.5	48.9	51.1	47.2
14	13 - 14	58.3	51	43.3	48.9
15	14 - 15	58.3	50.5	42.3	48.7
16	15 - 16	58.3	50.8	42.8	48.7
17	16 - 17	57.3	50.3	42	48.5
18	17 - 18	56.8	50.5	43.5	50.1
19	18 - 19	57.3	51.5	43.3	50.9
20	19 - 20	56.3	56.5	43.5	53.6
21	20 - 21	55.3	50.6	42.5	50.6
22	21 - 22	49.5	46.5	40	44.6
23	22 - 23	48	43.5	37.5	40.9
24	23 - 24	47.5	43.5	36	40.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	49.6 dB(A)
Leq (night)	22:00 - 06:00	44.7 dB(A)
L90 (background)	07:00 - 18:00	42.8 dB(A)
Leq (24 hours)	00:00 - 24:00	48.5 dB(A)
1hr Leq max	22:00 - 06:00	49.8 dB(A)


Mrs Morony, 10 Riverside Cresc.
Wed (21-24), Thu(24-20)
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

Total Noise Statistics for: BRUNSWICK HEADS
Dave Richardson, Nursery, Bashfords ln.

Location no: 2

Totals	Descriptor	Period	Totals
2	L10 (18 hours)	06:00 - 24:00	47.5 DB(A)
2	Leq (night)	22:00 - 06:00	41.7 DB(A)
2	L90 (background)	07:00 - 18:00	35.2 DB(A)
2	Leq (24 hours)	00:00 - 24:00	46.3 DB(A)
2	1hr Leq max	22:00 - 06:00	44.4 DB(A)

Comments

Note: Calculations include concatenated days, including weekends, to ensure "good weather measurements" are represented.

TABLE A-1

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Dave Richardson, Nursery, Bashfords ln.
DATE/DAY/LOC: 5/11/92, THU

FILENAME: A:\123R3\BRUNS\NURS.WK3
WEATHER: FINE
COMMENTS: NONE
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23				
24	23 - 24				
1	24 - 1				
2	1 - 2				
3	2 - 3				
4	3 - 4				
5	4 - 5				
6	5 - 6				
7	6 - 7				
8	7 - 8				
9	8 - 9				
10	9 - 10				
11	10 - 11				
12	11 - 12				
13	12 - 13				
14	13 - 14				
15	14 - 15	50.5	44	35.5	41.6
16	15 - 16	49	43	35	40.7
17	16 - 17	57.5	46.5	34	52
18	17 - 18	58.5	52	37	48.4
19	18 - 19	61.5	50.5	39	49.9
20	19 - 20	67	65.5	40.5	58.5
21	20 - 21	54	48.5	42	47.3
22	21 - 22	55	47.5	41	46.7
23	22 - 23	51.5	46	37	44.3
24	23 - 24	47.5	44.5	36	42.2

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	48.8 dB(A)
Leq (night)	22:00 - 06:00	0 dB(A)
L90 (background)	07:00 - 18:00	35.4 dB(A)
Leq (24 hours)	00:00 - 24:00	47 dB(A)
1hr Leq max	22:00 - 06:00	0 dB(A)

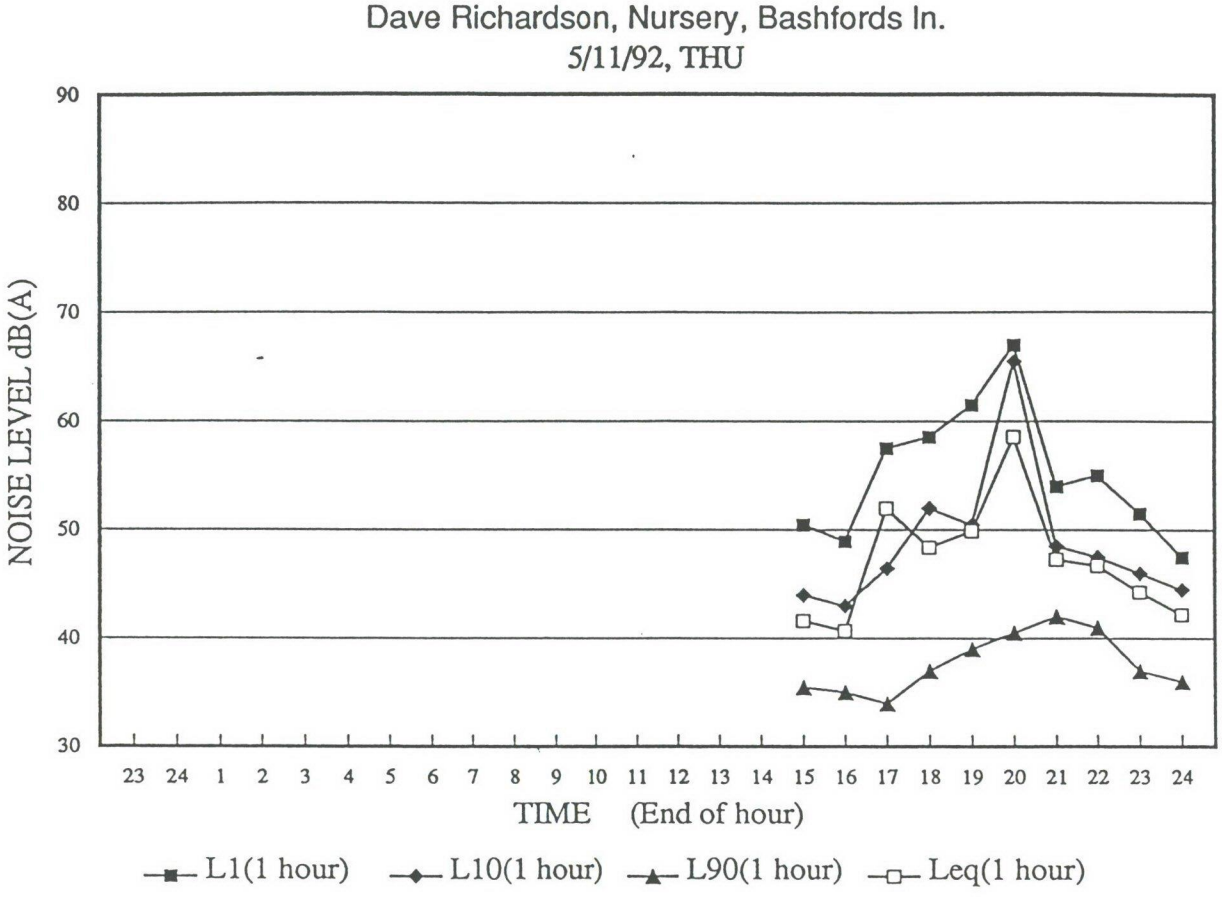

Dave Richardson, Nursery, Bashfords ln.
5/11/92, THU
NOISE LEVEL dB(A)
90
80
70
60
50
40
30
23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (End of hour)
L1(1 hour)
L10(1 hour)
L90(1 hour)
Leq(1 hour)

TABLE A-2

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Dave Richardson, Nursery, Bashfords ln.
DATE/DAY/LOC 6/11/92, FRI

FILENAME: A:\123R3\BRUNS\NURS.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	51.5	46	37	44.3
24	23 - 24	47.5	44.5	36	42.2
1	24 - 1	46.5	43.5	34.5	41
2	1 - 2	47.5	44	35	42
3	2 - 3	49	43	34	41.4
4	3 - 4	45.5	39	30.5	36.2
5	4 - 5	45.5	40.5	29	37.5
6	5 - 6	55.5	43.5	29	42.6
7	6 - 7	52.5	40.5	31	41.9
8	7 - 8	57	52.5	29	47.2
9	8 - 9	55.5	46	35.5	45.6
10	9 - 10	54.5	47	36	44.7
11	10 - 11	50.5	44.5	35	42
12	11 - 12	52.5	45	34.5	42.7
13	12 - 13	61	48.5	35	49.5
14	13 - 14	54.5	47.5	34	45.1
15	14 - 15	57.5	51.5	34.5	48.2
16	15 - 16	60	46.5	35.5	49.8
17	16 - 17	56	49.5	38	46.6
18	17 - 18	56.5	51.5	39.5	49.6
19	18 - 19	61.5	59.5	40.5	53.1
20	19 - 20	68.5	65.5	42	58.9
21	20 - 21	58.5	53.5	43	50.9
22	21 - 22	57	53.5	41.5	50.1
23	22 - 23	54.5	50	41	48.1
24	23 - 24	55	49	40	47.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	50.1 dB(A)
Leq (night)	22:00 - 06:00	41.5 dB(A)
L90 (background)	07:00 - 18:00	35.1 dB(A)
Leq (24 hours)	00:00 - 24:00	49.2 dB(A)
1hr Leq max	22:00 - 06:00	44.3 dB(A)

Dave Richardson, Nursery, Bashfords In.
6/11/92, FRI

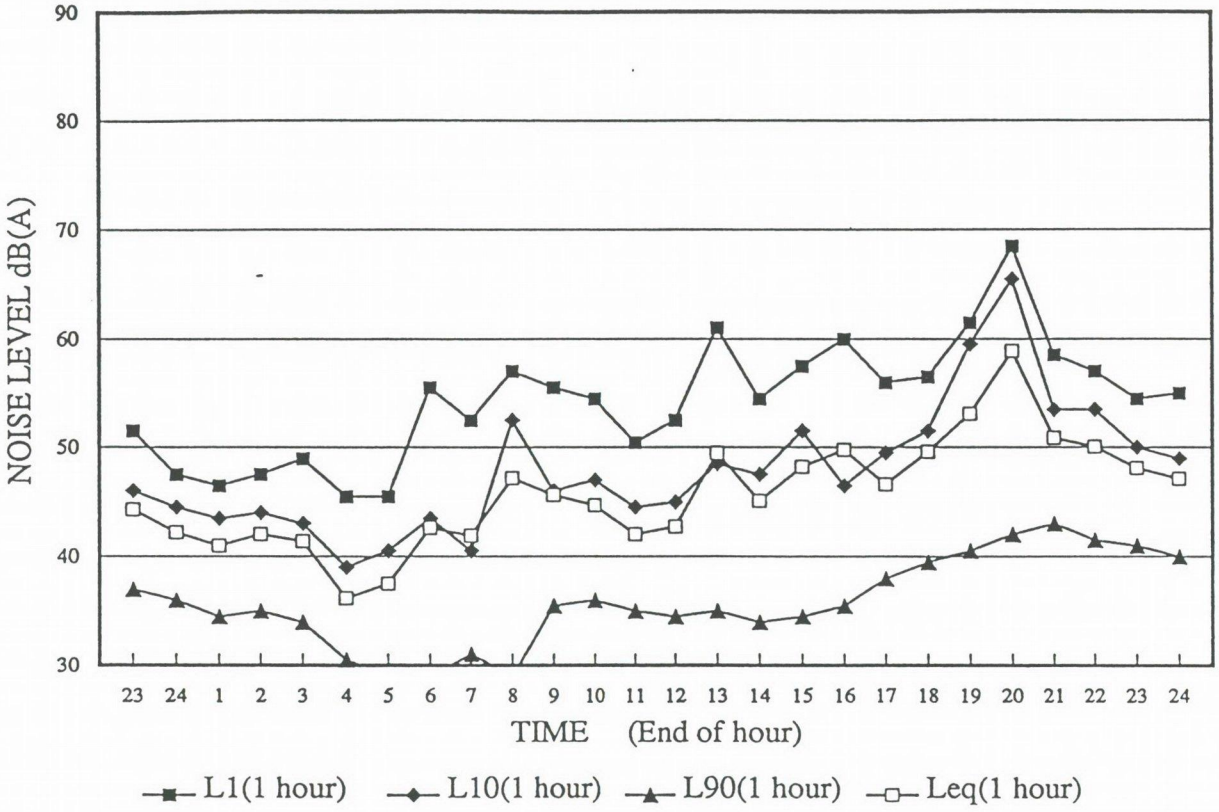


TABLE A-3

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Dave Richardson, Nursery, Bashfords ln.
DATE/DAY/LOC 7/11/92, SAT

FILENAME: A:\123R3\BRUNS\NURS.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	54.5	50	41	48.1
24	23 - 24	55	49	40	47.1
1	24 - 1	52	48	39	45.8
2	1 - 2	54	48.5	38.5	46.2
3	2 - 3	53	48	38	45.8
4	3 - 4	51.5	47.5	39	45.5
5	4 - 5	53.5	47	34	43.5
6	5 - 6	57.5	47.5	35	45.4
7	6 - 7	55.5	45	35	43.6
8	7 - 8	52	45	36	42.9
9	8 - 9	53.5	49	38.5	46
10	9 - 10	56	49	39.5	46.7
11	10 - 11	59	55.5	41	51.7
12	11 - 12	56	52	41	48.8
13	12 - 13	58.5	51	40.5	48.6
14	13 - 14	53.5	49.5	40.5	47
15	14 - 15	55	51.5	41.5	48.2
16	15 - 16	57.5	48	38.5	48.4
17	16 - 17	59	54.5	39	50.8
18	17 - 18	55.5	53.5	39.5	51.1
19	18 - 19	55	51.5	39	47.9
20	19 - 20	68.5	67	40	59.9
21	20 - 21	53.5	50.5	38.5	46.4
22	21 - 22	53	44.5	35.5	43.1
23	22 - 23	51	45	35	42.5
24	23 - 24	48	45	34.5	43.1

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	50.4 dB(A)
Leq (night)	22:00 - 06:00	46.1 dB(A)
L90 (background)	07:00 - 18:00	39.6 dB(A)
Leq (24 hours)	00:00 - 24:00	49.6 dB(A)
1hr Leq max	22:00 - 06:00	48.1 dB(A)

Dave Richardson, Nursery, Bashfords ln.
7/11/92, SAT

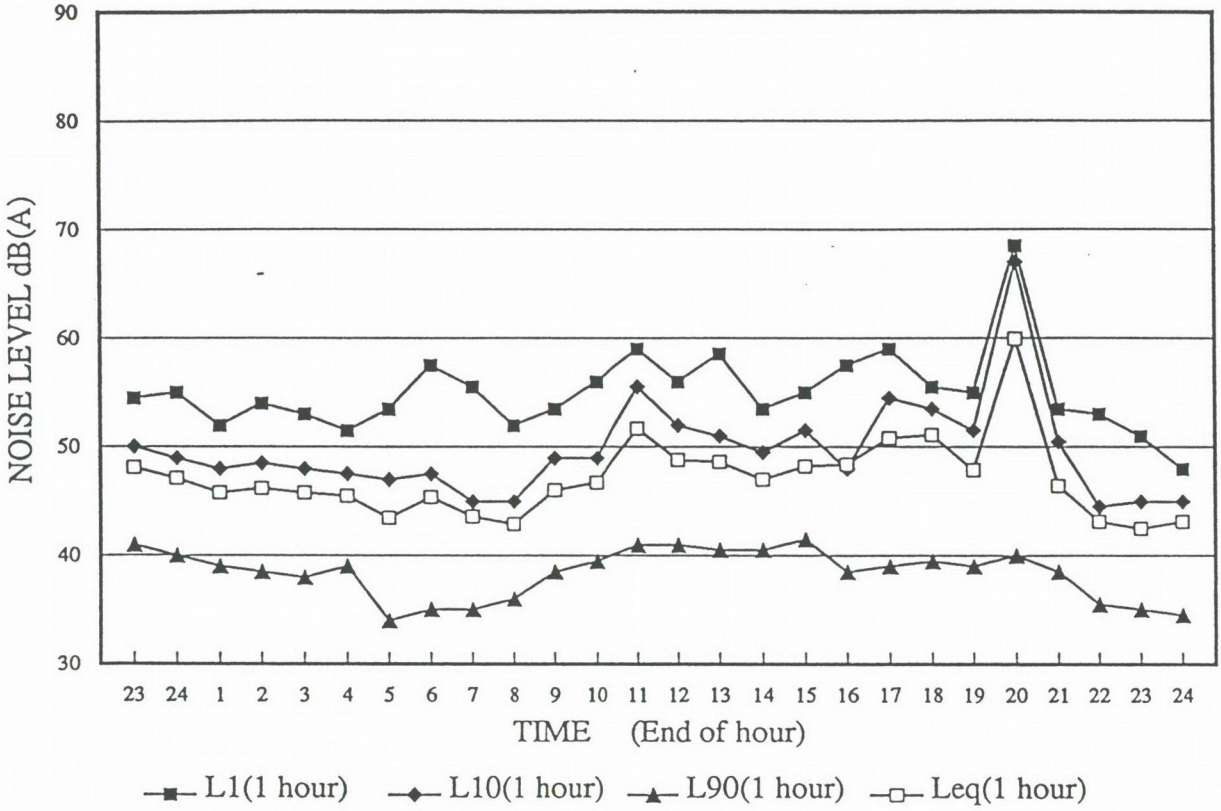


TABLE A-4

PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Dave Richardson, Nursery, Bashfords ln.
DATE/DAY/LOC 8/11/92, SUN

FILENAME: A:\123R3\BRUNS\NURS.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 1

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	51	45	35	42.5
24	23 - 24	48	45	34.5	43.1
1	24 - 1	47	41.5	34	39.7
2	1 - 2	53	41.5	33	40.9
3	2 - 3	46.5	41.5	33	38.3
4	3 - 4	51.5	49.5	34	44.6
5	4 - 5	47	44.5	33.5	41.2
6	5 - 6	54	43.5	32.5	41.6
7	6 - 7	56.5	42.5	32	44.2
8	7 - 8	53.5	43.5	33	42.1
9	8 - 9	55.5	45.5	34.5	43.9
10	9 - 10	56.5	48.5	35	46.3
11	10 - 11	51.5	43	34	41.6
12	11 - 12				
13	12 - 13				
14	13 - 14				
15	14 - 15				
16	15 - 16				
17	16 - 17				
18	17 - 18				
19	18 - 19				
20	19 - 20				
21	20 - 21				
22	21 - 22				
23	22 - 23				
24	23 - 24				

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	44.6 dB(A)
Leq (night)	22:00 - 06:00	41.9 dB(A)
L90 (background)	07:00 - 18:00	34.1 dB(A)
Leq (24 hours)	00:00 - 24:00	39.4 dB(A)
1hr Leq max	22:00 - 06:00	44.6 dB(A)

Dave Richardson, Nursery, Bashfords ln.
8/11/92, SUN

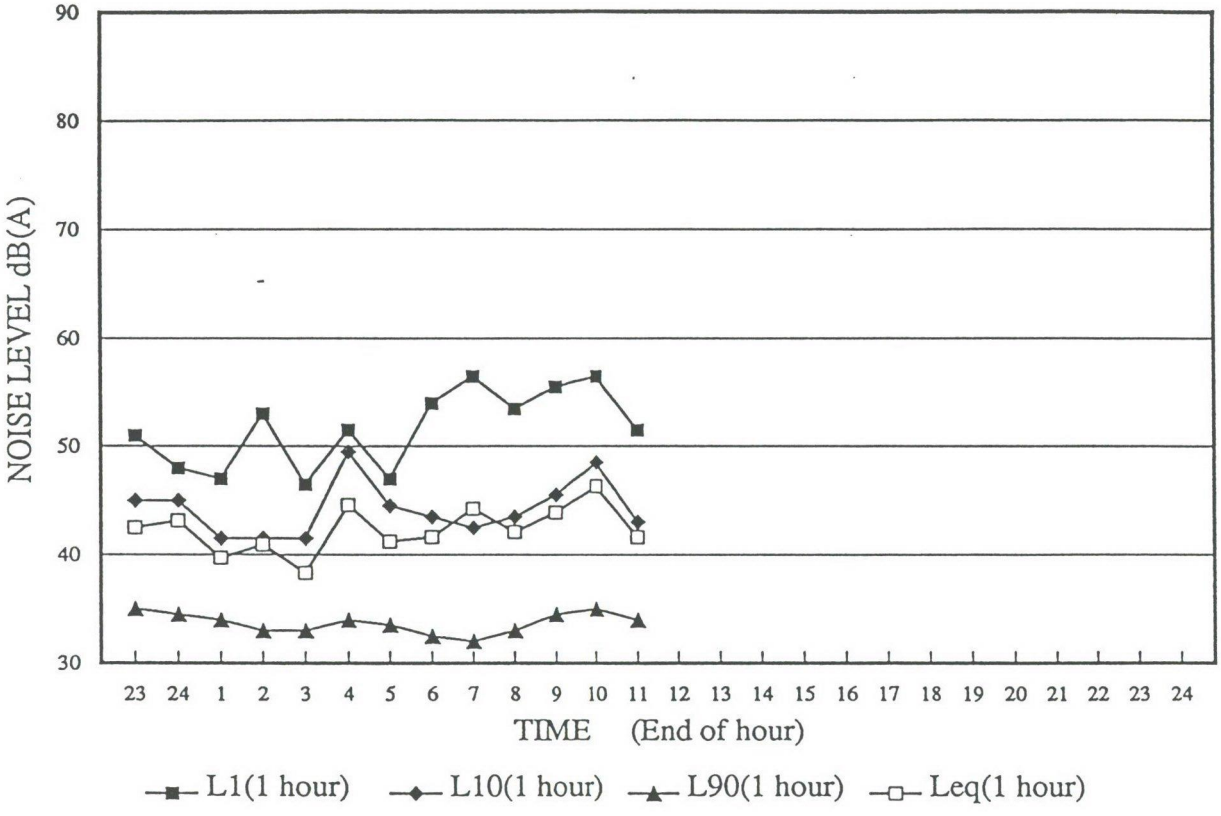


TABLE A-5

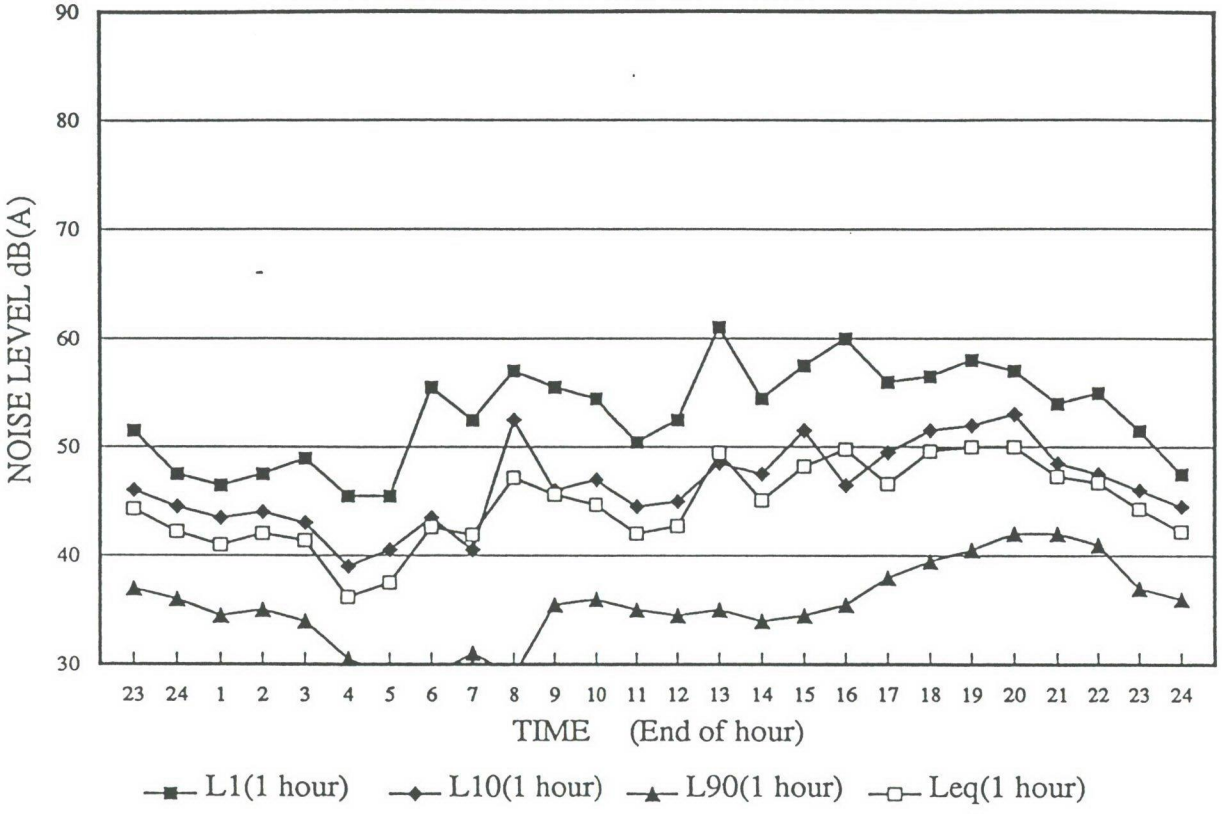
PROJECT NAME: BRUNSWICK HEADS
OWNER/ADDRESS: Dave Richardson, Nursery, Bashfords ln.
DATE/DAY/LOC THURSDAY-NIGHT + FRIDAY

FILENAME: A:\123R3\BRUNS\NURS.WK3
WEATHER:
COMMENTS:
WEEKEND ? NO = 0, YES = 1: 0

	TIME	L1 dB(A)	L10 dB(A)	L90 dB(A)	Leq dB(A)
23	22 - 23	51.5	46	37	44.3
24	23 - 24	47.5	44.5	36	42.2
1	24 - 1	46.5	43.5	34.5	41
2	1 - 2	47.5	44	35	42
3	2 - 3	49	43	34	41.4
4	3 - 4	45.5	39	30.5	36.2
5	4 - 5	45.5	40.5	29	37.5
6	5 - 6	55.5	43.5	29	42.6
7	6 - 7	52.5	40.5	31	41.9
8	7 - 8	57	52.5	29	47.2
9	8 - 9	55.5	46	35.5	45.6
10	9 - 10	54.5	47	36	44.7
11	10 - 11	50.5	44.5	35	42
12	11 - 12	52.5	45	34.5	42.7
13	12 - 13	61	48.5	35	49.5
14	13 - 14	54.5	47.5	34	45.1
15	14 - 15	57.5	51.5	34.5	48.2
16	15 - 16	60	46.5	35.5	49.8
17	16 - 17	56	49.5	38	46.6
18	17 - 18	56.5	51.5	39.5	49.6
19	18 - 19	58	52	40.5	50
20	19 - 20	57	53	42	50
21	20 - 21	54	48.5	42	47.3
22	21 - 22	55	47.5	41	46.7
23	22 - 23	51.5	46	37	44.3
24	23 - 24	47.5	44.5	36	42.2

DESCRIPTOR	PERIOD	NOISE LEVEL
L10 (18 hours)	06:00 - 24:00	47.9 dB(A)
Leq (night)	22:00 - 06:00	41.5 dB(A)
L90 (background)	07:00 - 18:00	35.1 dB(A)
Leq (24 hours)	00:00 - 24:00	46.2 dB(A)
1hr Leq max	22:00 - 06:00	44.3 dB(A)

Dave Richardson, Nursery, Bashfords ln.
THURSDAY-NIGHT + FRIDAY



APPENDIX Q

Energy Guidelines for Local Planning

Where possible, optimise heights of commercial buildings to minimise the energy costs of services - water pumping, lifts, etc.

Utilities/services should, as far as possible, follow natural drainage lines. Drains should be in straight lines or long easy curves, to minimise the necessity for and cost of pumping.

(3) *To make the most efficient use of energy supplies and infrastructure in commercial/industrial development*

Keep neighbourhood facilities (e.g. shops) close together to intensify land use; examine whether making commercial and industrial lot sizes smaller and lot frontages narrower will reduce travel/transport costs; double load all roadways and service ways (i.e., develop streets with building lots on both sides).

When planting street trees consider the location of connection points between mains service and allotment service to reduce the cost of maintaining underground services.

D. TRAFFIC AND TRANSPORT

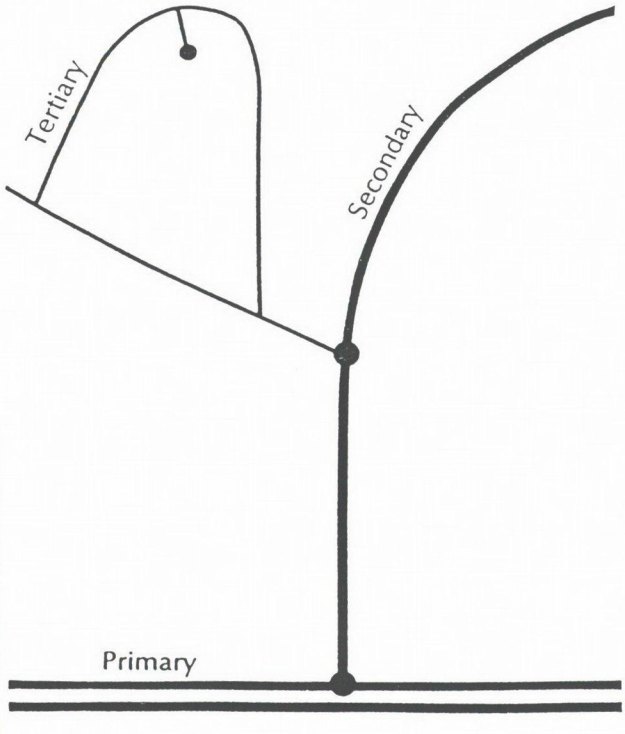
One of the most effective strategies for saving transport energy costs is to encourage land use patterns which reduce the need to travel by road. In addition, large areas of dark paved surfaces can significantly affect the heat absorbance of an area, thus influencing the local climate. Streets should also be oriented for wind control.

(1) *To minimise unnecessary vehicular movements and reduce fuel costs*

Street width should relate to the amount and type of traffic generated on the street. Roads should be designed to fit a suitable use according to the traffic generated. Ease of movement within a residential area could be maintained through the use of loop roads that prevent backtracking.

Encourage walking and cycling as alternatives to the use of motor vehicles. Bicycle parking facilities could be included in new buildings.

Plan to regulate speed and reduce volume of traffic along local roads; e.g. roundabouts are a relatively low cost option for promoting safe traffic movement at intersections. However, care needs to be taken in the design and maintenance of lane widths and merging points so that narrowing does not increase the risk of accidents, particularly for cyclists.



ROAD HIERARCHY TO
REDUCE BACK TRACKING

SOURCE: DEPARTMENT OF PLANNING / OFFICE OF ENERGY (1991):
Energy Guidelines for Local Planning, Technical Bulletin No. 20



TRAFFIC ISLAND AND ROUNDABOUT



(2) *To allow for convenient access to public transport at activity centres to reduce fuel costs*

Provide direct linkages to activity centres such as shops, schools and community facilities, for pedestrians and cyclists.

Provide public transport terminals (interchanges) within major centres. Increase development densities around major centres.

(3) *To encourage the development of an integrated system of land use and transport that maximises accessibility*

Expand and integrate public transport services and and co-ordinate pedestrian and cyclist access to public transport.

By encouraging multiple land uses at neighbourhood centres, travel distances for residents will be reduced and, consequently, so will the demand for large street networks.

(4) *To maximise energy efficiency in the construction and maintenace of roads and consider the climatic impact of surfaces chosen*

Road width and surface should be appropriate and relative to usage. Surface material should be used to maximise durability and minimise maintenance (care, however, needs to be exercised to control stormwater runoff).

Smooth surfaces for cycleways increase comfort and safety levels, lower rolling resistance and encourage their use.

Large areas of dark paved surfaces can significantly affect the heat absorbance and hence general comfort of any area. Light coloured pavement will not absorb as much heat.

Consider using porous paving materials and low maintenance surfaces. Use trees to shade paved areas and reduce heat absorption.

Streets can be oriented for wind control to both funnel cooling breezes and block unfavourable winds.

(5) *To review street lighting requirements*

High efficiency lamps with reflective backing ensure maximum lighting on road surface and minimise glare.

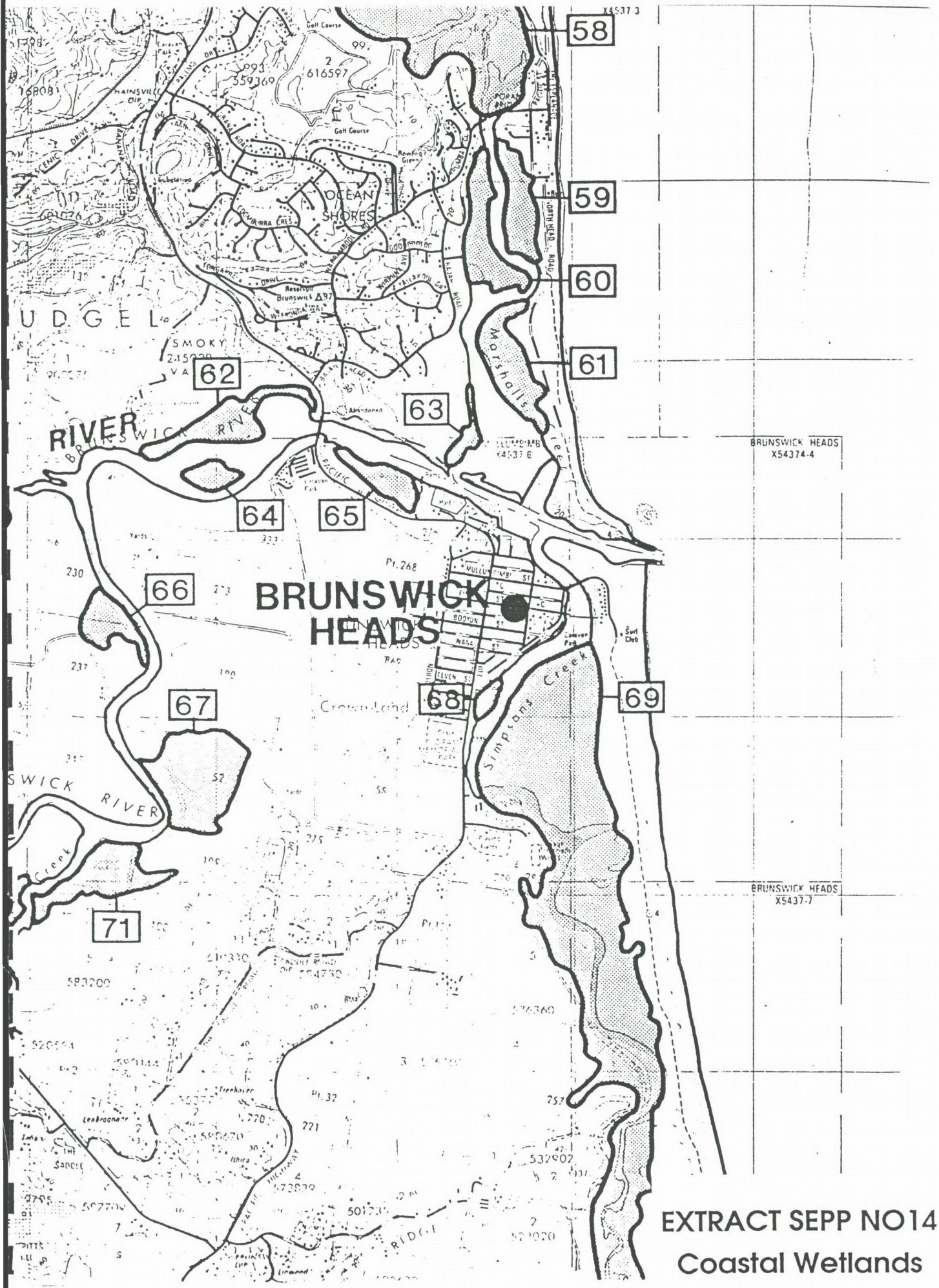
Use of reflective devices should be considered where street lighting is not required for safety or security reasons.



WIDE SHADELESS STREET

APPENDIX R

Extract SEPP No. 14 - Coastal Wetlands



EXTRACT SEPP NO14
Coastal Wetlands

APPENDIX S

Assessment of Rainforest Stands in Smoky Valley Area

STATE HIGHWAY NO.10, PACIFIC HIGHWAY
PROPOSED BRUNSWICK HEADS BYPASS
SIGNIFICANCE OF RAINFOREST VEGETATION
IN THE SMOKY VALLEY AREA

Areas of rainforest vegetation north of the Brunswick River and south and west of the Pacific Highway (Smoky Valley) were inspected during the period 20-22 March 1992. The Roads and Traffic Authority proposes to re-route the highway through this area as part of a bypass to the west of the township of Brunswick Heads on the southern side of the Brunswick River. The aim of the inspection reported on here was to gain some idea of the significance of rainforest stands in the Smoky Valley area. It is emphasised that inspection of these areas was constrained by time available and difficulty of access into some stands. As such the results reported are incomplete and do not preclude the need for more intensive survey before the final selection of a route is made.

For convenience, and because they are generally spatially distinct, the rainforest stands are discussed under four sections (see attached map).

Area 1. Slopes to the west of road to Sewerage Works

Geology: Slates and phyllites of the Palaeozoic Neranleigh - Fernvale Group metasediments.

Soil: Yellow-brown clays.

Drainage: Well drained; drainage to south.

Aspect: Generally southerly.

Vegetation: Originally subtropical rainforest and probably fairly similar to the "hill rainforest" (subtropical rainforest on upland slates and phyllites) described by Williams and Harden (1984) for part of Brunswick Heads Nature Reserve. Field inspection showed that most of this area was cleared at some time with probably only some Hoop Pine being left of the original vegetation. Today the occasional Hoop Pine tower above regrowth rainforest. This regrowth is relatively well advanced and forms a closed canopy over much of the area. However, while there are some 50 species of rainforest trees and shrubs present in the area, a small number of species including Rose Myrtle (*Archirhodomyrtus beckleri*), Guioa (*Guioa semiglauca*), Veiny Wilkiea (*Wilkiea huegeliana*), Cudgerie (*Flindersia schottiana*)

and Scentless Rosewood (*Symoum glandulosum*) comprise most of the stems present.

Species of interest occurring in this area are:

Randia moorei (= Xeromphis sp.). Spiny Gardenia. Listed as 3ECi -(endangered and inadequately conserved) by Briggs and Leigh (1988), this small tree extends from Broken Head to the Logan River. One specimen was seen in the eastern side of this area.

Endiandra globosa Black Walnut. Listed as 3RC- (rare and adequacy of conservation unknown) by Briggs and Leigh (1988), this tree occurs in the Brunswick and Tweed Valleys in NSW and the Tallebudgera and Currumbin valleys in Southern Queensland, with a disjunct population in north Queensland. Several specimens were seen in the upper slopes in the north-eastern part of the area and another was seen in the southern part of the area adjacent to swamp forest.

Medicosma cunninghamii Pinkheart. While not listed as rare or threatened, this species is limited to the coastal lowlands between the Richmond River and Maryborough and is not common in New South Wales. One specimen was seen on a slope above a watercourse in the southern part of the area.

Area 2. Upper slopes to the east of road to sewerage works

Geology, soils, drainage and aspect: as for area 1.

Vegetation: Originally Subtropical Rainforest but almost completely cleared in the past. Now a mosaic of remnant rainforest trees and clumps, regrowth rainforest and exotic (weed) species. Movement through this area is made difficult by abundance of Lantana (*Lantana camara*) between rainforest patches. Despite the seemingly poor quality of this area, there are over 30 species of rainforest trees and shrubs present. One species is particularly significant:

Acacia bakeri Marblewood. This species is listed as 3VC- (vulnerable and adequacy of conservation unknown) by Briggs and Leigh (1988). It occurs between Brunswick Heads and Maryborough. Some 20 or more specimens occur in this area.

Area 3. Lower slopes to the west of the Pacific Highway

Geology and soils: As for areas 1 and 2.

Drainage: Well drained; drainage to west.

Aspect: Generally south-westerly.

Vegetation: Originally Subtropical Rainforest, partially distributed by construction of highway upslope, clearing on toe slopes and tracks at base of slope. The area includes well developed rainforest (southern part of area on toe slopes), viney rainforest (particularly adjacent to highway in watercourses), regrowth rainforest (generally with Forest Red Gum (*Eucalyptus tereticornis*), Pink Bloodwood (*E. intermedia*), Blackwood (*Acacia melanoxylon*) or Brush Ironbark Wattle (*A. aulacocarpa*) and small areas of open forest.

Five significant species occur in this area:

1. *Davidsonia pruriens* var. *jerseyana*. Davidson's Plum. This species is regarded as endangered. It is recorded from 28 sites, all but one in the Tweed and Brunswick valleys.

Most of these sites are roadside verges and the species is therefore threatened at these sites in the long term but conserved by default at present. Most of the remaining sites support individual trees in open areas, generally grazing land, and offer no long term security to the species. A handful of specimens occur in Brunswick Heads Nature Reserve. Watson (1987) reports that the most outstanding occurrence of the species is about 1.25km upstream from the Pacific Highway bridge on the north bank of the Brunswick River (that is, on the Green route). Watson sees the only option for conservation of the species, which he argues is an edge species or early successional species, as being inclusion of this area in Brunswick Heads Nature Reserve - the nature reserve boundary being extended westward to the confluence of Brunswick River and Midjimbil Creek.

The area presently under consideration also includes a population of Davidson's Plum. Twelve specimens were counted near the central western edge of the area in a small watercourse

and adjacent toe slope just above the alluvial flat to the west. The species occurs here in the edge of the rainforest. This population while smaller than that further west should also be conserved. Davidson's Plum is edible and has potential as a cultivated food crop.

2. *Acacia bakeri* Marblewood. This vulnerable species has been discussed above (area 2). Several specimens were seen in Area 3.

3. *Endiandra globosa* Black Walnut. This rare species was commented on above (area 1). A population of about 10 specimens was seen in the south-west of the area.

4. *Archidendron muellerianum*. Veiny Lace Flower. Listed as 3RCa (rare and adequately conserved) by Briggs and Leigh (1988), this small tree is confined to the coastal lowlands between the Richmond River and Tallebudgera Creek. One specimen was seen on the toe slope in the southern part of this area.

5. *Helicia ferruginea* Rusty Oak. This species occurs between Woolgoolga and the Lamington Plateau. Some authorities (for example,
believe that it is rare. One specimen was seen in the area.

Area 4. Alluvial flat to west of Pacific Highway (part of the western section of Brunswick Heads Nature Reserve)

Geology: Alluvium of mixed origin.

Soils: Heavy clay alluvium.

Drainage: Flat, swampy in places, grading into riverbank mangrove communities and wetland forest communities.

Aspect: Nil.

Vegetation: Essentially undisturbed subtropical rainforest. Williams and Harden (1984) correctly note that this community is "rather different to the other rainforest communities" in Brunswick Heads Nature Reserve. This is due to the quite different soils and drainage in this area; this being one of the very few examples of floodplain lowland subtropical rainforest to have escaped clearing. The area is of very high conservation significance not only because

of its different vegetation but also because of the concentration of significant plant species within it. Williams and Harden recorded over 100 native rainforest trees and shrubs, 30 native vines, 11 native herbs and 1 native epiphyte for this area of rainforest; several more species have been added as a result of my inspection. Significant species present include:

1. *Syzygium hodgkinsoniae* Red Lilly Pilly. Listed as 3VC- (vulnerable and adequacy of conservation unknown) by Briggs and Leigh (1988), this is a very attractive tree with large, sweetly scented flowers. The flowers retain their scent when dried for many years and it has been suggested they may be utilised in perfume manufacture. The tree occurs on the coastal lowlands between the Richmond River and Gympie.

2. *Syzygium moorei.* Durobby or Coolamon. Listed as 2VCi (vulnerable and inadequately conserved), this is another very attractive tree. It occurs naturally only on the coastal lowlands between the Richmond River and Mudgeeraba Creek.

3. *Cryptocarya foetida.* Stinking Cryptocarya. Listed as 3VCi (vulnerable and inadequately conserved) by Briggs and Leigh (1988), this tree was first recorded from this area during this inspection. It was previously recorded from the section of Brunswick Heads Nature Reserve to the east of the highway (Floyd 1977, Williams and Harden 1984). It occurs mainly in littoral rainforest from Iluka to Fraser Island.

4. *Xylosma terrae-reginae* Xylosma. Listed as 3RC- (rare and adequacy of conservation unknown) by Briggs and Leigh (1988), this tree was first recorded from this area during this inspection. It was previously known from the section of Brunswick Heads Nature Reserve to the east of the highway (Williams and Harden 1984). The species occurs from Ballina to near Maryborough.

5. *Tinospora tinosporoides* (formerly Fawcettia tinosporoides). Arrow-head Vine. Listed as 3VC- (vulnerable and adequacy of conservation unknown) by Briggs and Leigh (1988), this species occurs from the Richmond River to

South-east Queensland.

6. *Randia moorei* Spiny Gardenia. 3ECi. Discussed earlier under Area 1.

7. *Acacia bakeri* Marblewood. 3VC-. Discussed earlier under Areas 2 and 3.

8. *Endiandra globosa* Black Walnut. 3RC-. Discussed earlier under Areas 1 and 3.

9. *Archidendron muellereanum.* Veiny Lace Flower. 3RCa. Discussed earlier under Area 3.

10. *Cordyline ? congesta* Toothed Palm Lily. Williams and Harden (1984) report C. stricta from this area; from any experience I suspect that this may actually be the similar and recently recognised C. congesta. Unfortunately I did not find either species in the area during the brief inspection and this hypothesis remains unconfirmed. C. congesta is listed as 2RC- (rare and adequacy of conservation unknown) by Briggs and Leigh (1988); it occurs from Ballina to south-east Queensland generally in littoral rainforest.

11. *Grevillea lilliana* White Yiel Yiel. This is a very showy tree which reaches a record size (30m high and 35cm diameter) in Brunswick Heads Nature Reserve (Floyd 1990); Williams and Harden (1984) comment on the fine specimens of this species and Bennett's Ash (Flindersia bennettiana) in Area 4. White Yiel Yiel originally extended as far south as the Clarence River but is now known only as far south as Brunswick Heads (Floyd 1989). It is rare in NSW and is only known from a few restricted localities. It is more common in Queensland.

Relationship of Highway Options to Rainforest Areas

Black option: would severely affect Areas 4, 3 and 2, and upper edge of Area 1.

Red option: would bisect Area 1.

Blue option: would bisect Area 1.

Green option: would affect main remaining population of Davidson's Plum.

References

Floyd, A.G. (1977). Vegetation resource inventory - Brunswick Nature Reserve. Unpub. report to NPWS.
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Watson, G. (1987). A comparative study of the two New South Wales tree species belonging to the rainforest family Davidsoniaceae. Unpub. Masters thesis, UNE, Armidale.

Williams, J.B. and Harden, G.J. (1984) (2nd ed.) The Vegetation and Flora of Brunswick Heads, NSW. Department of Botany, UNE, Armidale.

R.J. Hunter

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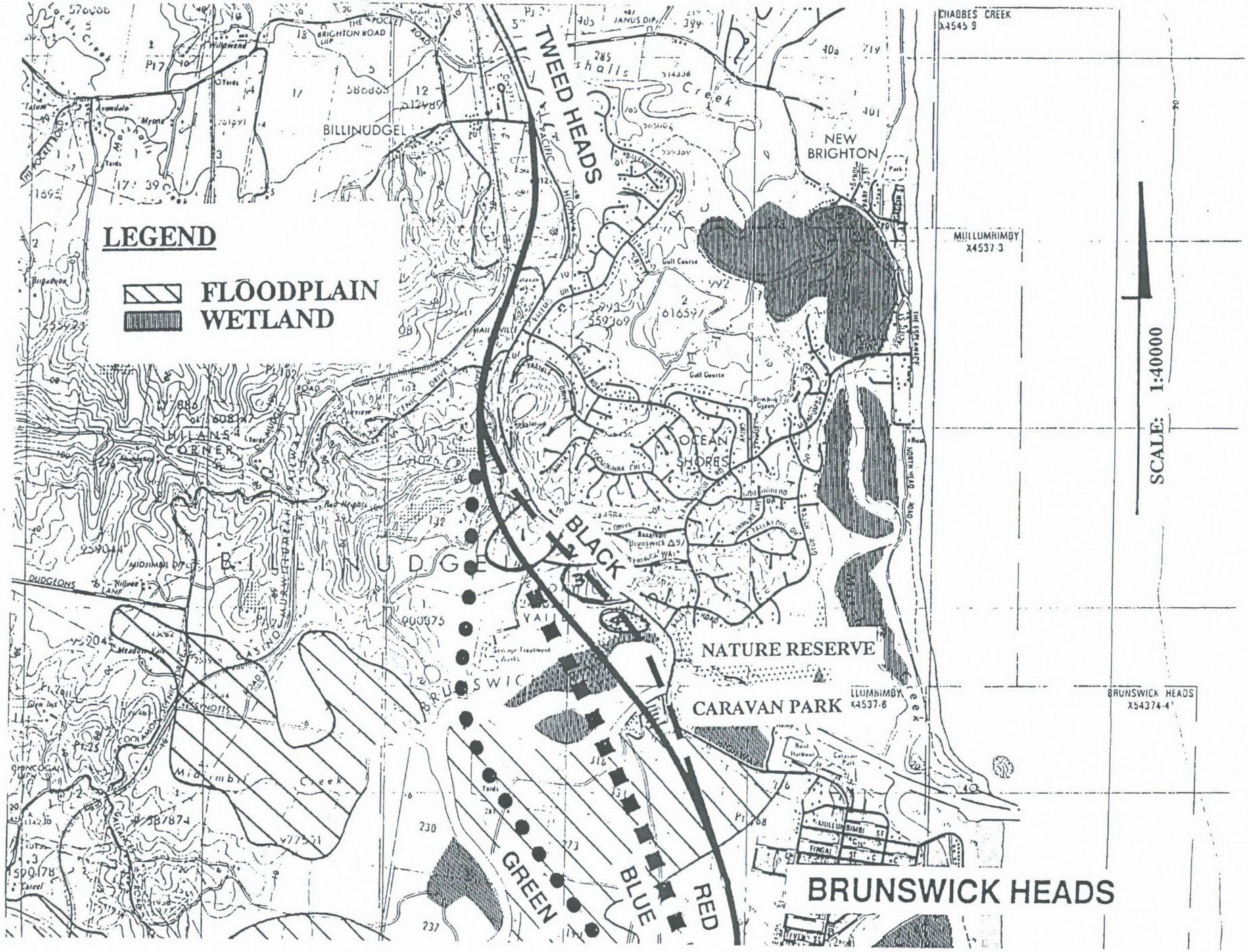
PROJECT OFFICER
(RAINFOREST MANAGEMENT)


LEGEND
FLOODPLAIN
WETLAND
TWEED HEADS
BILLINUDGEL
NEW BRIGHTON
OCEAN SHORES
BLACK
NATURE RESERVE
CARAVAN PARK
BRUNSWICK HEADS
GREEN
BLUE
RED
SCALE: 1:40000