Gosford City Council

Preliminary Light Rail Feasibility Study for the City of Gosford.

January 1996

Prepared for the Gosford City Council

By

Parade Consulting

PTY. LTD.

A.C.N.: 069129960.

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PO Box 239,
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Executive Summary

This report details the Preliminary Light Rail Feasibility Study for the City of Gosford.

The corridors examined were Woy Woy to Umina and Ettalong (the Peninsula Corridor), Gosford to Terrigal via Erina (the Terrigal Corridor), and Erina to Ettalong via Kincumber (the Kincumber Corridor).

The Peninsula corridor, including both branches, is about 6 kilometres in length and would cost approximately $53.3 million. Financially this corridor would currently operate at a profit and returns will improve. The project is also economically worthwhile with a Cost Benefit Ratio of 1.61 and a Net Present Value of Invested Capital of 0.61. Sources of funding will need to be secured to construct this line.

The Terrigal Corridor is about 14 kilometres in length and would cost approximately $133.4 million. Financially this corridor would operate at a profit and returns will improve considerably. The project is also economically worthwhile with a Cost Benefit ration of 1.65 and a Net Present Value of Invested Capital of 0.65. Sources of Funding will need to be secured to construct this line.

The Kincumber Corridor is about 15 kilometres in length and would cost approximately $184.4 million. Financially this corridor would not operate at a profit until considerably more development has occurred in the area. This project is not yet economically worthwhile.

Development potential is considerable in all corridors but will need to be well planned and managed to ensure that development is optimised and that benefits to the community are maximised.

The result of implementing light rail services in the corridors examined in this study would be demand for residential and commercial development within easy access of the line. This market demand could be focused at strategic locations to create definable villages where urban densities are distinctively higher than the surrounding areas.

The surrounding areas can, therefore, effectively remain untouched. This, in effect, is a process of damage control that concentrates growth in a more sustainable pattern than is occurring with current suburban trends. The resultant villages develop in lieu of allowing further suburban subdivision. The subsequent increases in density also serve to feed the Light Rail line, in effect anchoring it into the urban landuse/transport pattern for the area.

It is felt that the implementation of the proposals examined in this study, and the likely, well managed, development patterns that it will encourage, would be favourable by comparison to current development trends.

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1. INTRODUCTION

1.1. Background

This report has been prepared by Parade Consulting for Gosford City Council. Its instigation grew from the perceived need to create an alternative vision for the future of Gosford.

By late 1994 it had been realised that current trends in Gosford were leading towards the destruction of the amenity, quality and social equity of the area. Trends of private car use have become entrenched resulting in traditional demand orientated planning responses that only serve to encourage more car use. Similarly, land use patterns represent a typical response to car domination: land hungry urban sprawl, where traffic orientated street design has been the primary design factor.

These two trends combined have resulted in a gradual shift in Gosford's character away from one of "the quiet collection of villages beside the sea" to one of "a formless agglomeration of sprawling suburbs amid ever increasing traffic congestion". With this shift there has been a loss of amenity, identity and village legibility. Further losses include loss of Urban Form in the Town Centres and ultimately a corresponding loss of Civic Pride.

In an attempt to alleviate the pressures that car congestion is continuing to impose upon the amenity of the entire Council area it was suggested that alternative systems of transportation should be explored. In association with this it was also proposed that the alternatives should encourage beneficial side-effects such as positive impacts on the nature of the built environment.

In other words there is a need to stop Car Dominance and Urban Sprawl and encourage Public Transport Usage and Medium Density Housing. The Aims of this study are orientated towards achieving these objectives.

1.2. Aims of study

The Aims of this study are to instigate a new approach to the strategic planning of the Gosford City Council area and to provide a vision towards achieving a more equitable and economically sustainable future. This study intends to provide alternatives for Gosford's future transport and landuse patterns to counter the current trends of car domination and suburban sprawl. It is proposed that the current trends will be reversed through the implementation of strategic mass transit corridors that can serve as foci for medium density urban development. As such, it is also an aim of this study to incorporate transportation and land use integration principles.

This study also aims to demonstrate, at a preliminary level only, the feasibility (or otherwise) of Light Rail Mass Transit services that are proposed within the Study Area.

Specifically, this study will:

(I) Identify existing Urban Nodes at which to concentrate future development,
(II) Identify Transport Corridors linking those nodes which can be utilised by a mass transit system,
(III) Design proposed alignments for Light Rail Transit (LRT) links servicing those corridors (LRT being the potential ultimate level of service provision foreseeable within the next fifty years),
(IV) Propose amendments to the current zoning patterns within the study area to achieve better potential in realising the aims set out above,
(V) Assess the likely current and future demand for LRT services and their implementation,
(VI) Assess the possible benefits to the local economy due to the implementation of LRT along the study corridors,
(VII) Identify potential sources of funding to implement these infrastructure proposals.
(VIII) Comment on the potential impact that implementation of LRT within the Study Area will have on development potential.

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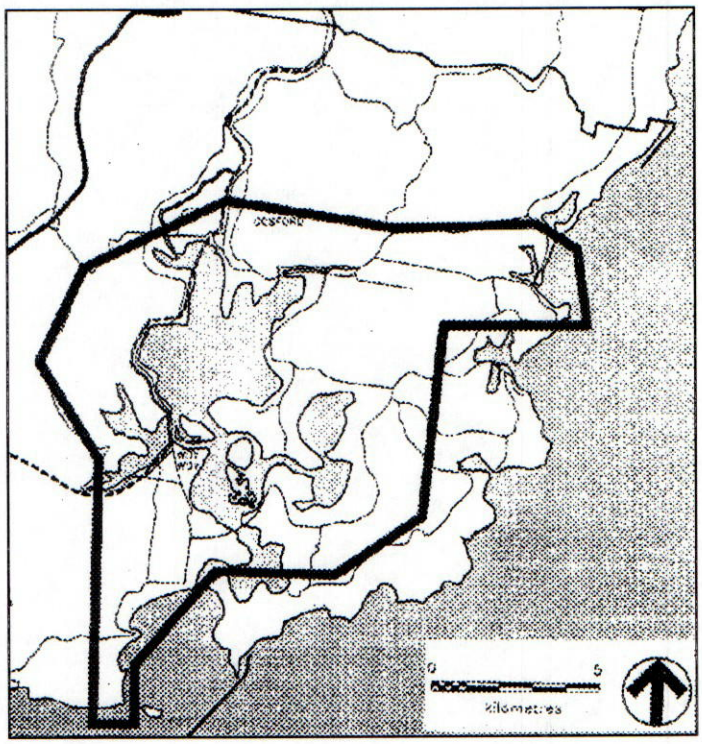
1.3. Study Area

The Study Area is identified on Figure1.3.A. entitled "Study Area". The Study Area is made up of the lands constituting the Woy Woy Peninsula, the lands between Gosford and Terrigal via Erina and the lands between Erina and the Woy Woy Peninsula. Lands outside of these areas were considered beyond the reasonable scope of this study.

Figure 1.3.A. Study Area.



1.4. Data Sources

All data used in the preparation of this study has been supplied by the client, although much of this data has been prepared by others as a result of previous studies. A list of material used in the preparation of this study is contained in Appendix A.

1.5. Methodology

The following Methodology has been used in the preparation of the findings and recommendations contained in this report.

Initially, the existing nodes and trip generators were established and ranked in order of scale. These were then linked conceptually to satisfy travel demand lines. These links were further developed into corridors and the resultant corridors were analysed to determine the gradients and engineering required to realise them.

After establishing the location of the corridors further analysis was conducted regarding the potential for Urban Village (high density) locations at various stops along the routes. These were based upon the existing zoning and the development potential of each location.

Finally, based upon the above information, patronage forecasts, revenue projections and economic analyses were conducted (see sections 7 through 9 for more detailed methodology) to determine the economic worth of each project.

The results of these findings are a list of conclusions and recommendations contained in section 13 of this report.

1.6. Trend Analysis

Trend Analysis Methodologies have been discarded for the purposes of this Study. As the aims of this study were to present viable alternatives to the current trends in transport and land use patterns, it was decided that Trend Analysis Methods would only serve to perpetuate those current trends that are intended to be replaced. As new ideologies, systems and patterns are the subject of this study analysis of current trends would prove to be redundant.

2. EXISTING LAND USE PATTERNS

2.1. Existing Zoning

Within the study area there are currently a range of zoning patterns. The existing zoning is outlined here so as to serve as a base to be referred to when zoning amendments are presented in sections 5, 10 and in the recommendations.

Most of the study area is zoned 2A and 2B (residential) or Rural. For detailed zoning within the Study Area refer to the Alignment Diagrams contained within Section 3. These diagrams have been produced on recent Zoning Maps (1995).

The outcomes of this study will outline a number of potential amendments to the current zoning, especially with regards to relevant Residential and Commercial zones. The areas of residential and commercial for which changes are proposed are likely to be affected by increases in density and the addition of a combination of residential/commercial mixed use zones.

2.2. Centres Analysis

This study represents the integration of transportation and land use planning. The Integration of transport and landuse usually consists of functional links between urban centres, or places of concentrated activity, such as town centres.

Activities in these centres include employment, retail, recreation and also residency. All of these activities generate a large demand for transport, both to and between centres. It is the centres that represent the primary destination and sources for a majority of journeys that can be catered for by Public Transport. It is also the centres that will be best able to accommodate increases in employment/retail and residential densities.

Through an analysis of the existing centres in the study area the current pattern of development will be revealed. Subsequent to identifying these centres they will be ranked in an order of size/importance. This Hierarchy will help to establish which centres generate the most trips and which should serve as primary destinations for a public transport system.

Within the study area the following Centres have been identified as significant for the purposes of this study:

> Gosford, East Gosford, Erina, Terrigal, Woy Woy, Umina, Ettalong, Kincumber.

Each of these centres will be ranked in order of size and importance in the next section.

2.2.1. Centres Hierarchy

A number of significant centres have been identified within the study area. Each of these centres will be ranked to generate a centres hierarchy. This ranking will be based on the following criteria:

Size (land take) of the area occupied by the centre,
Scale of activities (amount of employment and retail activity)
Potential for growth.

Each criteria is scored out of 3, 1 being the lowest score and 3 being the highest. The scores for all three criteria are then totalled to obtain the ranking for each centre. The ranked scores are then divided into three size categories. These categories correspond with conventional scale descriptors.

The three categories are Regional, District and Local.

The following table presents the scores calculated for each centre and the resultant ranking and categorisation of each.

Table 2.2.1.A

Centre	Size (Land Area)	Scale of Activities	Growth Potential	Ranking score	Category
Gosford	3	3	2	8	Regional
East Gosford	1	1	1	3	Local
Erina	3	3	3	9	Regional
Terrigal	2	2	2	6	District
Woy Woy	2	2	2	6	District
Umina	2	1	2	5	District
Ettalong	1	1	2	4	Local
Kincumber	2	1	2	5	District

The following table summarises the categorisation of the centres in the study area.

Table 2.2.1.B

Centre	Category
Gosford	Regional
Erina	Regional
Woy Woy	District
Terrigal	District
Umina	District
Kincumber	District
Ettalong	Local
East Gosford	Local

It is an objective of efficient transport links to connect Local Centres to District Centres and District Centres to Regional Centres.

2.2.2. Centres Linkages

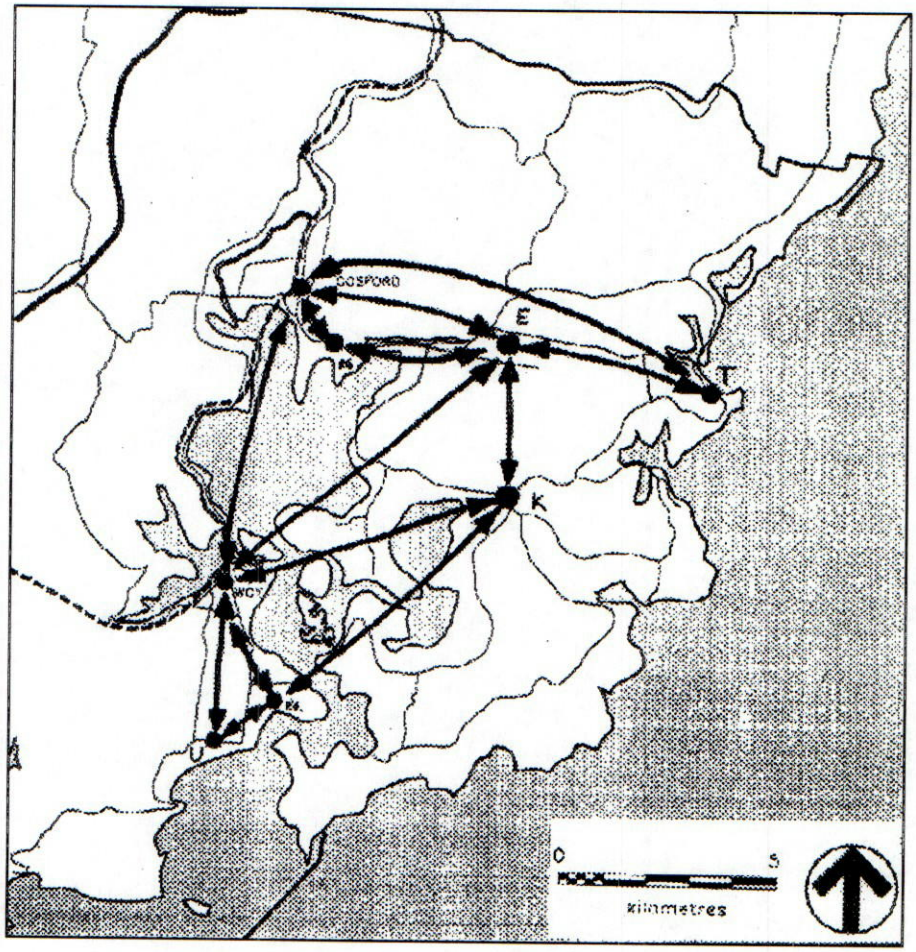
Local Centres should be linked to the nearest District or Regional Centre. Regional Centres themselves should also be linked. This methodology results in the following conceptual linkages between centres:

Gosford to:	Woy Woy, Erina, Terrigal, Umina, Kincumber.
Erina to:	Gosford, Woy Woy, Terrigal, Umina, Kincumber.
Woy Woy to:	Gosford, Erina, Umina, Kincumber.
Terrigal to:	Gosford, Erina.
Umina to:	Erina, Woy Woy.
Kincumber to:	Erina, Woy Woy.
Ettalong to:	Erina, Woy Woy, Umina, Kincumber.
East Gosford to:	Gosford, Erina.

Clearly, these links are rational and would be apparent anyway had this process not been used to justify them. Many of these linkages duplicate themselves and in doing so strengthen the potential for the link. Where the linkages duplicate there is demand for a corridor. Such a corridor will sustain considerable patronage as it will be serving a number of centres along its length.

The map on the following page presents the conceptual demand for linkages between centres in the study area.

Figure 2.2.2.A
Conceptual Demand for
Linkages Between Centres



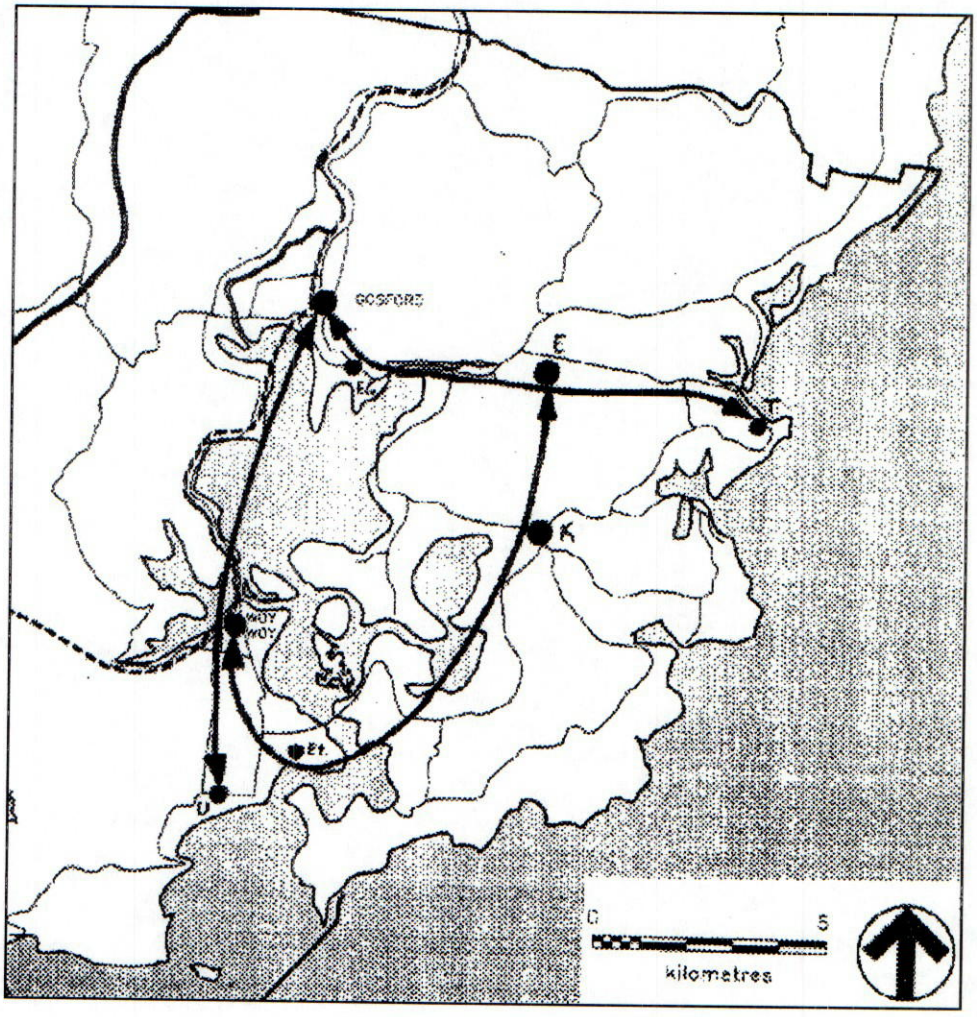
2.2.3. Corridor Identification

Identifying corridors between centres in the study area is now straight forward due to the findings of the preceding sections. The following Corridors have been identified:

Gosford to Terrigal via East Gosford and Erina.
Woy Woy to Erina via Ettalong and Kincumber.
Gosford to Umina via Woy Woy.

The following map presents these corridors Schematically.

Figure 2.2.3.A.
Schematic Presentation of Corridors



Gosford to Woy Woy is already serviced by State Rail Services. As a result it is not considered necessary to further cater for this corridor. Except for comments regarding residential density along the Gosford to Woy Woy Corridor, which could be increased around station locations, no further detail about this corridor will be discussed.

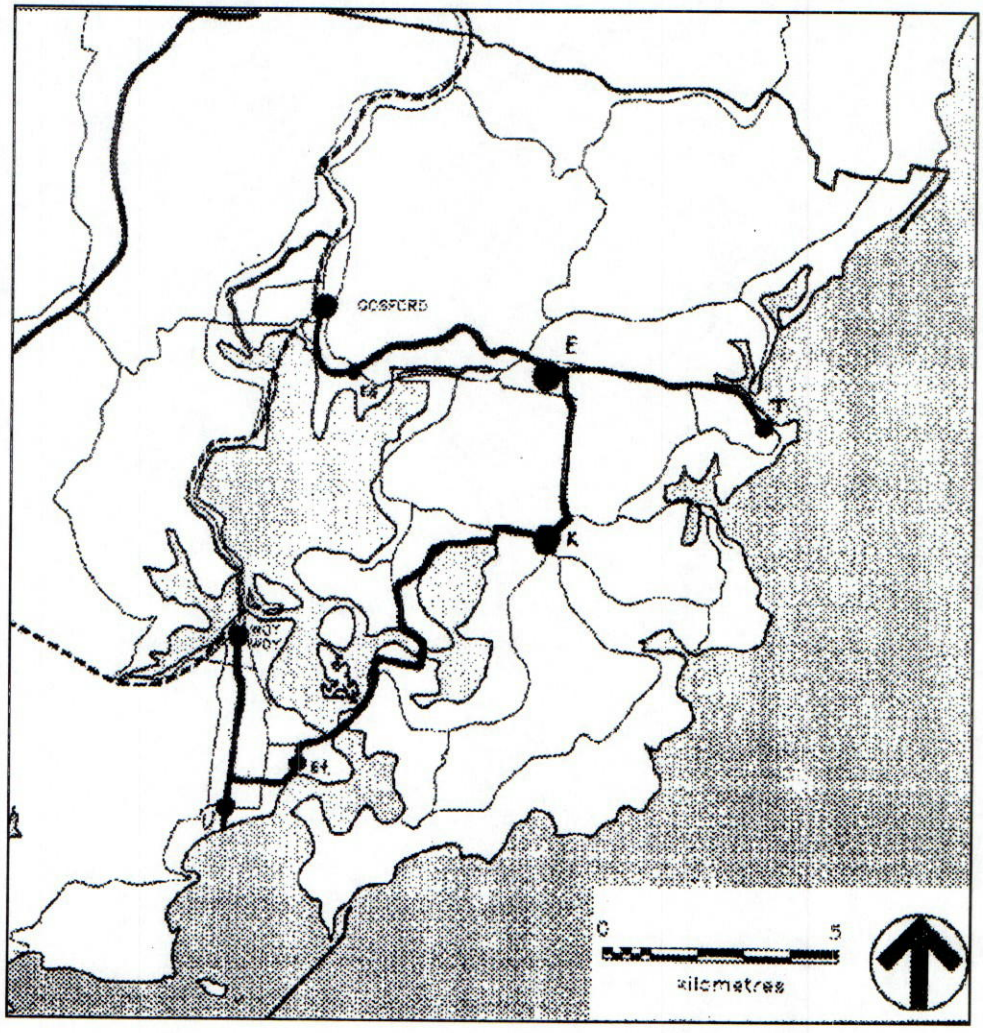
The portion of the Gosford to Umina corridor remaining, Woy Woy to Umina, will be detailed as one of the corridors examined in this study.

Therefore, the following corridors will be examined:

Woy Woy to Umina\Ettalong,
Gosford to Terrigal,
Woy Woy\Ettalong to Erina.

The following Map identifies the corridors to be examined in this study:

Figure 2.2.3.B.
Corridors Examined In This Study



2.3. Existing Transport Patterns.

It is important to comment on the existing transport patterns prevalent in the area. Apart from the rail line linking Gosford to Woy Woy (and the Towns in-between) the Study Area is essentially serviced by road transport only. Private cars constitute a majority of the journeys made in the study area and Privately Operated Buses provide Public Transport services. Taxis also service the area but are currently few and far between and in many instances the distances travelled within the study area by many people would result in an expensive fare.

The Networks of Roads and Buses, that operate on those roads, effectively link all the centres identified within the study area. However, at many times of the day traffic congestion is crippling, constraining the buses as well as the cars. As growth in the study area continues, and continues to accelerate, congestion will increasingly become a major public issue.

As has been proven many times by countless studies (ie. Newman, Kenworthy, et. al.) expanding the road network to accommodate more growth and alleviate congestion only serves to attract more traffic and exacerbate the problem. The Road and Bus Networks are currently straining under these pressures, especially along the corridors identified as the subjects of this study. This study will assess the potential for Light Rail Transit (LRT) services on these very corridors, those corridors that would otherwise be unable to accommodate the demand for transport into the next 50 years.

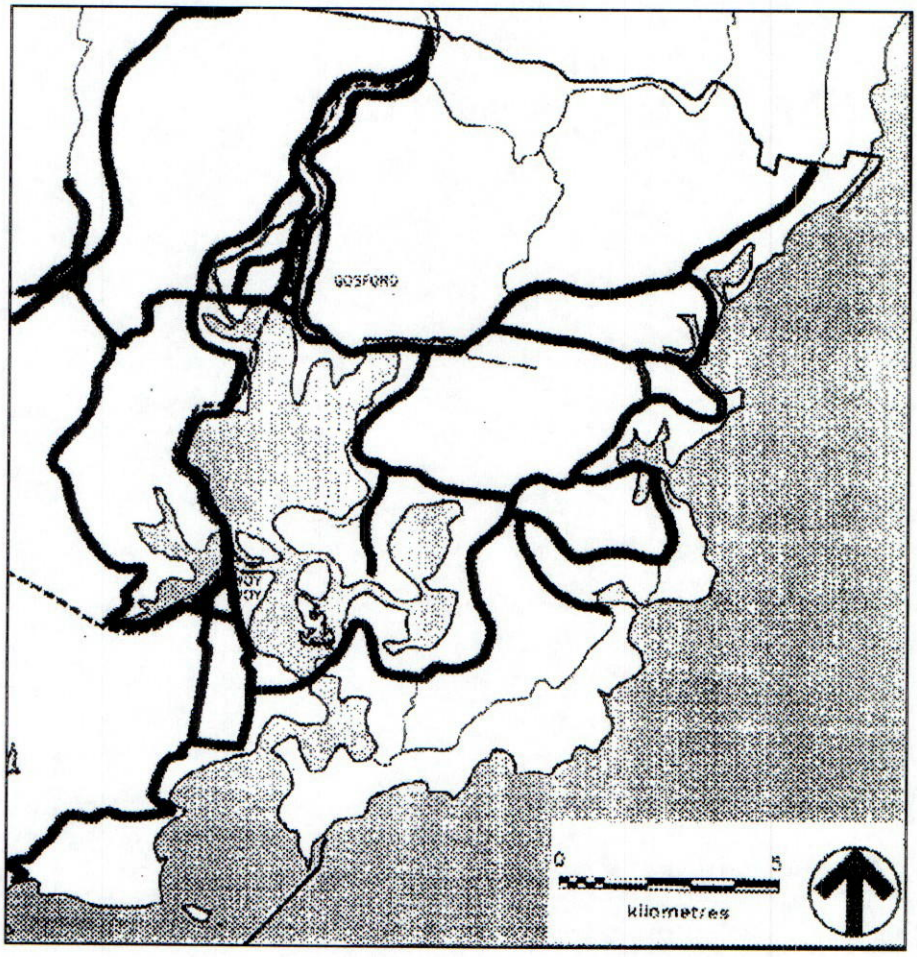
2.3.1. Road Network

The road network in the study area is fairly comprehensive. Most feasible links are already built or under construction. Although most main roads and arterials are of 2 lane construction (1 lane in each direction) many are 4 lane and works are continuing to improve the safety, flow and capacity of those that, as yet, are not.

Unfortunately, the policy of continuously improving and expanding the road network in the area will only exacerbate the current problems and offer no alternatives for a functionally appropriate future.

The Map on the following page details the Main and Arterial Road network in the Study Area.

Figure 2.3.1.A.
Main and Arterial Roads within the Study Area



2.3.2. Bus Network

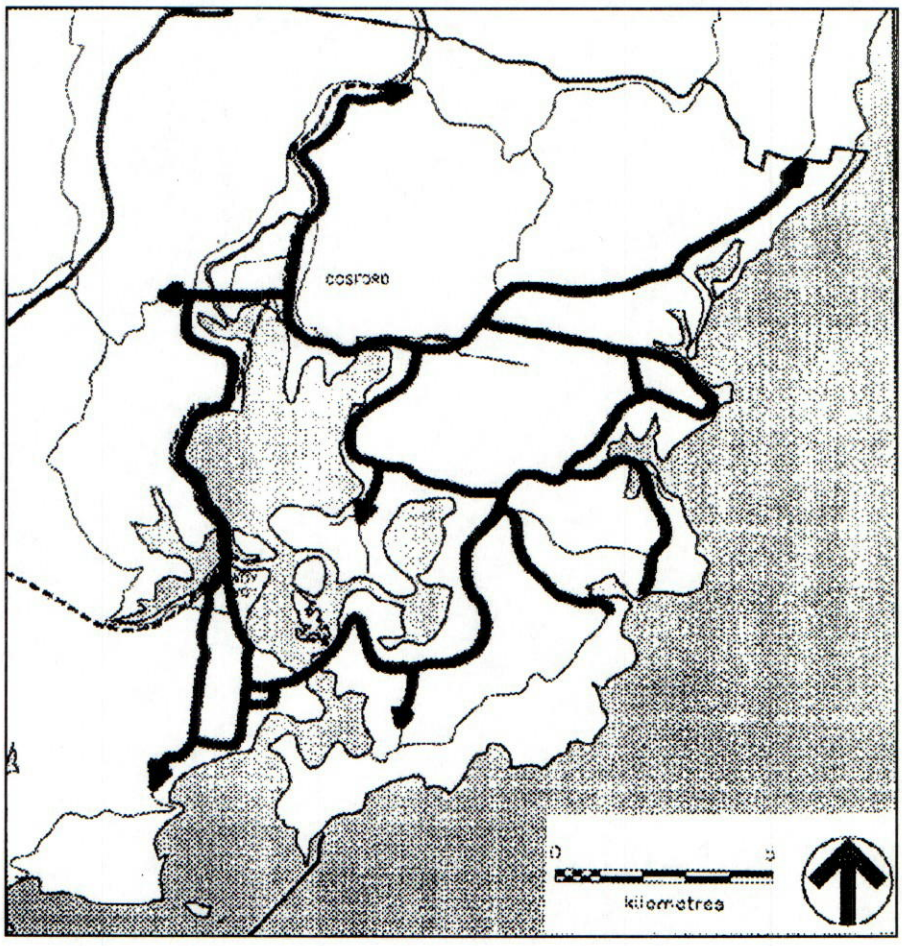
The Buses in the Study Area operate on the existing road network. Subsequently, they are subject to the often congested nature of those roads. Short of construction of an exclusive bus roadway system this issue will not be resolved.

The Bus Network is provided by Two main Bus companies: Peninsula and Red Bus. Most bus routes follow main roads and a number of routes combine to result in higher frequency of operation in busier areas and closer to centres. It is along these corridors where a number of routes combine, and are suffering with traffic congestion, that LRT may provide an appropriate, higher capacity mode.

A complete set of current bus routes and time tables for Peninsula and Red Bus services is contained in Appendix B "Current Bus Services". (Only one copy of Appendix B has been produced and it is kept with the Master Copy of this report at Gosford City Council.)

The following Map presents the majority of Bus routes in the study area.

Figure 2.3.2.A.
Main Bus Routes in the Study Area.



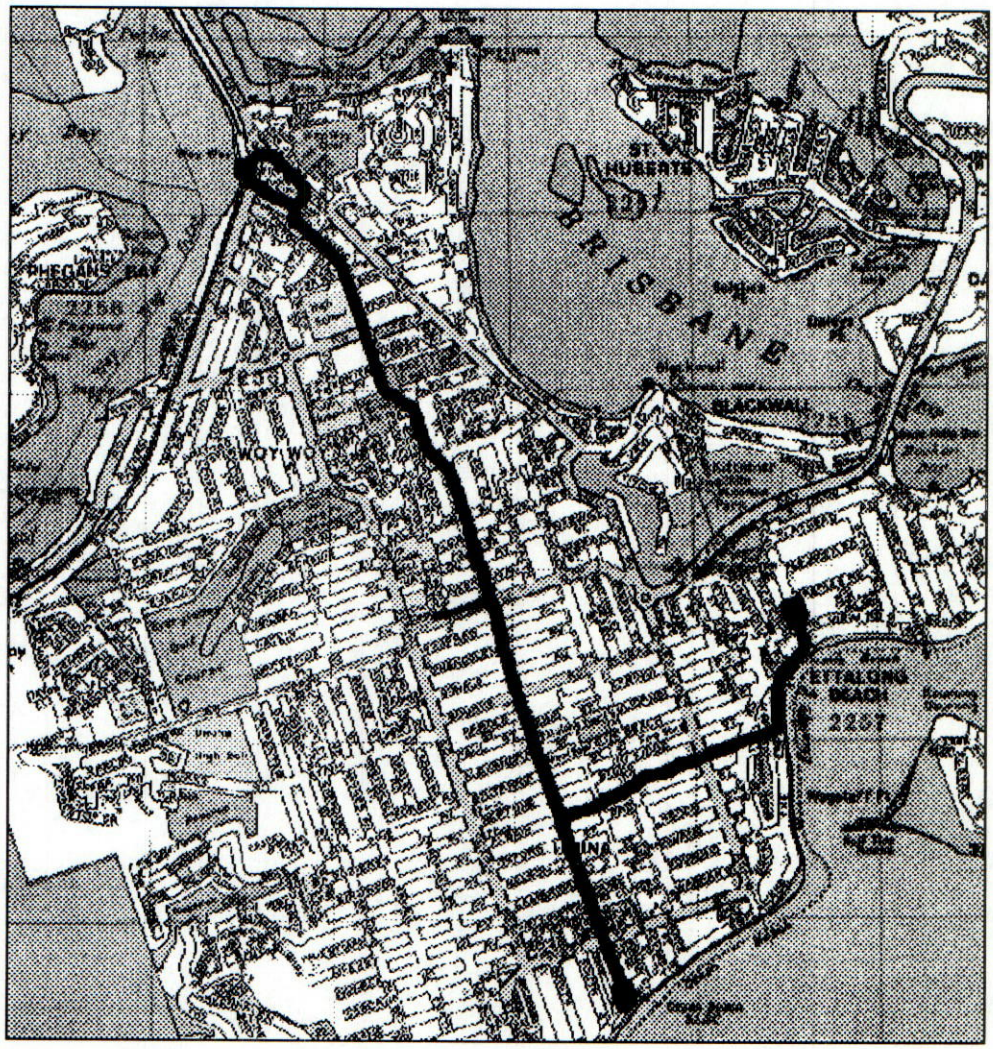
3. CORRIDOR ANALYSIS

The three identified corridors will be outlined and then detailed through both planning and engineering analyses.

3.1. Woy Woy to Umina/Ettalong

The proposed corridor for the Peninsula runs from Woy Woy Station to both Umina Beach and Ettalong Shops. The Ettalong Branch of this corridor is stage one of a possible further extension to Erina via Davistown and Kincumber. This link to Erina is detailed as a separate corridor in section 3.3.

Figure 3.1.A.
Proposed Alignment Woy Woy to Umina/Ettalong



3.1.1. Proposed Optimum Alignment

The proposed LRT alignment between Umina and Woy Woy Station is as follows. Further details regarding the proposed alignment are contained on the Alignment Maps at the end of this section.

Starting at Woy Woy Station and heading south towards Umina, services are proposed to commence at the interchange adjacent to the station. Leaving the interchange in a northerly direction, the single line (down line) would round the corner into Blackwall Road. There would be a stop opposite the Police Station outside the Peninsula Plaza. The line then continues south east in Blackwall until the access road on the southern side of the Kentucky Fried Chicken car park into which the line would turn. Continuing across George Street, where the Up line branches off towards the south end of the interchange, a stop would be located on the down line outside the southern exit of Deepwater Plaza. Entering the southern car park of Deepwater Plaza, the double track alignment turns south-east again to line up with the alignment of Edward Street. The proposed alignment then crosses Victoria Road end enters Edward Street.

(Note: the alignment proposed above is believed to be the most functional from a Light Rail operations point of view. This is because, being the end of the line, a loop enables easier throughput without congestion, and secondly passenger distribution and pick up in the shopping area and at the Station. The precise rationale behind this alignment in the Woy Woy CBD area is further explained in section 3.1.3. Planning Analysis.)

Following Edward Street south the alignment crosses Rawson/Allfield Roads where there would be a stop. Continuing south the alignment meets with James Browne Park, where there would be another stop. Crossing the park in a south-easterly direction the alignment joins Welcome Street. Crossing McMasters Road, with some straightening out of the intersection, into Trafalgar Avenue the alignment continues south to another stop beside the post office at the corner of Waterloo Avenue. Following Trafalgar Avenue south the next stop would be on the approach sides of Bourke Road. The next stop would be on the north side of Albion Street.

At Albion Street the Ettalong Branch separates and heads east. (Operating services are envisaged to operate Woy Woy to Ettalong or Woy Woy to Umina only and not between Umina and Ettalong. However, the junction at Trafalgar Avenue and Albion Street would be able to operate in all directions for depot and emergency operations.)

Continuing towards Umina the next stop would be on the northern side of West Street. The southern terminus would be located at the very end of Trafalgar Avenue in the Beach car park. The terminus would simply consist of a double track stub with a preceding double crossover.

The Ettalong branch, after diverging from Trafalgar Avenue at Albion Street, would proceed eastwards towards Springwood Street. Straightening out of the intersection would need to occur to cross Springfield Street into Bangalow Street. A stop would be located on the approach sides of Springwood Street. The alignment would then

continue along Bangalow Street crossing Barrenjoey Road and Broken Bay Road until reaching the Esplanade. A stop would be located upon turning north onto the Esplanade. This stop would service the proposed JetCat Terminal. Following the Esplanade north and joining Picnic Parade the alignment would cross Ocean View Road and terminate with a stop on the northern side of the intersection. This terminus would be similar to that at Umina Beach, a double track stub with double crossover preceding.

From here this line could be extended to Davistown, Kincumber and Erina. (See section 3.3.

Returning towards Woy Woy Station the Up line leaves the Down beside Deepwater Plaza at George Street. The Up alignment follows George Street north, with a stop beside Deepwater where the current Bus stop is, and crosses Railway Street into the car park beside the railway. Here it joins the interchange and terminates. This terminus is on a loop (see Woy Woy CBD LRT alignment diagram) and requires no stub but would require two tracks. One for Umina bound services and the other for Ettalong bound ones. This would also allow for passing if required.

Figure 3.1.1.A.
Blackwall Road looking North.
LRVs departing Woy Woy would be approaching.

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Figure 3.1.1.B.
Departing LRVs would proceed to Deepwater Plaza past KFC (on right).

Figure 3.1.1.C.
LRVs approaching Woy Woy would pass Deepwater Plaza with a stop beside this entrance opposite the Car Park.

Figure 3.1.1.D.
Departing LRVs would have a final stop before leaving Woy Woy CBD outside the southern entrance of Deepwater Plaza.

Figure 3.1.1.E.
The line would pass through the Southern Carpark of Deepwater Plaza and join Edward Street.

Figure 3.1.1.F.
Departing LRVs would need to pass through the intersection of Railway Street and Blackwall Road. This would necessitate the redesign of the intersection to accommodate LRV operation.

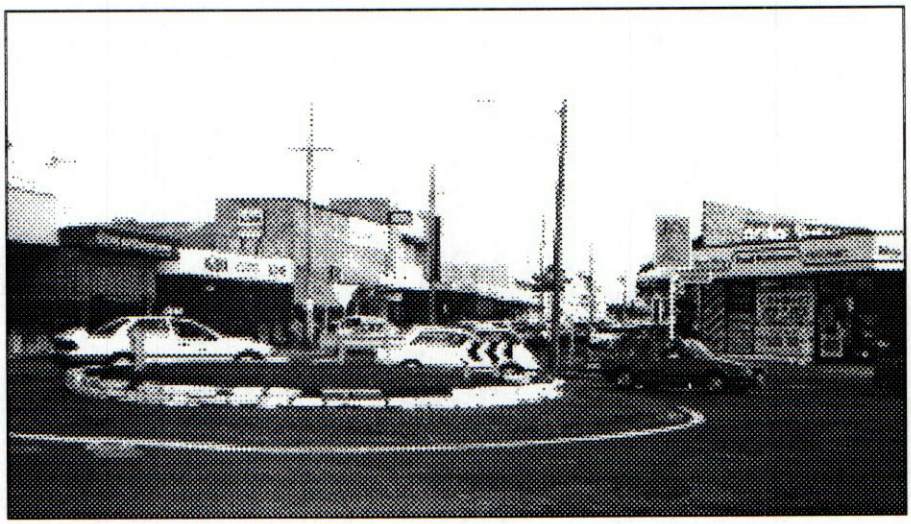


Figure 3.1.1.G.
The Interchange beside Woy Woy Station would require redesign to afford efficient passenger movements between modes.

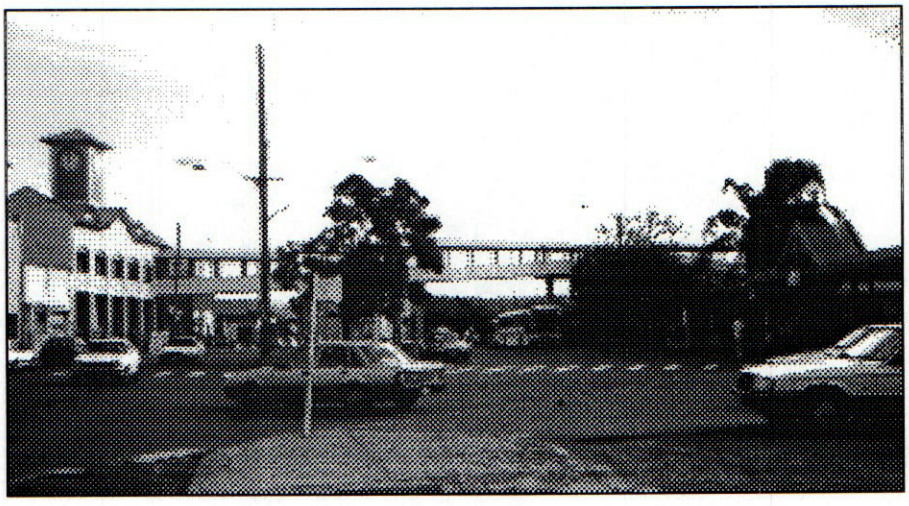
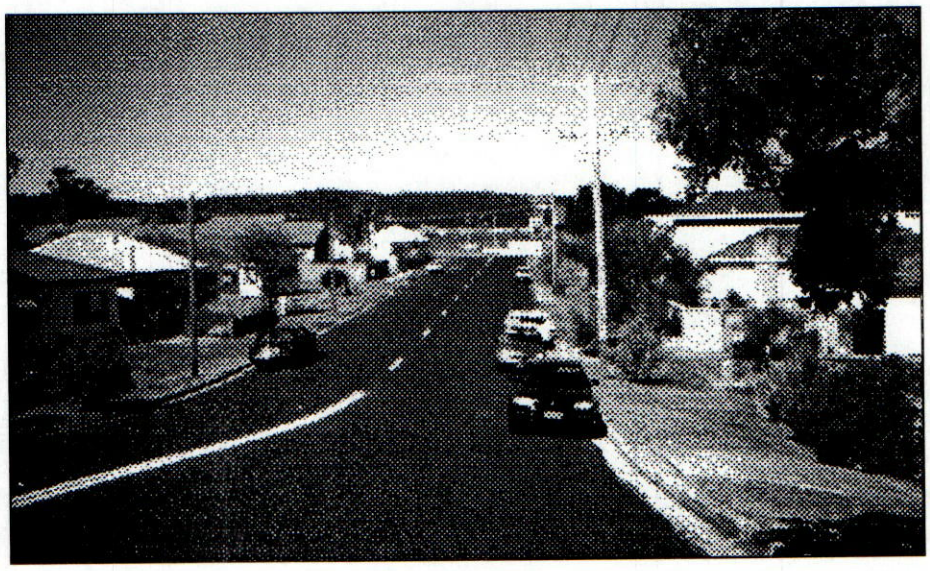
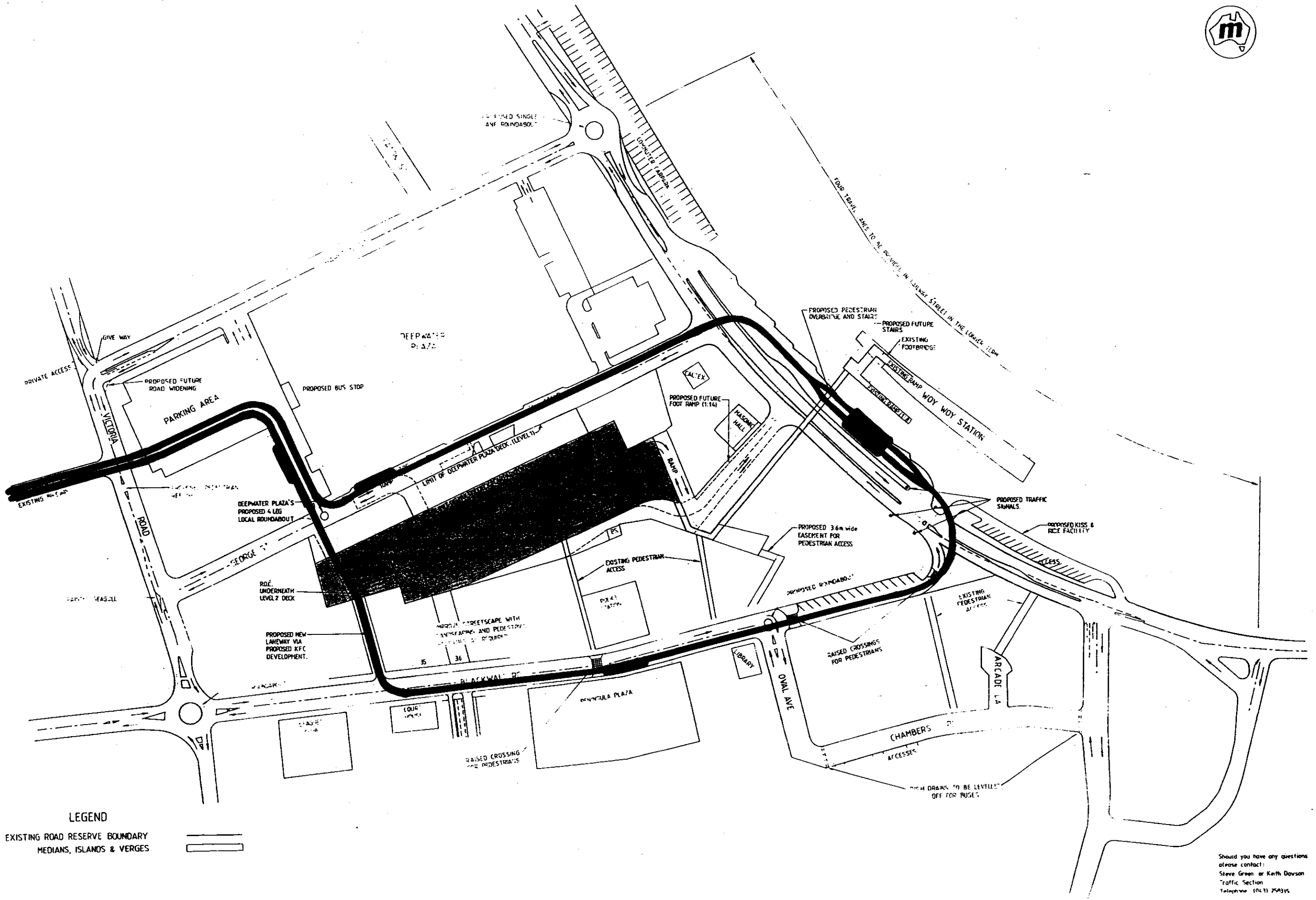


Figure 3.1.1.H.
The Junction of Trafalgar Avenue and Albion Street where the Umina and Ettalong branches meet.

Figure 3.1.1.I.
Bangalow Street heading to the proposed Ettalong wharf.





Should you have any questions please contact:
Steve Green or Keith Dawson
Traffic Section
Telephone (043) 259315

UTILITIES	PLAN	SECT
WATERMAIN	W	CW
UNDERGROUND POWER CABLES	E	CE
GAS MAIN	G	CG
UNDERGROUND ATC CABLES	T	CT
SCC POLES	⊕	
ATC POLES	⊕	
SEWER	S—O	CS

LEGEND

	EXISTING	PROPOSED
KERB AND GUTTER		
TABLE DRAIN		
ROAD CENTRELINE		
HEDGED LINE		
PIPE DRAIN		
GULLY PIT		
JUNCTION PIT		

REVISION DETAILS	DRAWN	APPROVED	DATE

DATUM

	FIELD BOOKS	LEVEL BOOKS

SURVEYED	
DRAWN	
CHECKED	
ENGINEER	22/8/91

BASE SCALE: N.T.S.

BAR SCALE

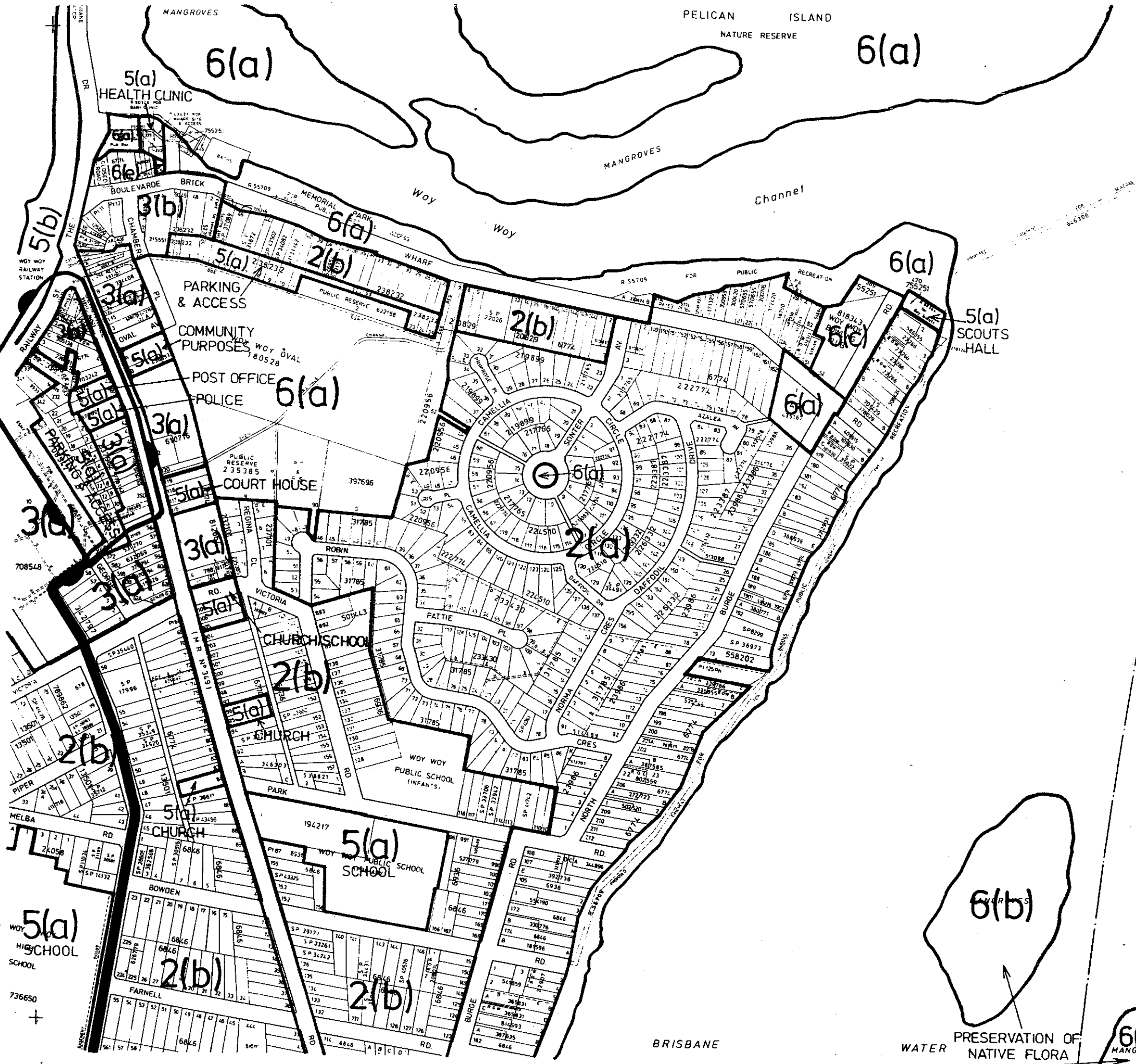
GOSFORD CITY COUNCIL

WOY WOY C.B.D. DRAFT TRAFFIC STUDY
PREFERRED OPTION (OPT. 7)

FILE No. 947 · 02 · 02

DRAWING No. 1058 / 3 / A1

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

WOY WOY

KEY TO LOCALITES

267B	268A	268B
267D	268C	268D
277B	278A	278B

KEY TO ADJOINING SHEET

This map is not a true copy of the zoning provisions o the Gosford planning instruments.

Reference should be made to the official maps deposite in the office of the Gosford City Council for accurate zoning information and later amendments.

METRES

CENTRAL MAPPING AUTHORITY

MAP REFERENCE

WOY WOY U2790-53

GOSFORD CITY COUNCIL

PRESERVATION OF NATIVE FLORA & FAUNA

6(b)

BRISBANE

WATER

Blackwall Point

COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

WOY WOY

KEY TO LOCALITES

267D	268C	268D
277B	278A	278B
277D	278C	278D

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METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-81

GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

WOY WOY

UMINA

KEY TO LOCALITES

277A	277B	278A
277C	277D	278C
286A	286B	287A

KEY TO ADJOINING SHEET

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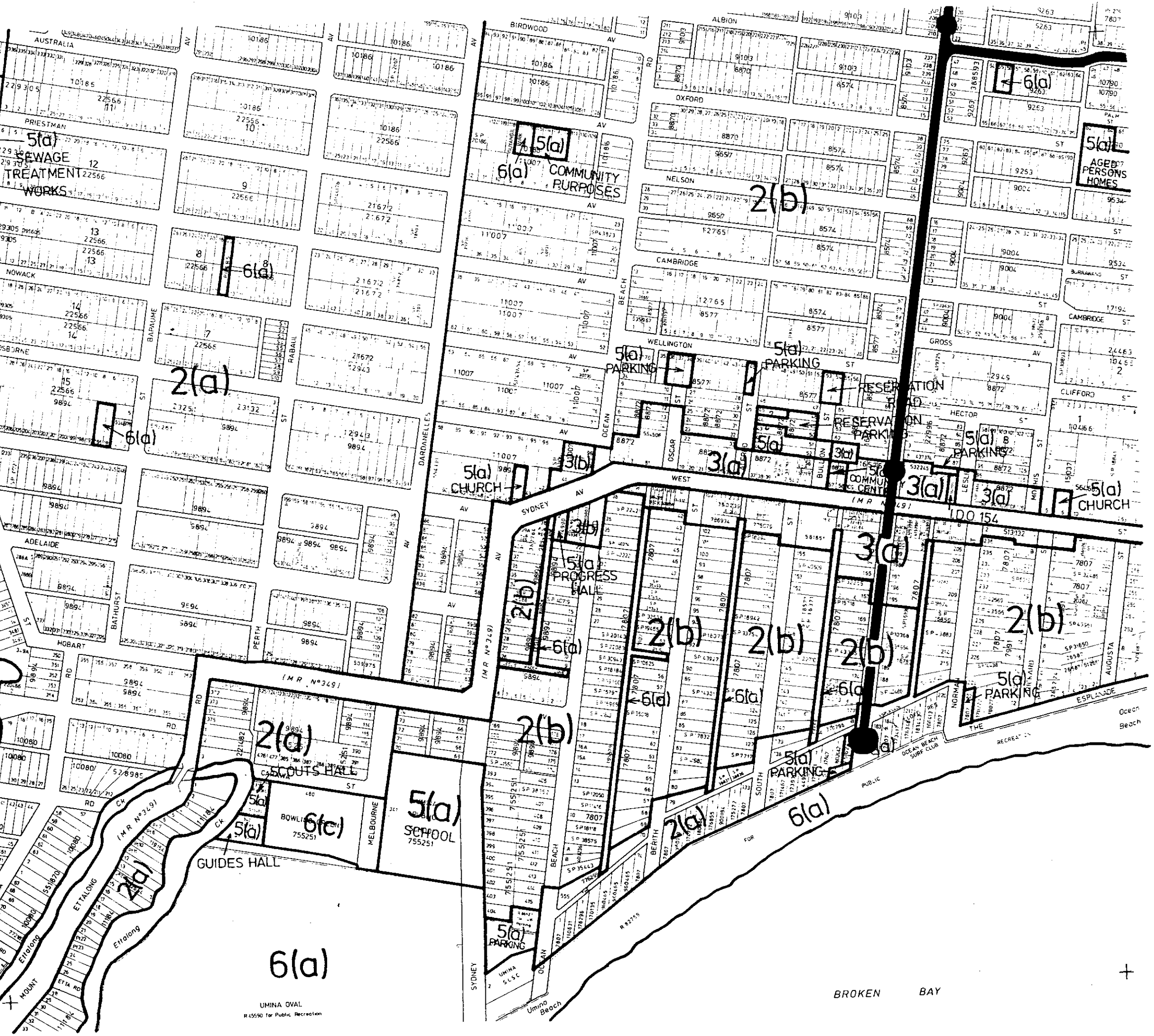
METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-74

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

UMINA

KEY TO LOCALITES

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286C	286D	

KEY TO ADJOINING SHEET

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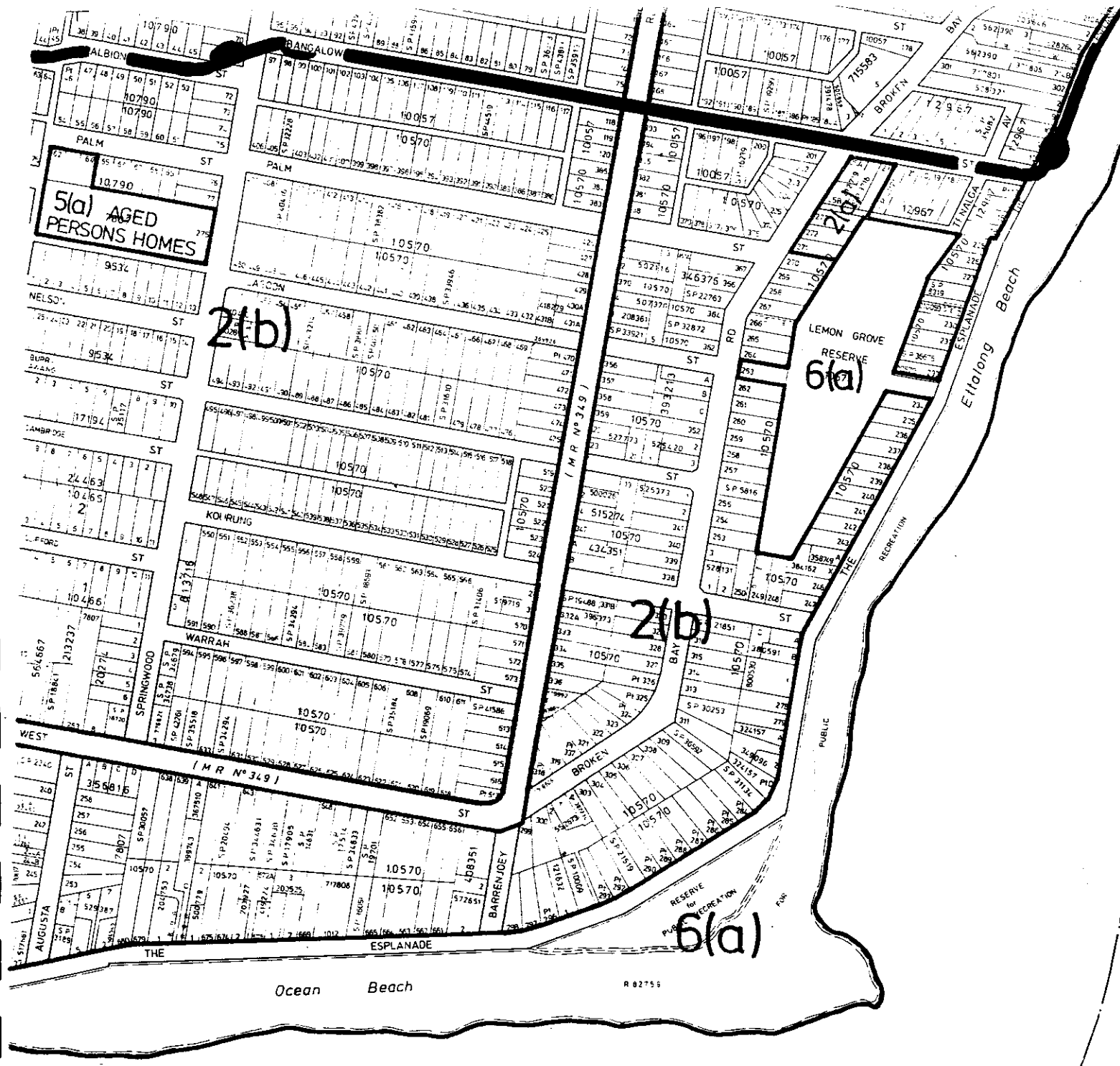
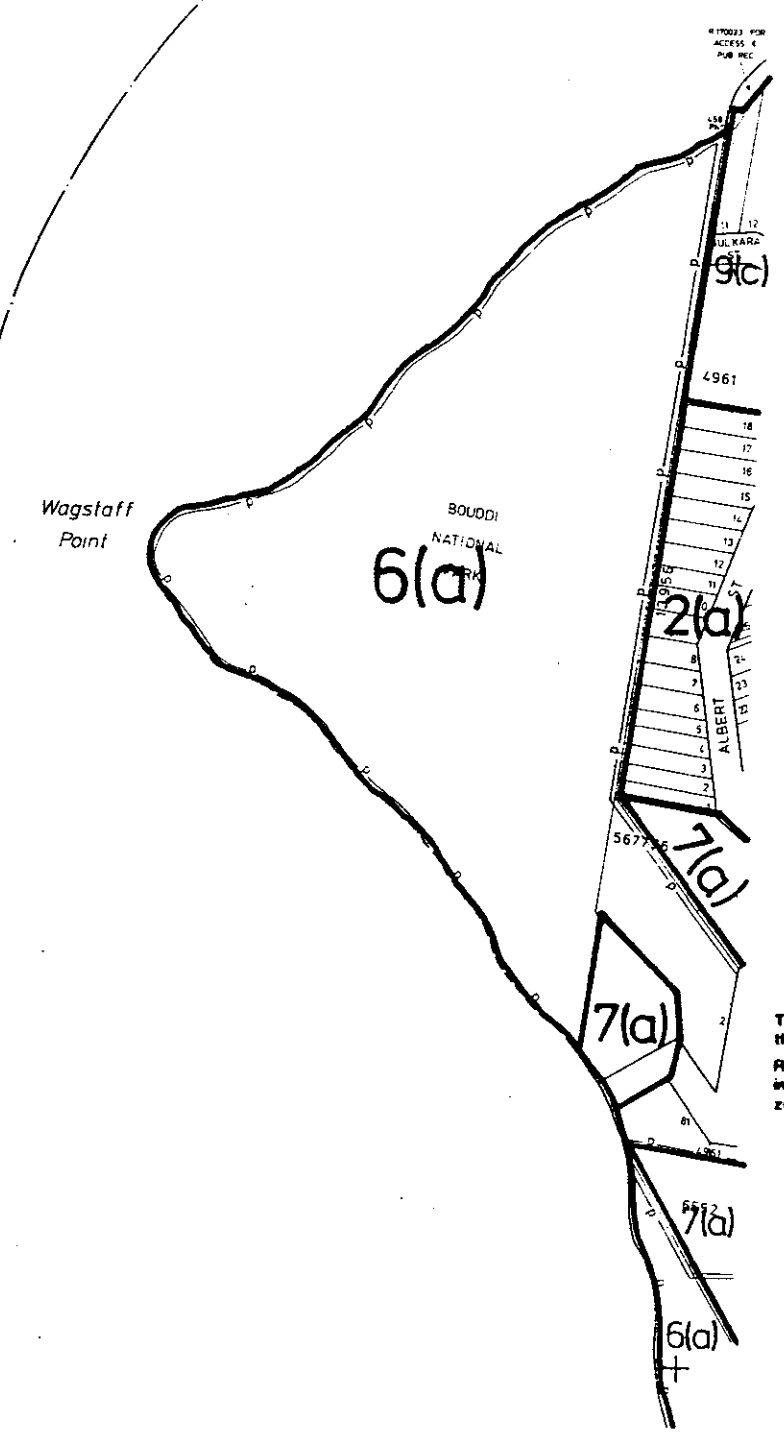
Reference should be made to the official maps deposited in the office of the Gosford City Council for accurate zoning information and later amendments.

METRES

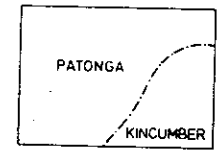
CENTRAL MAPPING AUTHORITY
MAP REFERENCE
BROKEN BAY U2782-12

GOSFORD CITY COUNCIL





COUNTY OF NORTHUMBERLAND



KEY TO PARISH

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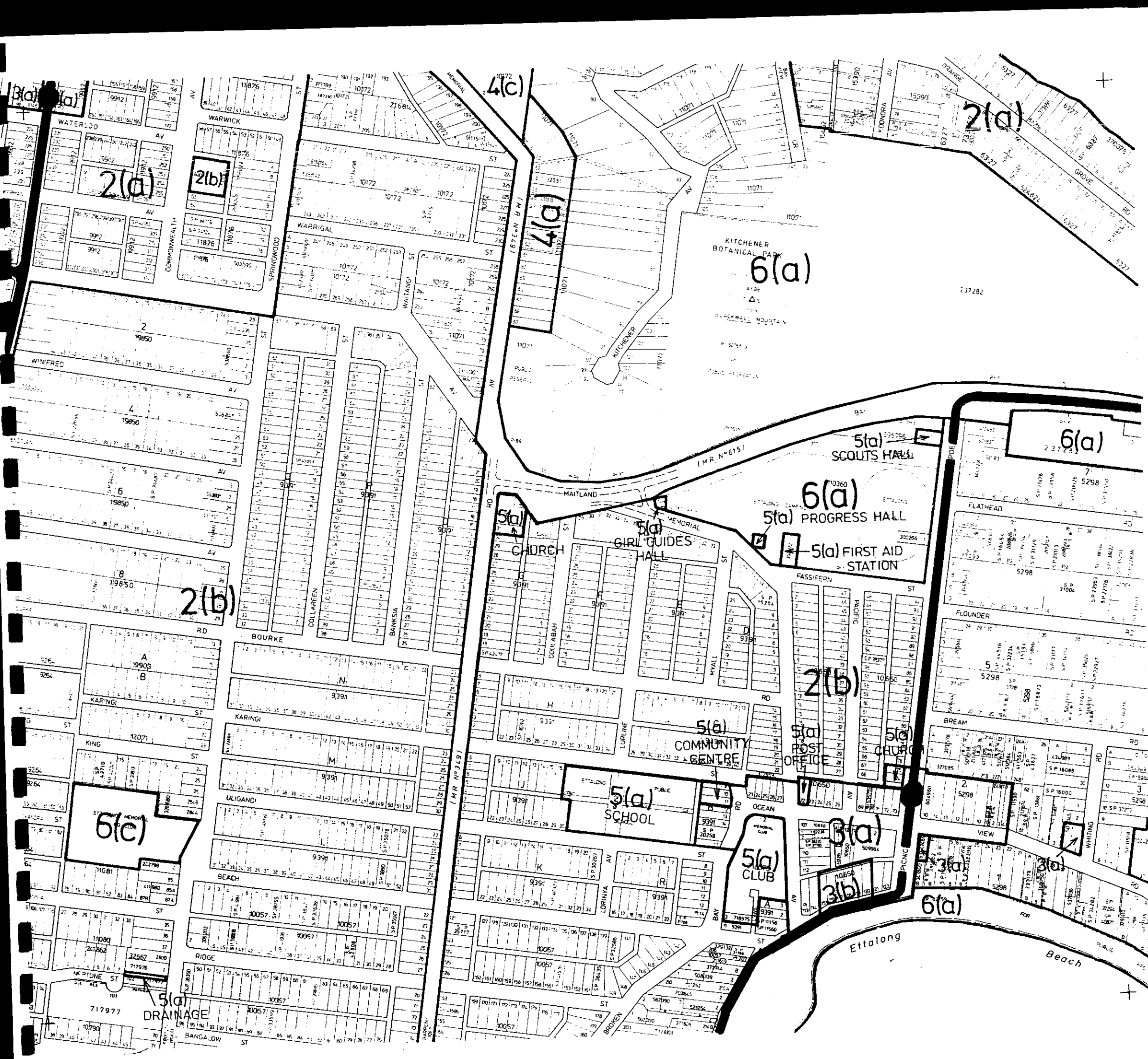
CENTRAL MAPPING AUTHORITY
MAP REFERENCE
BROKEN BAY U2782-21

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

WOY WOY

UMINA ETTALONG

KEY TO LOCALITES

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286B	287A	287B

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METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-83

3.1.2. Engineering Analysis

Between Woy Woy and Umina the following Engineering requirements will be needed to achieve the proposed LRT alignment:

Gradients are effectively non existent between Woy Woy and Umina and as such no vertical alignments have been prepared for this corridor. The proposed corridor traverses an area so flat that even the water gives up and just sits around not knowing which way is down. It is apparent that gradients will not be a design issue for this corridor. However, track drainage will need to be paid special attention in order to avoid severe pooling in the flange groves.

There are no requirements for any earth works along this corridor as the existing ground and street levels are all appropriate for the proposed track levels.

Traffic management will require special attention in a number of locations. In most localities "T" intersections and cross streets will only require stop signs. However cross streets with considerable through traffic will need traffic Signals. In such instances the approaching Light Rail Vehicle (LRV) will trigger the lights to the appropriate phasing to ensure free flowing of the LRT services.

Considerable traffic management will be necessary in the Deepwater Plaza area and in and around Woy Woy CBD. Further study will need to be undertaken to establish the precise interaction between Light Rail services, Car and Delivery traffic, Pedestrians and Access to Shops in the Woy Woy CBD. Further study may find that the proposed LRT Loop is not the most efficient solution and instead propose more appropriate options if they are found to exist.

A Depot and Maintenance Facility will be required for the Peninsula Corridors. Short of proposing a resumption, and subsequent rezoning to special uses (transportation), the only appropriately located Council owned land that could be used for this purpose is the existing Council depot on the corner of Ocean Beach Road and Gallipoli Avenue. Access to the site would be via a short link along Gallipoli Avenue from Trafalgar Avenue. This site is not ideally located but will serve effectively enough.

The Ettalong Branch will require some regrading work of existing street levels. From the corner of Trafalgar Avenue and Albion Street, where this line branches off the Umina Branch, to the Corner of Bangalow Street and Broken Bay Road no major earth works will be required. However, the eastern side of Bangalow from Broken Bay Road will need to be regraded to lessen the gradient (see Vertical Alignment Diagrams Following this section). No further regrading will be required for the rest of the corridor to Ettalong Shops.

Traffic management will be minimal for this section of corridor. Traffic signals will be needed at the crossings of Springfield, Barrenjoey, Broken Bay and Ocean View Roads.

Vertical Alignment Diagram

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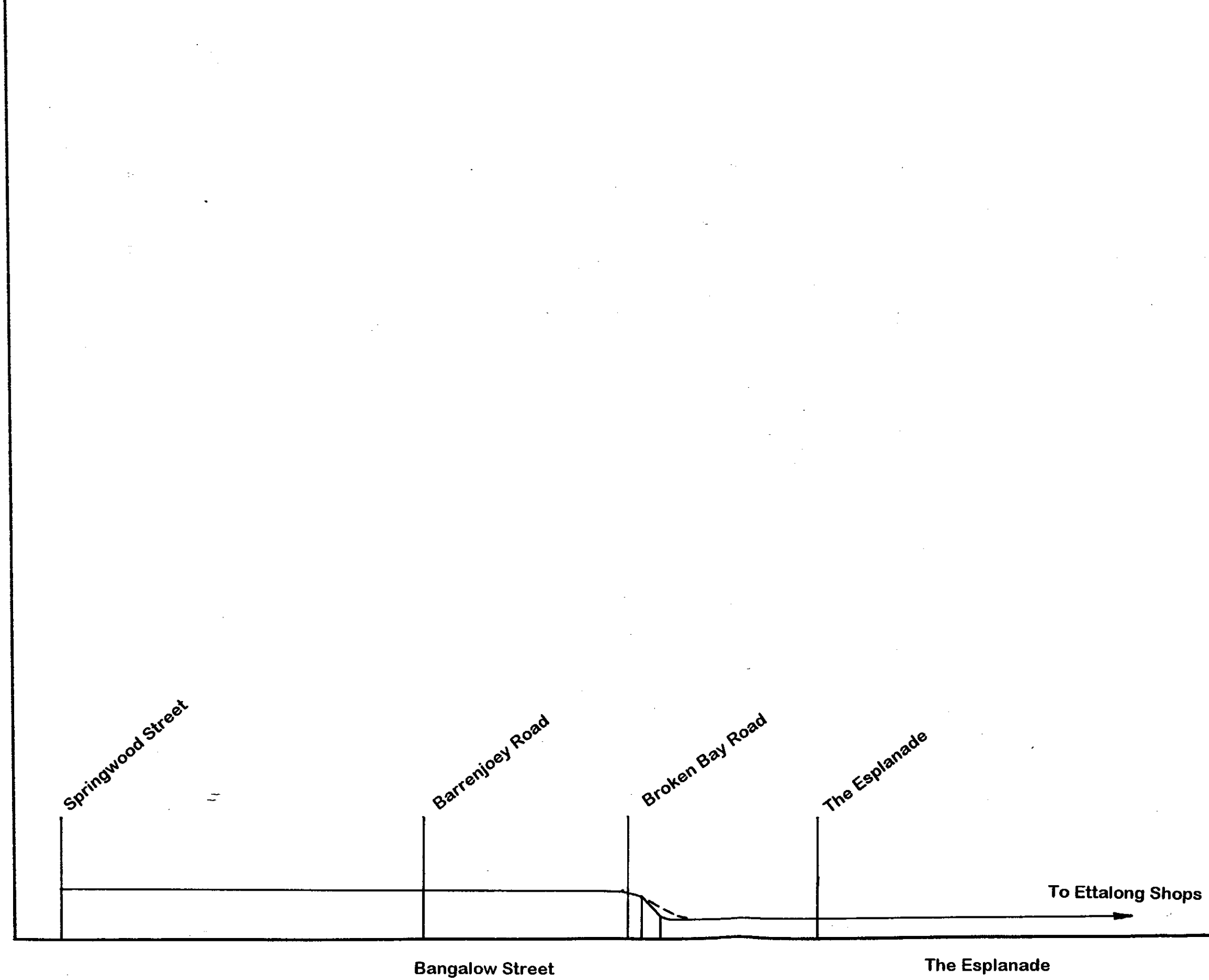
URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.



Horizontal Scale
1:4000

Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Woy Woy to Ettalong.

Locality:

Diagram #:

3.1.3. Planning Analysis

For the Woy Woy to Umina corridor the following Planning issues have been taken into account.

The rationale behind the proposed Woy Woy CBD LRT loop is as follows:

People heading towards Woy Woy are likely to be either destined for the Railway Station or shops. As such it is important to set down people close to both of these facilities. The stop in George Street next to Deepwater Plaza satisfies the Shoppers needs This stop would only involve a short walk to the Blackwall Road shops as well. The proposed stop at the interchange beside the station will set down people beside the station as conveniently as possible for interchange purposes.

For people leaving Woy Woy CBD via the LRT, the start of the line in the Interchange beside the station conveniently picks up commuters changing from the railway. The next stop near the police station, although close to the first, will pick up shoppers loaded with goods so that they need not walk far to another stop less conveniently located. The third CBD pick-up stop is beside the southern exit of Deepwater Plaza. Again this stop is located here to conveniently serve shoppers leaving the Plaza loaded with goods.

Although these three stops are located closely together they are at the beginning of the line and patrons should not be discouraged as from this point onwards the service will pick up speed as it heads out of the CBD and into the suburbs.

The next stop near Allfield Road would serve the adjacent High School. The stop near James Browne Park would serve the nearby Hospital and Swimming Pool. The next stop near McMasters Road would serve the nearby community facilities on Ocean Beach Road.

The next stop near Waterloo Avenue would serve the adjacent Post Office, shops and nearby Public School. This stop could be the focus of a new Urban Village in conjunction with appropriate rezoning and drainage controls. The stop at Bourke Road could also become a future Urban Village location but is more likely to maintain its local context.

The next stop is at the junction with the Ettalong branch. This stop, located on the northern side of Albion Street, would be an ideal location for an Urban Village with appropriate rezoning.

The stop at Umina would be on the northern side of the intersection with West Street. This stop would serve the surrounding shopping area and possible residential redevelopment above commercial/retail uses. The final stop at the beach beside the Surf Club would serve the beach and surrounding beach-side development.

On the Ettalong Branch the stop at the crossing of Springwood Street would serve the nearby Retirement Village. The stop at the end of Bangalow Street beside the beach would serve not only the beach but also the potential JetCat Ferry Terminal serving commuters to Sydney. Redevelopment at this location could be considerable, especially if the JetCat Service proves viable and long lasting.

The final stop on this line at Ettalong shops would serve the shops, the northern end of the beach and residential development above shops.

Resumption along the line would be necessary in the following locations (refer to the Alignment Diagrams at the end of section 3.1.1.):

(I) Access agreements would be necessary in the Deepwater site,
(II) Corridor identification across James Browne Park,
(III) Resumption of Properties to afford straighter crossing of McMasters Road from Welcome Street into Trafalgar Avenue,
(IV) Possible resumption of two properties on the corner of Gallipoli Avenue and Wentworth Avenue South to afford direct access into the proposed depot facility,
(V) Resumption of Properties to afford the straighter crossing of Springwood Street from Albion Street into Bangalow Street.

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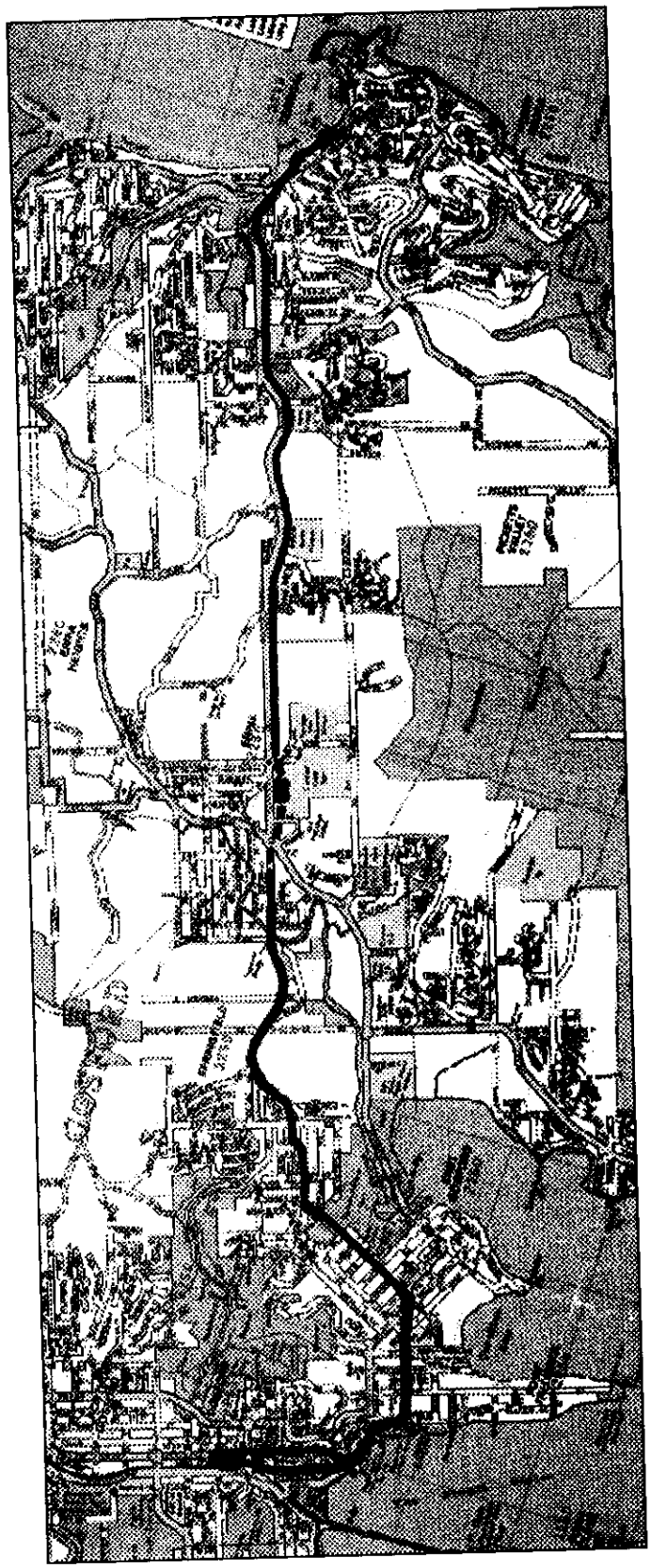
3.2. Gosford to Terrigal

The proposed LRT corridor between Gosford and Terrigal Runs via Erina Fair and mostly uses the Wells Street and Terrigal Drive Alignment. The station at Erina Fair is proposed to be Underground.

East of Erina there are two possible future branches to this line. The first is immediately east of Erina where the Kincumber branch would diverge and head south. This line is detailed separately in section 3.3. The other branch, heading to The Entrance would branch off near the Junction of Terrigal Drive and Serpentine Road. This branch is not detailed as it is considered beyond the scope of this study. This corridor (The Entrance Corridor) should perhaps be the subject of another study conducted jointly with Wyong Council.

The following section details the Proposed Optimum Alignment between Gosford and Terrigal.

Figure 3.2.A.
Proposed Alignment Gosford to Terrigal.



3.2.1. Proposed Optimum Alignment

Commencing at Gosford Station and heading for Terrigal the LRT alignment is proposed as follows. More detail can be attained through reference to the Alignment Maps following this section.

The interchange at Gosford Station would be on a clockwise loop that circles the Gosford CBD. Commencing in a north bound direction the single (Down) line would turn through 180 degrees to join Mann Street and head south. A stop would be located on the approach side of Donnison Street (Pick Up only). Continuing south past the Council Chambers the line would cross Georgiana Terrace and then turn south-west into Vaughan Avenue.

Rounding the Memorial Gardens, the Up line is met. (The up line branches north here along the eastern side of the park towards Baker Street.) A stop would be located beside the Memorial Gardens opposite the Gosford Ferry Wharf and proposed Marina. Following the northern side of Dane Drive, the now double track alignment joins Masons Parade and has another stop just north of York Street beside the pool. This concludes the Central Portion of the Line.

Turning East into York Street, the line starts its Suburban run. Following York Street, the next stop would be immediately west of Webb Street beside the Public School. Continuing, the line turns north-east into Althorp Street where another stop would be located on the eastern side of Victoria Street (The East Gosford Stop).

The next stop would be at the eastern end of Althorp Street. From Althorp Street to Wells Street some Property Resumption would be required to obtain a corridor. (See attached Alignment Maps for detail). Heading East along Wells Street another stop would be located immediately west of Headlam Parade beside the Springfield shops.

It is here that a short deviation from Wells Street is proposed to avoid the steep grade. From the corner of Wells and Headlam, the alignment cuts across to Cary Crescent with some Property Resumption. Heading east in Cary Crescent the line crosses Springfield Road and enters a vacant site running through to Wells Street again. Following Wells Street the next stop would be near the Chertsey Public School. From here the alignment continues to follow Wells Street and crosses Erina Creek into Barralong Road.

A stop would be near Aston Road in Barralong Road. A proposed Depot and Maintenance Facility is proposed to be on one side or the other of Barralong Road. This site would be central to the line and also central to a system of lines focusing on Erina (possible lines to Kincumber/Woy Woy, and The Entrance).

Before reaching The Entrance Road it is proposed that the Alignment go Underground at the start of the hill. This also avoids the congested intersection with Terrigal Drive, congestion that is bound to get worse over time. Still Underground the line enters the only Underground station proposed for the system, the Erina Fair Station. The line

continues east and emerges from the ground immediately west of the intersection with Chetwynd Road, where it would follow the southern side of Terrigal Drive.

Future stops are proposed near the intersections with Portsmouth and Serpentine Roads but will not be required initially due to lack of demand and/or development. (See section 5.1.2. Terrigal Growth Corridor).

Following Terrigal Drive, the next stop would be located between the junctions with Charles Kay Drive and Brunswick Road. Thereafter the next stop would be between Willoughby Road and Ocean View Drive. The final stop and eastern terminus of the line is at Terrigal Beach on the site of the current car park beside the Information Centre. The terminus would consist of a double track stub with a preceding double crossover.

Returning to Gosford CBD the Up line would diverge from the Down near the Corner of Danes Drive and Vaughan Avenue. The Up line would head north, along the eastern side of the Park, towards Baker Street. Crossing Donnison Street, a stop would be located immediately upon entering the Car Parking Station (Drop Off only). The final stop would be in the interchange beside Gosford Railway Station.

Figure 3.2.1.A.
The lines enter Gosford CBD via Dane Drive and pass by the proposed Marina site.

Figure 3.2.1.B.
At the intersection of and Dane Drive and Vaughan Avenue the lines part with the Gosford Station bound line proceeding north through the park.

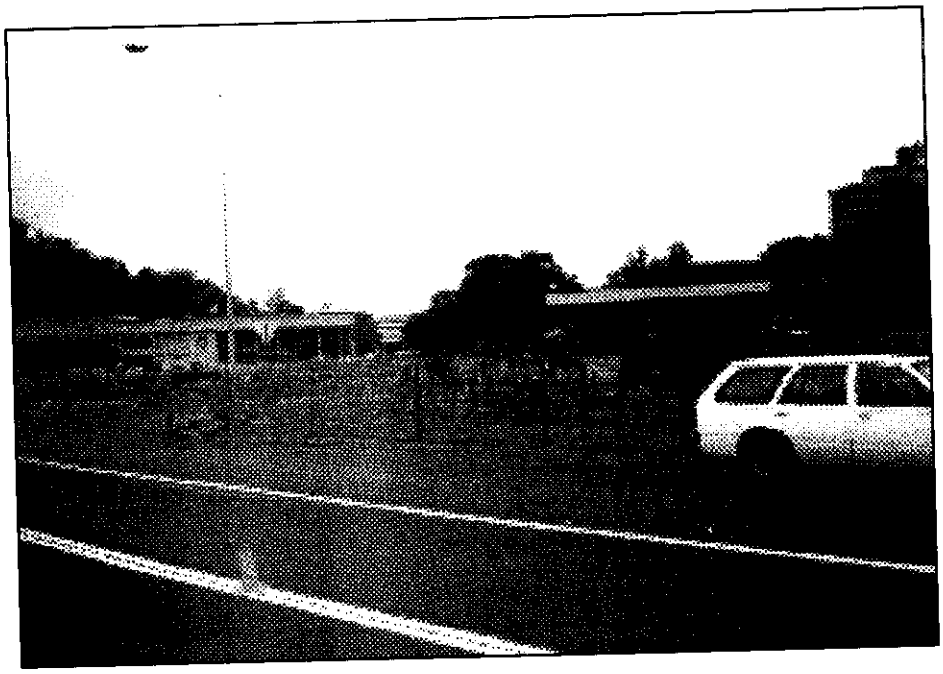


Figure 3.2.1.C.
Proceeding north on Baker Street the approaching line would pass under the parking station.

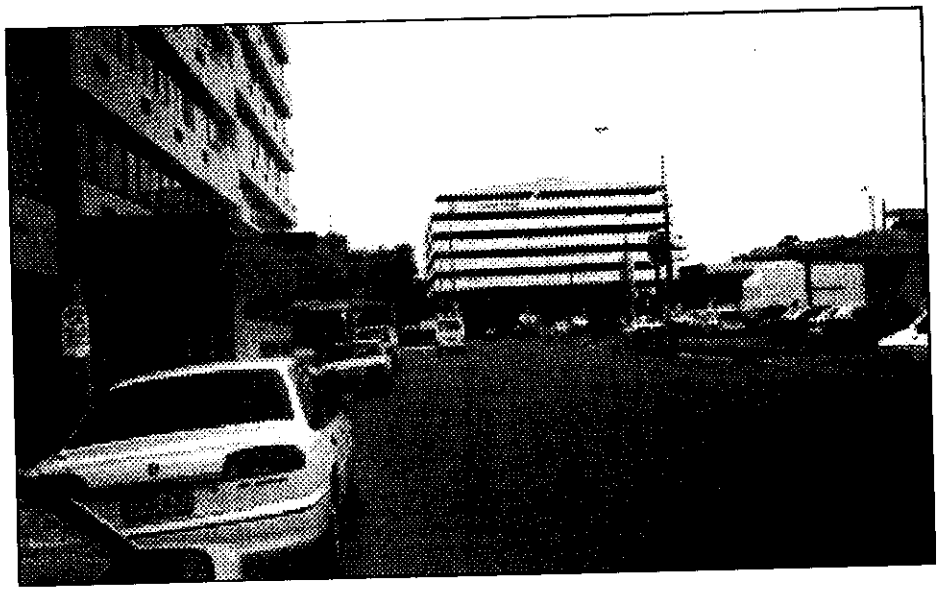


Figure 3.2.1.D.
The approaching line will require the widening of this laneway behind Mann Street between Erina Street East and the Gosford Station Interchange. This can be achieved by cutting into the embankment on the left of the photo.

Figure 3.2.1.E.
The opposite end of the same laneway. The widening would occur along the strip of bushes in the centre of the shot.

Figure 3.2.1.F.
The Gosford Station Interchange which would require only minimal remodelling to accommodate LRVs.

Figure 3.2.1.G.
Leaving arrangements for LRVs departing Gosford Interchange would be via a similar controlled intersection as now exists for buses.

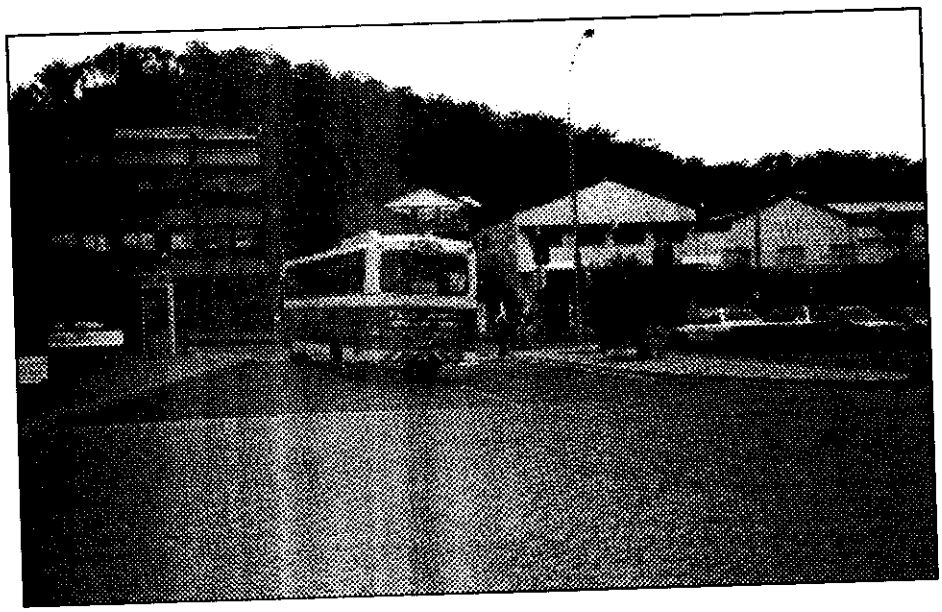


Figure 3.2.1.H.
Upon leaving Gosford Interchange the LRVs would run down Mann Street in a south bound direction.

Figure 3.2.1.I.
LRVs would stop in Mann Street in the same way as this bus does. The curb would need to be widened to meet the LRV in the Centre Lane and the Stop would be some 50 Metres before the traffic lights.

Figure 3.2.1.J.
The location of the tunnel porthole to enter Erina Station is located in the foreground with Terrigal Drive proceeding in the distance.

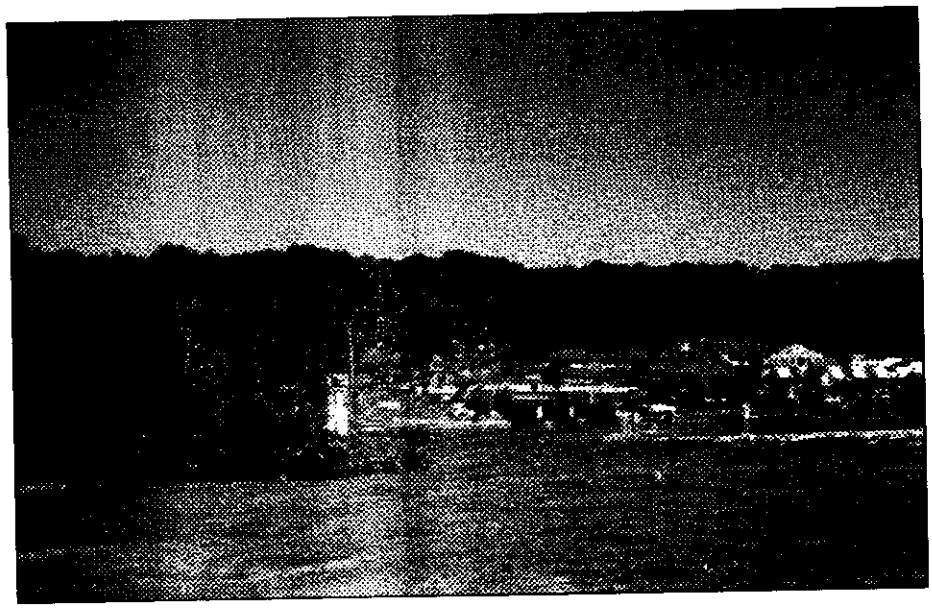
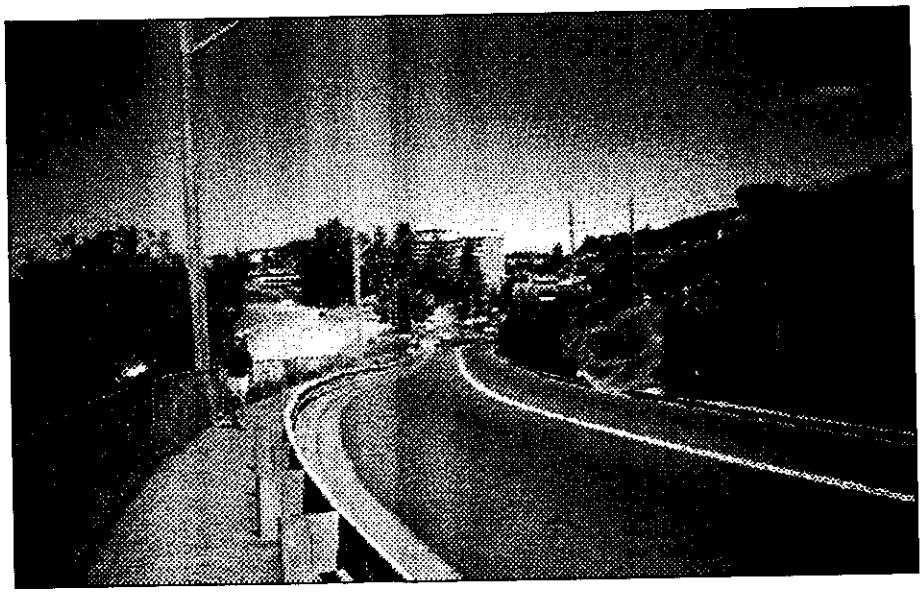


Figure 3.2.1.K.
The approach to Terrigal.



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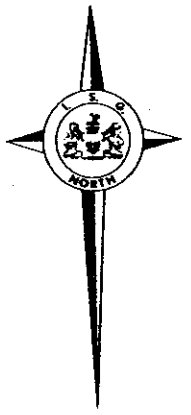
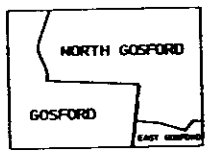


COUNTY OF NORTHUMBERLAND

GOSFORD

KEY TO PARISH



KEY TO LOCALITIES

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KEY TO ADJOINING SHEET

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CENTRAL MAPPING AUTHORITY
MAP REFERENCE
GOSFORD U2797-54

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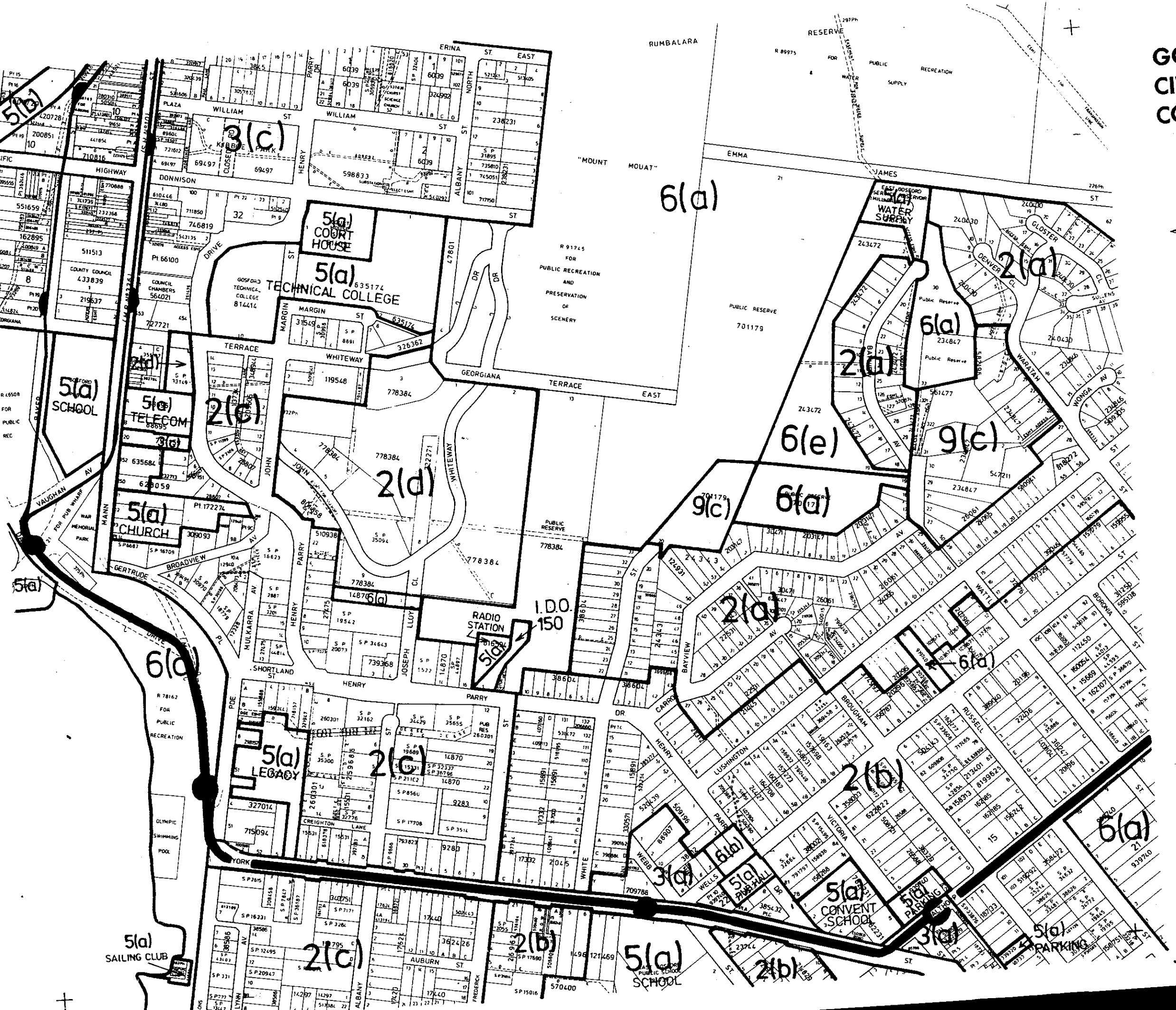
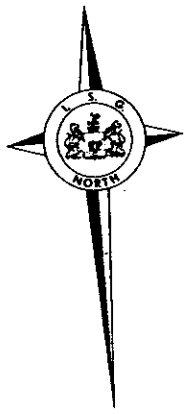


COUNTY OF NORTHUMBERLAND



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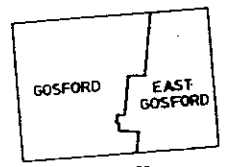

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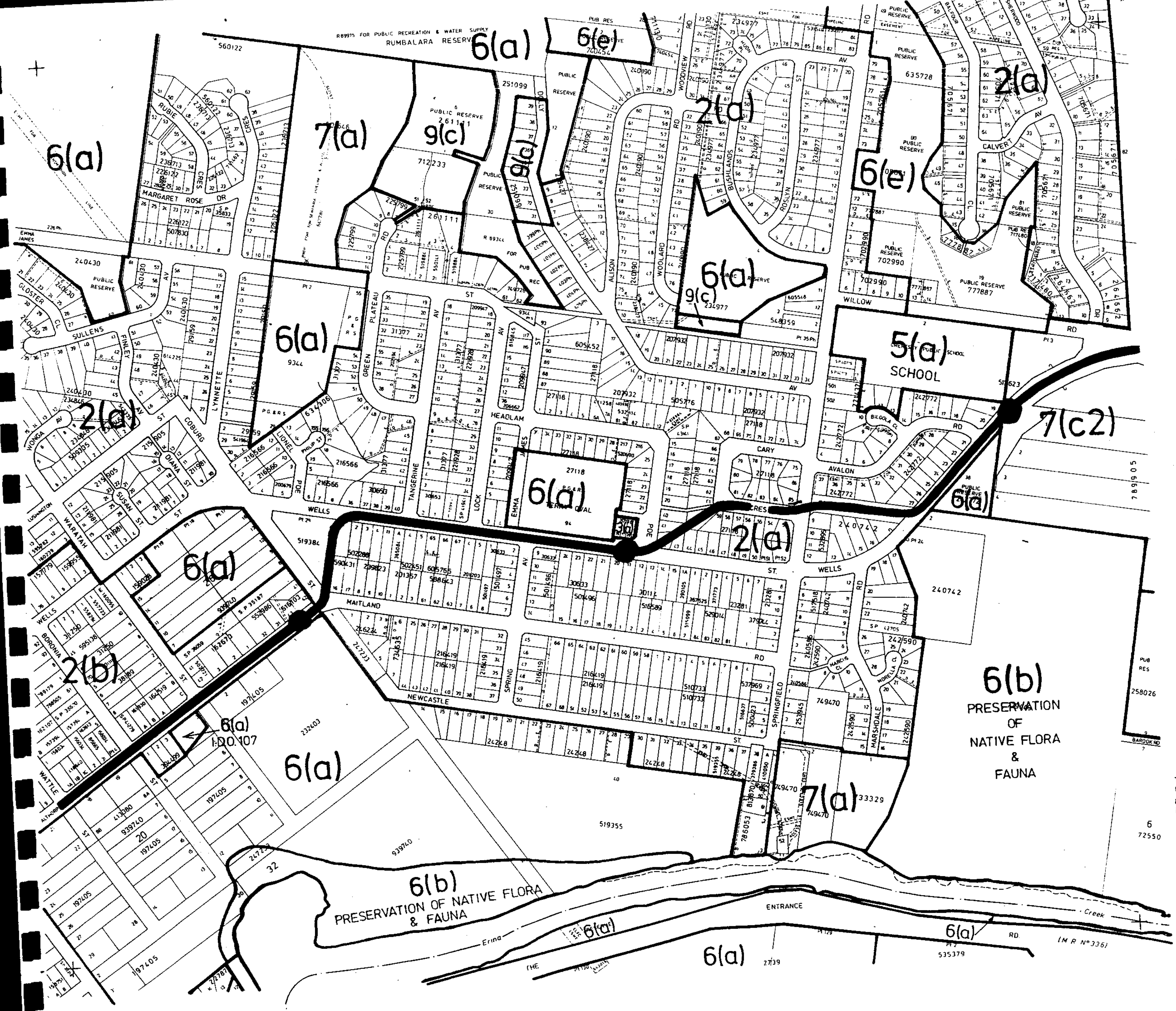

GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

GOSFORD

KINCUMBER

KEY TO PARISH

SPRINGFIELD

EAST GOSFORD

KEY TO LOCALITES

228D	229C	229D
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METRES

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MAP REFERENCE
GOSFORD U2797-91

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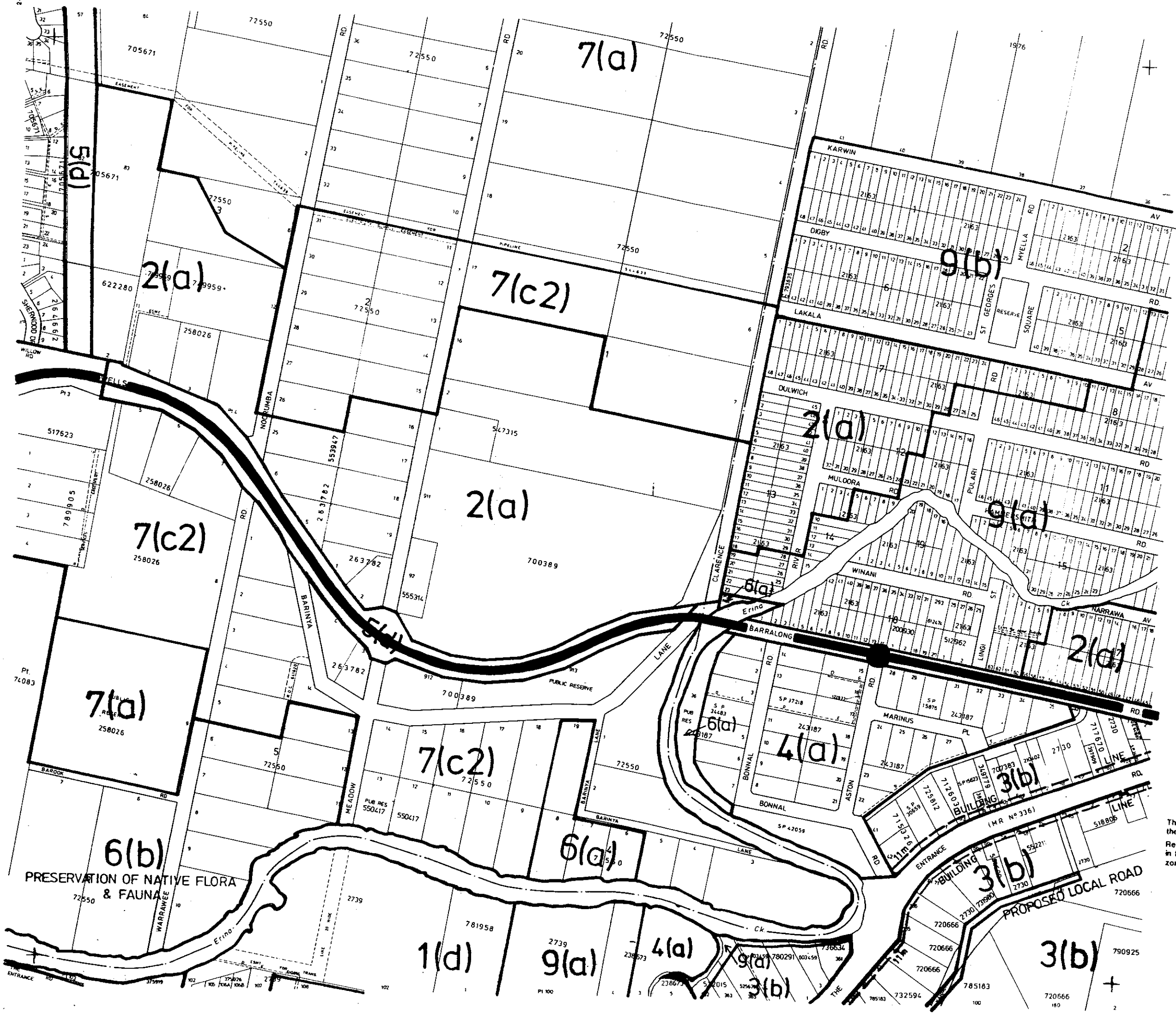
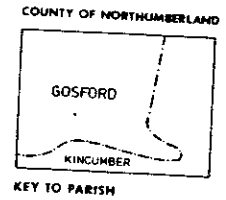


COUNTY OF NORTHUMBERLAND



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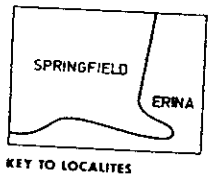

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METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
GOSFORD UZ797-92

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COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

ERINA HEIGHTS

ERINA

KEY TO LOCALITES

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METRES

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MAP REFERENCE
N/A

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2488

THE ENTRANCE RD
SERPENTINE
ERINA
ERINA PUBLIC SCHOOL
BEAUFORT
VALLEY
HASTINGS
RD
(MR Nº505)
DRIVE
COTSWOLDS CL
HELENA PDE
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5(a)
3(a)
2(a)
7(c2)

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

ERINA HEIGHTS
TERRIGAL
ERINA

KEY TO LOCALITES

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HELENA POE TERRIGAL (M R N°505) DRIVE RD STRATFORD PARK DR AVON CL CORNWALL CL WELLESBOURNE AV CHELTENHAM CL MOBBS DR KARALTA RD HAMPTON CL KINGS DR SOTHERBY AV MARLBOROUGH RD RICHMOND RD WINDERMERE CL SALISBURY DR PUBLIC RESERVE 817733 PUBLIC RESERVE 259809 DEWRANG RD KALE ST SACHA TERRACE BELAR IRVING SHEM CL TLE 599703 TLE 504683

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

ERINA TERRIGAL

KEY TO LOCALITES

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METRES

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N/A

GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

TERRIGAL

KEY TO LOCALITES

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KEY TO ADJOINING SHEET

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CENTRAL MAPPING AUTHORITY
MAP REFERENCE
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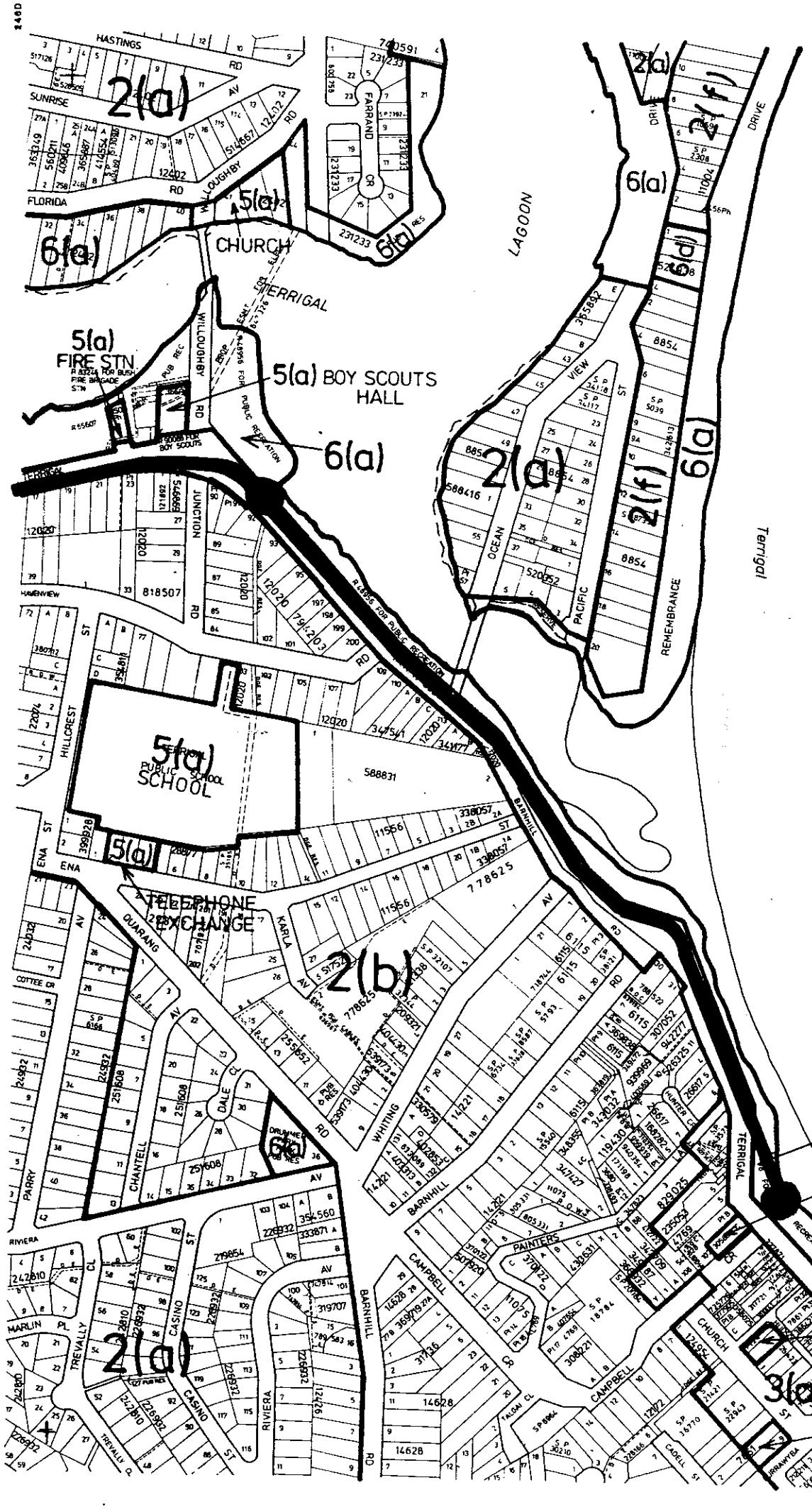

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

TERRIGAL

KEY TO LOCALITES

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METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WAMBERAL U3697-84

3.2.2. Engineering Analysis

Between Gosford and Terrigal there will be considerable gradient and earth works required. Reference to the Vertical Alignment Diagrams following this section should be made for further detail.

Starting at the Interchange beside Gosford Station, the line turns into Mann Street. Following Mann Street south to Vaughan Avenue, no major regradings are required. Running downhill, on the lefthand edge of Vaughan Avenue, regrading will be required to lessen the slope, however, this will be minimal and could easily be incorporated into the landscaping of the surrounding garden. No further regradings would be required along Dane Drive, York and Althorp Streets until Wells Street.

I refer to the Vertical Alignment Diagrams for detail of Wells Street but outline the nature of the proposed works here. Smoothing of the vertical curve over the crest near Lock Avenue will be required. Similarly, smoothing of the vertical curve over the following crest east of Headlam Parade will also be necessary. East of Cary Crescent, after crossing Springfield Road, a small embankment will be required to drop down to Wells Street again. The vertical Alignment of Wells Street, although approaching the maximum permissible gradient for Light Rail, will be appropriate from here all the way to the crossing of Erina Creek. If necessary an underpass may be constructed at the intersection with the proposed North-Eastern Bypass, as the gradients favour such an arrangement. (See Vertical Alignment Diagrams).

A bridge will be required to cross Erina Creek and graded so that flooding is rarely a problem.

Due to both traffic and gradient it is proposed to underground the line in Barralong Road before the intersection with The Entrance Road. The proposed underground station at Erina Fair will be some 20 Metres underground and will need to be of cut and cover construction. (Refer to Erina Station Diagram).

Following Terrigal Drive eastwards gradients are steep but not beyond those achievable by Light Rail. The Vertical Alignment Diagrams reveal the "roller-coaster" nature of this section of the line. The line is proposed to run along the southern side of the road and widening of the existing embankments and cuttings will be required at a number of locations. (Note that the Vertical Alignment Diagrams here show the existing ground level on the southern side of the road and not the levels of the actual road which are similar to the proposed LR gradient).

From Charles Kay Drive to just east of Junction Road no earth works will be required as the southern side of the road is already appropriately graded. The hill between Whiting Avenue and the Terminus at the Beach will need only minor smoothing of the vertical curve and banking of the corner.

Returning to Gosford no regrading will be required to access the interchange via Baker Street and the Parking Station Underpass except for behind the shops between Erina

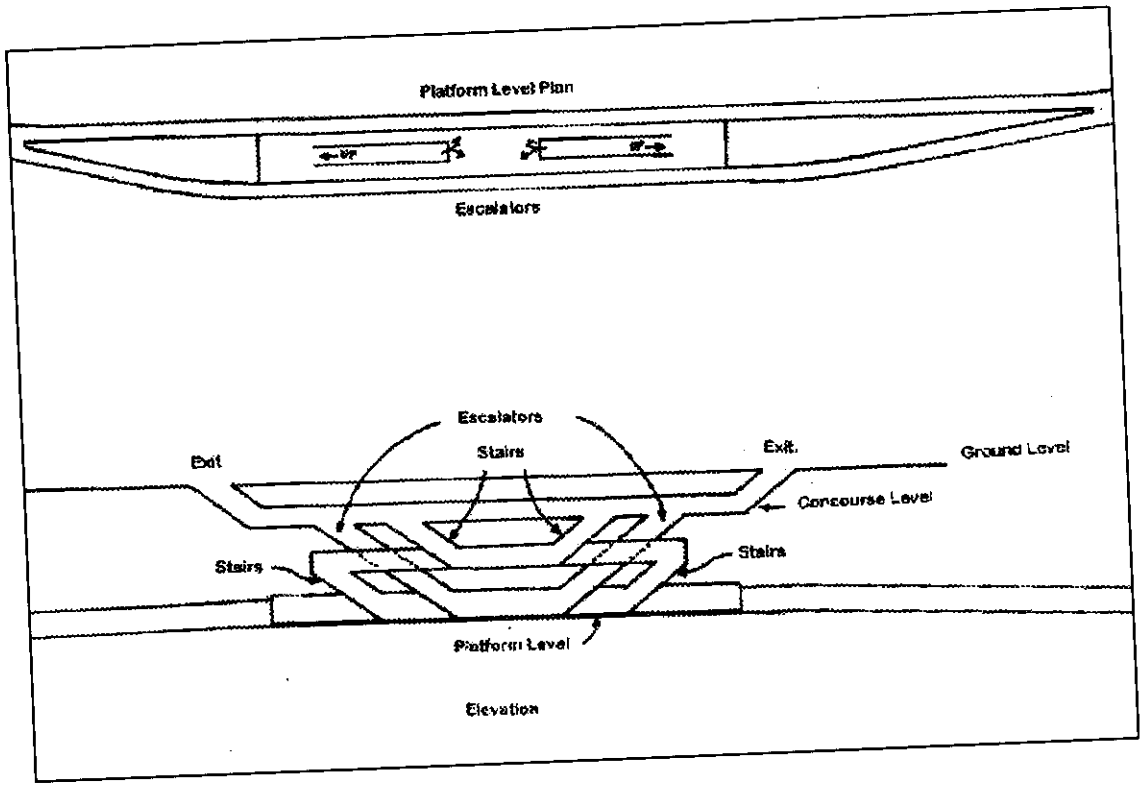
Street East and the Southern end of the interchange. (See Vertical Alignment Diagrams). Here the cutting will need to be widened to allow for deliveries and single track LRV passage.

Traffic management will be necessary at a number of locations along the Terrigal Line. Most of these will simply be traffic signals triggered by the approaching LRV. Such signals would be required at:

the exit from the Gosford Station Interchange,
crossing Donnison Street from Baker Street,
along Mann Street,
turning into Vaughan Street from Mann Street,
joining Masons Parade from Danes Drive,
crossing Frederick Street,
the intersection with Henry Parry Drive,
joining Althorp Street from York Street,
crossing Tarragal Glen Avenue,
at Charles Kay Drive and Brunswick Roads,
at Willoughby Road,
at Ocean View Drive, and
upon entering and leaving the terminus in the current carpark at Terrigal Beach.

Additional Traffic control measures would include "No Right Turns" in York Street except at Henry Parry Drive and Frederick Street at the lights. In general traffic would have to give way to LRVs at any location generating potential conflict.

Figure 3.2.2.A.
Erina Station Diagram.
(Conceptual Only. Not to scale)



Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.

Horizontal Scale
1:4000

Vertical Scale
1:400

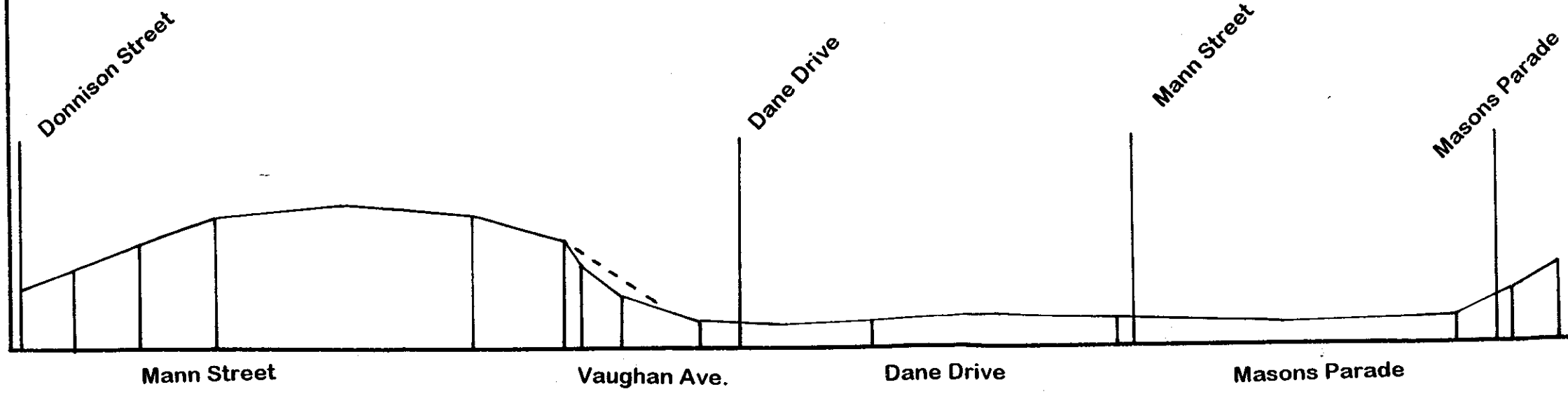
Solid Line Represents Existing Ground Level.
Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

Locality:

Diagram #:



Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.

Horizontal Scale
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Vertical Scale
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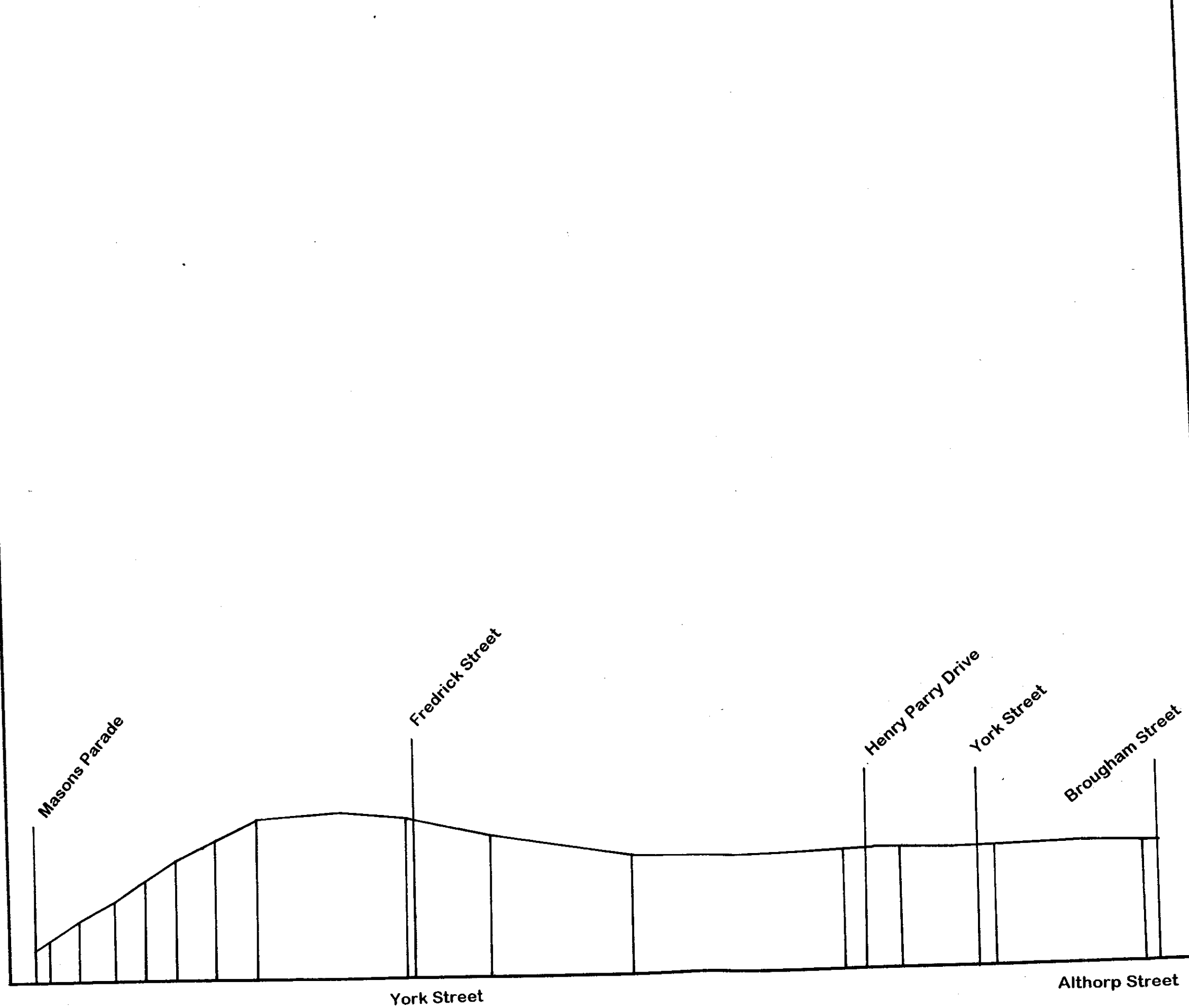
Corridor:

Gosford To Terrigal.

Locality:

Diagram #:



Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.

Horizontal Scale
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Vertical Scale
1:400

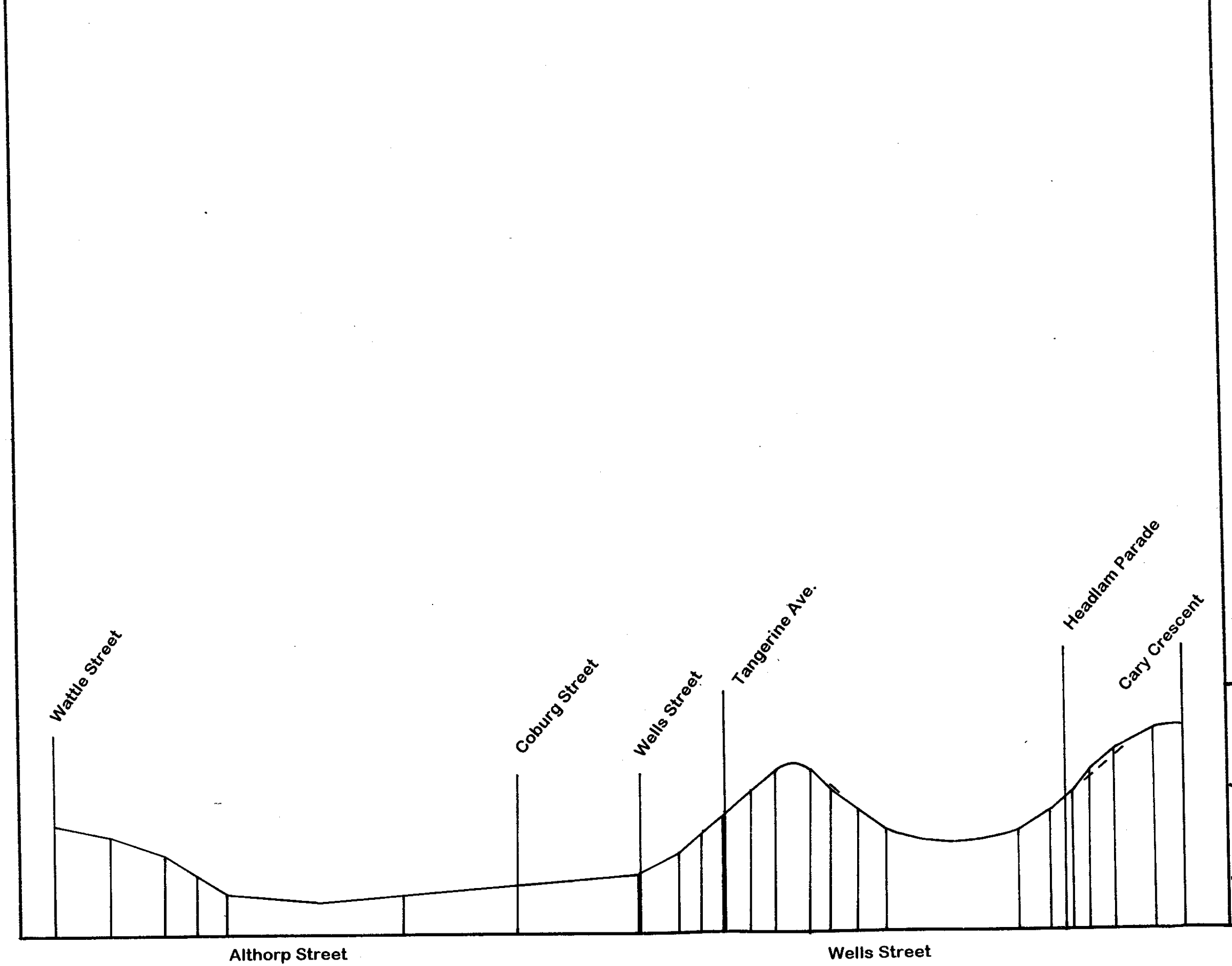
Solid Line Represents Existing Ground Level.
Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

Locality:

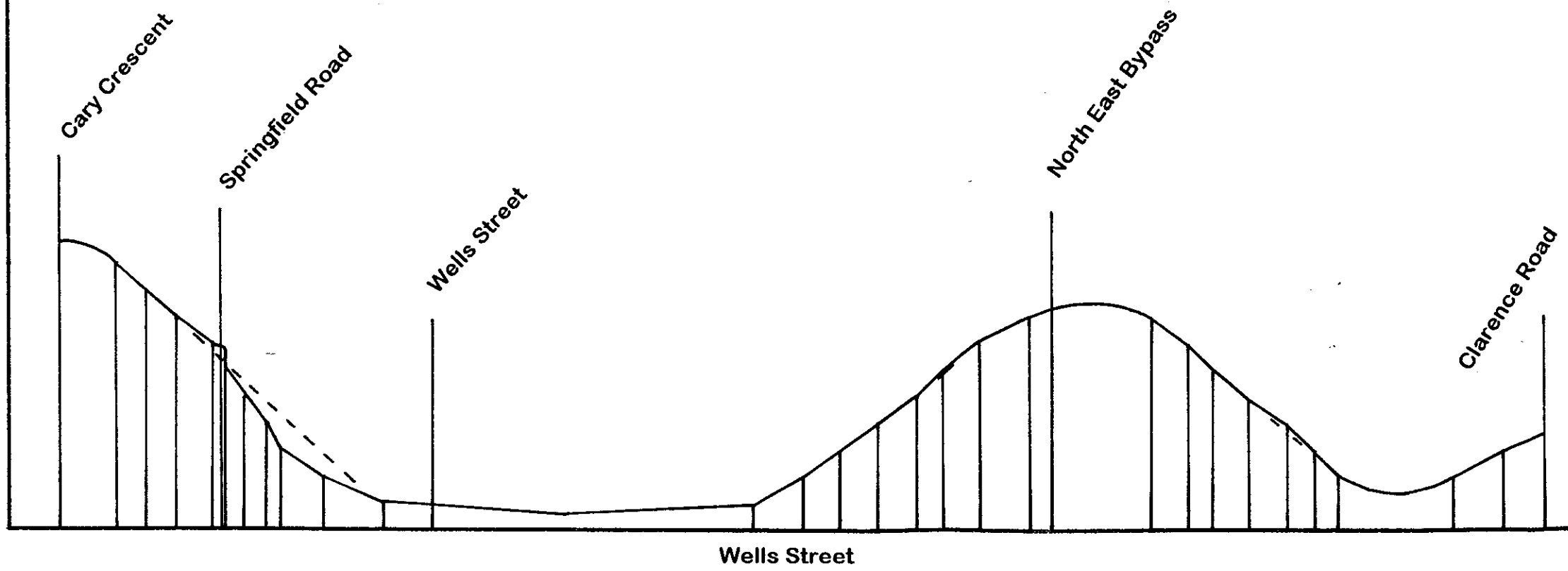
Diagram #:



Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.



Horizontal Scale
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Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

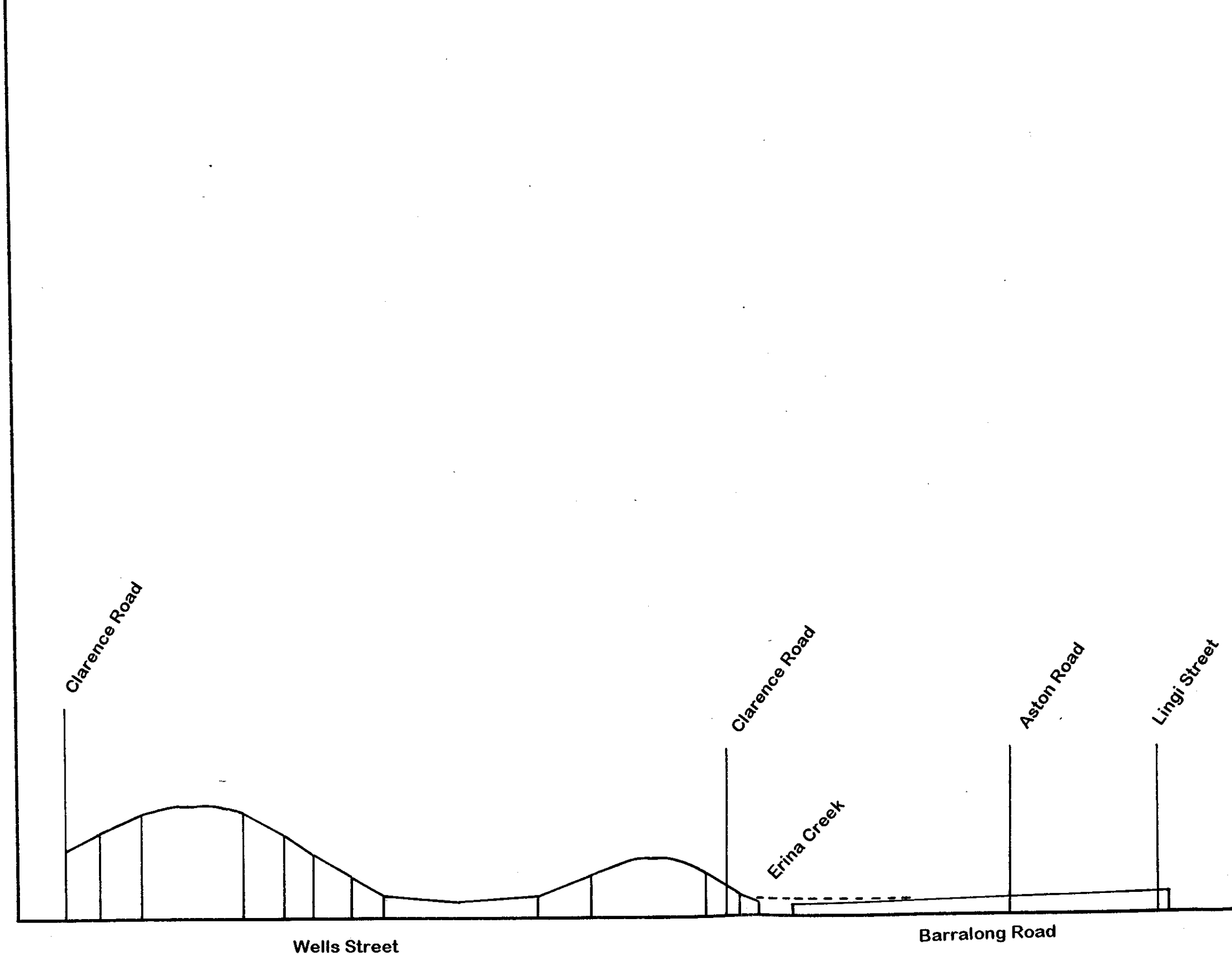
Locality:

Diagram #:

Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.



Horizontal Scale
1:4000

Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

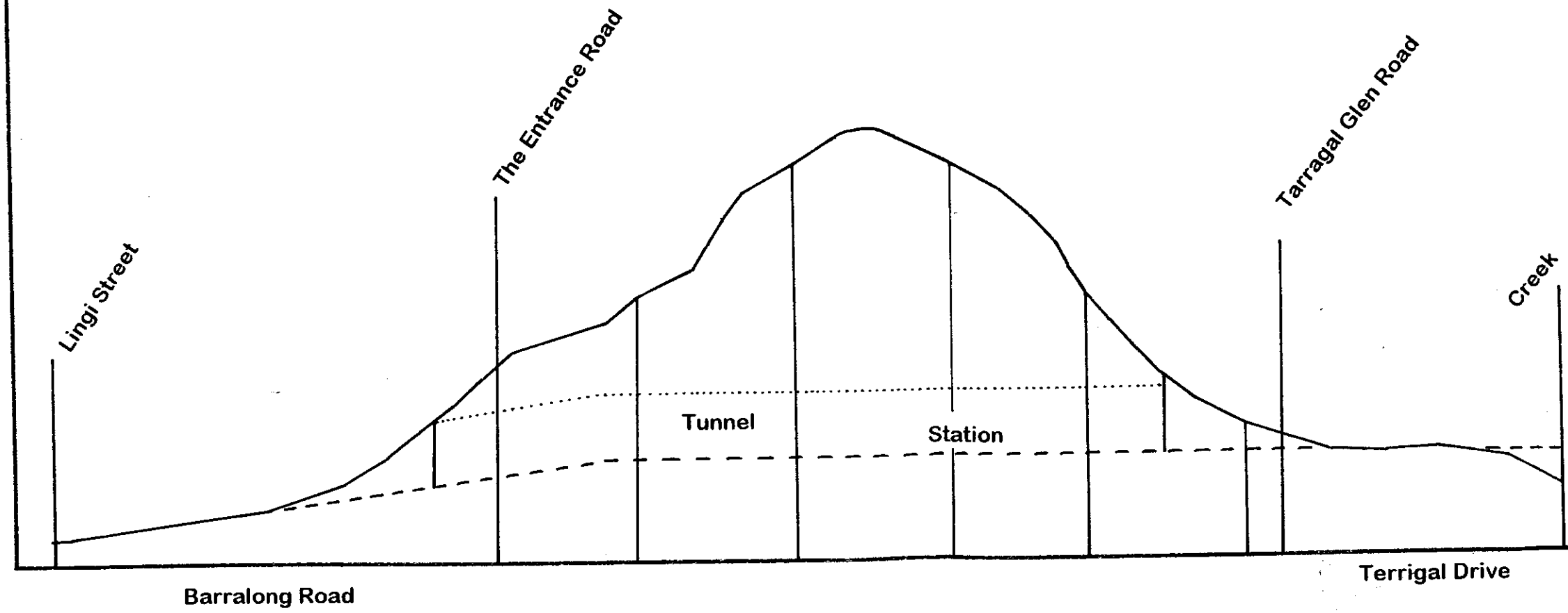
Locality:

Diagram #:

Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.



Horizontal Scale
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Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

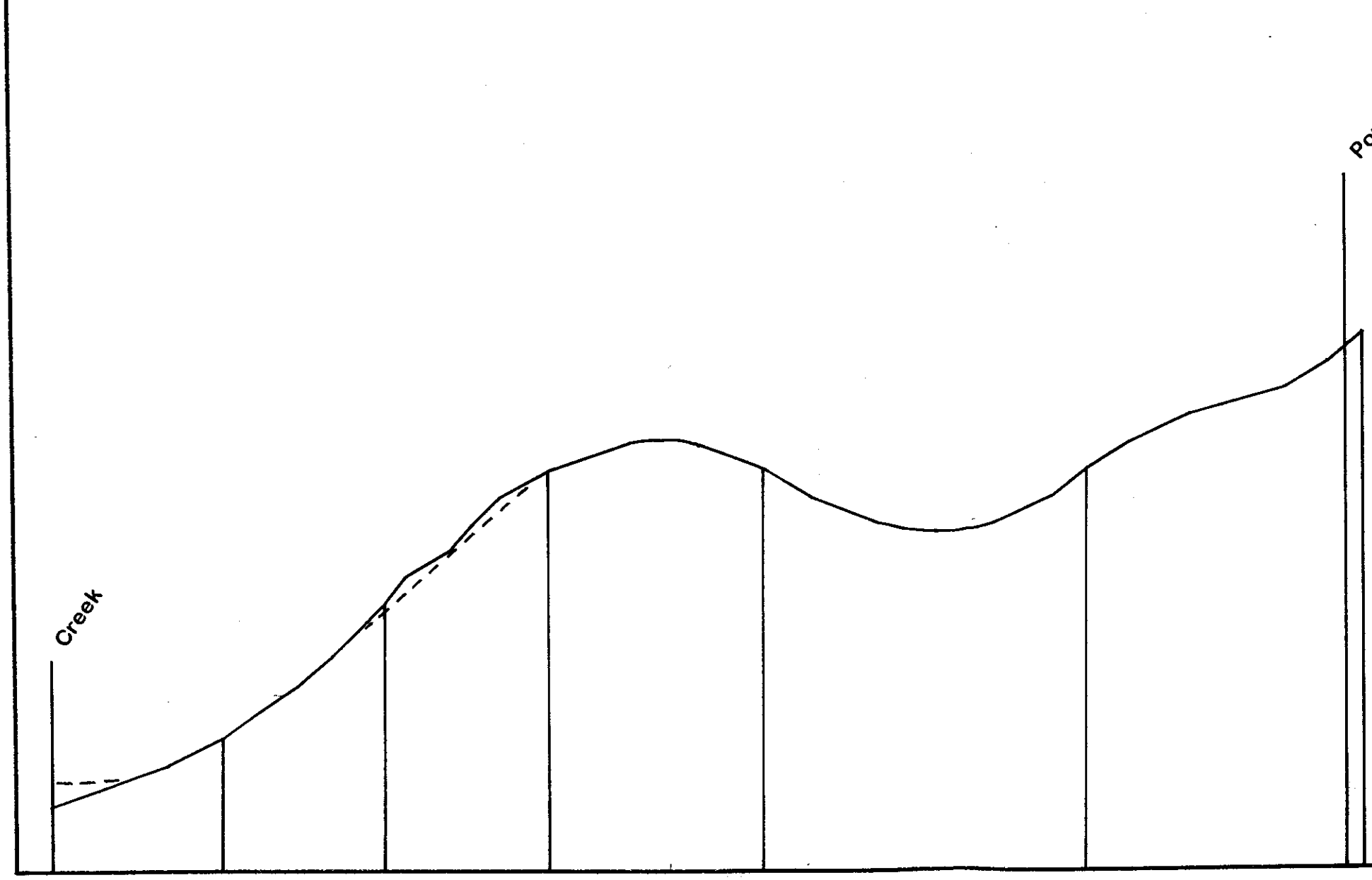
Locality:

Diagram #:

Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.



Horizontal Scale
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Vertical Scale
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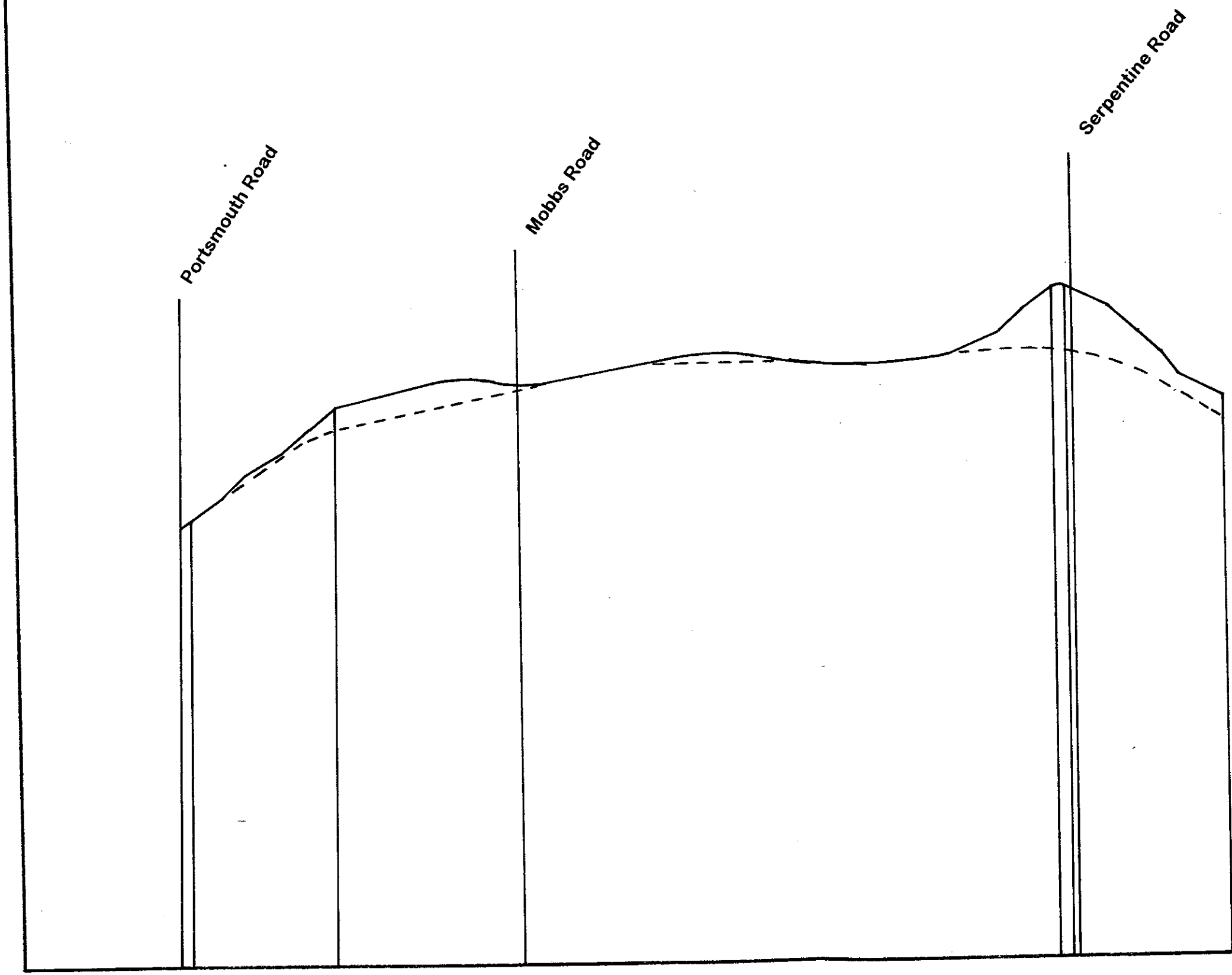
Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

Locality:

Diagram #:



Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.

Horizontal Scale
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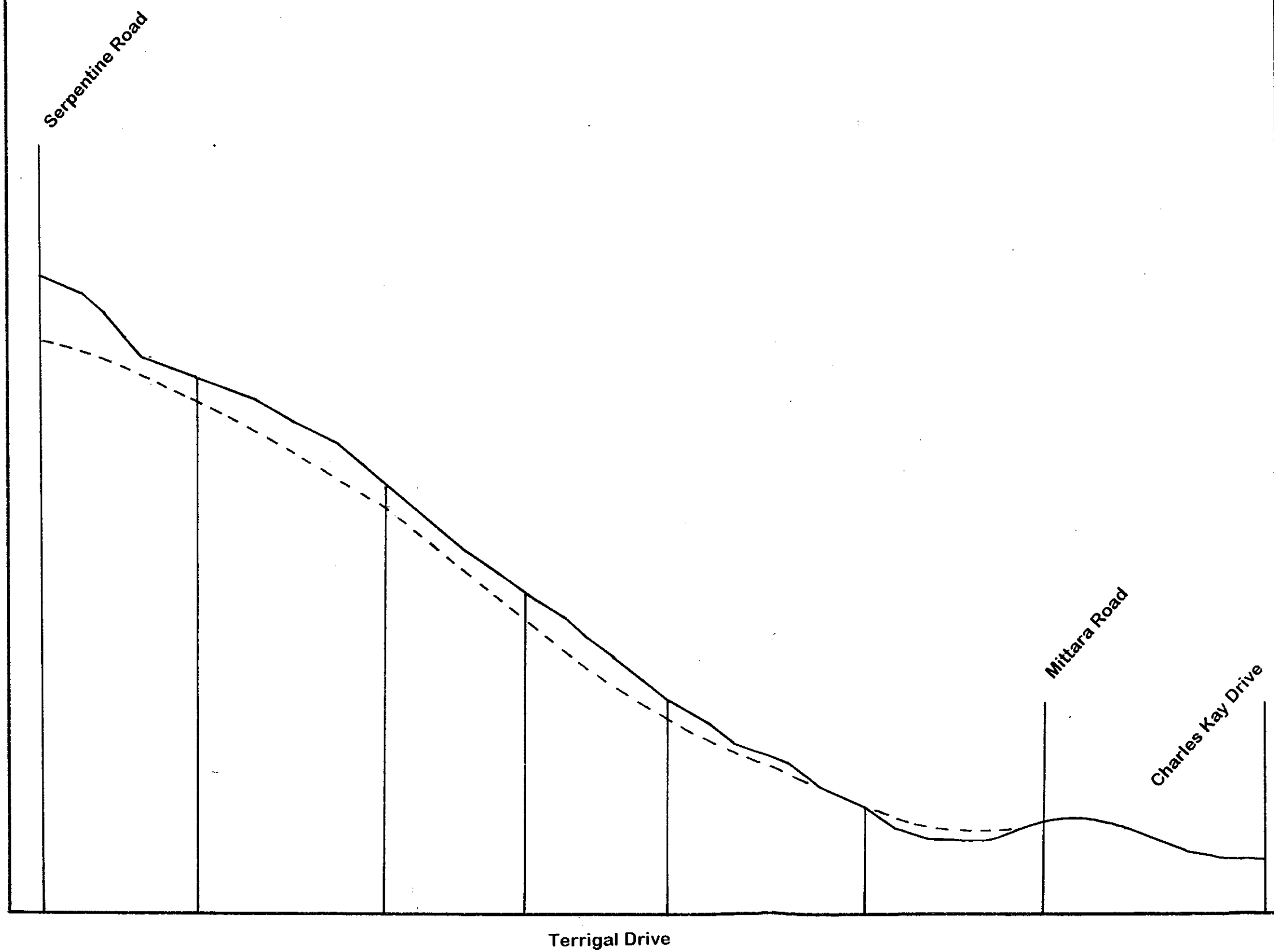
Corridor:

Gosford To Terrigal.

Locality:

Diagram #:



Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.

Horizontal Scale
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Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

Locality:

Diagram #:

Vertical Alignment Diagram

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URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
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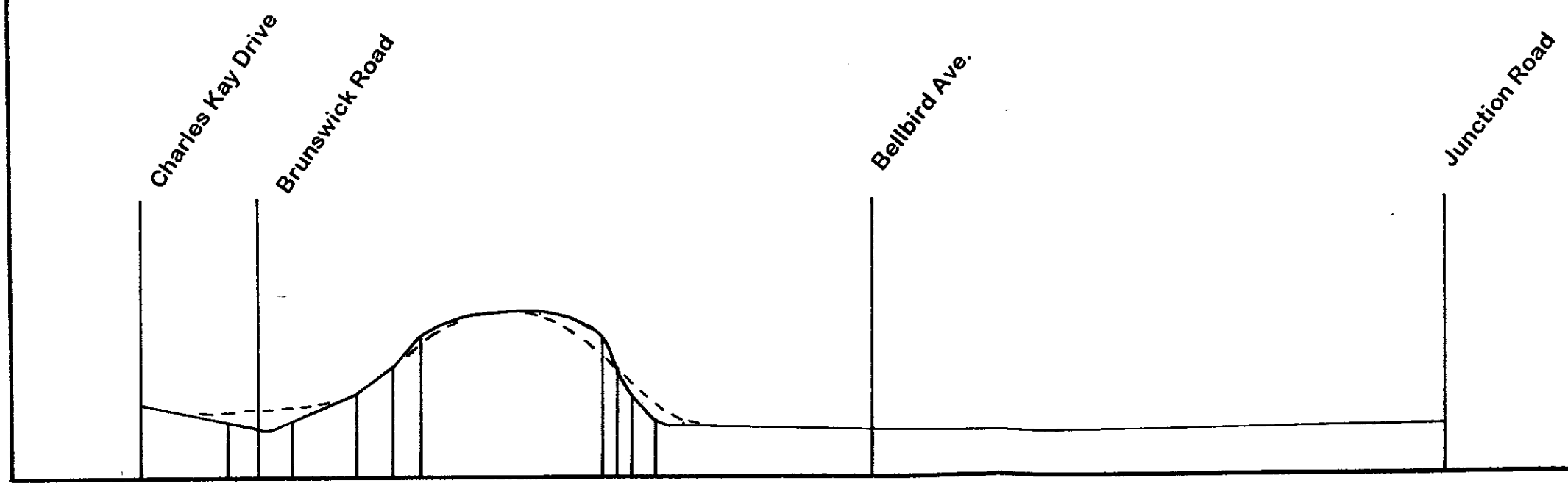
ECONOMISTS.



Horizontal Scale
1:4000

Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

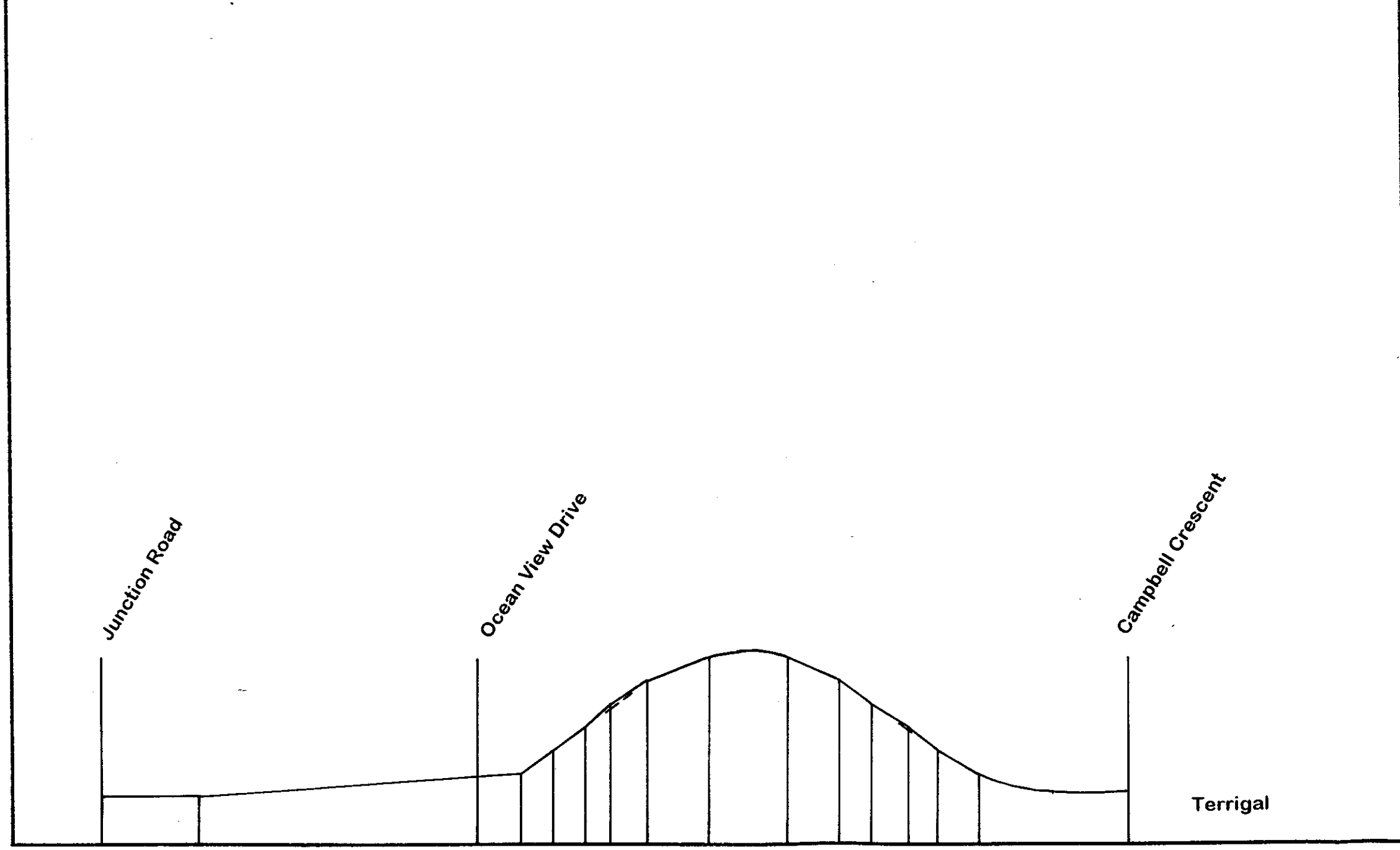
Locality:

Diagram #:

Vertical Alignment Diagram

Parade Consulting

URBAN LANDUSE
TRANSPORTATION
INFRASTRUCTURE
PLANNERS &
ECONOMISTS.



Horizontal Scale
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Vertical Scale
1:400

Solid Line Represents Existing Ground Level. Dashed Line is proposed Rail Level.

Corridor:

Gosford To Terrigal.

Locality:

Diagram #:

3.2.3. Planning Analysis

From Gosford to Terrigal The following Planning issues have been taken into account:

Looking at the Gosford CBD loop the following rationale has been adopted in determining the route and stop locations. The first stop is at the corner of Danes Drive and Vaughan Avenue beside the proposed Ferry Terminal and Marina Development. The next stop would be upon entering the car parking station, a short walk to the Mann Street shops. The final stop would be at the Gosford Station Interchange for Interchanging passengers and people wishing to shop at the northern end of the CBD.

Picking up at the Interchange, for commuters and North CBD people, the next stop would be in Mann Street at the corner of Donnison Street for loaded shoppers and workers. The next stop would be at the corner of Vaughan Avenue and Danes Drive, beside the proposed Ferry Terminal and Marina Development again, where the loop ends and double track operation recommences.

The stop in Masons Parade near York Street would serve the adjacent Swimming Pool, park and Sailing Club, and the rest of Point Frederick. The next stop, in York Street, adjacent to Public School would also serve the adjoining shops, with potential residential development above, and the nearby Private High Schools.

The stop east of Victor Street in Althorp Street will serve the east Gosford Shops, potential residential development above the shops, possible residential redevelopment in the surrounding area and the existing Private School. The next stop at the eastern end of Althorp Street would serve the surrounding Parks and residential development. Higher density residential development may be a possibility at this location onlooking the parklands.

An urban village will be a possibility around the next stop located at the corner of Wells Street and Headlam Parade. This site currently has only the local Springfield shops. Appropriate rezoning in the near future of the surrounding blocks will allow a good Urban Village to develop with good views of the nearby Hills, Parklands and Waterways. The next stop would be located on Wells Street near the Chertsey Public School.

After crossing Erina Creek The next stop would be located near Aston Road serving the surrounding Commercial Area and proposed Depot and Maintenance facility.

The Erina Underground Station would ultimately be the primary Station for the entire system, especially if the Kincumber and even The Entrance Lines are ever built. This Station will be the focus of the network, acting as a major interchange between lines and also servicing an area that has the potential to be the largest centre in the region in twenty years time. This is largely due to its central location. Growth in this location is detailed more in section 5.2.2.

Potential exists for future stops at both the intersections of Portsmouth and Serpentine Roads. However these stops would be necessary at the initial stages of the system and should be constructed in conjunction with appropriate rezoning of the surrounding lands to achieve high density Urban Villages (see Section 5.1.2.).

The next stop between the junctions with Charles Kay Drive and Brunswick Road would serve the nearby High School and residential area. The stop between Willoughby Road and Ocean View Drive would serve the residential areas surrounding the Lagoon and the nearby Public School.

The final stop at Terrigal Beach would serve the developing Terrigal Beach area and the beach itself.

Resumption would be necessary at a number of locations along the corridor. The first location requiring resumption would be the commercial properties on the south side of Erina Street East immediately on the western side of the parking Station underpass roadway so as to afford straighter access into the lane behind the shops on the northern side of the Street. (See Alignment Diagrams following section 3.2.1.)

Access arrangements will be required from State Rail for the widening of the cutting behind the shops between Erina Street East and The Gosford Station Interchange.

With reference to the Alignment Diagrams resumption will be required at the following locations:

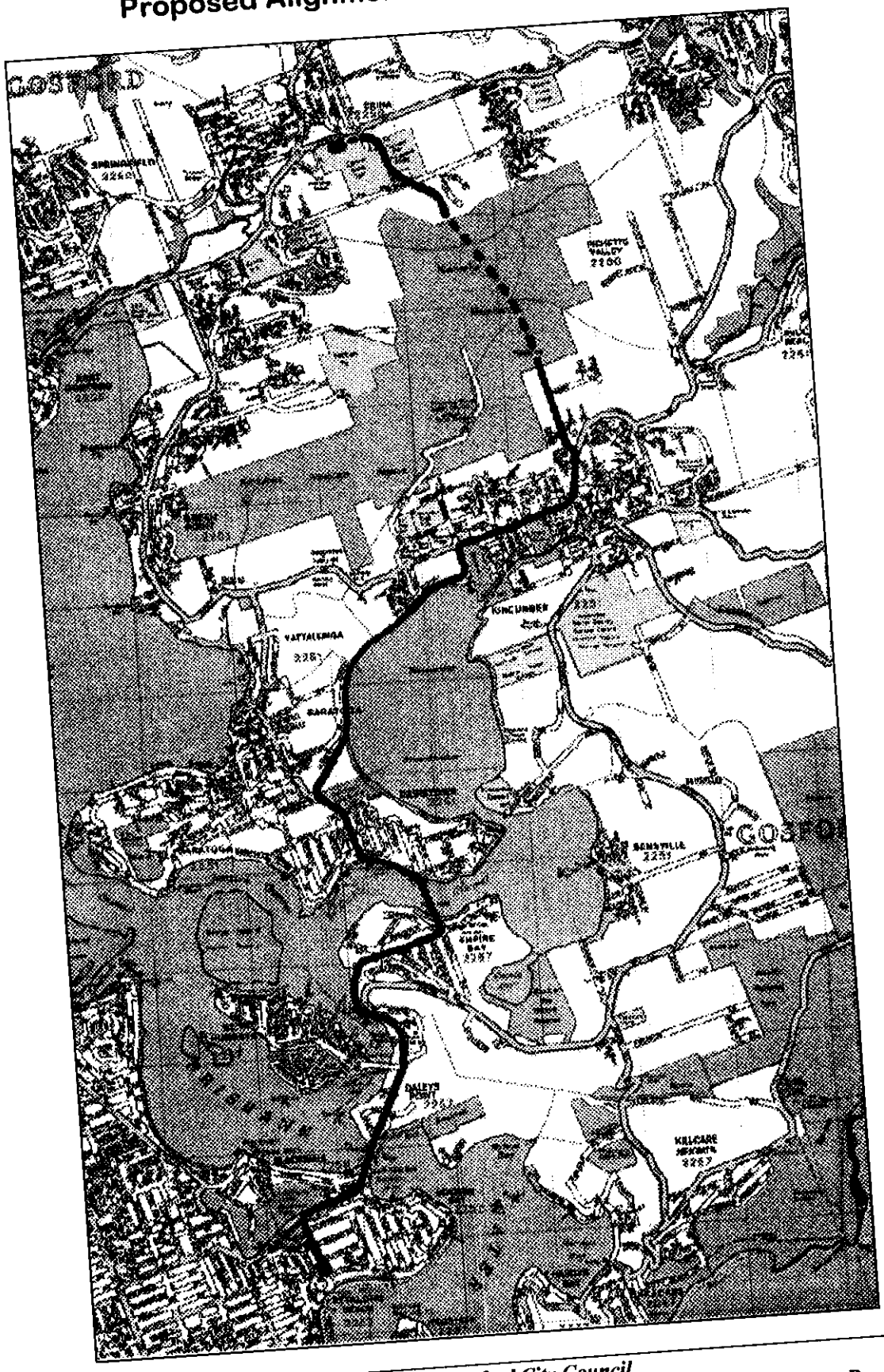
(I) between Althorp Street and Wells Street,
(II) between the corner of Wells Street and Headlam Parade to the south-eastern corner of Cary Crescent,
(III) opposite Cary Crescent from Springfield Road to Wells Street,
(IV) near the intersection of Terrigal Drive and Tarragal Glen Avenue, and
(V) on the northern side of Barralong Road for a possible Depot and Maintenance Facility.

3.3 Woy Woy\Ettalong to Erina

The final corridor detailed in this study is that proposed between Erina and Woy Woy Station via Kincumber, Davistown and Ettalong. This corridor is not envisaged to be feasible for many years and is only detailed briefly for future planning reference. For further detail of this alignment see the Alignment Maps immediately following this section.

Prepared By Parade Consulting Pty. Ltd.
Phone: (02) 357 2394. Fax: (02) 358 1502.

Figure 3.3.A.
Proposed Alignment Ettalong to Erina.



Prepared By Parade Consulting Pty. Ltd.
Phone: (02) 357 2394. Fax: (02) 358 1502.

3.3.1. Proposed Optimum Alignment

Operating between Woy Woy and Erina, this corridor is proposed to follow the following alignment. The Woy Woy Station to Ettalong section has already been detailed in section 3.1.1. This line is an extension of that corridor to Erina.

Recommencing at the Ettalong shops, the double track alignment heads north on Picnic Parade until turning east into Maitland Bay Drive. A stop is proposed on the southern side of The Rip Bridge. Continuing north onto Daley Avenue, the next stop would be near the junction with Helmsman Boulevard. Following the road onto Empire Bay Drive, the alignment would leave the road and cut across to Rickard Road to avoid the hill. Following Rickard Road to Empire Bay, the next stop would be located in the vicinity of the Post Office.

A bridge would be required to cross Cockle Channel to Davistown. This bridge would most likely be a low-level opening bridge. The alignment would turn west immediately upon crossing the channel, where there would be a stop, and follow the foreshore until reaching, and turning north into, Davistown Road where there would be another stop.

Following Davistown Road, the next stop would be Coomal Avenue from where the alignment would leave the road and cut in a north-easterly direction towards the foreshore of Kincumber Broadwater. Another stop may be located somewhere near Broadwater Drive. The alignment would follow the foreshore until reaching Carpark Road into which it would turn north. A stop would be located on the south side of the intersection with Avoca Drive immediately before the line turned east into it.

Following Avoca Drive the next stop would be near Empire Bay Drive. The alignment would continue north along Avoca Drive until turning into Ballorok and then Kerns Roads. The alignment would continue north along Kerns Road until just north of Tudor Street where the line runs onto a proposed embankment to cross the valley before entering a tunnel to pass under Kincumber Mountain. This tunnel would be 1.58 kilometres long and cost approximately $30 million for single track or $40 million for double track. (1995 dollars).

After passing under Kincumber Mountain and leaving the tunnel the line would cross Karalta Road and join Tarragal Glen Avenue before turning west to join with the Gosford line. The next stop would be the Erina Underground station. Services would either terminate here or continue on to Gosford.

GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

ERINA HEIGHTS

ERINA

KEY TO LOCALITES

229D	230C	230D
244B	245A	245B
244D	245C	245D

KEY TO ADJOINING SHEET

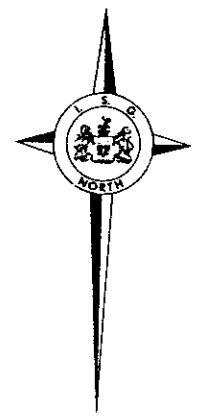
This map is not a true copy of the zoning provisions of the Gosford planning instruments.

Reference should be made to the official maps deposited in the office of the Gosford City Council for accurate zoning information and later amendments.

METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
N/A

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

ERINA

KEY TO LOCALITES

244B	245A	245B
244D	245C	245D
257B	258A	258B

KEY TO ADJOINING SHEET

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METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
N/A

3(b)
3(a)
790925
2(c)
6(a)
PUBLIC RESERVE
703424
2(c)
792027
523525
716394
800802
746467
746467
2(a)
792027
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552480
KARALTA
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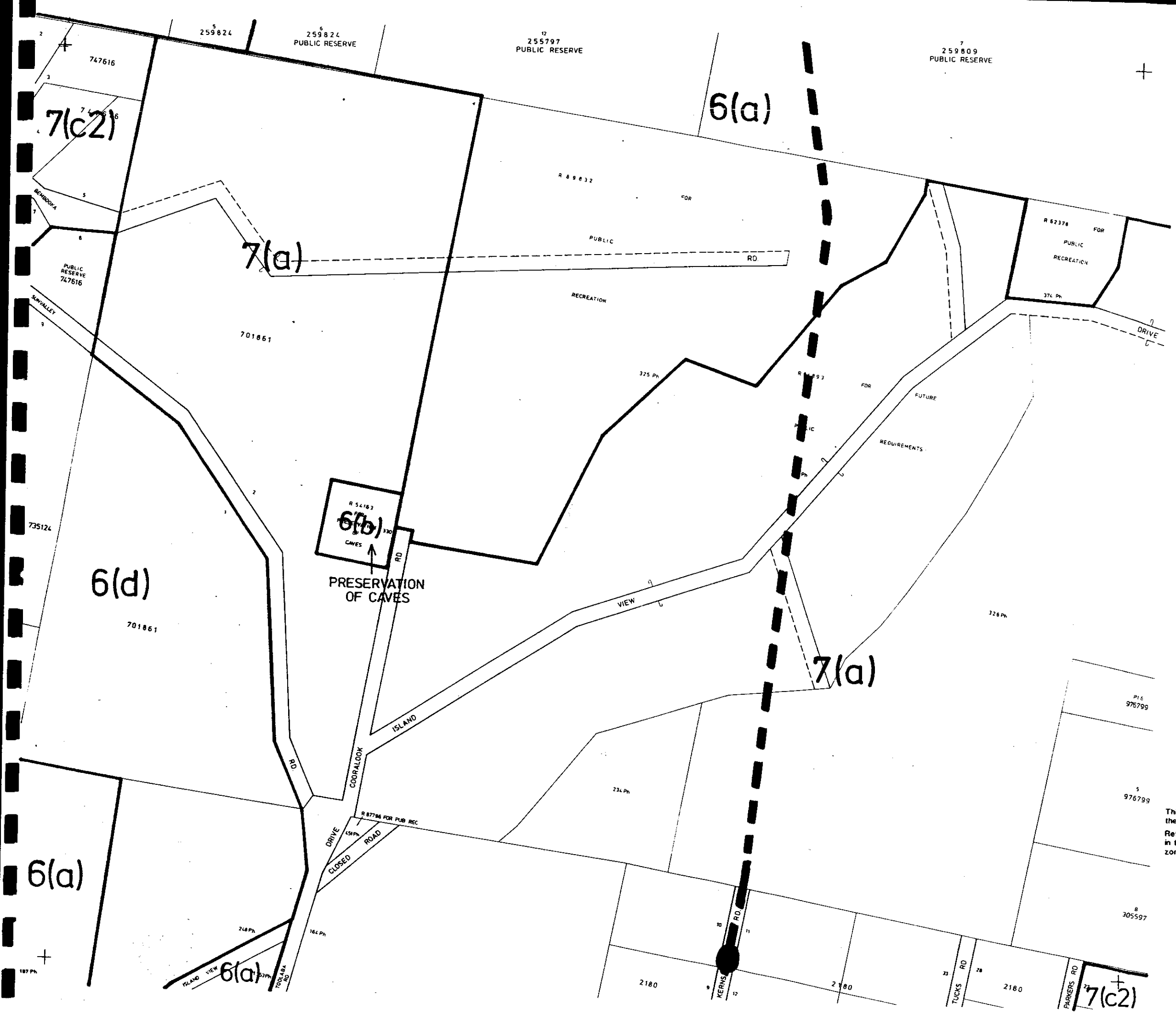
TARRAGAL
GLEN
AV
RD

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

GREEN POINT

KEY TO LOCALITES

244D	245C	245D
257B	258A	258B
257D	258C	258D

KEY TO ADJOINING SHEET

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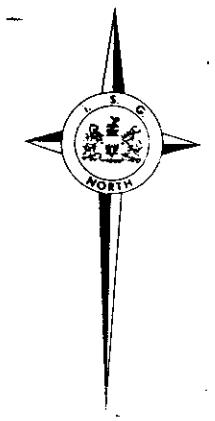
METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
N/A

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

KINCUMBER

KEY TO LOCALITES

257B	258A	258B
257D	258C	258D
269B	270A	270B

KEY TO ADJOINING SHEET

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METRES

CENTRAL MAPPING AUTHORITY

MAP REFERENCE

AVOCA U3690-13

GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

GREEN POINT

KINCUMBER

KEY TO LOCALITES

257A	257B	258A
257C	257D	258C
269A	269B	270A

KEY TO ADJOINING SHEET

This map is not a true copy of the zoning provisions of the Gosford planning instruments.

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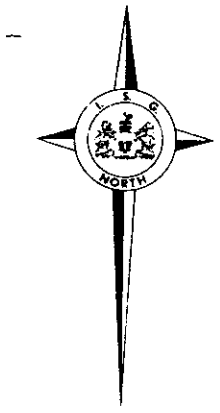
METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-34

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

SARATOGA

DAVISTOWN

KEY TO LOCALITES

256D	257C	257D
268B	269A	269B
268D	269C	269D

KEY TO ADJOINING SHEET

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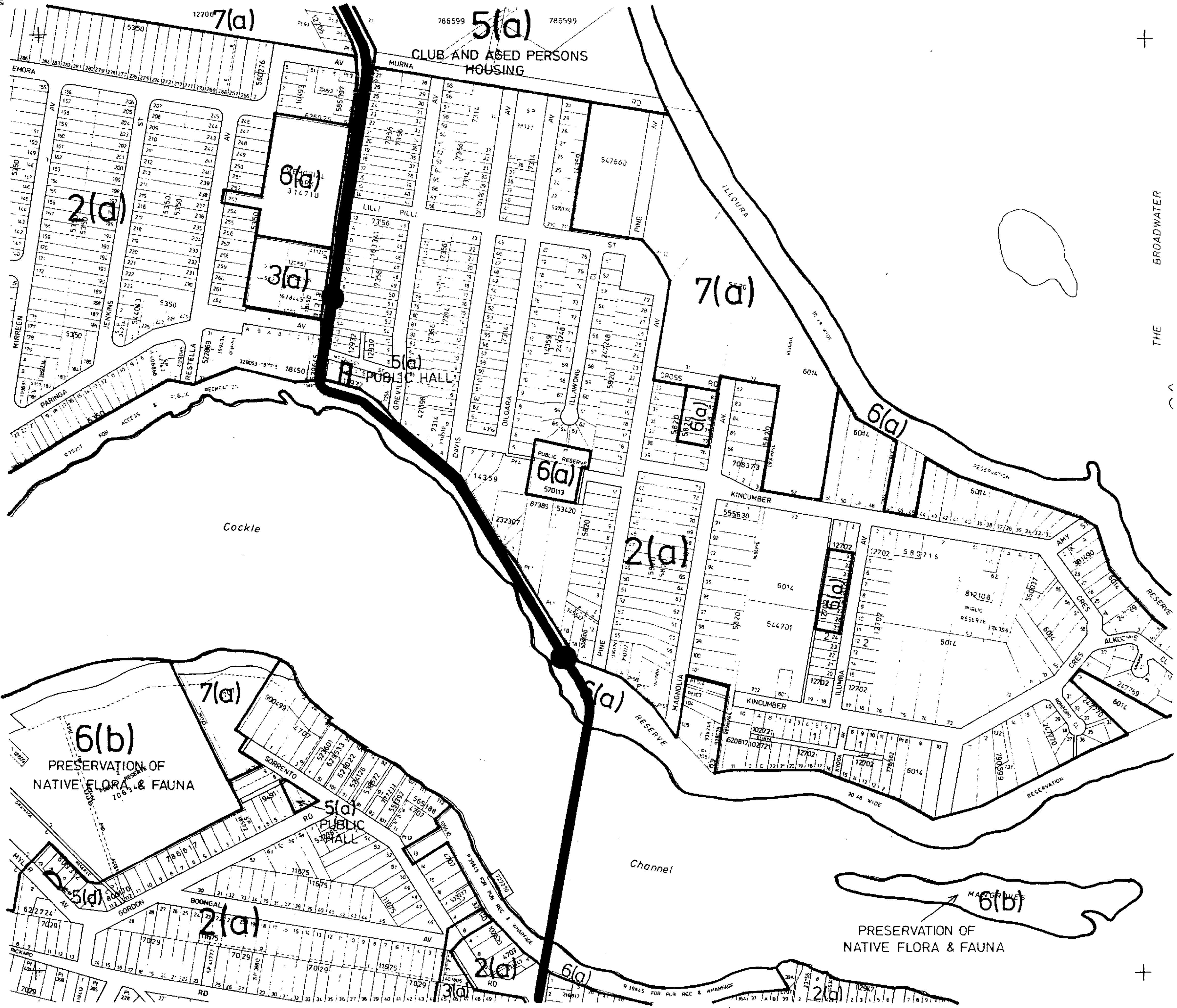
METRES

CENTRAL MAPPING AUTHORITY

MAP REFERENCE

WOY WOY U2790-61



GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

DAVISTOWN

EMPIRE BAY

KEY TO LOCALITIES

268B	269A	269B
268D	269C	269D
278B	279A	279B

KEY TO ADJOINING SHEET

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METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-63

GOSFORD CITY COUNCIL

Cockle Channel

THE BROADWATER

6(a) FOR PUB REC & WHARFAGE

3(a)

5(a) FIRE STATION

6(a)

7(c2)

6(b) PRES. OF FLORA & FAUNA

2(a)

7(a)

6(b)

6 PUBLIC RESERVE

PUBLIC RESERVE

7(a)

6(b)

CLAUSE 93

5(a) WATER SUPPLY

6(b) PRESERVATION OF NATIVE FLORA & FAUNA

7(a)

2(a)

9(c)

5(a) SUB-STATION

1(d)

COCKLE BAY

RESERVE

7(a)

PUBLIC RESERVE 608796

7(c2)

6(b) PRESERVATION OF NATIVE FLORA & FAUNA

5(a) PUBLIC SCHOOL

7(c2)

1(d)

PUBLIC RESERVE 604064

WATER RESERVE 13982

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

EMPIRE BAY

KEY TO LOCALITES

268D	269C	269D
278B	279A	279B
278D	279C	279D

KEY TO ADJOINING SHEET

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METRES

CENTRAL MAPPING AUTHORITY

MAP REFERENCE

WOY WOY U2790-91

2788

GOSFORD CITY COUNCIL

ST HUBERTS ISLAND

WATER

BRISBANE

PRESERVATION OF NATIVE FLORA & FAUNA

6(b)

6(a)

2(a)

5(c)

7(a)

3(a)

9(a)

SANDY COVE

MARINA

VIEW

HELMSMAN

TRIAL INLET

NAUTILUS

SALACIA

CRESCENT

LONG ARM

BARRACOUTA AV

BOULEVARDE

NANNYGAI

SHELTER COVE

SANDY INLET

MERCATOR

HERON

CUTTLEFISH PDE

SOLSTICE POINT

RETENTION ISLET

OYSTER ISLET

HILLCREST

RES O/S REC

YUGARI DRIVE

YUGARI

BAY DR

TULANI AVE

DALEYS POINT

DALEY

MAITLAND

PUBLIC RESERVE 604064

COUNTY OF NORTHUMBERLAND

KINCUMBER

KEY TO PARISH

ST HUBERTS ISLAND

KEY TO LOCALITES

268C	268D	269C
278A	278B	279A
278C	278D	279C

KEY TO ADJOINING SHEET

This map is not a true copy of the zoning provisions of the Gosford planning instruments.

Reference should be made to the official maps deposited in the office of the Gosford City Council for accurate zoning information and later amendments.

METRES 40 20 0 40 80 120 160 200

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-82

GOSFORD CITY COUNCIL

278D

DALEYS PT

THE RIP

BRISBANE WATER

FISHERMANS BAY

BOOKER BAY

RILEYS BAY

9(c)

2(a)

7(a)

6(a)

2(b)

3(a)

5(a) CAR PARK

5(a) CHURCH

5(a) CHURCH

COUNTY OF NORTHUMBERLAND

KINCUMBER

PATONGA

KEY TO PARISH

EMPIRE BAY

ETTALONG

KEY TO LOCALITES

278A	278B	279A
278C	278D	279C
287A	287B	288A

KEY TO ADJOINING SHEET

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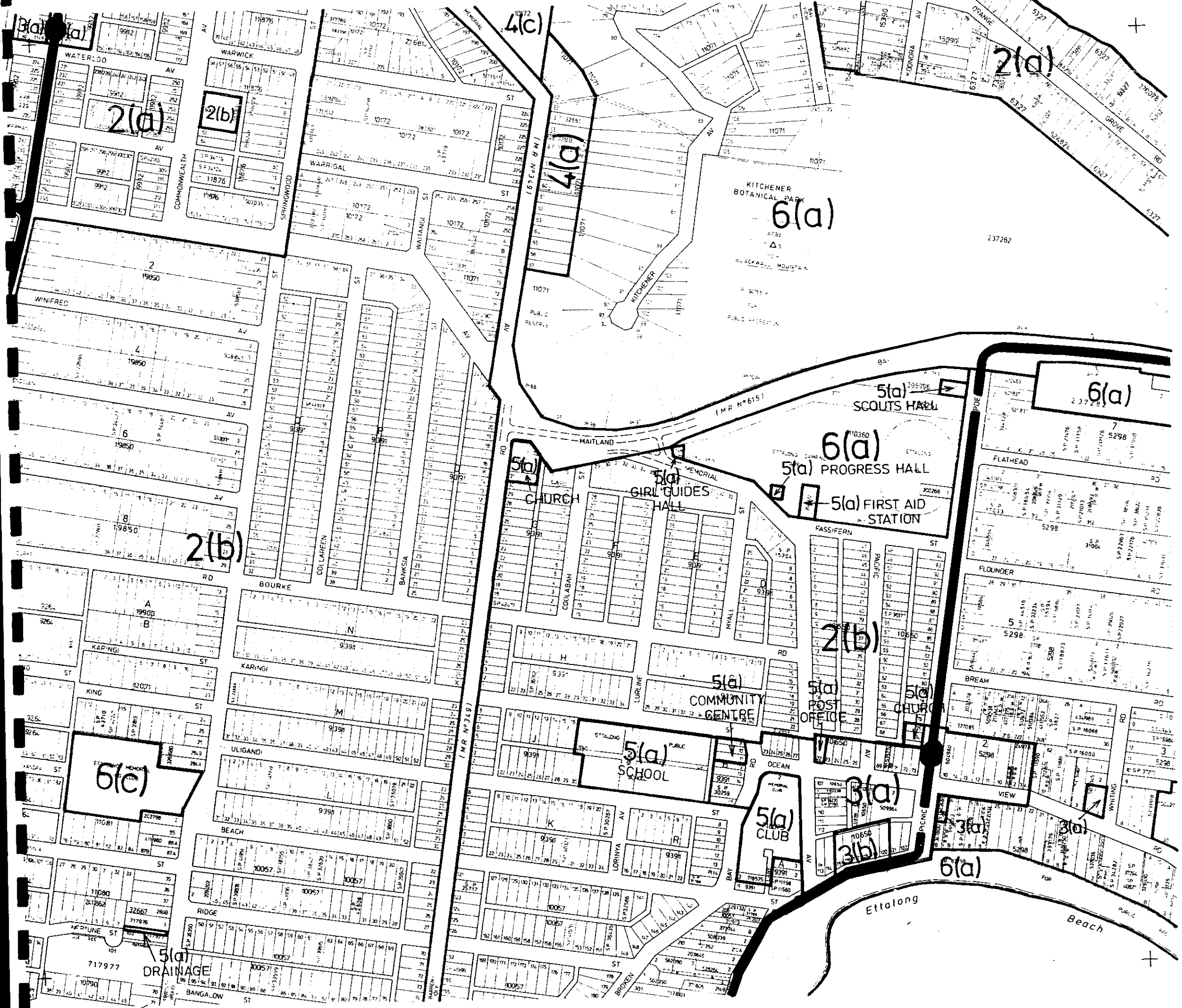
METRES

CENTRAL MAPPING AUTHORITY
MAP REFERENCE
WOY WOY U2790-84

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

WOY WOY

UMINA ETTALONG

KEY TO LOCALITES

277B	278A	278B
277D	278C	278D
286B	287A	287B

KEY TO ADJOINING SHEET

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Reference should be made to the official maps deposited in the office of the Gosford City Council for accurate zoning information and later amendments.

METRES

CENTRAL MAPPING AUTHORITY

MAP REFERENCE

WOY WOY U2790-83

3.3.2. Engineering Analysis

Between Ettalong and Erina there are a number of engineering requirements to make this corridor possible.

Firstly, gradients are very steep throughout the area that this corridor crosses.

Maitland Bay Drive between Picnic Parade to Empire Bay Drive is graded appropriately for Light Rail operation, however from this point onwards grades become more challenging. The corridor leaves Empire Bay Drive near the junction with Yagari Crescent and follows a similar alignment to that of the old road to access Rickard road. The grades in this area are still steep but within limits. Following Rickard Road the grades fall away well until flat terrain is reached.

A ramping structure will be required to attain about 5 metres clearance for the low-level bridge over Cockle Channel. This bridge may also need to be an opening structure dependent upon what demand there may be in the future for large vessel access into Kincumber Broadwater. A similar ramping structure will be required on the northern side of the crossing.

Gradients along the proposed corridor through Davistown are non existent. (In fact a rise in sea level of 1.5 metres would put most of Davistown underwater.) Continuing north, and passing the mangrove swamp to access the Foreshore Reserve near Broadwater Drive, gradients are still not an issue. However some embankments may be needed to maintain sufficient height to avoid high tide beside the swamp and while passing the foreshore.

Upon reaching Carrak Road and subsequently Avoca Drive, gradients are still negligible. Continuing east on Avoca Drive, gradients increase to a comfortable climb until past Empire Bay Drive and over the crest just to the north of Oberton Street. The grades around and into Kerns Road are also comfortable.

The north end of Kerns Road is rather steep in places and the proposed alignment here commences a highly engineered route which involves an embankment, some 250 metres long and 10 metres high, with a bridge for the creek and road to pass under near Berong Road. After coming back to ground the alignment hugs the side of the hill (which is very steep) and enters a short valley on a gentle climb. The alignment crosses the valley on a small bridge and subsequently enters a tunnel to take it under Kincumber Mountain.

This tunnel is about 1.58 Kilometres long and is proposed to have minimal grading for drainage purposes only. The alignment of this tunnel is almost dead straight but has a slight bend about 500 metres from the northern end where the alignment changes from about 5° east of true north to exactly true north.

Upon leaving the tunnel the line falls slightly as it traverses the side a short valley before crossing Karalta Road and joining Tarragal Glen Avenue and meeting with the Gosford/Terrigal Line. Regrading of the natural Ground levels will be minimal through this section of the route.

Traffic management and preparation of vertical alignment diagrams for this corridor are not considered within the scope of this study. This is because the realisation of services on this corridor are distant, and the existing traffic patterns likely to change as could the proposed alignment.

3.3.3. Planning Analysis

At this stage this corridor is considered extremely premature and development patterns are likely to have changed considerably before it is found to be justified on patronage grounds. This factor not withstanding some planning analysis has been undertaken in an attempt to anticipate likely station locations.

As this service is expected to be more of a high speed connector service, stops are well spaced and the corridor is more highly engineered. As a result stop density is low. Stops are proposed at the following locations:

At the southern end of The Rip Bridge, Booker Bay,
At the eastern end of Helmsman Boulevard, Dalleys Point,
Near the shops at Empire Bay,
At the southern end of Davistown Road, Davistown,
Near Broad Water Drive, Saratoga,
Near the Shopping Village on Carrak Road, West Kincumber,
Just north of the roundabout on Avoca Drive, East Kincumber, and
Possibly in the quarry site at the northern end of Kerns Road.

Most of these proposed stop sites could become urban villages dependent upon trends at the time and suitability.

Resumption in this corridor will be necessary between Empire Bay Drive and Rickard Road, at the northern end of Kerns Road and from the northern end of Kincumber Mountain Tunnel to Tarragal Glen Avenue. (Refer to the Alignment Maps at the end of section 3.3.1. for more detail).

4. FINANCIAL IMPLICATIONS, CONSTRUCTION COSTS & ROLLING STOCK

The following three sections are a breakdown of costs for each of the three corridors. The breakdown assesses expected resumption, construction/engineering and rolling stock costs. Following the three corridors is an estimate of costs for the proposed Depots and Maintenance Facilities. All costs are in 1995 dollars.

The following standard cost schedule will be used to determine costs for each corridor.

Double track plus Signals at:	$6 million per Km
Double track embankments:	$1 million per Km per metre high
Double track cuttings at:	$1 million per Km per metre deep
Double track tunnel at:	$25 million per Km (Track and Signals Not Incl.)
Single track tunnel at:	$18 million per Km (Track and Signals Not Incl.)
Stops at:	$100,000 each
Double track underground station at:	$8 million each
Double track Bridges at:	$5 million per 100 metres (2 spans of 50 metres)
Resumption at:	$150,000 per dwelling
New high performance LRVs at:	$2 million each

4.1. Woy Woy to Umina\Ettalong

The length of this corridor, including both branches, is 5.5 Km. of double track and 1 Km. of single track There are proposed to be 15 stops. There are no tunnels or bridges and only 30 metres of embankment at 1 metre high. Five properties are envisaged to be resumed. 6 LRVs will be required to operate a 15 minute service on both lines.

The following table provides a summary of envisaged costs for this corridor:

TABLE 4.1.A.

COSTS in $ Per Unit	m = million		
Corridor:	Woy Woy to Umina and Ettalong 6.5 Km long		
Item:	$ per Item Unit:	Units Required	Total Cost per Item: Costs in millions:
Double Track plus Signals	$6m per Km	6.5 Km	$39
Dble. Track Embankment	$1m per 6000 Cubic metres	180 cubic metres	$0.03
Double Track Cuttings	$1m per 6000 Cubic metres	0	$0
Double Track Tunnel	$25m per Km	0	$0
Single Track Tunnel	$18m per Km	0	$0
Stops	$100,000 each	15	$1.5
Dble. Track Ungrnd. Stop	$8m each	0	$0
Double Track Bridge	$5m per 100 metre	0	$0
Resumption	$150,000 per Dwell.	5	$0.75
LRVs	$2m each	6	$12
Total Alignment Cost			$53.28 million

Total costs, including rolling stock, for this corridor are estimated to approximate $53.3 million.

4.2. Gosford to Terrigal

The length of this corridor is 14.25 Km and is initially proposed to have 15 stops, one of which will be underground. 750 metres of double track tunnel is proposed. There is one bridge at less than 50 metres. Eight properties will need to be resumed to create the corridor. There will be approximately 5520 cubic meters of embankment and 18810 cubic metres of cutting required. 6 LRVs will be required to operate a 15 minute service.

The following table provides a summary of envisaged costs for this corridor:

TABLE 4.2.A.

COSTS in $ Per Unit	m = million		
Corridor:	Gosford to Terrigal		14.25 Km long
Item:	$ per Item Unit:	Units Required	Total Cost per Item: Costs in millions
Double Track plus Signals	$6m per Km	14.25 Km	$85.5
Dble. Track Embankment	$1m per 6000 Cubic metres	5520 cubic metres	$0.92
Double Track Cuttings	$1m per 6000 Cubic metres	18810 cubic metres	$3.135
Double Track Tunnel	$25m per Km	0.75 Km	$18.75
Single Track Tunnel	$18m per Km	0	$0
Stops	$100,000 each	14	$1.4
Dble. Track Ungrnd. Stop	$8m each	1	$8
Double Track Bridge	$5m per 100 metre	0.5	$2.5
Resumption	$150,000 per Dwell.	8	$1.2
LRVs	$2m each	6	$12
Total Alignment Cost			$133.4 million

Total costs, including rolling stock, for this corridor are envisaged to approximate $133.4 million. If a surface option at Erina was adopted, instead of the Underground Station, total costs would be only $106.8 million.

4.3. Woy Woy\Ettalong to Erina

The length of this corridor is 14. Km and is initially proposed to have 8 stops. There is proposed to 1.58 kilometres of double track tunnel. There are two bridges one at less than 50 metres and the other at 300 metres. Twelve properties will need to be resumed to create the corridor. There will be approximately 27540 cubic meters of embankment and 2400 cubic metres of cutting required. 9 LRVs will be required to operate a 15 minute service.

The following table provides a summary of envisaged costs for this corridor:

TABLE 4.3.A.

COSTS in $ Per Unit:	m = million		
Corridor:	Woy W.\Ettalong to Erina		
Item:	$ per Item Unit:	Units Required	Total Cost per Item: Costs in millions
Double Track plus Signals	$6m per Km	14 Km	$84
Dble. Track Embankment	$1m per 6000 Cubic metres	27540 cubic metres	$4.59
Double Track Cuttings	$1m per 6000 Cubic metres	2400 cubic metres	$0.4
Double Track Tunnel	$25m per Km	1.58 Km	$40
Single Track Tunnel	$18m per Km	1.58 Km	$0
Stops	$100,000 each	8	$0.8
Dble. Track Ungrnd. Stop	$5m each	0	$0
Double Track Bridge	$5m per 100 metre	7	$35
Resumption	$150,000 per Dwell.	12	$1.8
LRVs	$2m each	9	$18
Total Alignment Cost			$184.39 million

Total costs, including rolling stock, for this corridor are envisaged to approximate $184.4 million or $174.4 million with a single track tunnel under Kincumber Mountain.

4.4. Depot and Maintenance Facilities

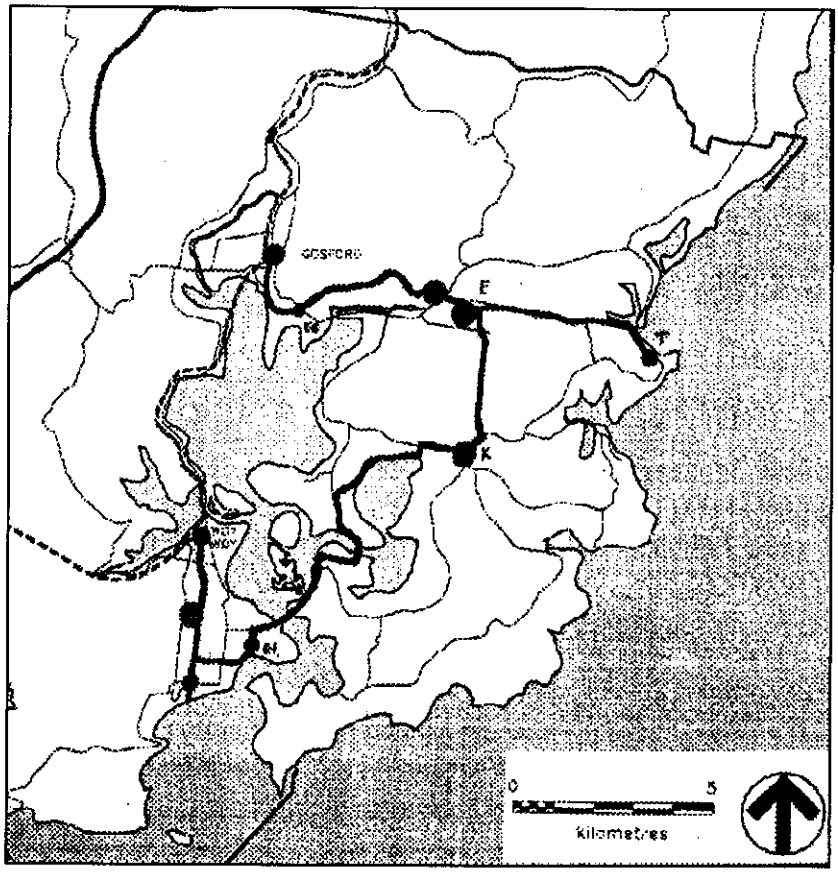
Two depot and maintenance facilities will be required for this system. This is because the first two lines are separate, one line being between Gosford and Terrigal and the other on the Woy Woy Peninsula. As such, separate Facilities will need to be established to service the separate fleets. This is unfortunate as the fleets will be very small consisting of no more than 7 LRVs for each initial line (probably only six). If Trucking to a primary Maintenance facility is feasible then the other facility need only serve as a depot.

Complete facilities, serving both Depot and Maintenance functions will cost $5 million each for up to 20 LRVs each. A depot facility alone for up to 20 LRVs would only cost about $2 million.

The main depot for the complete system would be the Erina Depot and Maintenance facility on Barralong Road. The Woy Woy facility could operate as a depot only if access could be achieved to the Erina facility.

This being the case, Depot and Maintenance facilities are anticipated to cost in the order of $7 million to $10 Million.

Figure 4.4.A.
Map of Depot Locations.



5. IMPACTS ON LAND USE AND URBAN DENSITIES

5.1. Land Use and Transportation Integration

Transport and land use are linked in a dynamic system that can often be very difficult to understand, or understand well. Put quite simply, transport and land use are co-dependent and counter balancing. This is because both require land take, so each are competing for the same resource. If transport takes more land space then, as a result, the land use density will be lower because there will be less land to build on. Conversely, if land use occupies most of the land space then the little space that is left for transport will need to be utilised very efficiently. This relationship also demonstrates that if high land use densities are required then high capacity transport systems will also be necessary.

5.1.1. Density

Land use Density is perhaps the primary influencing factor in determining transportation levels of demand and subsequent mode choices by planners and economists. High density areas have a high generation rate for trips, both into and out of the area, and often all day, not only during the peaks. High density areas also usually have very little space for surface transport.

It is a feature of many higher density areas to have more pedestrian orientated streetscapes than would be the case with lower density areas. In many instances surface transport, especially high traffic volumes, would be incompatible with these pedestrian orientated areas. High capacity modes not only make more efficient use of the available land space left for transport but also result in a more acceptable mode with less impact on the streetscape and pedestrians. An alternative to surface transport is underground transport, usually railways. However this option is very expensive, costing up to $50 million per Km, and is only an economically feasible option where densities are very high and surface congestion unmanageable.

The proposed densities of new urban development in the Central Coast region will be considerably higher than previous new areas. The anticipated densities will sustain frequent bus services and also many local mini buses acting as feeders. The town centres will be the most dense areas of all with a wide range of mixed uses. These Core or Node areas will sustain rail links servicing between them. These rail links would need to be well linked to the local feeder bus networks and be an express type high speed, high capacity service, but with stops located wherever densities justify demand.

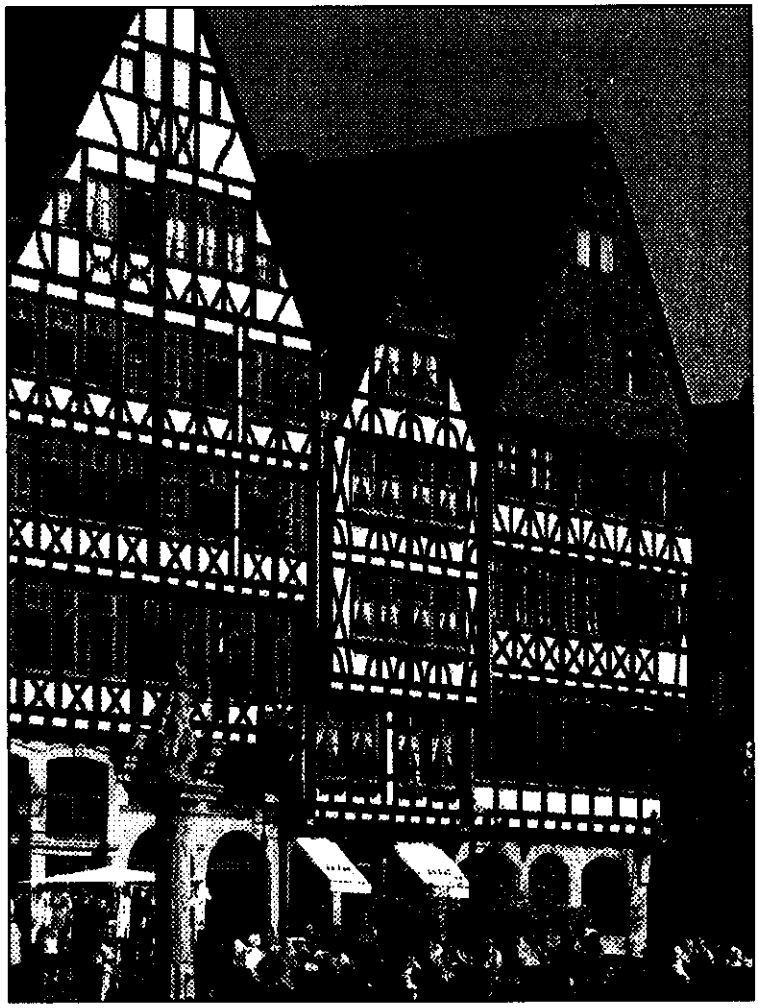
5.1.2. Mixed Uses

As has already been mentioned, mixed use areas will generate high demand for transport, in particular high capacity public transport. A number of existing town centres are anticipated to develop into high density mixed use areas. These areas will have a high level of pedestrian activity with many local trips being made by foot. Pedestrians will be the dominant mode of transport locally and should be given priority over most other modes. Integration and minimisation of conflicts between pedestrians and other modes will need to be a design priority.

Cars will need to be minimised and slow, shared zones encouraged for most streets in these areas. Streets would be relatively narrow and car drivers would be psychologically discouraged from entering such areas simply on sight.

Transit stops would need to be highly accessible but not imposing. That is to say that the stops will be well integrated with the rest of the urban form so as to be completely welcomed and accepted thematically and architecturally.

Phone: (02) 357 2394. Fax: (02) 358 1502.



Modern urban design can create new town centres with traditional charm, a nucleus of community, commercial and residential uses. The R merburg is the medieval centre of old Frankfurt which was destroyed in 1944. It was rebuilt between 1981 and 1983.

Phone: (02) 357 2394. Fax: (02) 358 1502.

5.1.3. Transit Stops

Transit Stops are the most important part of a high capacity public transport system. They are the public face of the system, its image, and every feature of them influences the public's perception of the Mode.

Transit stops firstly need to be well located, that is, conveniently near to a destination. Subsequently, they need convenient access to that destination. Once people leave the system they are pedestrians and as much attention needs to be paid to the pedestrian's needs from this point on as would be paid to the system generally.

The stop needs to be well designed and functional yet user friendly, especially for the mobility impaired. This means that they need to be weather protected, well lit, safe, with good lines of sight, bright and attractive/inviting in appearance, comfortable and clean.

The stops should be architecturally appropriate, with regard to the surrounding urban form, and not visually imposing unless intended to serve as an architectural feature. Architectural integration not withstanding, a corporate conformity should prevail throughout the system. A design theme incorporating a corporate logo and colours will increase user familiarity and confidence. People need to know that when they are at the stop they have joined the system.

Interchanges should be as efficient as possible without compromising the above principles. Exceptions to this rule are only acceptable in the primary nodal areas where interchanges can be broken down into a number of smaller facilities to reduce bulk. This can be made more acceptable to the user only in the primary node areas where shops and activities will service as opportunities to browse and "live a little" while making an interchange for a cross town journey. Most people do not mind a short walk, no more than 5 minutes between routes so long as there are plenty of distractions and interesting things along the way. (eg interchanging in Sydney CBD involving up to 3 narrow blocks walk past shops, cafes etc.)

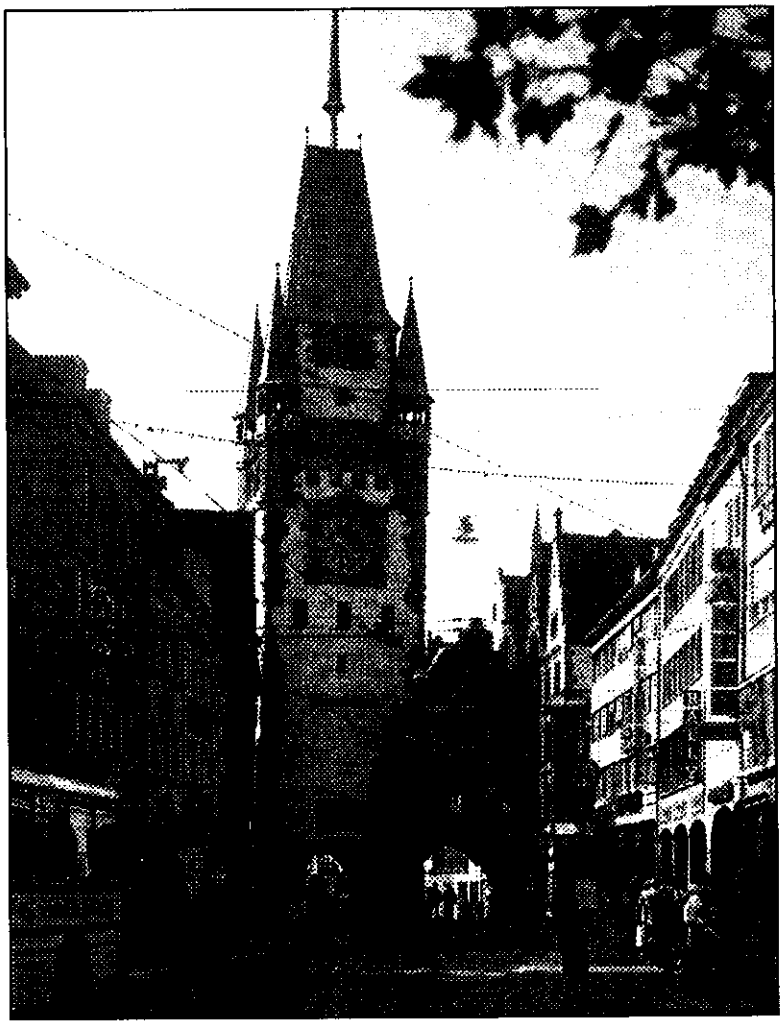


Figure 5.1.3.A.
This transit stop, in front of St. Martin's Gate in Freiburg, is located in a Commercial street with offices and residential flats above. Note that the Light Rail Lines pass through the Tower Gates. This demonstrates how well integrated this highly flexible mode of rail transport can be.

5.1.4. Carparking

Carparking is an instigating factor in demand for car usage. Links have been established between the amount of carparking available (or perceived to be available) and the likely amount of car traffic that will result (or attempt to result).

The less carparking provided the less car traffic will be attracted. This factor is particularly important in the high density, mixed use town centre areas. The town centres will be the most accessible destinations in the entire region, especially from a public transport perspective, and will also be the most pedestrian orientated part of the region. It would be illogical to encourage car access to this areas, and policy should be adopted to actively discourage it. Carparking will be a primary influencing factor in this regard.

Commuter and shopper parking should be heavily discouraged and any that is provided should be expensive to access, relative to the cost of public transport. The location of commuter/shopper parking should also be at the edges of the retail core for both reasons of amenity, economics and to serve as further discouragement to drive.

Exceptions to this rule will however be necessary, such as for disabled persons, taxis, and residents. Residents parking should be on site and in-building or underground. Due to the convenience of all services in the inner areas of the town centres not all people will need cars. A maximum residential car parking provision of 1.5 spaces for every three bedrooms or 2 spaces for every 3 units should be implemented in these centres. The car spaces should also be sold on individual titles in each strata plan. This is so that they can be best traded according to demand between owners in each building. Bulk buying and buying a car space without owning a unit in that building would not be permitted. People owning a space in their building but not owning a car should be encouraged to lease their space to someone in the building who does have a car.

5.2. Growth Corridors

It is apparent that, subsequent to appropriate rezoning and the pending construction of the proposed Light Rail lines, that the corridors occupying those lines will experience considerable growth. This is especially likely if development opportunities have been encouraged in these corridors and limited in other areas. Urban Villages are a likely outcome of this process.

This Urban Village concept consists of many of the attributes outlined in the previous sections; that is medium to high density residential development amongst mixed uses (primarily commercial and retail). Such villages have distinctive characters and most services and goods can be attained locally, or within a short walk.

Shops usually line the Main Street (around the LR Stop) with apartments above up to ten stories in some instances but usually only five stories high. (This would require a 3a zoning.) The surrounding blocks would consist of units or preferably townhouses up to 3 stories high. (Requiring 2c zoning) The next blocks beyond would have townhouses and semi-detached/zero lot line houses up to 2 stories high.(also requiring 2c). Beyond this conventional development would remain.

The result of this process is a definable village where urban densities are distinctively higher than the surrounding area that effectively remains untouched. This, in effect, is a process of damage control that concentrates growth in a more sustainable pattern than is occurring with current suburban trends. The resultant villages develop in lieu of allowing further suburban subdivision.

These villages are subsequently linked via convenient public transport. The linking together of these villages results in the corridor and in this instance, as there is plenty of potential for growth, they are growth corridors.

The following three sections outline some of the anticipated development patterns likely to occur in the three corridors examined in this study.

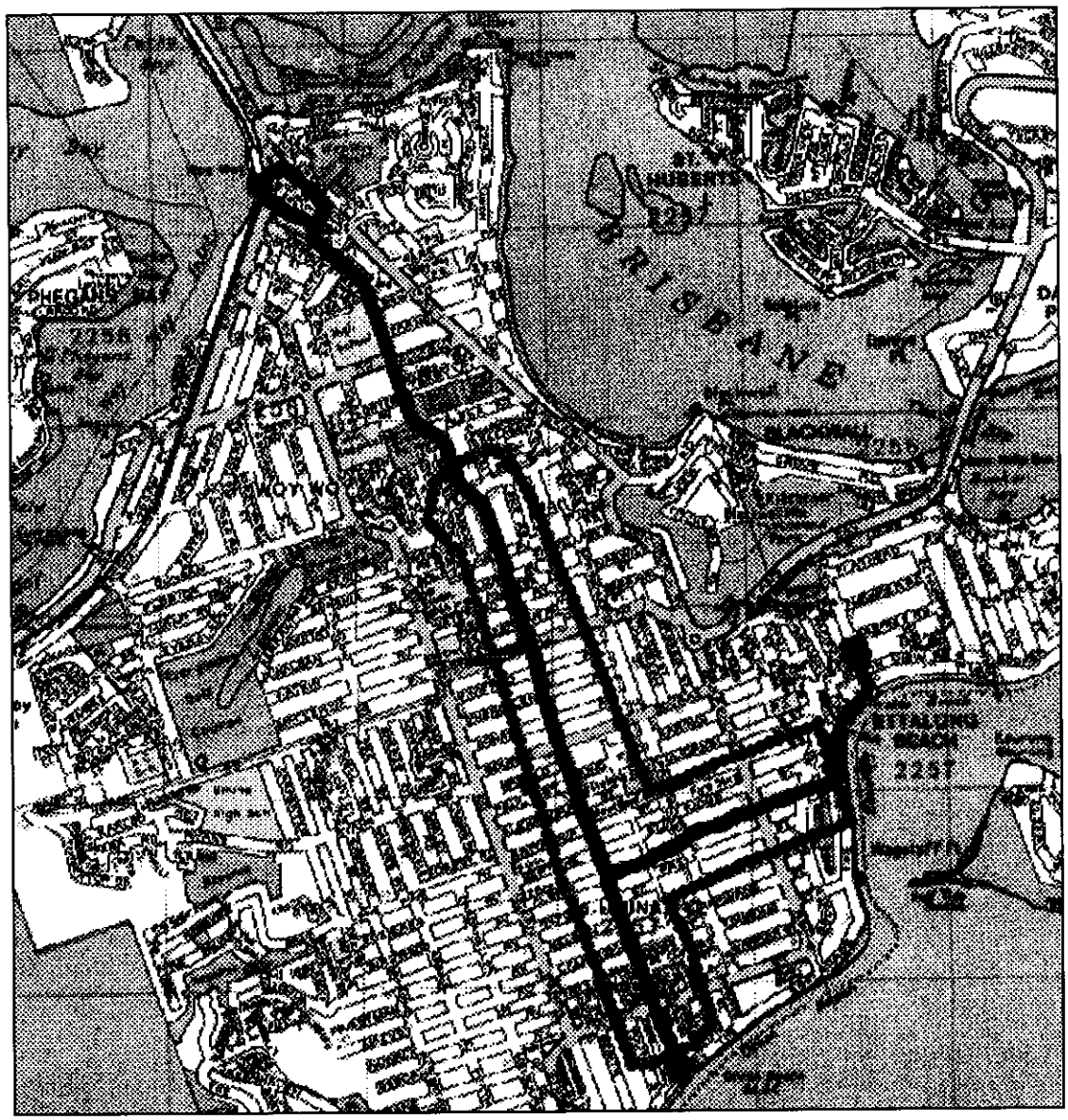
5.2.1. Peninsula Growth Corridor

There is considerable potential for concentrated growth along the Peninsula corridor. Most of this growth will take the form of higher density development in strategically appropriate locations. It is proposed that most of the stops on this corridor be surrounded with "Urban Village" type development in the near future.

In particular the following stops are envisaged to stimulate Urban Villages: around the Allfield Road stop on Edward Street, around the James Browne Park stop, around the Bourke Road stop, around the Junction stop at Albion Street, around the Ettalong Beach stop on Bangalow Street and at Woy Woy, Umina and Ettalong shops. (Refer to the following Growth Corridor Diagrams.)

Although development may be slow to start, appropriate developer incentives will stimulate higher density developments.

Figure 5.2.1. A.
Peninsula Growth Corridor.

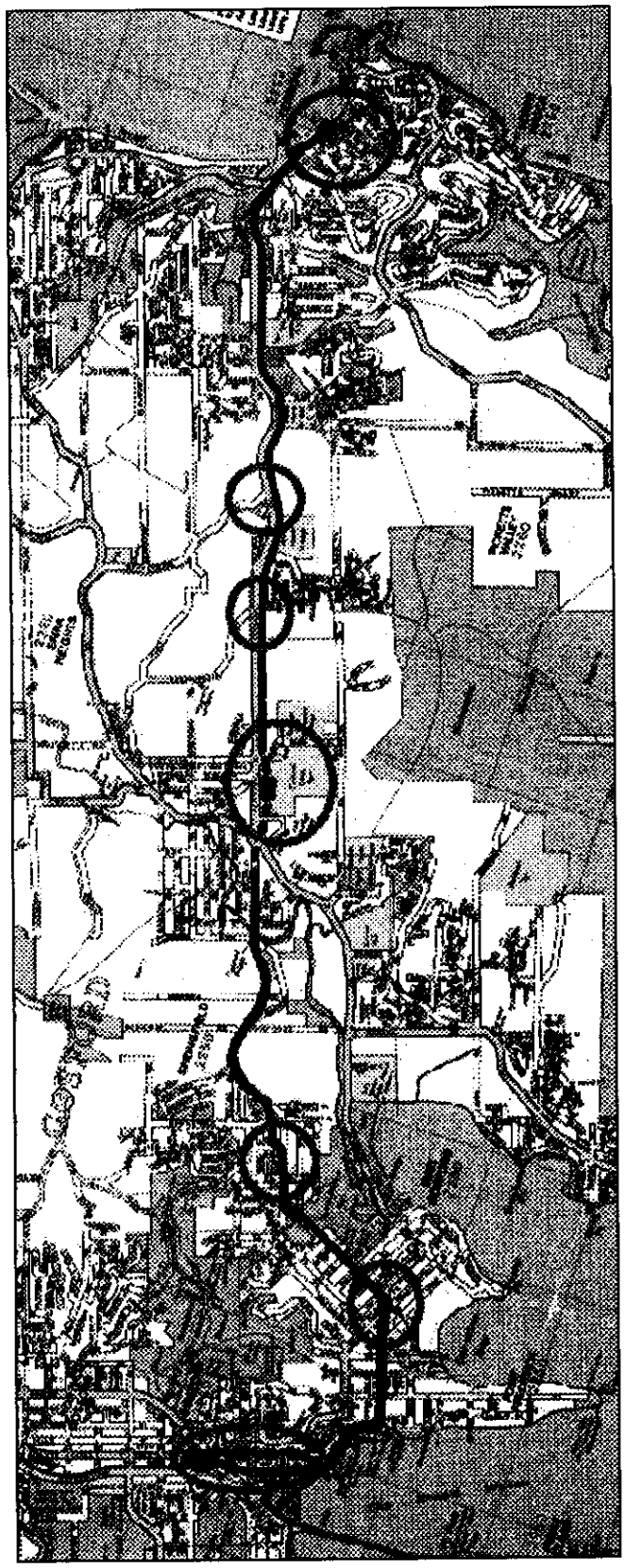


5.2.2. Terrigal Growth Corridor

There are a number of locations along the Terrigal corridor that will sustain higher densities. Erina and Terrigal will be looked at individually in following sections. The rest of this corridor contains the following opportunities for Urban Villages.

East Gosford could sustain considerably higher densities as could the rest of the stops along the Althorp/Wells Streets section of this corridor. An Urban Village could be allowed to develop around the Headlam Parade stop. Further Urban Villages could develop, as demand requires at both the intersections with Portsmouth Road and Serpentine Road. Higher densities should be encouraged in the west Terrigal area around the stop near Brunswick Road. (Refer to the following Growth Corridor Diagrams).

Figure 5.2.2.A.
Terrigal Growth Corridor.

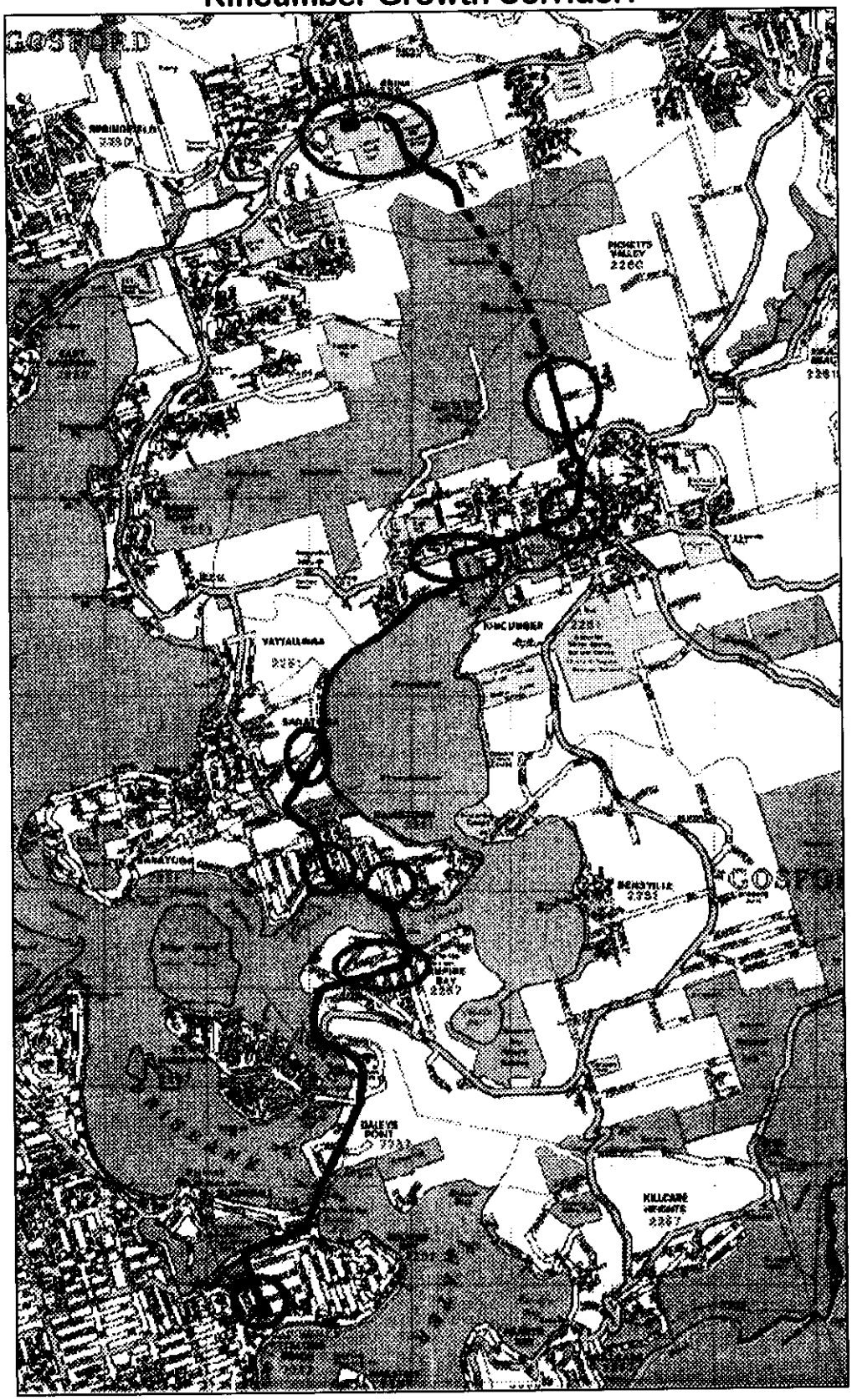


5.2.3. Kincumber Growth Corridor

Growth in the Kincumber Corridor should be restricted until the other corridors have consolidated. Subsequent to the other corridors reaching ultimate levels of development this corridor should be released. This should be in conjunction with the construction of the line. This corridor release may not occur for twenty years or more.

Upon release of this corridor, higher densities would be allowed to develop in strategic locations only around transit stops. The exact nature and location of these sites is too uncertain at this stage. In any event, in twenty years time development patterns and trends are likely to be considerably different to that which we may currently envisage. It is only important at this stage to establish that further study will need to be undertaken in forthcoming years, as demand for growth in this corridor approaches, and that change will occur and will need to be appropriately accommodated. Any further speculation at this stage would be purely academic.

Figure 5.2.3.A.
Kincumber Growth Corridor.



5.3. Growth Nodes

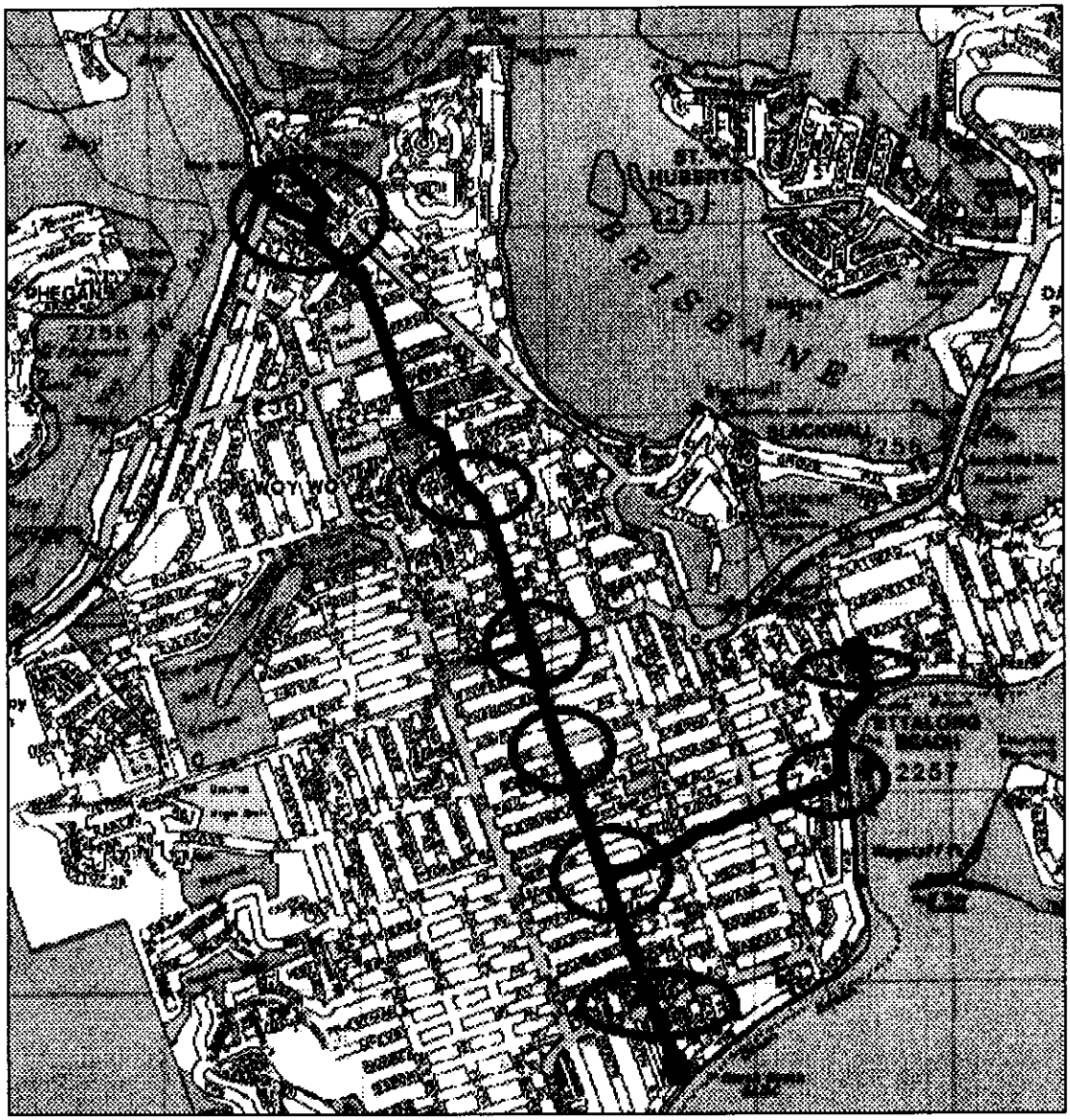
Growth Nodes are centres that are expected to experience considerable growth opportunities or are totally new centres that start growing due to demand. The following sections detail the four primary nodes that will see growth if zoning and developer incentives are appropriately managed.

5.3.1. Peninsula

The Peninsula is identified as a growth node primarily due to the nature of the proposed LR line to serve the area. This line has relatively close stops and development of Urban Villages could result in a strip style mixed use corridor from Woy Woy to Umina.

With reference to the following Growth Node diagrams it can be seen that should Urban Villages occur at each stop between Woy Woy and Umina then the entire corridor will, in itself, become an urban node from one end to the other.

Figure 5.3.1.A.
Peninsula Nodes



5.3.2. Erina

The Erina Node is likely to become the largest node in the entire region in years to come. This is primarily due to the fact that it is centrally located in the region. Development of a large, high density, mixed use Urban Centre is a definite possibility and a potential outcome of this study.

For such development to occur at Erina it will be necessary for a complete Urban Design Study to be undertaken to establish such things as transport integration, pedestrian areas and links, architectural themes, scale of development in various locations and the overall form and context of the centre.

The outcomes of the study should be specific allocations for 2c and 2d residential zones surrounding the existing 3a commercial zone. The 3a zone can however accommodate large residential structures as well and the locations for these buildings within this zone should also be established. The ultimate levels of development that this would result in would generate very high demand for the Light Rail Service.

5.3.3. Gosford

Gosford is the core centre for the region and is likely to maintain the administrative functions that it currently serves. Retail and Commercial growth is also likely to occur but not as rapidly as is expected to occur at Erina. Residential development is likely to represent the primary type of growth in the area mostly in 2c and 2d zones. Residential development above shops in the 3a zone should also be encouraged but height should be restricted to 5 stories.

5.3.4. Terrigal

Terrigal has plenty of potential for higher density development as the recent hotel construction demonstrates. Large scale developments could be encouraged in the 3a zone (except for those sites fronting Terrigal Drive which should be restricted to 5 stories to preserve the solar plane of the beach.). However it is important that a wide mix of residential uses (not just hotels/motels) be stimulated and controls placed to restrict an over supply of accommodation style development which would otherwise sterilise the town during the off season.

Some of the blocks behind the 3a zone could be zoned 2c to allow further medium density residential development. The resultant development would generate considerable demand for the Light Rail Service to both Erina and Gosford.

6. PROJECT PHASING

Three distinct Corridors have been proposed in this study, the Peninsula Corridor, the Terrigal Corridor and the Kincumber Corridor. Each of these corridors will be further described with regards to project phasing. Implementation timetables are envisaged to occur over the next twenty years or so as demand dictates.

The two branches of the Peninsula Corridor, Umina and Ettalong, will be detailed individually as either could be built independently of the other, or simultaneously.

Project Phasing is dependent upon funding sources and the nature of those sources. Clearly if funding is not forthcoming, from any of the outlined sources detailed in section 11, (or any other unforeseen source) then the project would be stalled. In addition to this, the location of various sources of funding may dictate which areas, or lines, are built and when. For example; if developer contributions from along the Terrigal Corridor are substantial then that corridor is likely to be undertaken, where as if contributions from the Peninsula are slow to accumulate then it may be some time before that corridor is commenced.

As these two corridors are totally independent of the other (the Terrigal and Peninsula corridors) it is not important when either are built relative to the other. They can be built simultaneously if funding is secure or decades apart if not. Funding and demand will dictate the exact time that each should be commenced.

6.1. Peninsula Corridor

The Peninsula Corridor has two distinctive branches, each of which could be built independently of the other or simultaneously. Each will be detailed individually. The Woy Woy to Albion Street section is common for both lines but is only detailed in the first section as it is similar for both. Reference to section 6.1.1 should be made for this detail and taken in conjunction with section 6.1.2.

6.1.1. Stage One: Woy Woy to Umina

The Woy Woy to Umina line could be commenced as soon as is practical, but not prior to completing the appropriate studies (refer to section 13.3.) and undertaking appropriate rezoning of the area. In addition sources of funding will need to have been secured and Developer Contribution Schemes implemented.

Upon restructuring of the local bus routes to act as feeders to the line current patronage will justify at least a fifteen minute all day service with perhaps ten minutes services in the peak on the common section of the line north of the Albion Street junction (see section 7 Patronage forecasting). Services would operate at half hour frequencies after 7pm and on weekends off peak. This level of service could see the line operational as soon as funding is secured.

This line could be operated as a stand alone service independent of any other Light Rail services in the region.

6.1.2. Stage Two: Woy Woy to Ettalong

The Woy Woy to Ettalong line is likely to be feasible in the near future, especially if rezoning around Ettalong Beach stimulates development. However the primary demand generator for this line would be the commencement of JetCat services to Sydney from Ettalong Beach at the eastern end of Bangalow Street. Upon commencement of the JetCat service demand for this line will be considerable, especially from the rest of the Woy Woy area.

In any event it is recommended that this line be built subsequently to the Umina line. The Umina line is more likely to be operating and adding a short branch to Ettalong shops via the proposed JetCat Wharf would be a relatively minor additional expense when demand justifies. (Cost Approximately $20 million).

This line is not expected to operate as a stand alone service but could do so if the Umina Branch was not already operational.

6.2. Terrigal Corridor

The Terrigal Corridor could be built as soon as the appropriate studies and rezonings have been completed (See section 13.3.). Current patronage levels will justify a twenty minute service between Terrigal and Gosford and fifteen minute service between Erina and Gosford (peak hours) with half hour services in the off peak. However, demand for service upon commencement of operation, with forthcoming development, may require ten minute service over the entire line and a possible lengthening of the peak period to accommodate midday travel. (See section 7.2. Patronage Forecasting).

This corridor could operate as a stand alone line independent of any other Light Rail service in the region.

6.3. Kincumber Corridor

The Kincumber line is clearly going to be the most expensive of all the proposed corridors examined in this study. It also would be servicing an area for which patronage demand is not expected to justify operation for many years, and only then conditional upon considerable concentrated development around the proposed station locations.

This line is not anticipated to be operation for at least twenty years and then only subsequent to the Terrigal and Peninsula corridors being fully operational. This line is not likely to be functional as a stand alone line unlike the other corridors in this study.

6.4. Summary of Phasing

The following Project Phasing is envisaged to be the most likely implementation scheme at this stage:

The Peninsula Corridor (Woy Woy to Umina) Stage One could be commenced as soon as is practical. It is proposed that this corridor be built first as it is the easiest to construct and the cheapest.
Implementation timetable from date: Say five to ten years.

Stage Two of the Peninsula Corridor (Branch to Ettalong) could be operational simultaneously with Stage One and when the proposed JetCat service is in use. Otherwise this line could become operational as demand dictates.
Implementation timetable from date: Say five to fifteen years.

The Terrigal Corridor could be commenced as soon as is practical. This corridor could also be built first if funding dictated such to be the case. However it is envisaged that the Peninsula Corridor would be built first.
For the Terrigal corridor the Implementation timetable from date is: Say five to fifteen years. (Dependent on funding).

The Kincumber Corridor would be the final corridor examined in this study to be commenced. It is not expected to be operational for at least twenty years.

7. PATRONAGE FORECASTING

For each of the three corridors examined in this study the same patronage forecasting methodology and assumptions have been used. The methodology, and assumptions used, involved the following:

Based upon the current bus timetables operating in the area of each proposed corridor current patronage was estimated. This involved determining which bus routes currently conveyed passengers along a similar route to that of the proposed Light Rail service and for which passengers could reasonably be expected to switch over to Light Rail which will replace the buses on these corridors when operational.

Once these bus routes had been identified the number of buses operating on a day basis for each route was counted (with reference to the current timetables). This produced a number of buses per day currently operating along the proposed corridor.

A loading assumption of 50% was assumed for all services. This assumption takes account of when buses run almost empty and almost full. (This is considered a conservative estimate as more services operate during the peak when they are likely to be fuller than 50%). This results in an assumed loading of 28 passengers per bus trip.

Note that this method takes no account of people alighting half way along the route and being replaced by a second fully paying passenger. Such would result in actual patronage being somewhat higher again than that estimated here. Without conducting a full travel pattern matrix, requiring market surveys, it is impossible to determine the exact affect that this factor would have on patronage. As such, it has been ignored in favour of the conservative estimate.

Equivalent full days of operation per week were assumed to approximate 6 as a half usual service is anticipated for the weekends.

Patronage was then forecast using the following formula:

$$\mathbf{Pax_{an} = P_b * B_d * D_w * W_y}$$ Where:

Pax_{an}	=	Passengers per annum
P_b	=	Passengers per bus
B_d	=	Buses per day
D_w	=	Days per week, and
W_y	=	Weeks per year.

A standard growth rate of 2% per annum was applied to the Peninsula corridor and 5% to the Terrigal and Kincumber corridors This is to reflect the anticipated rates of growth that are likely to occur in each corridor. These correspond with the city wide population growth rate of 2%. This estimate of growth is considered a conservative estimate as new rail services usually attract rapid growth in their initial years of operation and subsequent local development is at a higher growth rate than the city

wide average resulting in patronage growth higher than the average city growth rate. However, without exact predictions of the scale of either of these factors the conservative estimates of 2% and 5% per annum have been used.

7.1. Peninsula Corridor

The results of the patronage forecast for the Peninsula corridor were as follows:

TABLE 7.1.A.

Corridor:	Peninsula
Current Number of services per day total:	175
Assumed Number of Pax Per Bus:	28
Number of passengers per Day:	4,900
Assumed Number of Full Days per Week:	6
Pax per Week:	29,400
Pax per Year:	1,528,800

Current patronage for the Peninsula corridor is estimated to be in the order of 1.5 million trips per year. In 25 years this expected to increase to about 2.5 million trips per year. (This is considered a conservative estimate as actual trip growth rates are likely to be higher than 2% per annum with high density development).

7.2. Terrigal Corridor

The results of the patronage forecast for the Terrigal corridor were as follows:

TABLE 7.2.A.

Corridor:	Terrigal
Current Number of services per day total:	75
Assumed Number of Pax Per Bus:	28
Number of passengers per Day:	2,100
Assumed Number of Full Days per Week:	6
Pax per Week:	12,600
Pax per Year:	655,200

Current patronage for the Terrigal corridor is estimated to be in the order of 0.65 million trips per year. In 25 years this expected to increase to about 2.25 million trips per year. (This is considered a conservative estimate as actual trip growth rates are likely to be higher than 5% per annum with high density development).

7.3. Kincumber Corridor

The results of the patronage forecast for the Kincumber corridor were as follows:

TABLE 7.3.A.	
Corridor:	Kincumber
Current Number of services per day total:	25
Assumed Number of Pax Per Bus:	28
Number of passengers per Day:	700
Assumed Number of Full Days per Week:	6
Pax per Week:	4,200
Pax per Year:	218,400

Current patronage for the Kincumber corridor is estimated to be in the order of 0.21 million trips per year. In 25 years this expected to increase to about 0.74 million trips per year. (This is considered a conservative estimate as actual trip growth rates are likely to be higher than 5% per annum with high density development).

7.4. Development Induced Patronage Growth

Patronage growth could occur at considerably faster rates than predicted if development is rapid and dense. If large amounts of high density occurs around LRT stops then patronage could grow by as much as 10% per annum.

Such growth would result in increases in service frequency and associated operating costs, however, these would be offset by the corresponding increases in operating profit from increased ticket sales.

Any increases in the rates of growth would also have positive effects on the economic worth of the projects.

8. REVENUE PROJECTIONS

For each of the three corridors examined in this study the same revenue projecting methodology and assumptions have been used. The methodology, and assumptions used, involved the following:

Assumed average ticket prices were based on the like price for a similar current journey by the existing bus services. The exact amount used for each corridor varied and is detailed in the write ups for each individual corridor. All trips, on any one corridor, were assumed to generate the same average ticket price, concessions and school trips being reimbursed from State Government subsidies according to the existing Community Service Obligation (CSO) arrangements in practice.

The simple formula used to derive forecasted revenue is as follows:

$$R = P * T_{av.}$$

Where R = Revenue
P = Annual passenger trips, and
T_{Av} = Average ticket price.

The estimated operating expenses are conservative estimates based on an extremely efficient and streamline operation. Operating costs could be as much as 20% higher but such costs are not necessary. The effect of increasing operating costs by 20% reduces operating profits but does not have a large effect on the viability of these projects.

8.1. Peninsula Corridor

For the Peninsula corridor the average ticket price was assumed to be $1.20. With a forecast 1996 patronage of 1,528,800 ticket and CSO generated revenue would be ~$1,834,560. This would rise in 25 years to ~$3,009,790. There is not envisaged to be any increase in operating expenses (in real terms) as the seated capacity of the "start up" frequency is three times higher than demand. Therefore demand and revenue can increase by a factor of three and it will be adsorbed by the initial capacity of the system without any need for higher frequency of services.

The following table presents the calculation of the operating expenses and assumptions used.

TABLE 8.1.A.

Calculation of operating Expenses:			
	Number	Annual wage	Total wages
Time of operations 6 am to 10 pm, Total Hrs:	17		
Number of LRVs operating all day:	4		
Total of all day operating Hours:	68		
Number of driver shifts per LRV per Day:	3		
Shifts required for all day operations	12		
Additional peak hour shifts daily	1.5		
Total Number of daily driver shifts	13.5		
Number of fully paid weekday drivers	13.5		
Number of weekend drivers paid time + half:	4		
Total equivalent fully paid drivers:	15.5	$35,000	$542,500
Roaming inspector	1	$35,000	$35,000
Full time office support staff:	2	$35,000	$70,000
Depot managers:	2	$35,000	$70,000
Maintenance staff:	2	$40,000	$80,000
Part time additional office support	1	$3,500	$3,500
Total wage expenses			$801,000
Utilities expenses equal say 20% of wages:			$160,200
Total operating expenses:			$961,200

The resultant total operating expenses for 1996 comes to ~$961,200. There is no anticipated real terms rise in these expenses based on patronage demand for at least twenty five years (assuming that patronage growth is not considerably higher than 2% per annum).

Subtracting the Operating Expenses from the Revenue results in the Operating Profit. For 1996 the Operating Profit is forecast to be ~$873,360. This rises in twenty five years to ~$2,048,590.

8.2. Terrigal Corridor

For the Terrigal corridor the average ticket price was assumed to be $1.90. With a forecast 1996 patronage of 655,200 ticket and CSO generated revenue would be ~$1,244,880. This would rise in 25 years to ~$4,215,600. There is envisaged to be an increase in operating expenses (in real terms) as the seated capacity of the "start up" frequency will be insufficient in 20 years time. Therefore some operating expenses are expected to double around this time to produce additional capacity in the system through higher frequency of services.

The following table presents the calculation of the operating expenses and assumptions used.

TABLE 8.2.A.

Calculation of operating Expenses:			
	Number	Annual wage	Total wages
Time of operations 5 am to 10 pm, Total Hrs:	17		
Number of LRVs operating all day:	3		
Total of all day operating Hours:	51		
Number of driver shifts per LRV per Day:	3		
Shifts required for all day operations	9		
Additional peak hour shifts daily	1.0		
Total Number of daily driver shifts	10.0		
Number of fully paid weekday drivers	10.0		
Number of weekend drivers paid time + half:	3		
Total equivalent fully paid drivers:	13.0	$35,000	$455,000
Roaming inspector	1	$35,000	$35,000
Full time office support staff:	2	$35,000	$70,000
Depot managers:	2	$35,000	$70,000
Maintenance staff:	2	$40,000	$80,000
Part time additional office support	1	$3,500	$3,600
Total wage expenses			$713,600
Utilities expenses equal say 20% of wages:			$142,700
Total operating expenses:			$856,200

The resultant total operating expenses for 1996 comes to ~$856,200. There is an anticipated real terms rise in these expenses based on patronage demand in around year twenty (assuming that patronage growth is not considerably higher than 5% per annum).This is expected to involve doubling the driver shifts only. In year twenty five operating expenses are expected to be ~$1,402,200

Subtracting the Operating Expenses from the Revenue results in the Operating Profit. For 1996 the Operating Profit is forecast to be ~$388,680. This rises in twenty five years to ~$2,813,400.

8.3. Kincumber Corridor

For the Kincumber corridor the average ticket price was assumed to be $2.50. With a forecast 1996 patronage of 218,400 ticket and CSO generated revenue would be ~$546,000. This would rise in 25 years to ~$1,848,950. There is not envisaged to be any increase in operating expenses (in real terms) as the seated capacity of the "start up" frequency is three times higher than demand. Therefore demand and revenue can increase by a factor of three and it will be adsorbed by the initial capacity of the system without any need for higher frequency of services.

The following table presents the calculation of the operating expenses and assumptions used.

TABLE 8.3.A.

Calculation of operating Expenses:			
	Number	Annual wage	Total wages
Time of operations 6 am to 10 pm, Total Hrs:	17		
Number of LRVs operating all day:	4		
Total of all day operating Hours:	68		
Number of driver shifts per LRV per Day:	3		
Shifts required for all day operations	12		
Additional peak hour shifts daily	2.0		
Total Number of daily driver shifts	14.0		
Number of fully paid weekday drivers	14.0		
Number of weekend drivers paid time + half:	3		
Total equivalent fully paid drivers:	17.0	$35,000	$595,000
Roaming inspector	1	$35,000	$35,000
Full time office support staff:	2	$35,000	$70,000
Depot managers:	0	$35,000	$0
Maintenance staff:	2	$40,000	$80,000
Part time additional office support	0	$3,500	$0
Total wage expenses			$780,000
Utilities expenses equal say 20% of wages:			$156,000
Total operating expenses:			$936,000

The resultant total operating expenses for 1996 comes to ~$936,000. There is no anticipated real terms rise in these expenses based on patronage demand for at least twenty five years (assuming that patronage growth is not considerably higher than 5% per annum).

Subtracting the Operating Expenses from the Revenue results in the Operating Profit. For 1996 an Operating Loss is forecast to be ~$390,000. This loss reverts to profit and rises in twenty five years to ~$936,000.

9. PRELIMINARY COST BENEFIT ANALYSIS (CBA)

9.1. Evaluation Methodology

The following evaluation methodology has been utilised: benefits to users, operators and non users resulting from the introduction of each line have been compared against the costs. The user benefits included: benefits to bus users from improved light rail times and vehicle boarding times; benefits to road users from increased road speeds as a result of patronage diversion from road to rail; reduced pollution and accident costs from traffic diversion from road to rail; and, the physical, social and transport cost savings from urban consolidation attributed to each line.

The economic merit of each line has been calculated as the sum of seven components:

$$EB = C\$ + PS + UB - UDB + NUB + XB + UCB$$

EB	=	Net change in Economic Benefit
C$	=	Capital construction cost of each line
PS	=	Producer Surplus (operating profit)
UB	=	Benefits to the users of each line
UDB	=	Disbenefits to the users of each line
NUB	=	Time and Vehicle Operating Cost savings to remaining road users due to reduced road traffic congestion
XB	=	Reduced air pollution and road accidents due to traffic diversion from road to rail
UCB	=	Benefits from Urban Consolidation attributable to each line

Forecast operating costs were subtracted from the revenue stream to give an indication of producer surplus (operating profit) (see Section 8 Revenue Projections). User benefit was estimated by reference to time savings afforded by each new line and the derived value of time. Some bus users will disbenefit from the conversion of some bus routes to light rail operation, these disbenefits have been evaluated in the same way as user benefits. Non user benefits were estimated by assessing the level of congestion savings to the remaining road users and accident and pollution savings resulting from the diversion of car traffic to rail. The evaluation has also included an estimate of the potential savings from Urban Consolidation attributable to the existence of each line.

The economic evaluation has been undertaken to conform with New South Wales Treasury Guidelines. The underlying assumptions were:

- a 25 year capital investment period,
- constant 1995 prices,
- a real discount rate of 7%.

We have estimated the capital cost of providing light rail infrastructure for each of the Peninsula, Terrigal and Kincumber corridors to be ~$53.3M, ~$133.4M and ~$184.4M respectively. The cost of depots at ~$5M each has also then been added to the costs of the Peninsula and Terrigal corridors to bring them to ~$58.3M and ~$138.4M respectively. For the Terrigal corridor the Underground Erina Station option has been used in the evaluation as it is the more expensive option. (It is recommended that a separate Economic Evaluation would be needed prior to construction to specifically determine this option.)

Each corridor has been evaluated as if each were to be built immediately, completed within the year and are all costed in 1995 dollars.

User benefits consist many of the following. There is expected to be an improvement in travel times for the average journey of about five minutes. This is largely due to the off street operation of lines or the use of streets with low traffic volumes and little congestion in the peak hour. The values of time used for rail patrons was 42 cents per minute (Douglas 1995). Additionally, benefits to users include increased comfort due to a smoother ride quality, air conditioning and easier vehicle access.

Some existing bus patrons were assumed to be disadvantaged due the need to transfer between modes. This disbenefit effects approximately 12% of the current patronage (Hencher). It has been assumed that this 12% of patronage has been disadvantaged by 5 minutes.

No car users were assumed to divert to Public Transport. This is an unrealistic conservative assumption however without stated preference and stated intention surveys it is impossible to determine the exact extend of diversion likely. In any case, these additional patrons would only further benefit the proposals.

Car speeds have been assumed to increase upon commencement of Light Rail services from 30 kph to 50 kph in the peaks (remain at 50 kph at other times, ie. No benefit outside of peak). This is due to the Light Rail replacing the busses on these corridors and operating largely off street. Average traffic speeds have been assumed to then fall to 25 kph for the rest of the evaluation period. This benefit has been assumed to benefit the equivalent of 5% of the anticipated LR patronage worth of car users. This is also considered a conservative estimate as real benefits to the resultant road users are likely to be considerably higher.

The reduction in accident costs were based on an accident cost per road vehicle kilometre of 3.46 cents (RTA 1993) and a rail accident cost of 1.37 cents per passenger kilometre (DJA 1994, Airport Link Evaluation).

The savings in noise, noxious air pollution and CO_2 emissions were based on a noise cost of 0.3 cents per road vehicle kilometre, a noxious air pollution cost of 0.7 cents per kilometre (BTCE, 1993) and a cost of carbon dioxide emissions of 0.17 per kilometre (Douglas, 1994).As modern LRVs make almost no noise at all and all rail generated pollution is concentrated at the power station, where it can be contained and

scrubbed, there is not envisaged to be any offsetting increase in rail pollution. The value of time used for car persons was 20 cents per minute (RTA).

Urban Consolidation Benefits are envisaged to be considerable and directly related to these projects. This evaluation considers three categories of urban consolidation savings:

- physical infrastructure savings;
- social infrastructure savings; and,
- transport related benefits from reduced commuting distance.

Physical infrastructure savings include: sewage, water, storm water drainage, gas, electricity, telecommunications and local roads.

Social infrastructure savings include: community facilities, local open space, schools, hospitals, emergency services, shopping facilities and social amenities.

Transport related benefits include: Public Transport operating cost savings associated with transporting commuters to work and school over a reduced distance, access savings in bus and car operating costs from a reduced access distance over fringe locations and time savings to commuters.

These light rail corridors will act as catalysts for residential and employment development. The evaluation assumed that these corridors would stimulate over half of the new residential development in these areas, over the 25 year evaluation period, but none of the employment growth:- this is considered a conservative assumption.

Dwyer Leslie Pty. Ltd. Estimated the physical infrastructure savings per dwelling of urban consolidation in established areas of Sydney to range from $18,900 to $30,700 per average building lot. The lower estimate of $18,900 has been used in this evaluation. The DJA Airport Link economic evaluation estimated total infrastructure savings to be 2-3 times the amount of physical infrastructure savings. A factor of 2 was used in this study. Per dwelling, the total benefit of urban consolidation stimulated by the new lines were estimated to be ~$9,250. These benefits are "once and for all" capital benefits, and have been assumed to occur in the year of building construction. Urban consolidation benefits are likely to provide a considerable proportion of the total benefits attributable to these projects.

As these Cost Benefit Analyses are of a preliminary level the results are intended to be indicative only. These evaluations will indicate whether these projects are worthwhile but are not intended to provide an exact measure of their economic worth. This is primarily due to a lack of exact travel data, the nature of the local travel market/economy and as yet unknown project commencement and completion dates. Full scale market research would need to be undertaken to determine some of these factors and as such it is also recommended that a Full Scale Light Rail Feasibility Study be undertaken upon approval to pursue these projects.

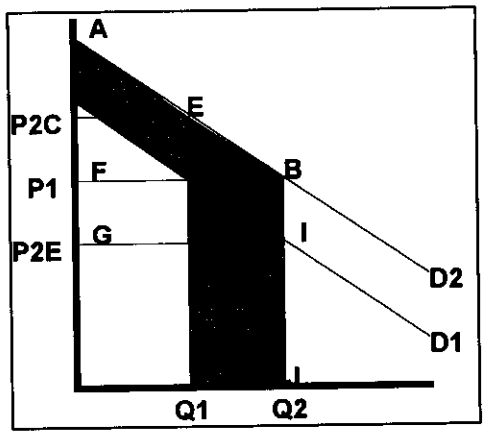
9.2. Evaluation Model

The following figures help to explain the evaluation model. Figure 9.2.1. shows the impact on the public transport travel market and figure 9.2.2. the impact on the private motor vehicle market.

Each light rail line improves the level of public transport service; the impact of which is to shift the public transport demand curve (the relationship between the number of trips by public transport and the fare) outwards to the right; this is shown in figure 9.2.1. by the shift from D1 to D2: at each fare level public transport patronage is increased. At the prevailing price P1 (the evaluation assumes that the current bus operators maintain their fares at the "as now" level), revenue to the operators increases by the change in demand (Q2 - Q1), this is shown as the rectangle **CBQ2Q1**.

The new public transport users induced by each new Light Rail line gain by the triangle **ECB**. Existing Users gain by the trapezium **AECD**. This measure of benefit, often referred to as the "Marshallian Measure", is the difference between the maximum each user is willing to pay and the actual amount paid before and after the change in public transport service levels.

Figure 9.2.1.
Impact of New Light Rail Lines on Public Transport User Benefits and Revenue.



There are also two other measures. These are the compensating measure and the equivalent measure.

The compensating measure is the fare rise (measured in terms of public transport fare) that would leave users indifferent to having an improvement in the level of service. In 9.2.1. a fare rise from P1 to P2C would keep demand at Q1 after an increase in service level. The compensating benefit measure is therefore DEBCF.

The equivalent measure is the fare reduction that would leave users indifferent to going without the proposed improvements in service levels. In figure 9.2.1. a fare reduction from P1 to P2E would result in demand rise to Q2 without any improvements in service levels. The equivalent benefit measure is therefore FCIHG.

With linear demand curves as shown in figure 9.2.1. all three benefit measures will be identical. With non linear demand curves, the measures will diverge (indeed the Marshallian measure may be undefined with a constant elasticity demand function).

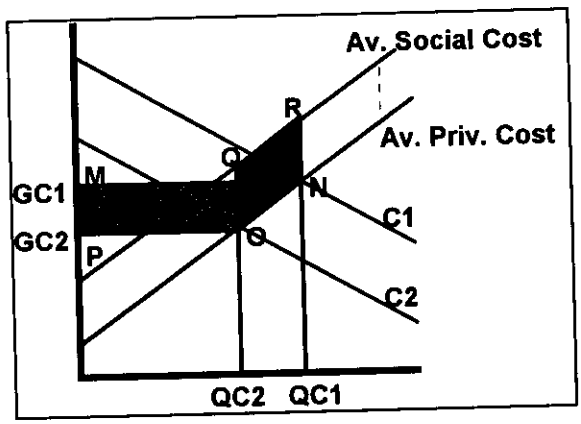
In this evaluation, public transport user benefits have been estimated by translating benefits through values of time. That is to say, public transport demand has been expressed through passenger journey time and translated into aggregate user benefit measures by applying values of time. The estimate will be similar to the equivalent and compensating benefit measures as shown in figure 9.2.1. In any case, without fresh local travel market data from extensive stated preference surveys it would be impossible to determine the exact nature of the demand curve.

A significant number of the new public transport trips will have previously used cars prior to the installation of the light rail lines. The abstraction of traffic from road will have positive repercussions on the car market, and society at large, if road congestion is present and also some road costs (eg: air and noise pollution and accidents are not fully costed). The situation is depicted in figure 9.2.2.. The road market is characterised by road congestion, such that, as road traffic volume increases the cost of road travel increases; and, an average social cost of road travel above the average private cost of travel. This model has been used to derive the air and noise pollution costs and accident costs.

By abstracting road traffic (shown as the shift in demand curve C1 to C2), the increase in public transport levels of service afford opportunities for increased speed for the remaining road users. The cost of road travel thereby reduces by GC1 to GC2. Road users therefore benefit by the polygon **MNOP**, that is, the difference in cost multiplied by the number of travellers benefiting.

The abstraction of traffic to public transport also has an externality benefit if all the social costs of road travel are not attributed. Cars, and buses, emit air and noise pollution, and travel by road has a higher accident rate than rail. Adding these costs to the private cost of road use produces an average social cost of road travel in addition to the private cost as shown in figure 9.2.2.. The reduction in trips by road therefore also produces a benefit equal to the trapezium **RNOQ** (the difference in social and private cost multiplied by the number of diverted trips).

Figure 9.2.2.
Impact of New Light Rail Lines on the Road Travel Market.



9.3. Peninsula Corridor

The project is economically worthwhile.

The estimated benefits of the Peninsula light rail corridor are greater than the estimated costs. At a 7% discount rate, the Net Present Value (NPV) of the Corridor is $35.9 million with a Benefit Cost Ratio (BCR) of 1.61 and a Net Present Value of Invested Capital (NPVI) of 0.61.

TABLE 9.3.A.

Dollars In Thousands	
NPV (of benefits - disbenefits)	$94,204
NPV (total Benefits - total Costs)	$35,904
Benefit Cost Ratio (Benefits / Costs)	1.61
NPVI (NPV / Construction Costs)	0.61

Most benefits were attributable to Urban Consolidation however additional benefits would also result from any increase in patronage above 2% pa. Such an increase is likely due to the rapid rise in urban densities planned around stations. With a larger rate of patronage growth (say 5%) the project becomes considerably more worthwhile.

Further benefits could also be attributed to this project including savings from reduced road construction, road enlargement and road maintenance. Because these benefits are intangible at this stage they have not been included, however had they been included they would have further increased the worth of this project.

Even without the inclusion of these factors the project demonstrates a positive economic worth to the community's long term economic interests.

9.4. Terrigal Corridor

The project is economically worthwhile.

The estimated benefits of the Terrigal light rail corridor are greater than the estimated costs. At a 7% discount rate, the Net Present Value (NPV) of the Corridor is $90.1 million with a Benefit Cost Ratio (BCR) of 1.65 and a Net Present Value of Invested Capital (NPVI) of 0.65.

TABLE 9.4.A.

Dollars In Thousands	
NPV of benefits - disbenefits	$228,475
NPV (total Benefits - total Costs)	$90,075
Benefit Cost Ratio (Benefits / Costs)	1.65
NPVI (NPV / Construction Costs)	0.65

Most benefits were attributable to Urban Consolidation however additional benefits would also result from any increase in patronage above 5% pa. Such an increase is likely due to the rapid rise in urban densities planned around stations. With a larger rate of patronage growth (say 10%) the project becomes considerably more worthwhile.

Further benefits could also be attributed to this project including savings from reduced road construction, road enlargement and road maintenance. Because these benefits are intangible at this stage they have not been included, however had they been included they would have further increased the worth of this project.

Even without the inclusion of these factors the project demonstrates a positive economic worth to the community's long term economic interests.

9.5. Kincumber Corridor

Due to the preliminary nature of planning in this corridor it is not possible to establish the current economic worth of the project. However it is fair to say the following:

- The proposal will produce high user benefits per user compared to current road travel,
- User disbenefits will be very low due to the more direct route compared to road,
- Benefits to Road users will be low due to the current relatively low levels of traffic,
- The corridor would currently run at a loss for many years,

Additionally:

- Intense levels of development would be needed to produce enough benefits to offset the high construction costs of this corridor, and
- Such high levels of development will need to be postponed until the other corridors have reached near ultimate levels of development. If development in this corridor is not postponed there will be an over supply of high density development potential and maximum densities, and thus benefits, will be lost in all corridors.

This corridor will not prove to be economically worthwhile for many years and only then with those factors present as mentioned above.

It is recommended that this corridor be fully planned well in advance of any rezoning for high density development in the area and that such development be postponed for at least 15 to 25 years. (Note that this is beyond the investment life of any infrastructure and voids any current economic evaluation.)

10. GENERAL ECONOMIC IMPACT ASSESSMENT (EIA)

10.1. Local Economy

The proposed Light Rail Corridors, Woy Woy to Umina/Ettalong, Gosford to Terrigal, and Woy Woy/Ettalong to Erina, will undoubtedly have positive effects on the local economy of the Gosford City Council area. These positive benefits include improvements in the local Tourism Industry (see section 10.1.1.), increases in land values (section 10.2.) and improved development potential (section 10.3.).

Benefits will primarily occur during construction with the injection of potentially $370 million into the local construction and labour markets over 10 to 15 year period.

In addition to these benefits there will also be increased local trade afforded due to improved access times and savings in travel costs to the community. Also, the increased development that the new lines will focus will create a larger base market to feed local trade.

With a corresponding increase in local employment opportunities, and a larger local market, more money will be spent locally, local economic multiplier effects will increase and the local economy will become richer.

This growth can be focused locally for many years, (in fact, with good planning, for many decades) and should continue to grow while well planned, economically feasible development opportunities persist.

10.1.1. Tourism Impacts

The proposed light rail corridors will also have positive impacts on the local Tourism Industry. These impacts are envisaged to take the form of improved local access for tourists, added convenience for a wider tourist market (ie: the non car tourist and the mobility impaired) and added attraction due to the image of modern, clean, convenient and fast rail public transport (ie: perceived as higher local standards compared to other areas).

Additionally the increased development will create more tourist attractions and tourist industry opportunities (ie: Hotel/Motel sites).

Although it is difficult to predict the exact scale of the improvements to the local tourist industry without full scale surveys of the current industry, (its potential and the latent demand in the market), it is apparent that an increase will occur and will be primarily due to, and in, those sectors mentioned above.

10.2. Land Values

Land values in the immediate vicinity of stops will ultimately be considerably higher than would otherwise have been the case without any light rail corridor. This is primarily due to demand for sites of high access to transport and commercial development. In some cases land values have tripled within two years of the commencement of new rail service (eg: Bondi Junction).

It is important to remember, however, that if development densities are to be optimised that land supply will need to be tightly controlled and managed. This is to prevent any rush on sites to achieve quick profits from low density developments. Land supplies will need to be released slowly, each locale one at a time, waiting until the previous locale has reached a predesignated level of development before the next area is released.

Although future release sites to be rezoned will be known to the market, they will not be developed until rezoned and released when profits will be higher. Sites will be bought and sold, at profit, in advance of rezoning but little development is likely to occur.

The resulting development will be profitable and yet still provide affordable housing and commercial opportunities for the local and new markets. Although individual housing units will be cheaper, due to the increase in supply, land value will be higher due to the increased levels and scale of development permissible on each site after rezoning.

10.3. Development Potential

As has already been outlined in previous sections, development potential will increase along each transit corridor, especially at specific nodes along each line. Indeed, this is one of the primary motivating factors for constructing fixed track public transport in the first place and the motivation for the light rail proposals contained in this study.

In an attempt to reverse the current trends of urban sprawl in the area an alternative, and usually a more profitable alternative, needs to be implemented. That alternative is urban villages and to encourage their growth a permanent investment must be made in the form of transport infrastructure. This will act as a catalyst and focus for development.

With the announcement of the proposed corridors land speculation will commence, especially once a real commitment to the proposals is affirmed. This speculation itself will encourage increased development and demand for higher densities in an attempt to maximise rapid returns for developers. As the speculative nature intensifies, tight control will need to be exercised over the land and density supply so as to maximise the benefits that the demand will generate.

This process involves a very intense relationship between landuse, transportation infrastructure, market potential, pricing and the right timing. Once the construction of the light rail corridors have commenced Council will only have control of landuse directly and timing only in so much as when rezoning occurs. It is recommended that a tight plan of land supply management be devised to maintain control of these forces and use them to best benefit the existing and future community .

11. SOURCES OF FUNDING

Sources of funding will need to be secured before construction of any of the lines detailed in this study can commence. Sources of funding could come from a number of various locations. The following sections outline the most likely sources of funding and the nature in which that funding could be forthcoming. This section does not, however, expect to be presenting an exhaustive list of potential sources as "as yet unforeseen" sources may eventuate in the future.

11.1. Section 94 Contributions

Section 94 Contributions or Developer Contributions have the potential to generate the greatest amount of funding for large scale infrastructure projects of this nature. Assuming that the appropriate amendments are made to Council's Section 94 Plan then contributions from this source could be considerable.

Developer incentives could be included in the development approvals stage to encourage appropriate developments, which, due to their scale, can afford to pay considerable contributions. This form of "Value Capture" has proven to be very effective in the U.S. Examples such as larger than usual developments have been encouraged because of the forthcoming Rail Service which has enabled the developer to achieve more profit. This profit is then tapped into via a larger request for contributions. In effect the proposed line is used to feed the developer and the developer is subsequently used to feed the proposed line. So long as the line is a certainty in the near future, tapping into the increased funds resulting from the market speculative process has proven beneficial in funding Rail Lines sooner than might otherwise have been the case.

The resultant increases in development costs will be passed on to the final consumers whom will expect more for their money. In this instance for their extra money they will get a regular Light Rail Service.

An option that will still generate funds, yet save developers considerable expense, would be to calculate contributions from the date of the original approved development application but not enforce payment until completion of the development. This will save the developer having to pay interest on contributed funds during construction and will serve as a developer incentive. At the end of the day the same amount of funds will have been generated but with the saving of interest to the benefit of the developers.

It is recommended that Council amend its Section 94 Plan specifically to collect monies for this project.

11.2. Private Sector Investment

The private sector may opt to Invest in the corridor's development. Such an arrangement would take the following form:

A consortium consisting of land/building developers and infrastructure providers would be formed. The Land/Building Developers would build buildings at strategic locations along the proposed line as near to the proposed stops as they could acquire development sites. In conjunction with the Developers, the Infrastructure providing arm of the consortium would start building the Light Rail line. The outcome of this process would be that the line would generate market demand for the developments that the Developer arm was building and prices for the development would be considerably higher than would otherwise have been the case. The increases in profit would need to be considerable but would be diverted towards the infrastructure providing arm that built and paid for the Light Rail Line's construction.

The ultimate result/aim is that the consortium cross-subsidises itself by generating its own Value Capture opportunities. Both arms of the consortium profit, the Light Rail line is built and tendered off for operation and the Urban Village style development along the line at each stop is built, simultaneously and all fairly rapidly.

It is recommended that study be undertaken to identify opportunities to attract Private Sector Investment in the proposal and surrounding land developments.

11.3. Government Investment

Similarly to Private Sector Investment various levels of Government can also invest in the increased value that the line will generate. This can be achieved through a number of methods. One is direct funding which due to multiplier effects on the local economy will increase the taxable base of both businesses and land. Another is speculative investment in surrounding lands which can subsequently be released at profit. Both of these methods could be realised by Council, State or Federal Government. The anticipated moneys raised could be used to partially fund the project.

In addition, any level of government could participate in joint venture arrangements with the private sector to form consortiums which would operate similarly to private sector investments.

11.4. BOOT Schemes

Build-Own-Operate-&-Transfer Schemes can also prove effective ways of establishing large scale public infrastructure projects of this nature. Similar projects include the Sydney Light Rail Consortium's Pyrmont Light Rail Project currently under construction with proposed extensions, and Sydney's New Southern Railway (or Airport Rail Link) also currently under construction. Both of these projects are privately managed, built, owned and operated for twenty five years before complete transfer of the "on the Ground Assets" or "Track Down Assets" (including tunnels) to public ownership and control. Both of these projects have been part private and part publicly funded.

The private sector incentive is to achieve profitable returns on their investments in the project through returns on ticket sales within the first twenty five years of operation. Further land speculation is also possible.

11.5 User Generated Revenue

User generated revenue returns on public transport capital investments are rarely if ever expected to prove successful for a higher than 50% return. (This is why BOOT Schemes are usually at least 50% Government funded.)

However user generated revenue returns can reasonably be expected to offset operating costs. Certainly with the additional Community Service Obligations maintained by the State Government a profitable operation is more likely. Such an operating funding arrangement should ensure private sector interest in the system's operation which could be awarded to the most appropriate tender.

12. SYSTEM OPERATION OPTIONS

12.1. Corridor Tenure

One of a number of possible corridor tenure options could eventuate. Dependent upon the nature of the corridor tenure that results, a number of possible System Operation Options could be realised. The exact nature of Corridor Tenure that will eventuate is also dependent upon the nature of funding for the project. Therefore, in accordance with the possible funding option contained within section 11 the following corridor tenure options are proposed:

Complete Private Ownership
Temporary Private Ownership
Council Ownership
State Ownership
Joint Private/Public Ownership.

12.2. Private Tender Operation

Private Tender Operation is possible with any of the above Corridor Tenure options. The operator could be the corridor owner or a tendered operator in any case. Tenders would be overseen by the Department of Transport under current State legislation.

12.3. Public Authority Operation

Public Authority Operation is only likely where the corridor is Council or State Government owned. Such an Operator could be Council or an appropriate State operator.

13. CONCLUSIONS AND RECOMMENDATIONS

13.1. Conclusions

The following conclusions are made in regards the findings of this study:

Opportunities for Light Rail Public Transport exist within the Gosford City Council Area. Although Bus services could easily accommodate likely demand in all corridors for many years, introduction of Light Rail Services would provide a faster, more attractive and user friendly alternative. The nature of likely Light Rail Services, being largely Off Street or prioritised, would attract users to public transport that would otherwise have used cars and added to traffic congestion.

Current levels of patronage will sustain Light Rail services in both the Woy Woy to Umina and Gosford to Terrigal (via Erina) corridors. Revenues would balance operating costs at fifteen minute frequencies during the peak and half hour services off peak. Services to Ettalong would also be justified if or when a ferry terminal servicing a JetCat from Sydney became operational. The economic evaluation reveals that the Cost Benefit Ratios favour the projects in these corridors (see section 9), especially if road capacity is not increased.

The Kincumber Corridor will not sustain Light Rail Services until considerably more development has occurred, particularly near proposed stop locations, or unless traffic congestion increased and traffic delays doubled in both frequency and length. Initial indicators reveal that the Cost Benefit Ratio will only benefit this corridor when development has increased and traffic congestion has worsened. (This is largely because of the length and cost of the line).

The result of the implementation of light rail services in the corridors examined in this study would be considerable demand for residential and commercial development within easy access of the line. This market demand could be focused at strategic locations to create definable villages where urban densities are distinctively higher than the surrounding areas.

The surrounding areas can, therefore, effectively remain untouched. This, in effect, is a process of damage control that concentrates growth in a more sustainable pattern than is occurring with current suburban trends. The resultant villages develop in lieu of allowing further suburban subdivision. The subsequent increases in density also serve to feed the Light Rail line, in effect anchoring it into the urban landuse/transport pattern for the area.

It is felt that the implementation of the proposals examined in this study, and the likely, well managed, development patterns that it will encourage, would be favourable by comparison to current development trends.

13.2. Recommendations

The following recommendations are made to Council:

It is recommended that Council acknowledge, in principle, the findings of this study,

It is recommended that Council examine alternatives to the current car based transport patterns prevalent in the area,

It is recommended that Council adopt a vision towards a future for Gosford that is more environmentally and economically efficient than that which current trends will produce,

It is recommended that Council adopt specific policies that limit increases in road capacity,

It is recommended that Council limit the rate of 2A residential subdivision and low density Development Applications in all other zones,

It is recommended that Council adopt policies that encourage increased usage of public transport,

It is recommended that Council encourage medium and high density land use at strategic nodes,

It is recommended that Council amend its Section 94 Plan specifically to collect monies for this project,

It is recommended that Council gain community and industry support for these new directions,

It is recommended that Council disseminate the rationale behind these policies to the broader community,

It is recommended that Council gain the support of State and Federal Government in order to attain funding towards achieving these objectives.

13.3. Recommendations for Further Study

The following recommendations are made for further study should the findings and recommendations of this report be adopted by Council:

Gosford Council Area Strategic Plan (vision) for next 30 years incorporating Light Rail,

Full Scale Light Rail Feasibility Study,

Medium and High Density Residential Development Placement Study,

Light Rail Route Proving Design Study,

Erina Underground Station Economic Evaluation,

Erina Town Plan Study,

Woy Woy CBD Transport and Land Use Integration Study,

Town Centre Studies for Umina, Ettalong, East Gosford, Kincumber, Terrigal and every other new Urban Villages Planned.

It is also recommended that study be undertaken to identify opportunities to attract Private Sector Investment in the Light Rail proposal and surrounding land developments, and;

Undertake a study to identify likely sources of funding.

This concludes the findings, conclusions and recommendations of this study.

References

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Appendices

Appendix A. List of Materials Used in the Preparation of this Study.

1:4000 NSW Orthophoto Map Series.

Gosford City Council Zoning Book 1995 edition.

Gosford City Council Housing Strategy November 1994.

Gosford City Transportation Study Stage II March 1995

Gosford City Transportation (Road Infrastructure) Study April 1995.

Woy Woy CBD Traffic Study July 1991.

City of Gosford Transtep Data February 1988.

UBD Central Coast Street Map.

Faller 94/95 Catalogue (Photos).

Appendix B Current Bus Services. (Included in Master Copy Only) (Held by Gosford City Council)

Appendix C Alternative Routes Considered During Corridor Analysis

The following maps present the alternative alignments considered during corridor analysis. Most were discarded for reasons of either cost, indirectness, environmental impacts, traffic congestion, length or poor integration with existing destinations. Each set of potential option for each corridor is presented individually.

Figure A.C.1.
Alternative Peninsular Corridor Options.

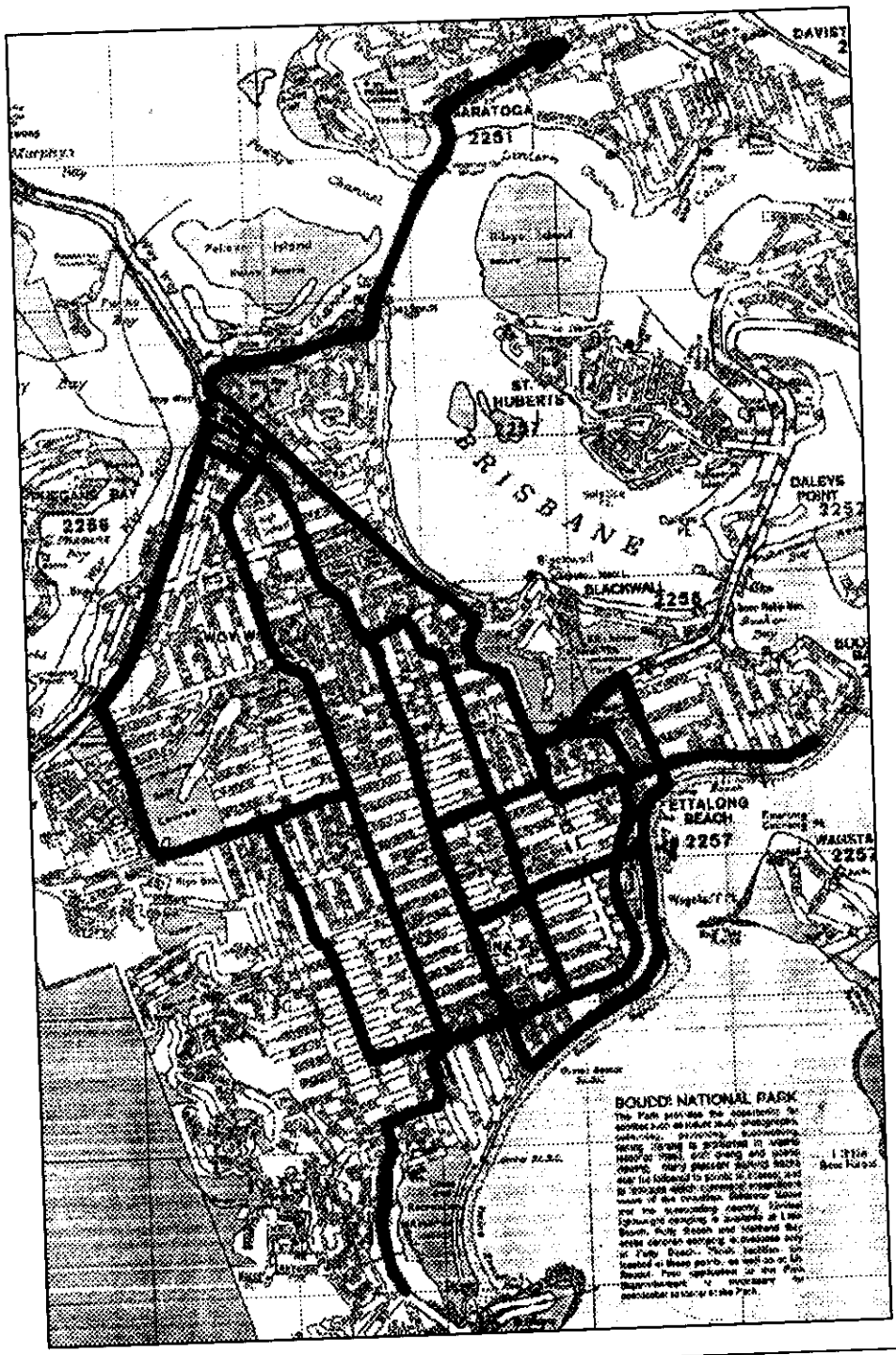


Figure A.C.2.
Alternative Terrigal Corridor Options.

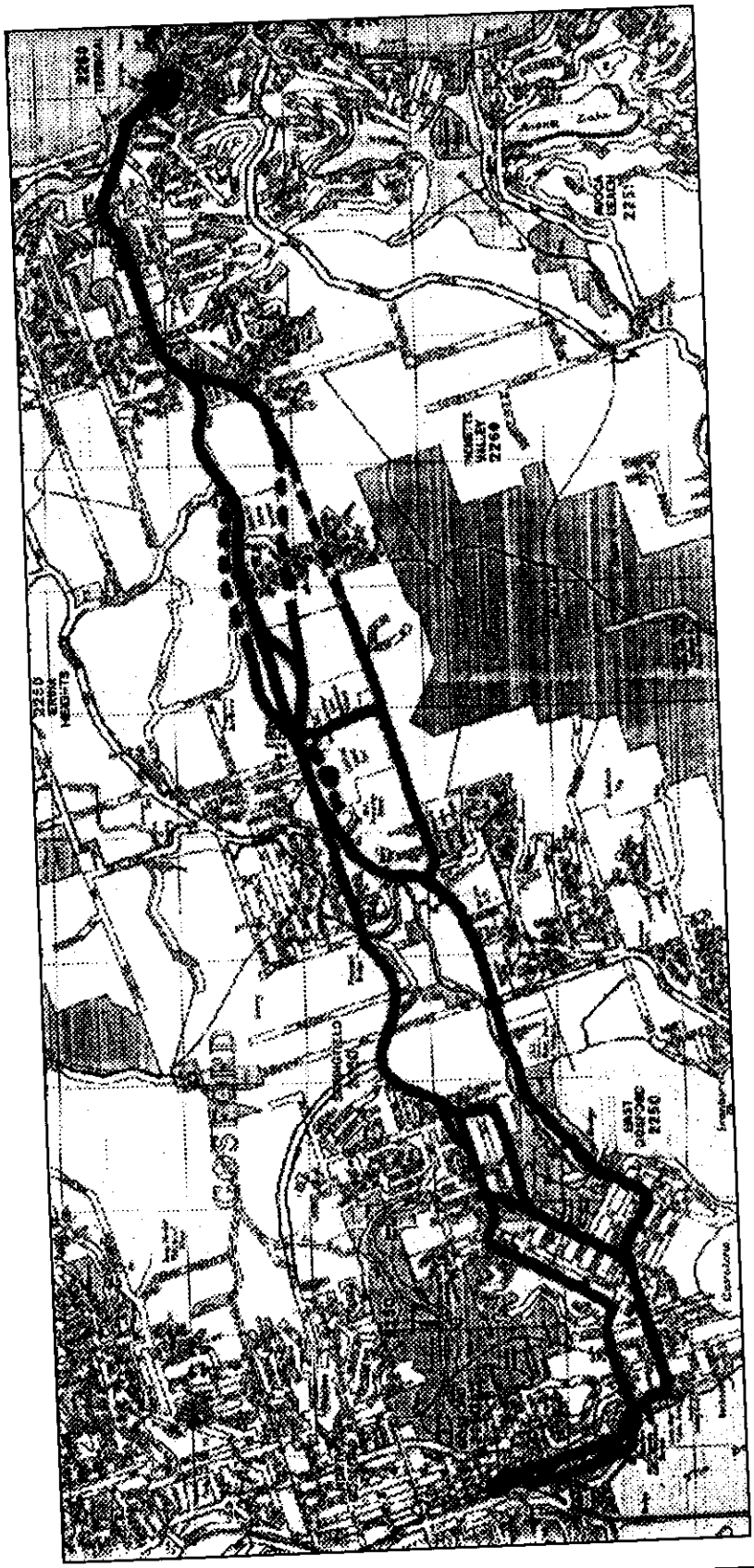
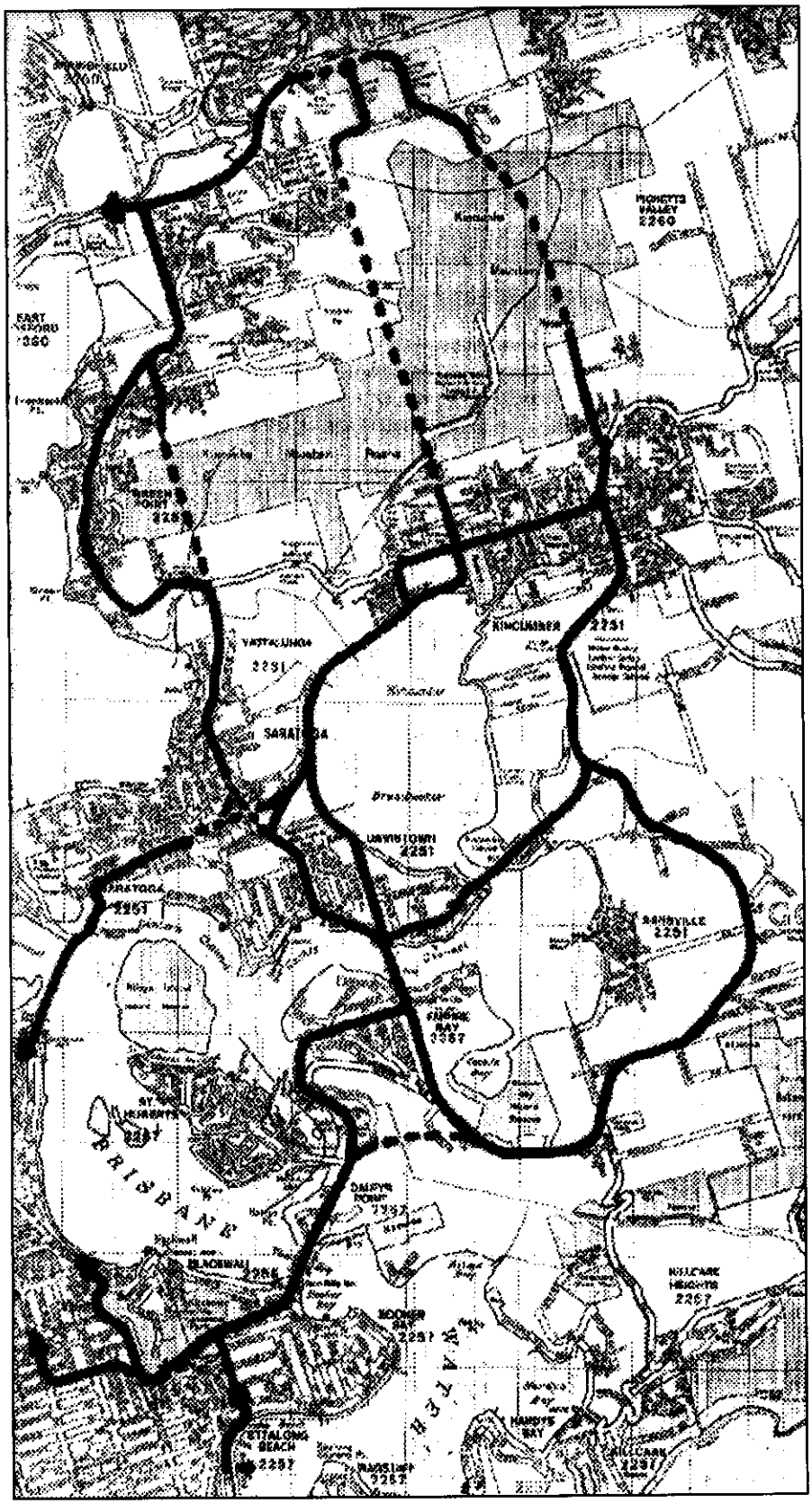


Figure A.C.3.
Alternative Kincumber Corridor Options.



Appendix D Mode Description: Light Rail Transit Technology.

Light Rail Transit (LRT) is the modern evolution of a concept originating as the "Street Tramway". Current LRT application tends toward higher segregation from road traffic than do more traditional examples. This enables higher operating speeds where desirable and higher reliability of service. LRT can operate in-street, in pedestrian precincts or on segregated rights of way. This flexibility is internationally considered as on of the most important advantages of LRT technology.

TABLE A.D.1.

TECHNICAL SPECIFICATIONS:	
Mode:	LRT.
Design Vehicle:	ABB Henschel Variotram.
Traction System:	Steel Wheel on Steel Rail.
Capacity:	5000 - 20,000 Passengers / hour / direction.
Distance between stops (on line):	500m - 1000m or long haul.
Distance between stops (at nodes):	300m - 500m.
Maximum Speed:	80 - 110km/h.
Service Speed:	30 - 60km/h.
Maximum Gradient:	9%.
Minimum Radius:	15m.
Control System:	Human/Signalling.

The capacity indicated represents Theoretical maximum capacity assuming crush loading (at 135%) and saturated service frequency. Realist capacities are less and are dictated by numerous other factors.

Maximum Speed is dictated by corridor dynamics or other speed limiting factors such as safety, lines of sight or frequency of stops.

Service speed is the average speed of the service between the two end points of the line. This includes stopping time.

Control systems for some LRT systems are fully automated, however, such technologies are not internationally accepted as cost or socially effective. This is largely due to the additional infrastructure required for a fully grade separated right of way.

Notes\Comments.