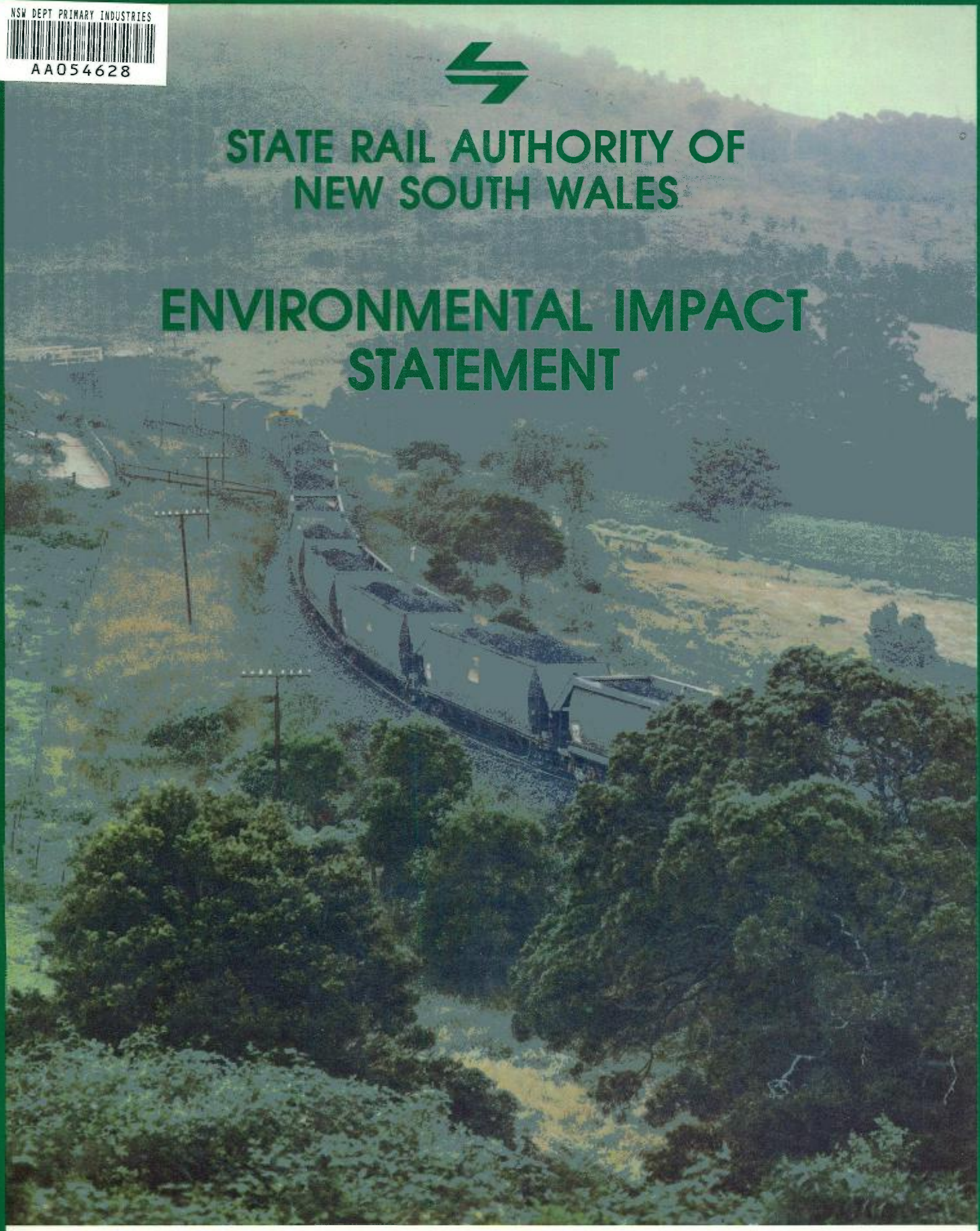
EIS 209 Vol 3

AA054628

Maldon-Dombarton-Port Kembla railway : environmental impact statement

STATE RAIL AUTHORITY OF NEW SOUTH WALES

ENVIRONMENTAL IMPACT STATEMENT



MALDON-DOMBARTON-PORT KEMBLA RAILWAY

Barnes & Moore

VOLUME III
OCTOBER 1983

Appendix A
B Land Studies
C Hydrology
D Climate and quality
E vegetation
F Wildlife
G Archaeology
H Noise
I Local Communities
J Social and Economic
K Conditions (duplicated) of Railway Operations

NOTHING IN "A"

APPENDIX A

PROPOSED RAILWAY, SPUR LINES AND FACILITIES

ALL IN APPENDIX B

COAL MINING: SEC 6.3

Sec 1.2.3.

Sec 4.4.

Bridge subsidence Sec 4.3.1.
consideration 4.3.2.

Tunnel subsidence Sec 4.4.4.

AIS INVOLVEMENT : P B.28

EASEMENT WIDTH : 40 m

APPENDIX A : TABLE OF CONTENTS

APPENDIX A : TABLE OF CONTENTS (cont)

APPENDIX A : LIST OF FIGURES

APPENDIX A : LIST OF TABLES

In this Appendix, each major element of the proposed railway system and major considerations involved in route selection are described. Brief accounts of the environmental safeguards to be incorporated in the design of the railway during both its construction and operation are also included.

1.0 OUTLINE OF PROPOSED ROUTE

1.1 ROUTE DESCRIPTION

The proposed railway links the Main Southern Line and the Moss Vale - Unanderra Railway from Maldon to Dombarton below the Illawarra Escarpment. Figure A-1 indicates the proposed route and the main features of the line. It will be a single track line with four passing loops. Except for bridge design, there is no provision for duplication at this stage.

The total route comprises 9.5 km new construction between the Main Southern Line to Wilton, 25.7 km new construction between Wilton to Dombarton and duplication of the existing railway between Dombarton and Port Kembla.

In general, the selected route leaves the Main Southern Line near Maldon and crosses the Nepean River north of the new Maldon road bridge. The line traverses generally open grazing country for approximately 9 km between the Nepean River and Wilton. This portion of the route crosses under the South Western Freeway (F5) and Wilton Road (Trunk Road 95).

At Wilton the route enters the Metropolitan Catchment Area passing to the south of Thorntons Hill and crossing the Cordeaux River about 23 km south of the junction of the Cordeaux and Avon Rivers. The Metropolitan Catchment Area is controlled by the Metropolitan Water, Sewerage and Drainage Board (hereafter called MWS&DB).

Within the MWS&DB Catchment Area the route generally heads in a southerly direction by following the existing alignment of fire roads numbered 6A and 6B. This portion of the route represents about one half of its total length between Maldon and Dombarton. It generally follows the ridge line which separates the Cordeaux River and Avon River catchment areas. Significant lengths of line will be located in an already cleared corridor, occupied by the fire roads, and all of it is readily accessible by road.

The route passes through a series of cuttings and a small tunnel. It then enters a 2.7 km long tunnel about 1 - 1.5 km north east of the upper Avon pumping station (western portal) and emerges near the Dombarton crossing facility on the Moss Vale - Unanderra Railway (eastern portal).

Four passing loops are located along the line. Preliminary locations for the loops have been identified. The first is adjacent to the forks joining the Main Southern line. A loop is situated near Wilton and two loops are located in the MWS&DB Catchment Area.

1.2 ROUTE SELECTION

1.2.1 General Considerations

The examination of route options was based primarily on three main factors: engineering feasibility, economics and environmental aspects. Route verification will follow thorough field investigations during the detailed design stage of the project.

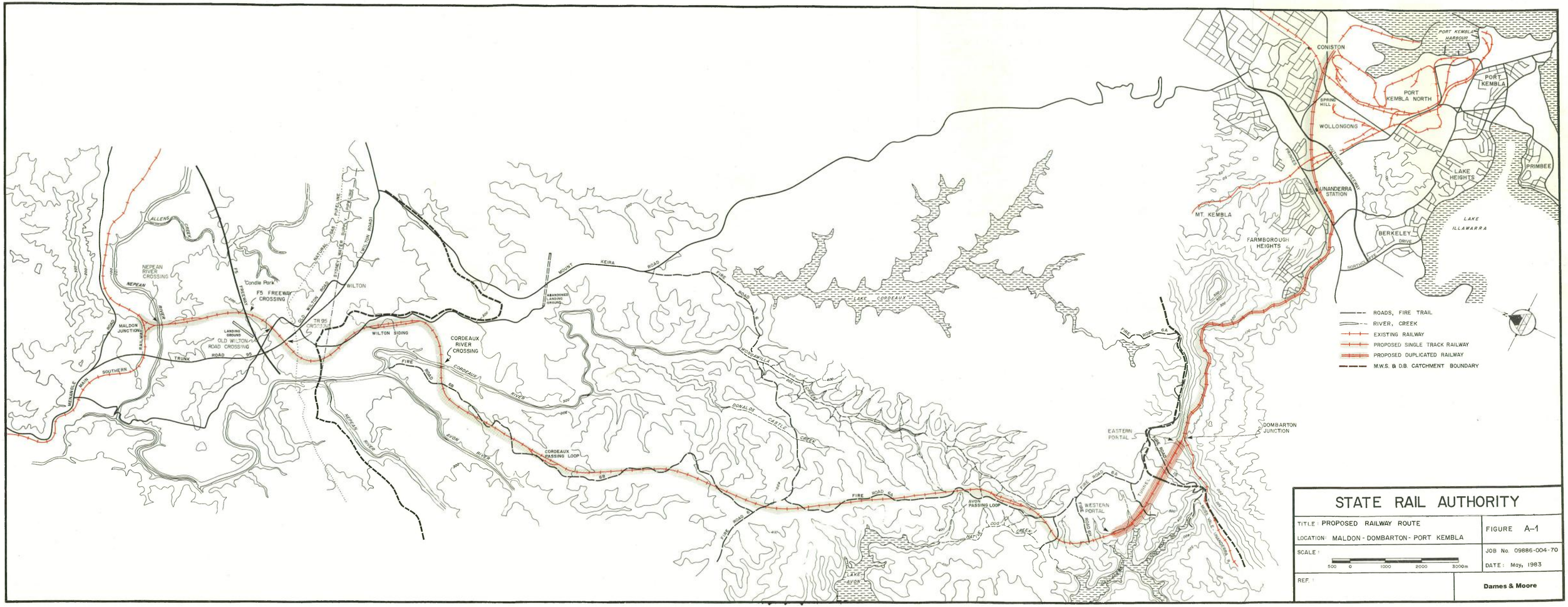
Apart from the design criteria set out in Section 4.1 the major engineering considerations involved in route selection were as follows:

- connection at the Main Southern Line;
- crossing of the Nepean and Cordeaux Rivers and the F5 Freeway;
- traversing the MWS&DB Catchment Area;
- the minimization of earthworks.

A number of partial route alternatives were developed during the course of this study. These alternatives fall into two location categories:

- the Main Southern Line connection to the MSW&DB Catchment Area.
- approximately 3-4 km west of the tunnel entrance.

Few alternatives were available for the location of the eastern tunnel portal.



STATE RAIL AUTHORITY

TITLE : PROPOSED RAILWAY ROUTE	FIGURE A-1
LOCATION: MALDON - DOMBARTON - PORT KEMBLA	
SCALE : 500 0 1000 2000 3000m	JOB No. 09886-004-70
	DATE : May, 1983
REF. :	Dames & Moore

Through the MWS&DB Catchment Area the most suitable route basically follows along the plateau area already occupied by Fire Roads No.6A and 6B. The eastern portal is located unobtrusively in the re-entrant in the escarpment face with suitable geological conditions for portal construction.

Fire Roads No.6A and 6B are constructed along the ridge and extensive clearing has already been undertaken. In following this route as closely as practicable, comparatively minor earthworks and hence minimal disturbance and risk of Catchment pollution is involved. Route accessibility for construction purposes is also easily attained.

Site inspection and detailed surveying confirmed the most suitable location for the Cordeaux River crossing, to give minimum bridge length and appropriate conditions for construction of the bridge approaches.

The alternatives considered for the route from the Main Southern Line to Wilton either involved an underpass at the F5 Freeway or a bridge.

1.2.2 Maldon to Catchment Area.

Three basic alternative routes, shown as A, B & C in Figure A-2 were investigated in this area.

Initial investigations were based on achieving a grade of 1 in 60. However, because of the desirability of reducing the ruling grade, the feasibility of achieving grades of 1 in 80 and 1 in 70 were subsequently investigated.

Route A

This route commences at approximately 79.34 km on the north fork of the line. It crosses the Nepean River at 0.70 km and passes under the F5 Main Southern Freeway at 3.30 km. This is a practicable location to cross the Freeway, bearing close to the highest level of a vertical curve on the Freeway and with minimum cut adjacent to the western side of the Freeway. It crosses the Old Wilton Road at ground level and Trunk Road 95 with an approaching 6 metre high embankment. It then continues on the northern side of Thorntons Hill between the Hill and Wilton township.

This is the shortest route. The junction with the Main Southern Railway poses some problems and probably would require relocation of the Main Line. The clearance below the F5 Freeway is adequate. A level crossing required at the Old Wilton Road is not desirable. Some regrading of Trunk Road 95 would probably be required to provide sufficient clearance.

No houses are directly affected. Eleven properties are traversed by the line, before it enters the Catchment Area, eight being significantly affected. Five of these properties are owned by Pitt, Son and Badgery. The route passes within 200 metres of 2 houses and would affect the amenity of an additional 5 houses due to noise and visual effects.

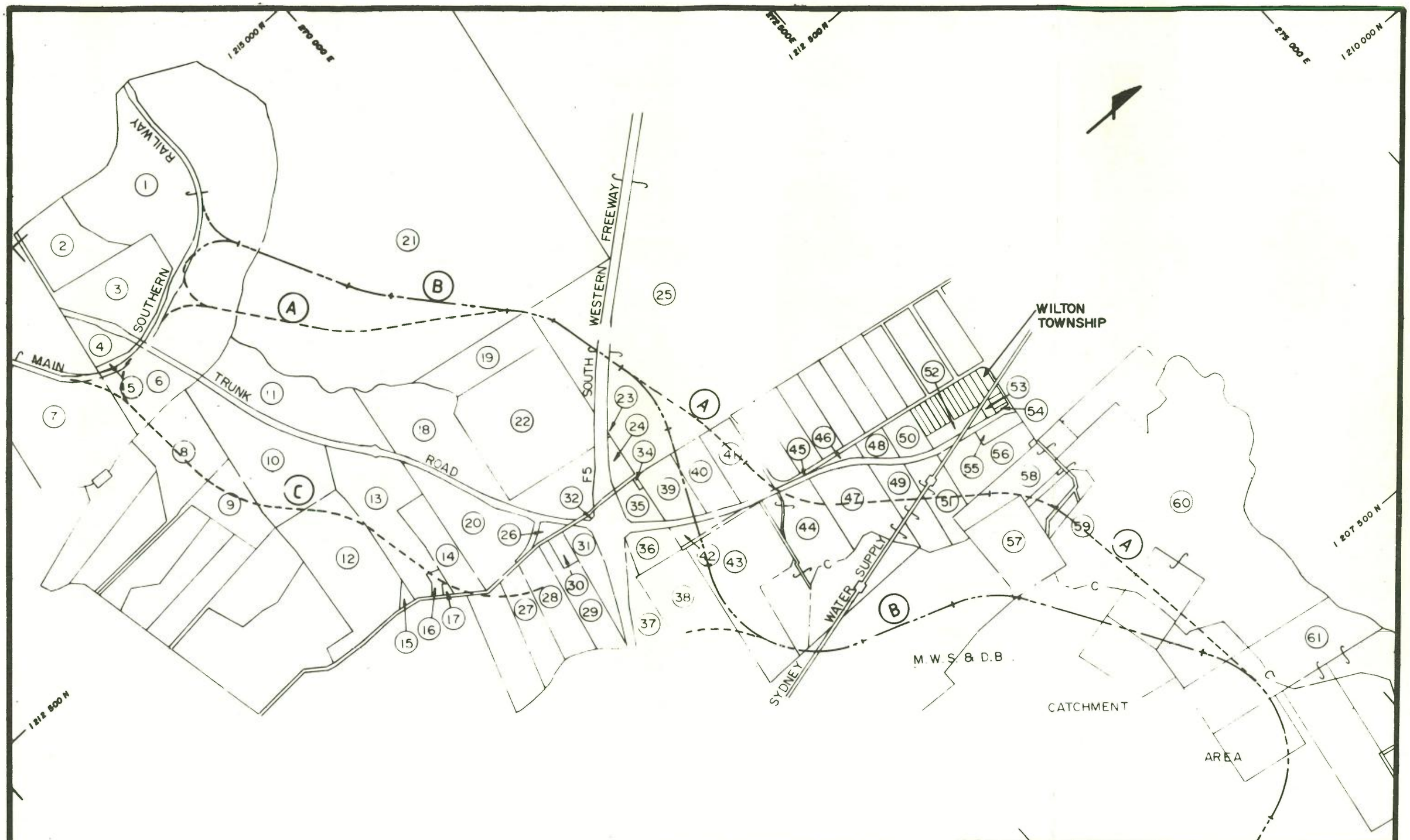
Most of the properties affected are small rural blocks. However, two larger agricultural properties are cut by the route. In the case of both properties, the line would subdivide each in such a way as to make the southern portion too small and consequently, difficult to operate and manage as an agricultural production unit.

Being located to the north of Thorntons Hill, the line is visible from part of the township of Wilton. This will adversely affect the quiet rural characteristics of the town. Properties along the southern and south western portion of the urban area will be affected by noise and visual disturbance. These aspects are discussed further in Appendix I in which the results of interviews with local residents are outlined.

Route B

This route commences from the Main Southern Line at approximately 78.55 km on straight track. It crosses the Nepean River at 0.99 km and passes under the F5 Freeway at 3.59 km at the same location as the Route A crossing.

It passes under the Old Wilton Road at 4.50 km in cut and under Trunk Road 95 at 4.99 km. It proceeds mainly in cutting to the south of the land owned by the Australian Gas Light Company and to the south of Thorntons Hill. It consequently does not intrude on the amenity of the township of Wilton.



NOTE : SEE LANDHOLDERS NEXT PAGE

STATE RAIL AUTHORITY

TITLE: ALTERNATE ROUTE MALDON TO WILTON	FIGURE A–2
LOCATION: MALDON - DOMBARTON ROUTE	
SCALE: 0 500 1000 1500m	JOB No.: 09886-004-70
REF.: B.H.P.	DATE: MAY 1983
	Dames & Moore

This is the longest route but has several advantages. A ruling grade of 1 in 70 can be achieved. The junction with the Main Southern Line causes no serious difficulties. There is no need for a level crossing on the Old Wilton Road as an underpass can be constructed. The crossing of Trunk Road 95 being in a cutting, a crossing similar to the F5 Freeway, could be achieved by a similar structure.

No houses are directly affected. Six properties are directly affected, one of these being held by the Department of Main Roads, before it enters the Catchment Area. There is a small encroachment on land held by the Australian Gas Light Company for a methane drainage project. From discussion with Company representatives, this appears to offer no serious difficulties, although a proposed dam may have to be relocated.

Three houses lie within 500 metres of the route will be affected to some extent by noise or visual effects. Of the properties directly affected, two are small rural blocks and these are transected. Three other properties are used for agricultural purposes. In all instances, the properties are sub-divided by the route in such a way that the resulting blocks can be used and managed effectively for agricultural production.

Route C

This route commences further south on the Main Southern Line at approximately 80.18 km. It crosses the Nepean River at 0.60 km and through a saddle in the hill at 2.70 km in a 16 metre deep cutting. It crosses the Old Wilton Road at 3.30 km at ground level and crosses the F5 Freeway on an over-bridge which would span the Freeway and southern ramps of Trunk Road 95.

The ruling grade is 1 in 60 and the line joins Route B at approximately 5.11 km but at a height of six metres below Route B. It then passes south of Thorntons Hill.

The junction with the Main Southern Line will require re-routing of that line. The crossing of the F5 Freeway will require a major bridge crossing due to the need to bridge the Freeway ramps. This and major fill areas will be highly visible and have a significant visual impact in contrast to the surrounding rural landscape.

The line does not directly affect any houses but sixteen properties are directly affected. A number of these are operating agricultural properties but the majority are small rural blocks. Most of these will be transected by the railway. The utility of a similar number of the smaller blocks will be lost because of subdivision. Four houses lie within 200 metres of the route. These will be significantly affected by noise and visual impact. No additional houses would be affected by noise and visual disturbance within 500 metres.

Comparison

All routes would create some visual impact and noise in the general area. Route B is considered to affect fewer residences and has little effect on the township of Wilton. It passes under the F5 Freeway, the Old Wilton Road and Trunk Road 95 and proceeds from that point in a cutting to the other side of Thorntons Hill and away from Wilton.

All routes will disrupt local drainage patterns and all involve major bridges at the Nepean and Cordeaux Rivers. Route A and Route C cause disruption to catchment areas of seven dams, whereas Route B only effects three. Route A will directly effect three dams, Route C, five and Route B, only one dam.

Route B affects fewer properties and of those affected that are used for agricultural purposes, subdivision should not significantly disrupt grazing activity or management.

The ruling grade against loaded coal trains going to Port Kembla is 1 in 70 (1.43%). This grade was chosen to equal the steepest grade between Sydney and Maldon. Route B is the only one of these to permit this grade to be economically achieved. Routes A and C permit a steeper than 1 in 60 grade (1.67%).

All routes are consistent with current local planning. However Routes B and C, because they are located further away from Wilton township, would place less restriction on future development of the township. They are also more in accord with the attitudes and wishes of the town residents.

Appendix 1 discusses these residents' attitudes. During the process of meetings, interviews and consultations undertaken

for the study, the major concern expressed by townspeople was the proximity of the proposed line to Wilton. Many of the people who live in the town were attracted to it by its location, the rural atmosphere, the cost and availability of land and the quality of life offered by living in a rural environment. Route A would pass within less than one kilometre of the town. People were concerned about the loss of amenity this would cause, increased noise levels and reduced property values. They were strongly opposed to this option and expressed preference for the routes located to the south of Thorntons Hill. The Wilton Progress Association passed a resolution that the route should affect the least number of landholders and be located away from the township.

On the basis of these environmental factors and the community concern and in conjunction with engineering and economic studies, Route B was selected as the preferred route.

1.2.3 Tunnel Area

Three routes were examined in the area near the Avon resevoir. These are shown in Figure A-3.

The first route examined was Route AA, which generally follows the contours in the area. The alignment has curves of down to 200 metre radius with substantial cuttings of up to 40 metres, the possibility of a short tunnel and a major bridge. For about 1.5 km, the route lies between 70 and 150 metres from the foreshore of Lake Avon.

The terrain is all sidling country with average cross slopes of about 2 to 1 with sections of up to 1 to 1 and steeper. The vegetation, described in Appendix E, would be significantly disrupted by construction and operation along this route. Once the land surface was disturbed and the vegetation reduced, much of the slope would be highly unstable. While it is technically feasible to construct a railway in this terrain, actual construction would present formidable difficulties. Because of steepness, fill areas and quantities need to be minimal. Railway construction would consequently need to be mostly in cut and it would be virtually impossible to achieve this without significant destruction of the adjacent vegetation, resulting in erosion and the movement of material into the adjacent dam.

The second alternative considered is Route BB, which avoids the sidling terrain by a tunnel 1.7 km long. It is 0.9 km shorter than Route A and minimises the problems associated with the steep slopes, vegetation removal and potential erosion.

Both Routes AA and BB join the Moss Vale - Unanderra Line near the 100 km point. The line at that location passes through difficult terrain and duplication is judged not to be feasible. Because of topographical contraints, it is not possible to construct passing loops in the area. The single line from that point to Dombarton would not be capable of carrying the required number of trains.

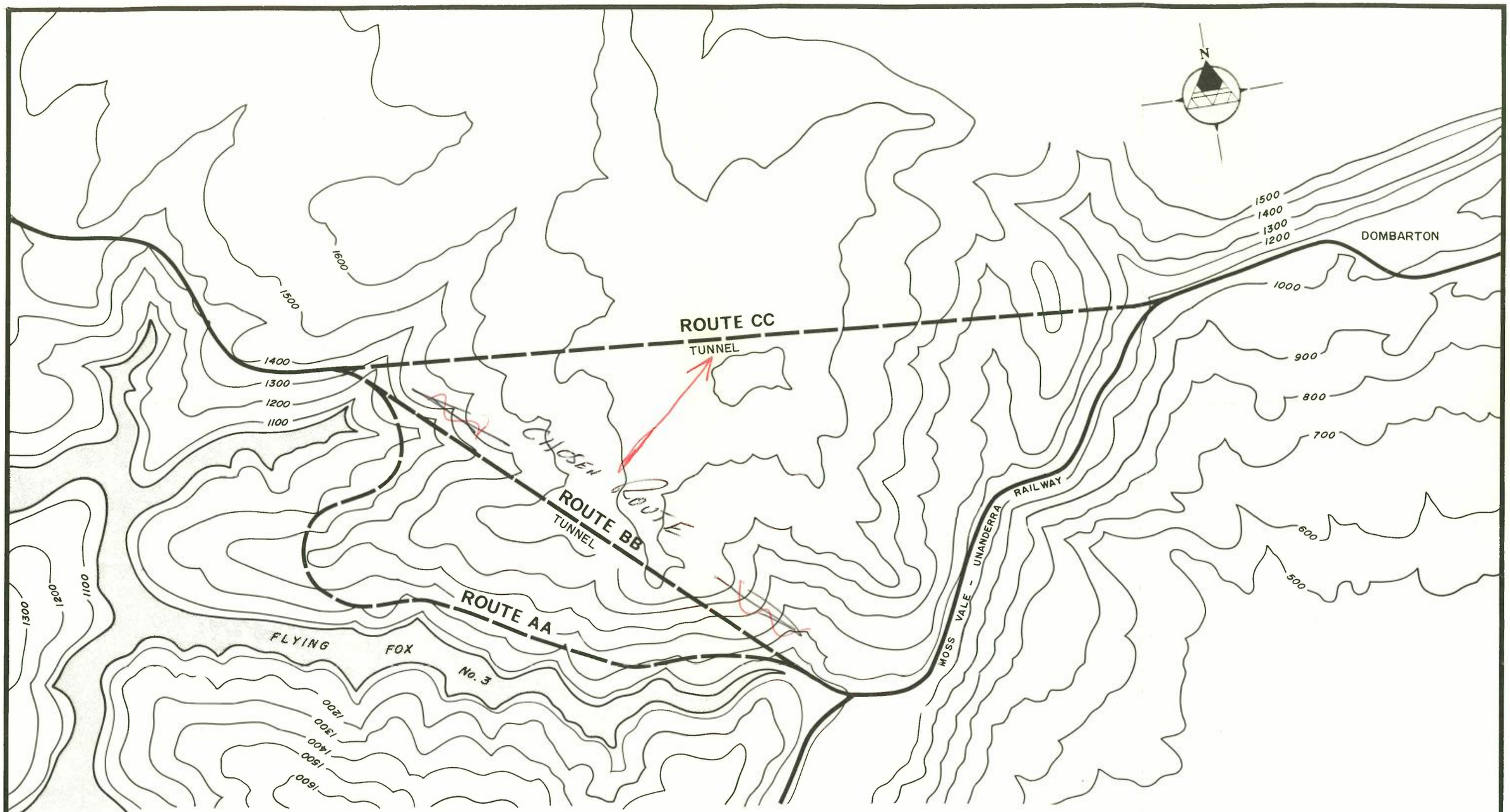
To overcome these constraints, it is necessary to locate the junction of the new line with the Moss Vale - Unanderra Line at a point where duplication is possible. Route CC meets this requirement joining the Moss Vale Line 0.8 km from Dombarton. Duplication of the track to Unanderra is feasible from this point.

Route CC passes through a tunnel of 3.5 km. The tunnel presents no serious engineering problems nor any environmental difficulties. It was selected as the preferred option.

Alternative routes down from the ridgeline to the western tunnel portal were also examined. The major constraints were operational ones in respect to grade requirements. However, due to the proximity of the route to the Avon Dam and to the sensitivity of local areas of rainforest and wetland, environmental constraints also applied.

A route was selected which is set back as far as possible from the Dam shoreline. It is shown in Figure A-4. The tunnel portal is located to minimise damage to rainforest. Two wetlands areas are traversed. The line will be constructed over culverts at these locations to ensure continued drainage flow to and through the wetland areas. Some fill will be necessary but this will be minimised. This is discussed further in Appendix E.

Because of the extent of cutting excavation in this area and excavation from the tunnel, it will be necessary to dispose of excess material on suitable areas adjacent to the ridgeline. The recommended location of these disposal areas



STATE RAIL AUTHORITY	
TITLE : ALTERNATIVE ROUTES - TUNNEL SECTION LOCATION : MALDON - DOMBARTON ROUTE	FIGURE A-3
SCALE 0 500 1000m	JOB No. : 9886-004-70 DATE : MAY 1983
REF. : G H D	Dames & Moore

STATE RAIL AUTHORITY

TITLE : PROPOSED ROUTE : WESTERN TUNNEL PORTAL LOCATION : MALDON - DOMBARTON ROUTE		FIGURE A-4
SCALE 0 — 500 m		JOB No. : 9886-004-70 DATE : MAY 1993
REF. : S.R.A.		Dames & Moore

is shown in Figure A-5. The quantity of excess material will be minimised where economical by its use elsewhere along the line where fill is required. The SRA will try to restrict the extent of borrow areas located within the MWS&DB Catchment Area.

All disturbed areas and the disposal areas will be stabilized and vegetated as quickly as possible. Techniques for this, formulated in conjunction with the MWS&DB and the Soil Conservation Services are set out in Section 5.5 of this Appendix.

2.0 PROPOSED DUPLICATION

2.1 DESCRIPTION

The existing Moss Vale - Unanderra - Port Kembla Line will be duplicated from the junction with the new line to Port Kembla, a distance of approximately 15 km. The proposed work will follow the existing route and will be located within existing railway land, apart from bridge-works proposed at the crossing of the Princes Highway and a small area of land at Dombarton.

The new line will be generally constructed on the northern or upside of the present line from Dombarton to just before Farmborough Heights. Investigations are being undertaken to determine the feasibility of locating the new line from that point through to the Princes Highway on the southern or downside. From the Princes Highway through to Port Kembla, duplication will generally be on the southern side.

No land clearing will be required outside the SRA reserve. A number of new or reconstructed bridges and causeways will be required. These include:

- a new bridge at the Dombarton Loop (see Section 3);
- the replacement of two or possibly three small access bridges over the line in the Farmborough Heights area;
- a new road (over the rail) bridge at Drummond Street at Mt St. Thomas;
- a new bridge over American Creek;

- a possible bridge structure over a potentially unstable area in the upper gully of Dapto Creek.

The locations of these structures are indicated on Figure A-6. They are comparatively minor structures and their construction presents no serious difficulties. During the construction period of the Drummond Street bridge, continued satisfactory access will be provided.

A major structure will be required at the crossing of the Princes Highway by the railway line. At present there is a level crossing with flashing lights at this point. In view of the increased rail traffic resulting from the new line and duplication of the existing line, this will not be adequate.

It is proposed to construct bridgeworks to allow the Princes Highway to cross the railway line at that point. Detailed design of this structure has not been completed. It is described in Section 4.

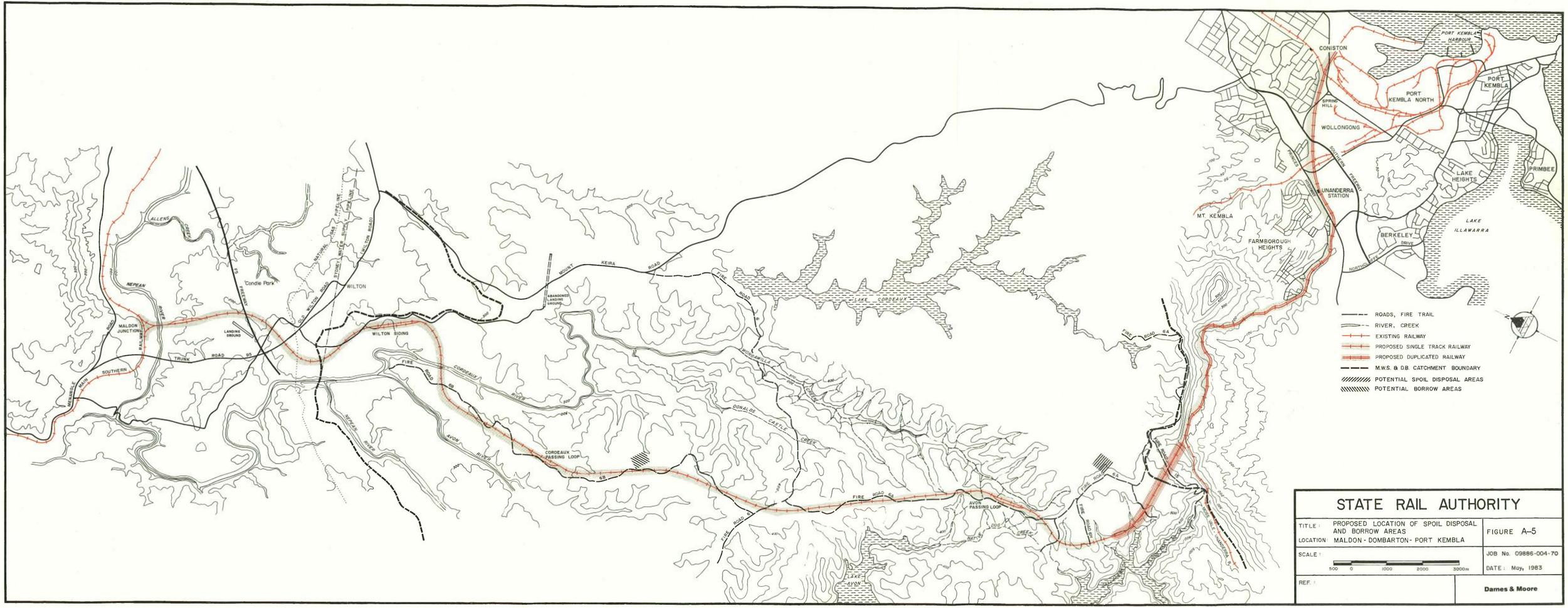
The level crossing at old Five Islands Road will be closed following agreement with Wollongong City Council. Traffic, by arrangement with Wollongong City Council, will have alternative access via the new Five Islands Road system and the Princes Highway.

2.2 ALTERNATIVES

There are no feasible alternatives to the duplication of this line. No other suitable route exists from Dombarton to Port Kembla. Any significant deviation from this route would affect land not owned by SRA and this is not considered desirable.

The alternative location of the new line on the north and south sides of the existing line was examined. It is preferable, to minimise land disturbance and costs, to locate the line on the northern side of the existing route. In the Farmborough Heights area this would result in the construction activity and the new line being located closer to local residences. An investigation is being undertaken to determine the feasibility of locating the new line on the southern side.

There is no alternative to line location from Unanderra to Port Kembla.



STATE RAIL AUTHORITY

TITLE : PROPOSED LOCATION OF SPOIL DISPOSAL AND BORROW AREAS

LOCATION: MALDON - DOMBARTON - PORT KEMBLA

FIGURE A-5

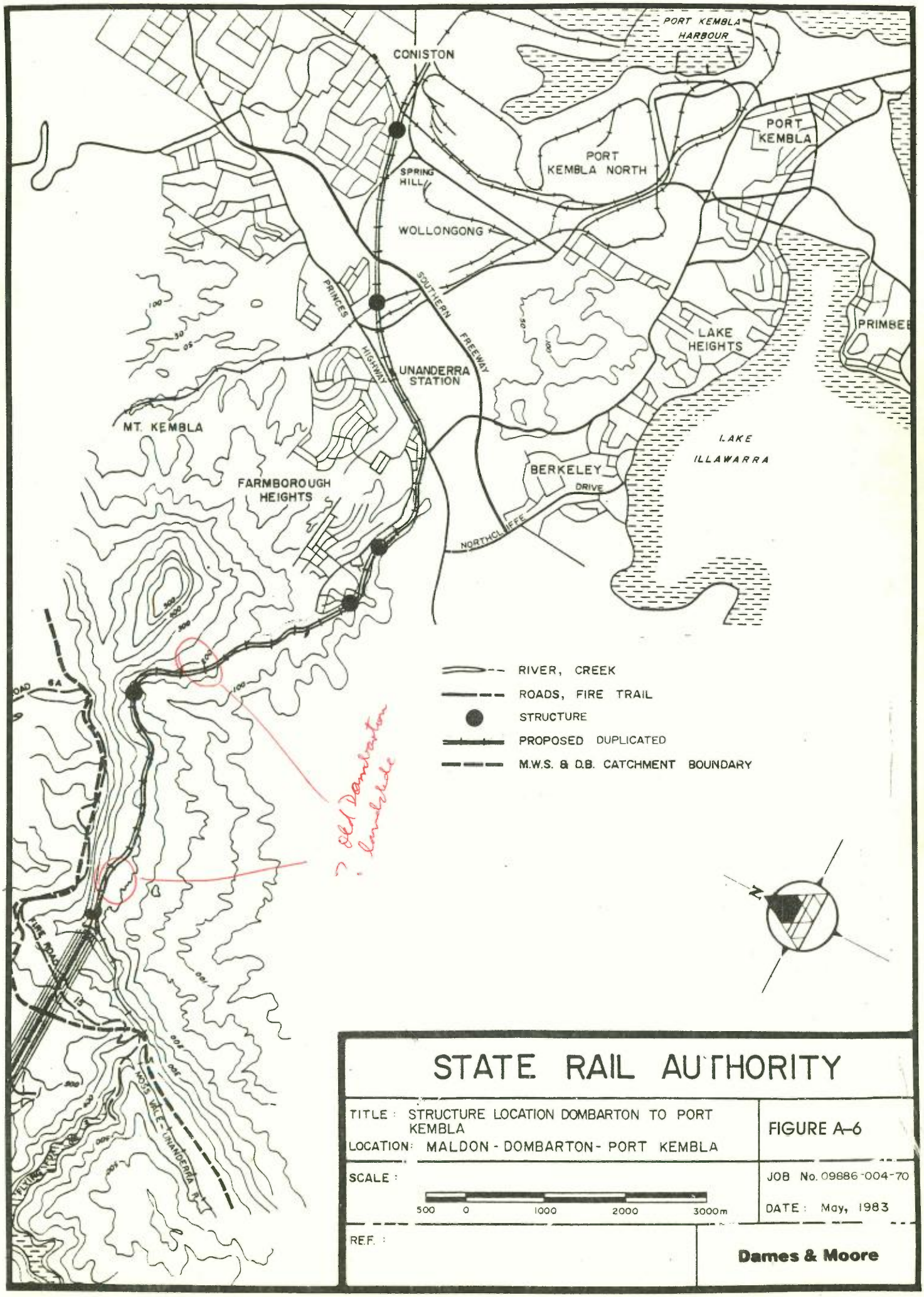
SCALE : 500 0 1000 2000 3000m

JOB No. 09886-004-70

DATE : May, 1983

REF :

Dames & Moore



STATE RAIL AUTHORITY

TITLE: STRUCTURE LOCATION DOMBARTON TO PORT KEMBLA LOCATION: MALDON - DOMBARTON - PORT KEMBLA	FIGURE A-6
SCALE: 500 0 1000 2000 3000m	JOB No. 09886-004-70 DATE: May, 1983
REF:	Dames & Moore

A number of alternatives were examined for the crossing of the Princes Highway. A reconstructed level crossing was considered inadequate on the basis of projected rail traffic, although road traffic movement figures show a reduction in Highway traffic since construction of the F6 Southern Freeway. Because of the grade of the rail line, it was not possible to construct a rail over road bridge structure. Detailed design of the preferred road over rail bridge will make provision for continued access to the four houses situated alongside the Highway near the crossing. One house, an old gate keepers cottage owned by the SRA, will have to be removed.

3.0 DOMBARTON LOOP

The Dombarton crossing loop was opened in May 1943 to relieve congestion over the difficult 19 km Unanderra - Summit Tank section of the line to Moss Vale. It is a complex crossing loop. Its unique arrangement is designed to allow for the passing of trains travelling in both directions and to provide relatively flat standing room for waiting trains. The line in that area climbs almost continuously at grades of 1 in 30.

Figure A-7 illustrates the existing loop arrangements. The loop operates as follows when trains cross there:

- trains from Port Kembla (i.e. Down Train) Arrives First: The Down train proceeds into No.1 Refuge Siding and backs into No.3 Refuge Siding to await the passage of the train from Moss Vale (Up train). On completion of the safeworking arrangements after passage of the Up train, the Down train resumes its journey via No.16 points to Moss Vale;

- train from Moss Vale (i.e. Up Train) Arrives First: The Up train arrives No.2 Refuge Siding and backs into No.1 Refuge Siding to await passage of the oncoming train before resuming its journey to Port Kembla after completion of necessary safeworking procedures.

Figure A-8 illustrates the proposed development of this loop to allow for duplication and the increased traffic from and onto the Maldon - Dombarton line. The proposal is designed for two loaded arrivals. In the event of there being a third

loaded train ready to run to Dombarton Junction, this train would have to be held back in the previous loop thus incurring a time penalty.

Alternative layouts were considered but all involved a more complex system incorporating additional crossovers. The re-development will be undertaken chiefly within the existing SRA land reserve. A small area of private land will be required to enable the extension of one arm of the loop.

4.0 ENGINEERING DESIGN

4.1 DESIGN CRITERIA

The line will be constructed with continuously welded rail on concrete sleepers. It will be constructed by modern engineering methods and in accordance with accepted design criteria.

The Maldon to Dombarton route was investigated in accordance with current standards. Departures from this standard as a result of terrain constraints include:

Curve radius - open track : 440 metre minimum desirable, 300 metre minimum for this route;

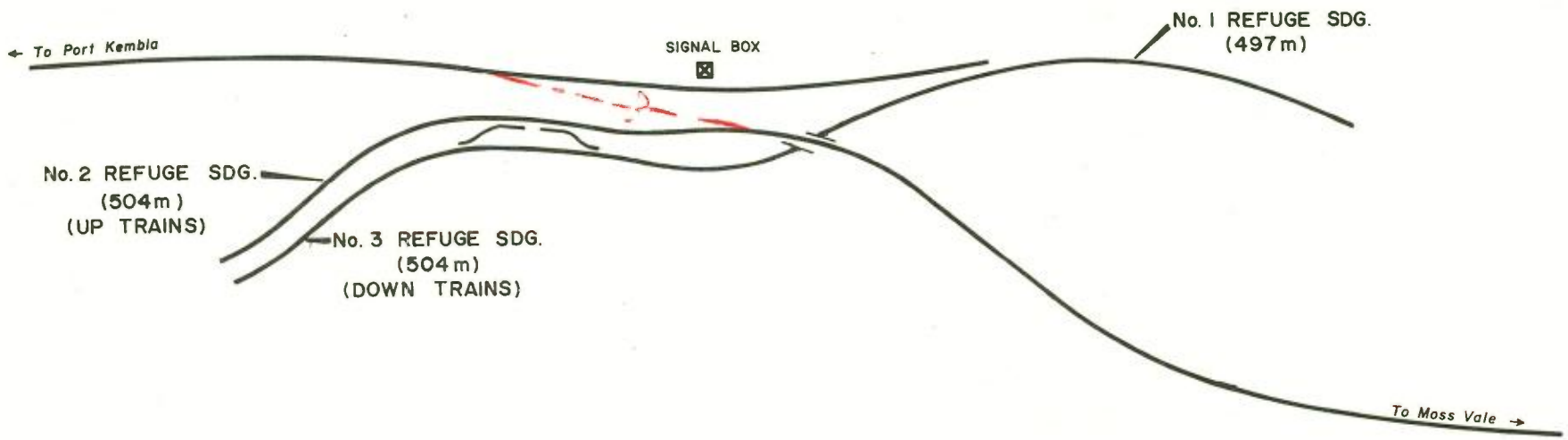
Curve radius - junctions : 300 metre desirable;

Maximum grade against loaded train : 1 in 100 (1.25%) desirable
1 in 70 (1.67%) absolute for this route;

Maximum grade against empty train : 1 in 50 (2.00%) desirable
1 in 30 (3.33%) maximum for this route.

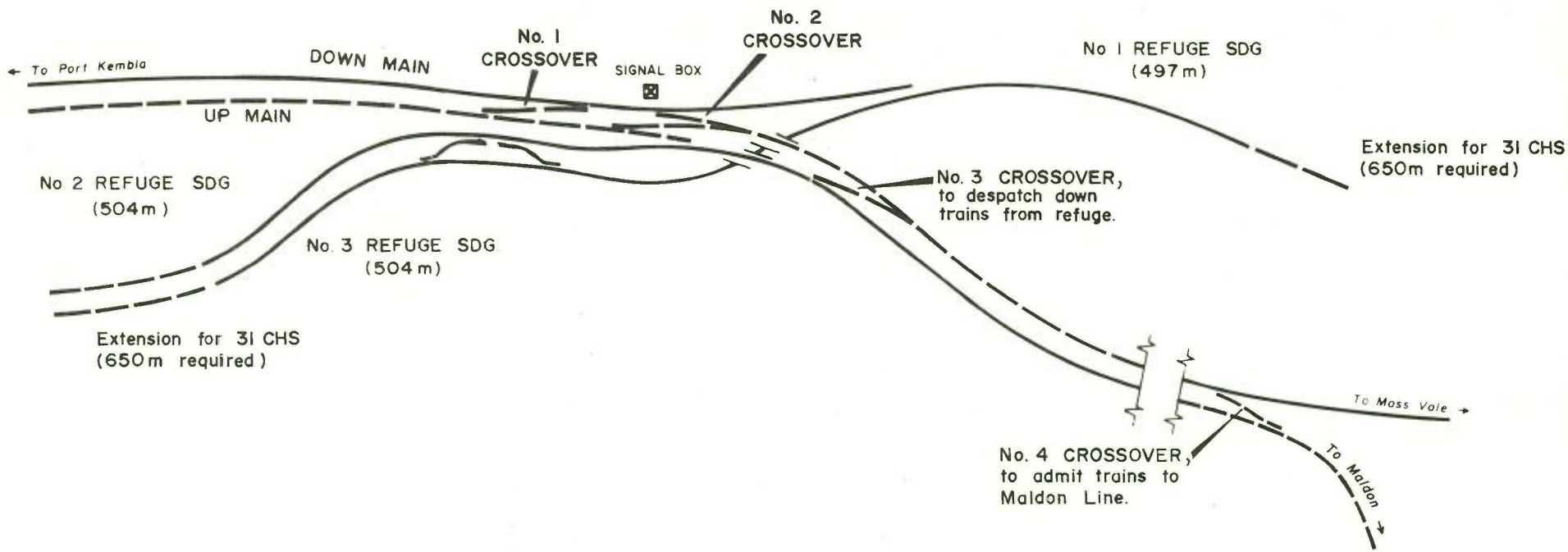
In addition to geometric standards the following criteria are also applicable to this route:

Bridge design : M27 loading



STATE RAIL AUTHORITY

TITLE : DOMBARTON LOOP - EXISTING LAYOUT LOCATION : DOMBARTON - PORT KEMBLA	FIGURE A–7
SCALE : NOT TO SCALE	JOB No.: 09886-004-70 DATE : MAY 1983
REF.: S.R.A.	**Dames & Moore**



Existing Track

Proposed Track

STATE RAIL AUTHORITY

TITLE DOMBARTON LOOP - EXISTING LAYOUT LOCATION : DOMBARTON - PORT KEMBLA	FIGURE A-8
SCALE NOT TO SCALE	JOB No 09886-004-70 DATE MAY 1983
REF : S R A	**Dames & Moore**

Batter slopes in cut (general)	: 1 horizontal to 4 vertical in rock 1 horizontal to 1 vertical in soil.
Batter slopes in fill (general)	1 vertical to 1.5 horizontal;
Formation width (concrete sleepers):	8.0 metre nominal main line or siding, increased for areas of possible subsidence;
Easement width :	40 metres/minimum.

N.B.

At the junction with the Main Southern Line, the new line rises on a maximum 1 in 70 grade for about 18 km. The route then continues for 11.5 km on more moderate grades and then on downgrades of about 1 in 50 before it enters the major tunnel which is on a downgrade of 1 in 30. This grade then continues on the duplicated Moss Vale line through the Dombarton loop to Unanderra.

A balloon loop preliminary design has been prepared to provide rail access to the proposed West Bellambi Colliery. The layout provides for minimum earthworks, access from both directions on the main line, and minimal impact on the proposed colliery pit top works. This preliminary design is currently being reviewed by the colliery development personnel, and will form part of their development.

4.2 ELECTRIFICATION

The new line from Maldon Junction to Dombarton and the two tracks from Dombarton to Port Kembla will be electrified. The existing Main South Line from Glenlee to Maldon Junction will also be electrified to match in.

The advantages of the electrification of the complete railway from Maldon to Port Kembla including the Main Southern Railway between Glenlee and Maldon Junction are as follows:

- completes the electrification network between the Main Southern Railway and the Illawarra Line to allow through-running of electric locomotives;

- allows through-running of electric-hauled coal trains from Lithgow to Port Kembla via Maldon without the need for changing to diesel traction at Enfield or Campbelltown.

  A locomotive exchange in the Campbelltown area would require exchange sidings, staff to operate it and tie-up of locomoties waiting for trains.

  Exchanging locomotives at Enfield would mean diesel traction running under electric overhead wires from Endfield to Glenlee.

  Also, noise levels from the diesel locomotive would be greater than the electric locomotive through the south western suburbs;

- electric locomotives are presently being built to haul coal to Port Kembla;

- electric locomotives are more environmentally acceptable due to quieter and cleaner operating. These locomotives are also more energy efficient.

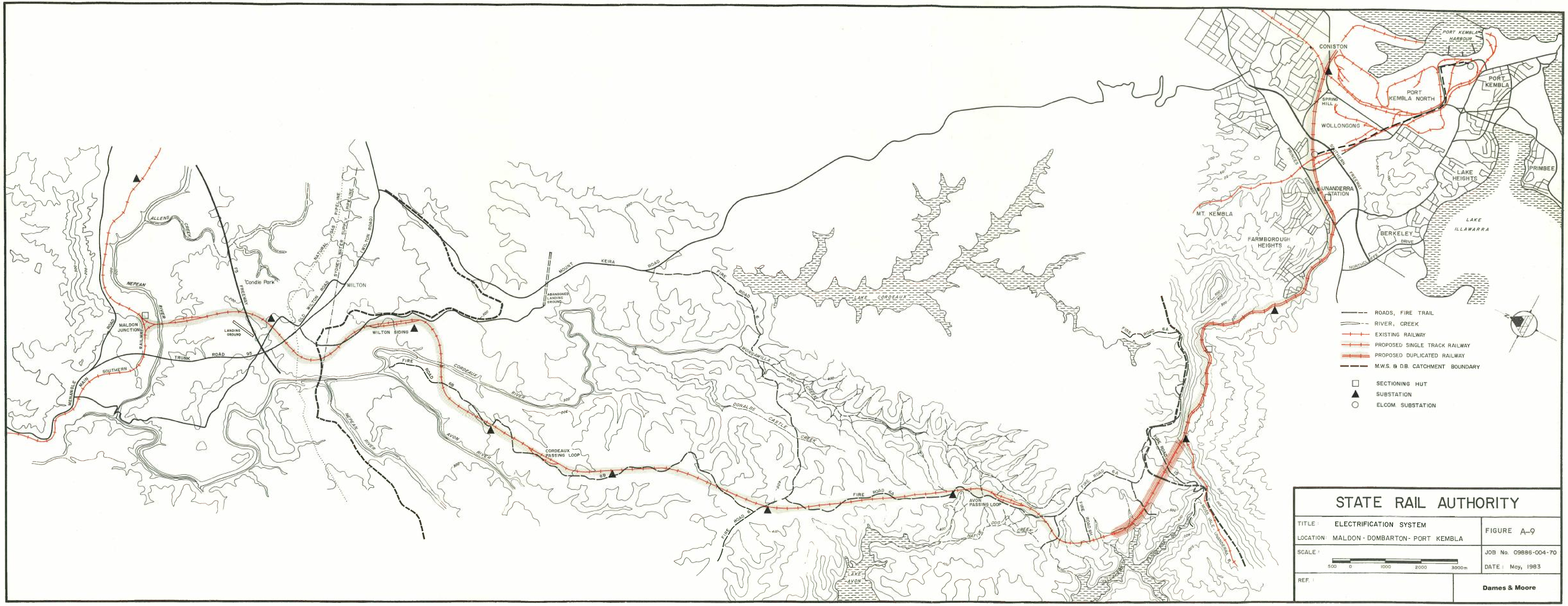
No decision has yet been made on the voltage or type of current for this electrification. It will be either 1500v d.c. to suit the existing network, or 25 Kv a.c. Studies are being conducted on this option.

Until electrification is extended south from Maldon Junction, trains from Tahmoor, Bargo and any from Moss Vale using the new line will be hauled by diesel-electric locomotive to Port Kembla.

The system is illustrated in Figure A-9.

4.2.1 Power Supply

The SRA has been allocated supply from the State Electricity Commission at Glenlee. The SRA will run aerial supply lines from this point to the closest and most economic area where access is available to the track. Once in the track area, the aerials run adjacent to the tracks and within the SRA boundary.


STATE RAIL AUTHORITY
TITLE: ELECTRIFICATION SYSTEM
LOCATION: MALDON - DOMBARTON - PORT KEMBLA
FIGURE A-9
SCALE: 500 0 1000 2000 3000m
JOB No. 09886-004-70
DATE: May, 1983
REF.:
Dames & Moore
ROADS, FIRE TRAIL
RIVER, CREEK
EXISTING RAILWAY
PROPOSED SINGLE TRACK RAILWAY
PROPOSED DUPLICATED RAILWAY
M.W.S. & D.B. CATCHMENT BOUNDARY
SECTIONING HUT
SUBSTATION
ELCOM SUBSTATION
MALDON JUNCTION
WILTON SIDING
CORDEAUX PASSING LOOP
AVON PASSING LOOP
LAKE CORDEAUX
LAKE AVON
CONISTON
PORT KEMBLA HARBOUR
PORT KEMBLA
PORT KEMBLA NORTH
SPRING HILL
WOLLONGONG
UNANDERRA STATION
LAKE HEIGHTS
PRIMBEE
MT. KEMBLA
FARMBOROUGH HEIGHTS
BERKELEY
LAKE ILLAWARRA
WILTON
MOUNT KEIRA ROAD
TRUNK ROAD 95
NEPEAN RIVER
CORDEAUX RIVER
AVON RIVER
DONALDS CASTLE CREEK
ALLENS CREEK
ABANDONED LANDING GROUND
LANDING GROUND
'Condie Park'

The supply aerials will follow existing lines from the Electricity Commission sub-station at Glenlee overland to Glenlee Junction.

Electrification will involve supply from Port Kembla. Aerials will originate at the Electricity Commission sub-station on Port Kembla Road.

4.2.2 Route Design

The supply aerials will generally follow the boundary of the proposed and existing railway reserves. Cable will be used through the tunnel. Aerials will be supported by single poles and no metal towers will be required.

Sub-stations will be located at four to five kilometre intervals on the single track section, and at about eight kilometre intervals on the duplicated section for the d.c. system. The exact location depends on detailed design which must take into account:

- density of trains;
- grade of line;
- local environmental factors.

The sub-station located near to the upper section of Farmborough Heights will be situated so as to minimise visual obstruction.

Sectioning huts for the duplicated line section, will be located approximately midway between substations.

Figure A-10 provides design details of the sub-stations. Sites will be fenced. Figure A-11 illustrates typical mast design. Distance between mast varies depending on the route and terrain. However, in general masts are located 30 - 40 metres apart.

4.2.3 Access

Access is required to the electrificiation system for construction, maintenance and repair/replacement.

General construction access is similar to that required for line construction. Special requirements however apply to the

transformers/rectifiers if required for the sub-stations. Installation will require a low loader and crane.

Maintenance of sub-stations will require access by four wheel drive or station wagon type vehicle. Route maintenance requires a visit by personnel approximately once a month. Repairs will require similar access. However, if the replacement of a transformer is required, a low loader and crane will have to be used.

The SRA use either public roads or roads built adjacent to the line to gain access to substations and sectioning huts.

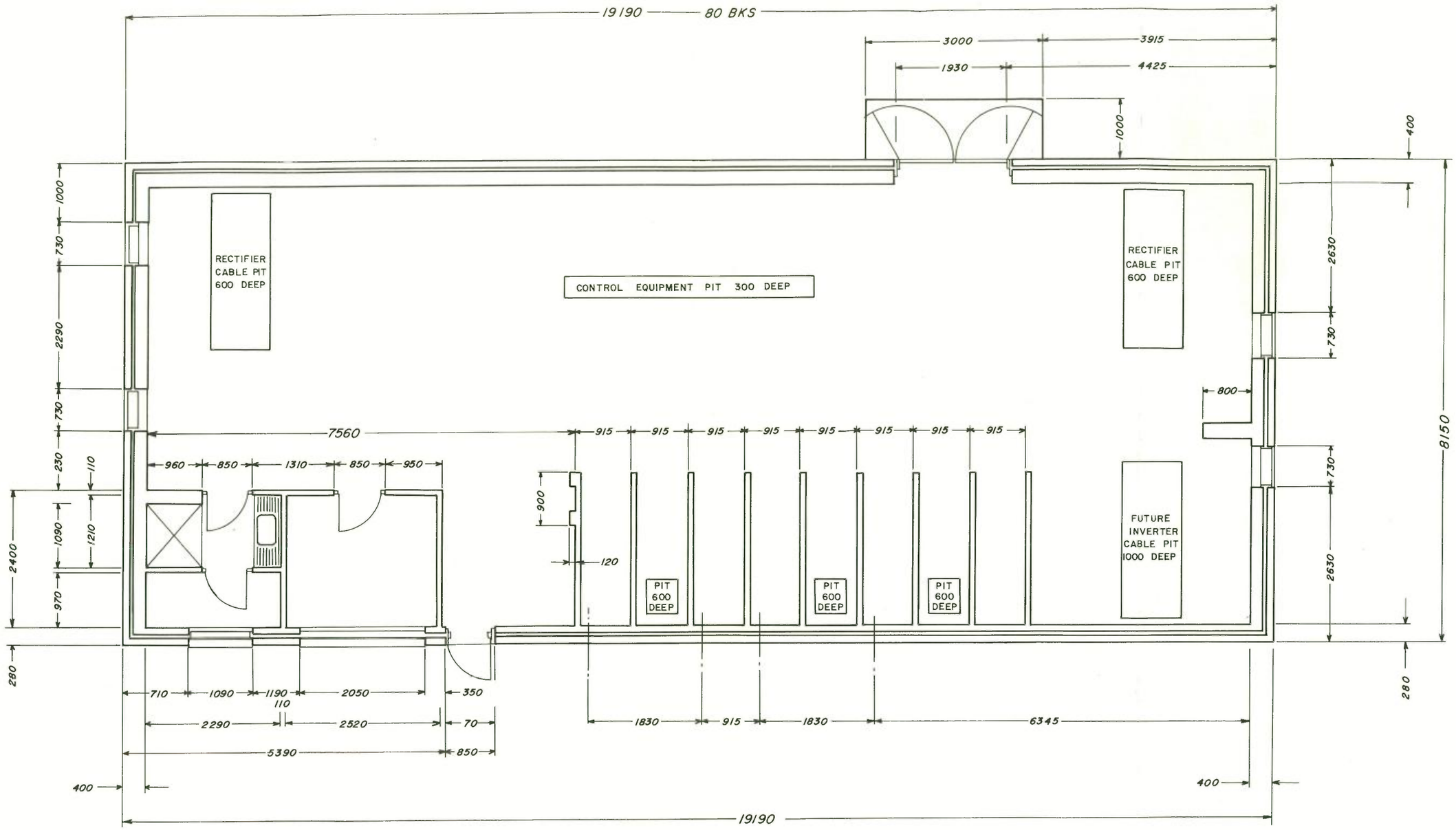
4.3 CROSSINGS AND BRIDGES

The major engineering considerations and governing design criteria involved in route selection have been reviewed. Compatibility with existing land use and resource constraints, economics, coal extraction and geotechnical constraints are the most important factors involved in engineering decisions concerning the railway's major structures.

The major structures are the Nepean River Crossing, the Cordeaux River Crossing, the South Western Freeway (F5) Underpass, the Trunk Road 95 and Old Wilton Road underpasses and other road crossings and tunnels, which are described below. The detailed designs of these structures have not been finalized.

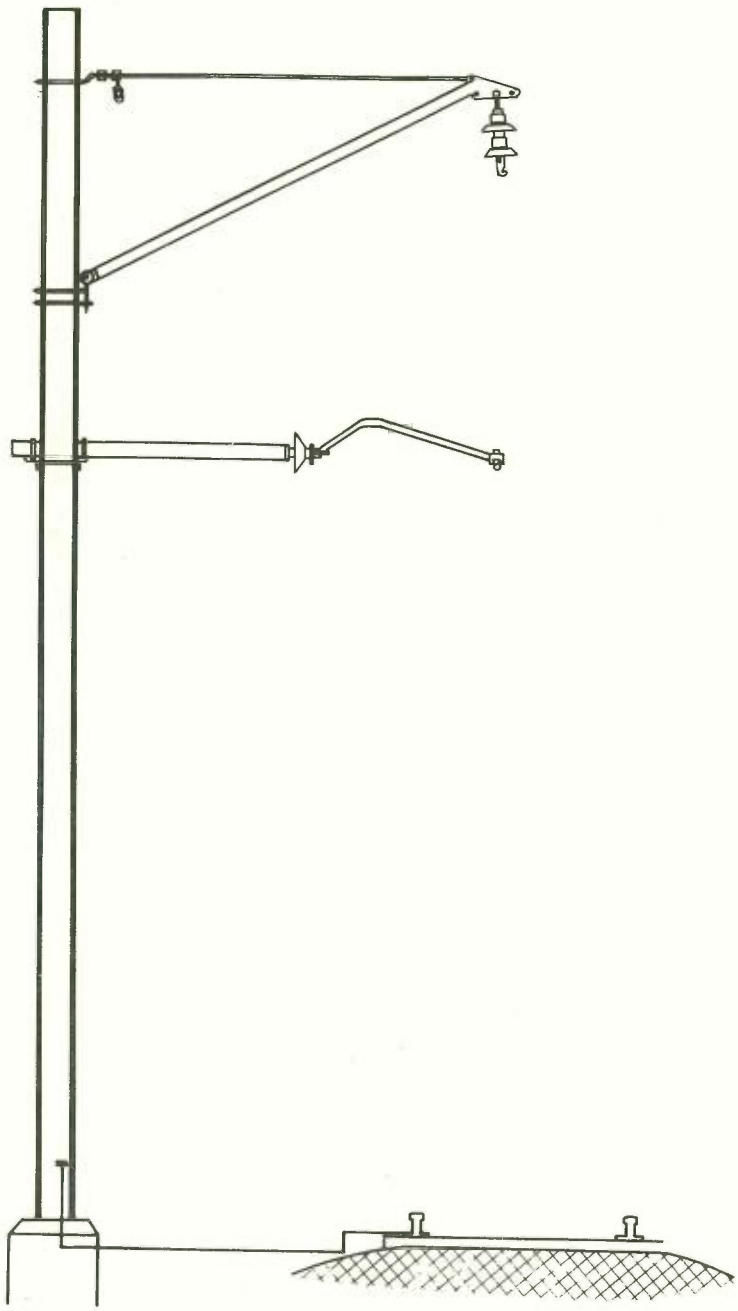
Engineering and economic evaluation during detailed design will determine whether the major Cordeaux and Nepean River bridges will be built of steel or concrete. Current trends suggest that concrete will be adopted, with batching either from established developments, e.g. Campbelltown or a plant on-site for the Nepean site. The Cordeaux site will probably require the establishment of an on-site batching plant. Specialised design consultants are about to be appointed to do these evaluations.

At the Cordeaux River Crossing it is expected that an arch bridge would be the most appropriate solution having regard to the shape of the gorge, the availability of massive rock beds, and the relative level of the rock and the abutments. Construction of an arch can be advanced from each abutment thereby minimising the impact of construction operations



STATE RAIL AUTHORITY

TITLE:	FLOOR PLAN - CAWLEY SUBSTATION	FIGURE A-10
LOCATION:	MALDON - DOMBARTON ROUTE	
SCALE		FILE No.: 09886-004-70
		DATE : MAY 1983
REF. :	SRA	**Dames & Moore**



STATE RAIL AUTHORITY

TITLE : OVERHEAD WIRING - TYPICAL CROSS SECTION LOCATION : MALDOM - DOMBARTON ROUTE	FIGURE A-11
SCALE	FILE No. : 09886-004-70 DATE : MAY 1983
REF. : SRA	Dames & Moore

within the gorge, and the associated need to substained access roads into the gorge itself.

Access to the abutments is readily available from nearby fire roads.

Construction sites will be established near the bridge abutments. These will be suitably fenced, drained and sewered (by temporary measures) to minimise impact on adjacent areas.

4.3.1 Nepean River

This may be achieved by constructing a three span single cell prestressed box girder bridge with a centre span of 75 metres and adjacent spans of 55 metres each and erected by balanced cantilever construction. Pier heights will be about 50 metres. Maximum height of rail above river is about 70 metres. The superstructure provides for a 4.5 metre wide deck and a depth which varies between six metres over piers to three metres at midspan. A plan of the bridge is provided in Figure A-12.

Although preliminary investigations reveal no severe foundation problems, further studies are planned in the detailed investigation and design stages. Adequate safety provisions will be made for a small extent of subsidence due to the possible partial extraction of underlying recoverable coal and for earthquakes.

4.3.2 Cordeaux River

A single span bridge is proposed for this crossing supported by an arch. The length of the arch will be approximately 135 metres. A plan of this bridge is shown in Figure A-13. The superstructure provides for a 4.5 metre wide deck.

The geological and geomorphological conditions at the proposed site are similar to those at the Nepean River crossing. Similar further studies and adequate safety provisions against the possible effects of come coal mining induced subsidence and earthquakes are planned.

4.3.3 South Western Freeway (F5)

A cut and cover "cast in situ" concrete underpass (53 metres long) is proposed at this location. It has the advantage of having a lesser visual impact than a bridge.

Construction will be staged to maintain continuity of vehicular through traffic on the Freeway. By arrangement with the Department of Main Roads, temporary diversion works utilising the median and existing shoulder space will achieve this continuity.

4.3.4 Trunk Road 95 and Old Wilton Road

Similar, although shorter, underpasses are proposed at these locations. The line is in cuttings at these points, thus the structure design is not complex.

4.3.5 Princes Highway Crossing

As discussed in Section 2.0, duplication of the Dombarton to Port Kembla line and the additional traffic anticipated on the line as a result of the new line will require the construction of a road over rail structure at the crossing of the Princes Highway.

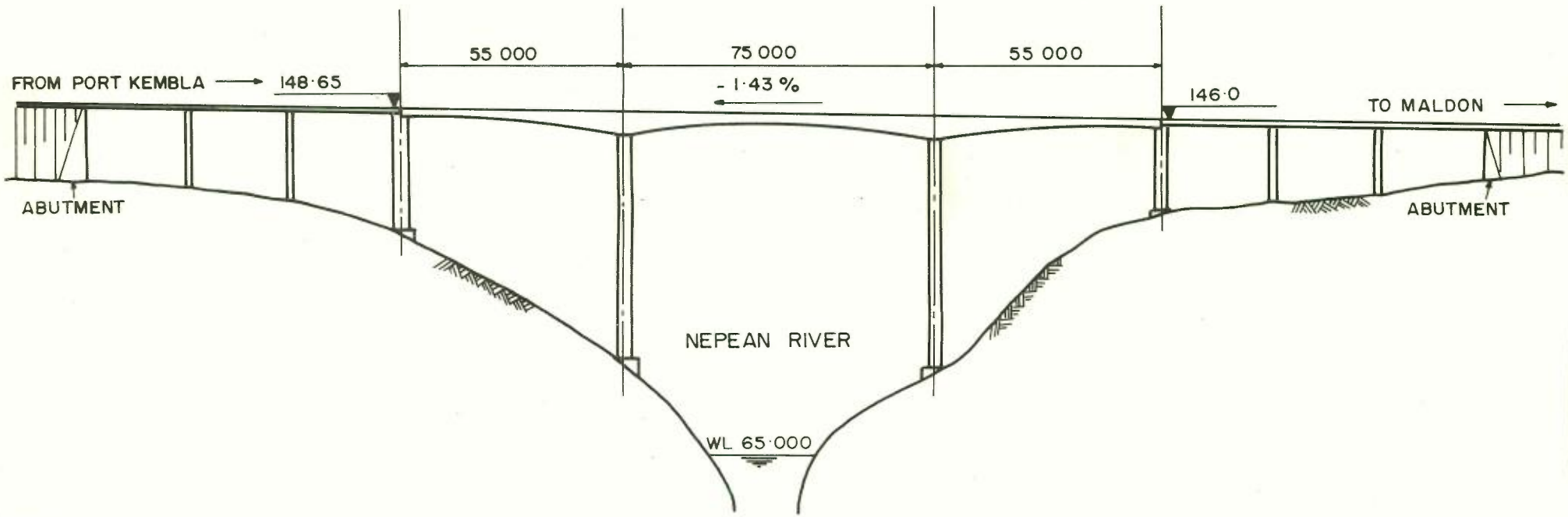
Final design of this crossing has not been undertaken pending further consultations with relevant State Government Authorities, Wollongong City Council and local residents. Figures A-14 and A-15 show the preliminary railway layout at the crossing.

The small former gate-keepers cottage alongside the line and Highway will have to be removed. It is SRA property. Other properties close to the crossing will have their access altered as direct access to the Highway will be restricted.

4.3.6 Other Crossings

As indicated in relation to the duplication of the Dombarton to Port Kembla section of the line, the replacement of a number of small replacement bridges will be required.

Other minor crossings will be level crossings with appropriate traffic warning devices. Final design is dependent on the topography at the crossing locations.

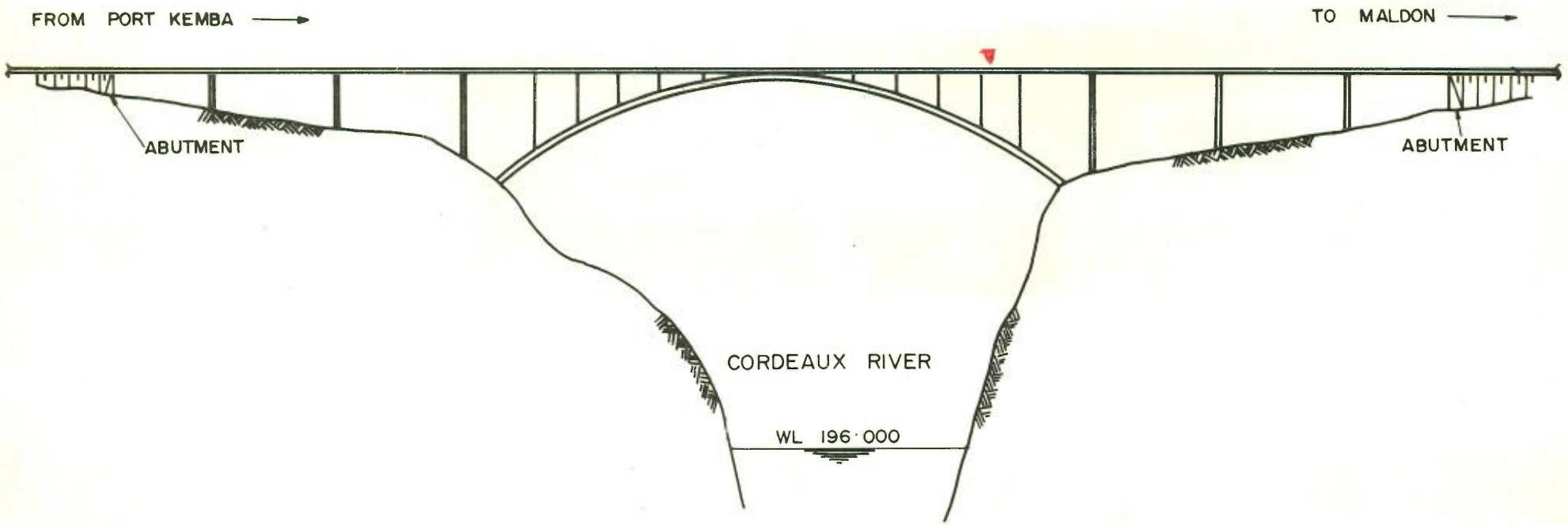


ELEVATION

SCALE 1:1000

STATE RAIL AUTHORITY

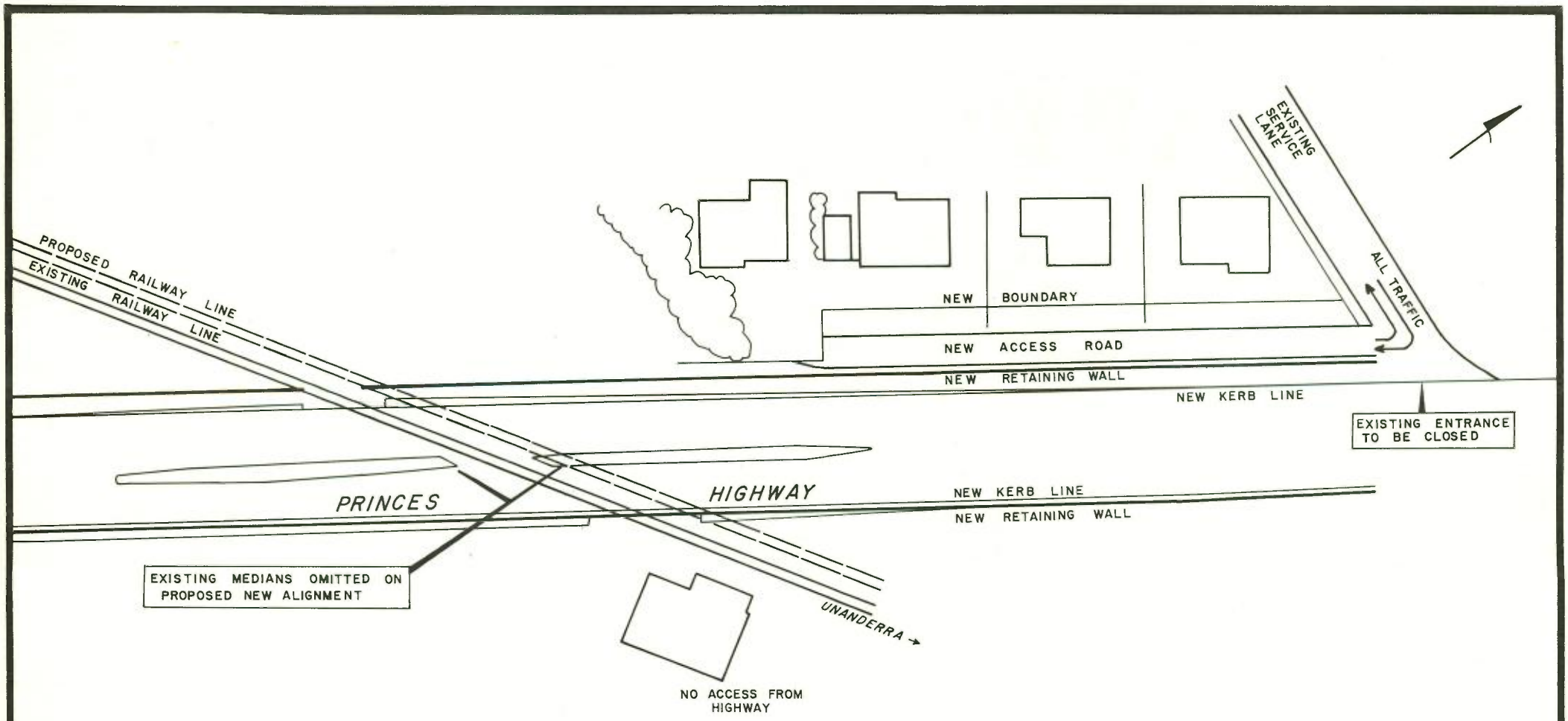
TITLE: NEPEAN RIVER BRIDGE CROSSING LOCATION: MALDON - DOMBARTON ROUTE	FIGURE A-12
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: May , 1983
REF: S.R.A.	Dames & Moore



ELEVATION
SCALE 1:1000

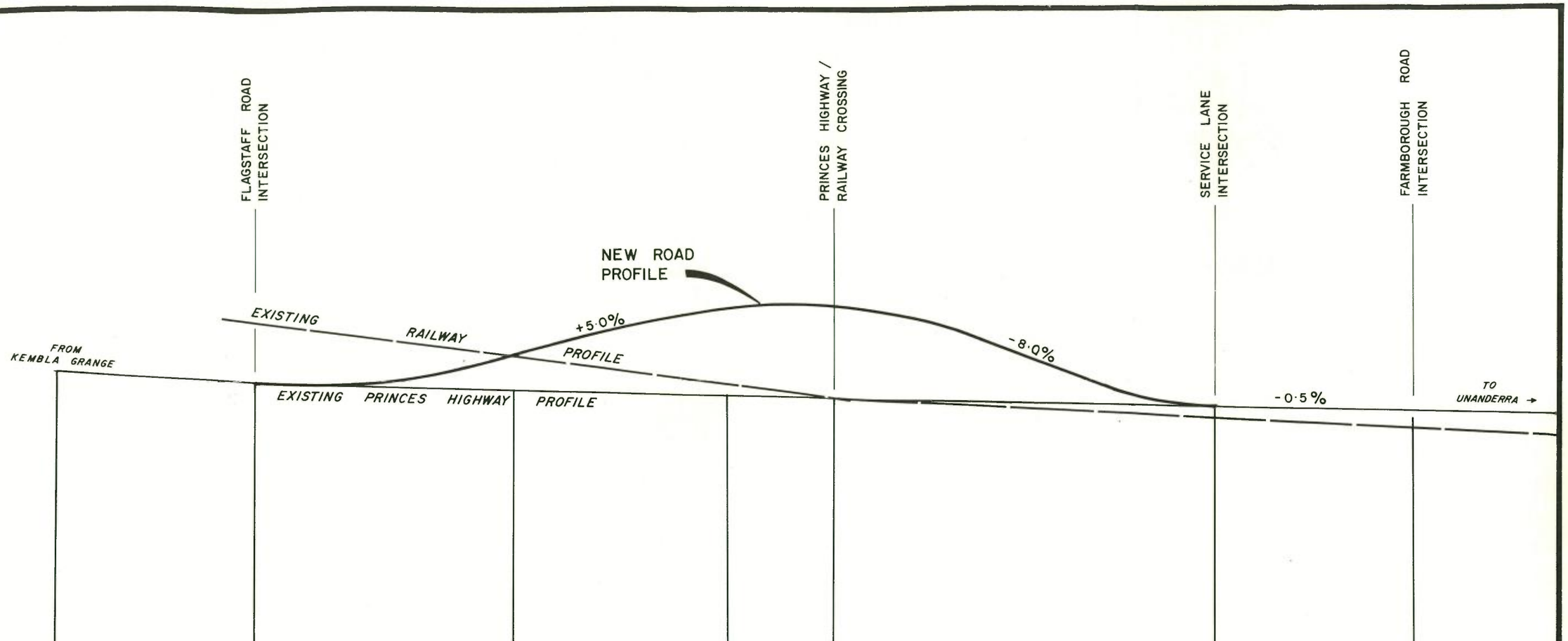
STATE RAIL AUTHORITY

TITLE: CORDEAUX RIVER BRIDGE CROSSING LOCATION: MALDON - DOMBARTON ROUTE	FIGURE A-13
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: May, 1983
REF: S.R.A.	Dames & Moore



STATE RAIL AUTHORITY

TITLE:	PRINCES HIGHWAY CROSSING	FIGURE A-14
LOCATION:	MALDON- DOMBARTON ROUTE	
SCALE	0 10 20 30 40 M	FILE No.: 09886-004-70
		DATE: MAY 1983
REF.:	SINCLAIR, KNIGHT & PARTNERS	Dames & Moore



	RL 00						
EXISTING SURFACE LEVEL	22·20	24·0	22·0	21·15	20·5	20·2	
DISTANCE	00	85·0	155·0	190·0	315·0	380·0	

STATE RAIL AUTHORITY

TITLE: PRINCESS HIGHWAY CROSSING - LONGITUDINAL SECTION

LOCATION: MALDON - DOMBARTON ROUTE

FIGURE A-15

SCALE Horizontal 0 10 20 30 40 50 M

Vertical 0 5 10 15 M

FILE No.: 09886-004-70

DATE: MAY 1983

REF.: SINCLAIR, KNIGHT & PARTNERS

Dames & Moore

4.4 TUNNELS

4.4.1 Location

A tunnel was selected as the only acceptable means of establishing a railway connection over approximately 92 metres elevation difference at the steep and prominent Illawarra Escarpment. Characteristic surface stablity problems and scenic and natural attributes impose severe surface route feasibility problems apart from design problems imposed by engineering constraints.

The proposed tunnel is 3.5 km long and has over 100 metres of cover over much of its length. The western portal is located in the gully of Flying Fox No.1 Creek and the eastern portal in the valley of a small creek alongside the Moss Vale - Unanderra Railway, 0.8 km west of the Dombarton Crossing Loop.

Both portals are located in steep areas where portalling conditions are ideal and the ground above the portal flattens out so that chance of rockfalls from above the portal are minimal.

Because of the environmental sensitivity of major fills in the Flying Fox Creeks, due to the close proximity to the Avon Dam waters, the railway route and grading provides for minimal earthworks. A small structure to carry the rail over the creek with an adequate water way opening for flood flows beneath will be provided.

4.4.2 Excavation

The most likely construction method is by road-heading tunnelling machine, excavating the tunnel by the heading and bench method with drill and blast back-up for dolerite dykes and the occasional strongly cemented sandstone. A large boring machine is not considered likely at this time due to the relatively short length of tunnels. The excavated profile is basically a horseshoe shape with maximum excavated heights and width of 6.3 metres providing sufficient clearance for a single track with provision for future electrification.

4.4.3 Drainage

Concrete drains will be provided on both sides of the track. Surface flows will be diverted into Flying Fox No.2 Creek thus minimising flows into the tunnels.

4.4.4 Trackbed and Lining

It is proposed to provide a concrete "blinding" and slab layer on the tunnel floor and a ballasted track structure. Allowance will be made in the tunnel design for the passage of the tunnel through ground subsidence associated with past mine workings.

The tunnels will be lined with pneumatically applied mortar and will have reinforced concrete portals. The bed of the tunnels will be track on concrete slab or flexible ballast trackwork on a concrete blinding layer. This proposal is subject to confirmation following geotechnical investigations.

The tunnel will be designed so as to reduce noise and air pressure effects on train crews.

During construction, the tunnels and approach cut areas at the portals will be adequately drained to a low point within the workings. This water will be pumped to a settlement area from which clean water will be decanted. Runoff from surrounding areas will be diverted from those tunnel workings.

The entire length of the tunnel will be above mine workings which have probably caused some loosening of the strata along joints. Rock bolting meshing and shotcreting is proposed to retain the integrity of the arch and walls.

4.4.5 Ventilation

A detailed examination into the provision of permanent ventilation has yet to be undertaken. However, from examination of studies carried out by the Snowy Mountains Engineering Corporation and Simpson Kotzman & Partners Pty Ltd (1980) for the Cordeaux Tunnel, which also made use of

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Snowy Mountains Engineering Corporation and Simpson Kotzman & Partners Pty Ltd (1980)
Report on Design Development Studies of Ventilation of the Cordeaux Tunnel
Prepared for Public Transport Commission of N.S.W.

tests undertaken in the Scarborough Tunnel, it would appear that mechanical ventilation is not required for this tunnel. In addition, the difference in elevation of the portals (approximately 92 metres) over the length of approximately 3.5 km should result in a considerable natural draft or chimney effect.

During detailed design a study of the ventilation needs of the tunnel will be undertaken.

4.5 EARTHWORKS

There are a series of large cuts located near the western portal. These are shown in Figure A-4. There are several other large cuts and fills which have a height to 20 metres. However along much of the route, earthworks while extensive do not require cuttings or embankments in excess of 15 metres. A long section of the route is illustrated in Figure A-16.

Eight seismic traverse were run along the route at the proposed major cuttings in order to obtain preliminary estimates of the excavation characteristics. A minimum formation width of 6.1 metres has been adopted based on using concrete sleepers and continuously welded rails as shown in Figure A-17.

Proposed batter slopes are shown in Figure A-18. In constructing rock batters by drill and blast techniques, pre-split blasting will assist in minimising rock overbreak and overfracturing in the parent rock. This technique will be used in deep excavations or heavy blasting to ensure accurate slope profiles.

From a preliminary terrain assessment of the Thorntons Hill area near Wilton, there appears to be several zones of seepage on the hills where the sandstone - shale transition occurs. These areas will be investigated further at the detailed design stage to ensure no adverse influence on the stability of local sections of the shale cuttings.

The upper 20 cm to 30 cm of formation will be constructed of selected fill having high frictional and load bearing properties. This will be obtained either along the route corridor or brought in from approved locations.

4.6 TRACK STRUCTURE

The track structure comprises rails, sleepers, fastenings and crushed rock ballast. The typical structure is as shown in Figure A-19.

Australian Standard rail with a mass of 60 kg per metre length will be used, giving a total requirement of about 3,200 tonnes of steel rail. The rails will be manufactured at Whyalla, South Australia and transported to the site by rail. They will be welded into 110 metre lengths at the SRA depot at Chullora and laid into the standard gauge, of 1,435 mm apart, prior to being continuously welded.

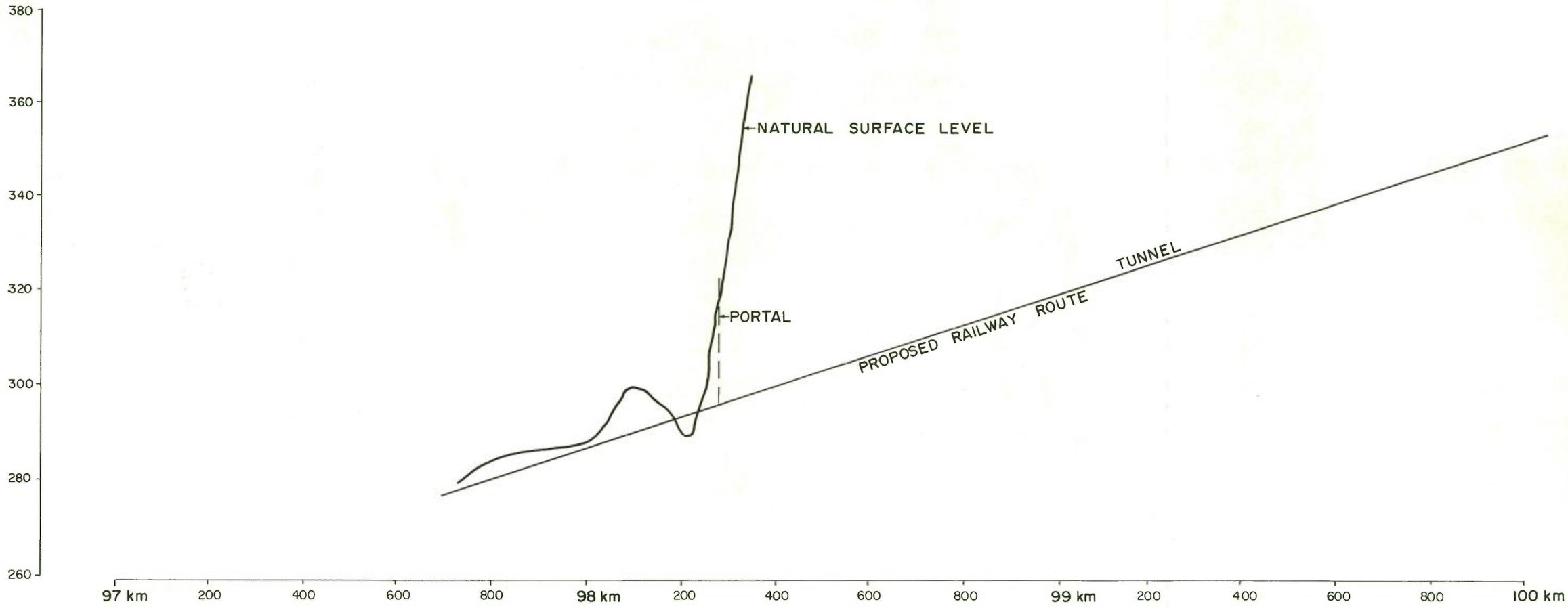
The sleepers will be pre-stressed concrete manufactured at a commercial plant off the site, probably at Denman N.S.W. They will be transported by rail to major stacking areas at Campbelltown - Douglas Park or Maldon and Port Kembla - Unanderra. Each area will be about one hectare in size with a rail siding. Rails will also be stored in this area. Both sleepers and rails will be loaded at this point onto wagons and transported by rail to the track laying machine on-site. They will be laid in at approximately 1,660 per kilometre giving a total requirement of about 88,000. Rails will be fastened to sleepers with resilient spring steel clips.

The ballast consists of crushed rock under and around the sleepers to distribute vertical and horizontal loads from the ballast in particle sizes ranging from 15 mm to 60 mm. Approximately 300,000 tonnes of ballast will be required. This will be obtained from existing ballast quarries at Bombo and in the Moss Vale area where loading facilities exist. A small percentage may be transported by road but the most will be by rail in hopper wagons.

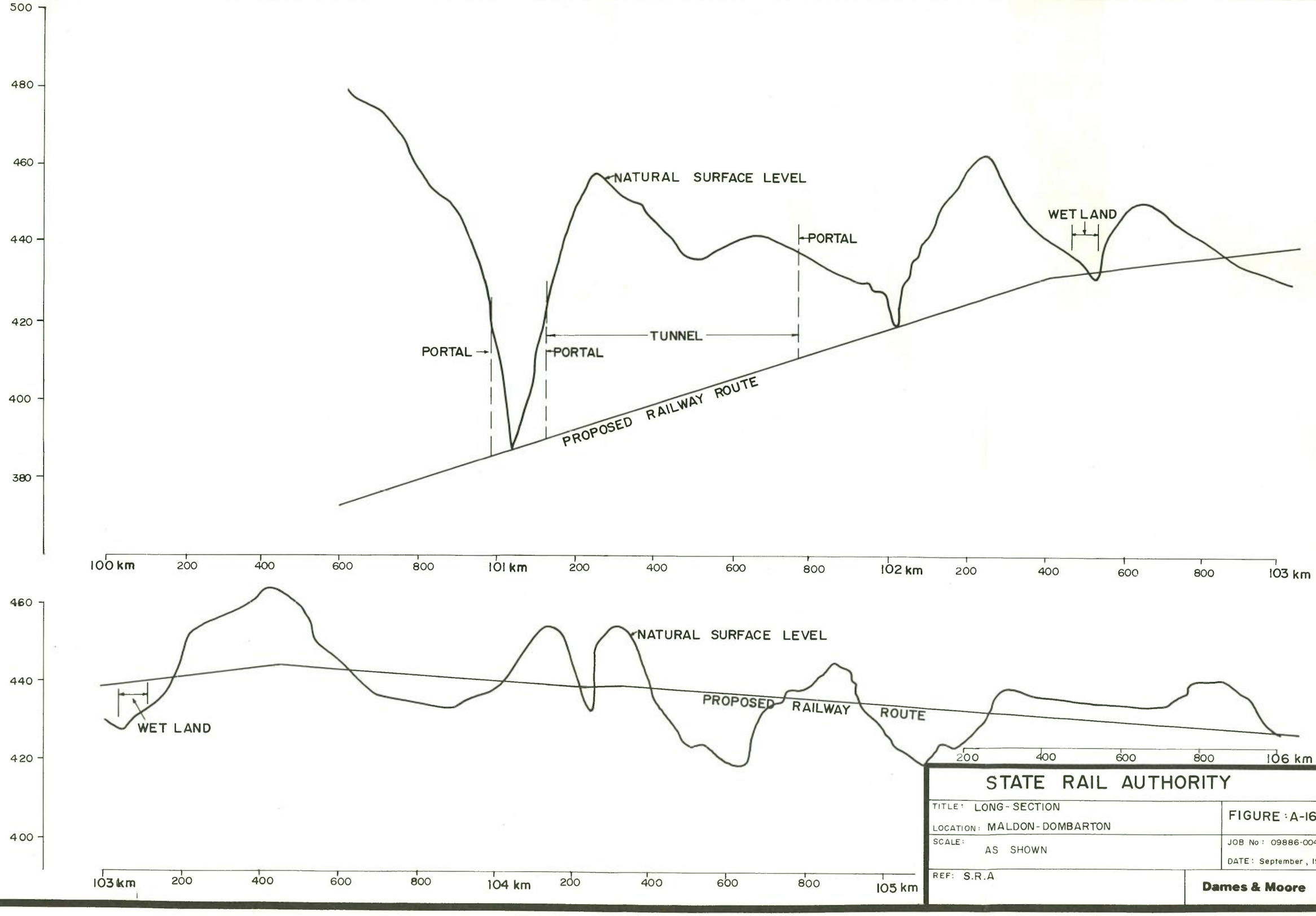
4.7 STATIONS AND SIDINGS

No railway passenger stations will be provided along the new line.

Sidings and/or passing loops will be provided at Maldon Junction, Wilton, Cordeaux and Avon. The existing loops at Dombarton and Unanderra will be duplicated. The passing loops will be 650 metres clear in length.

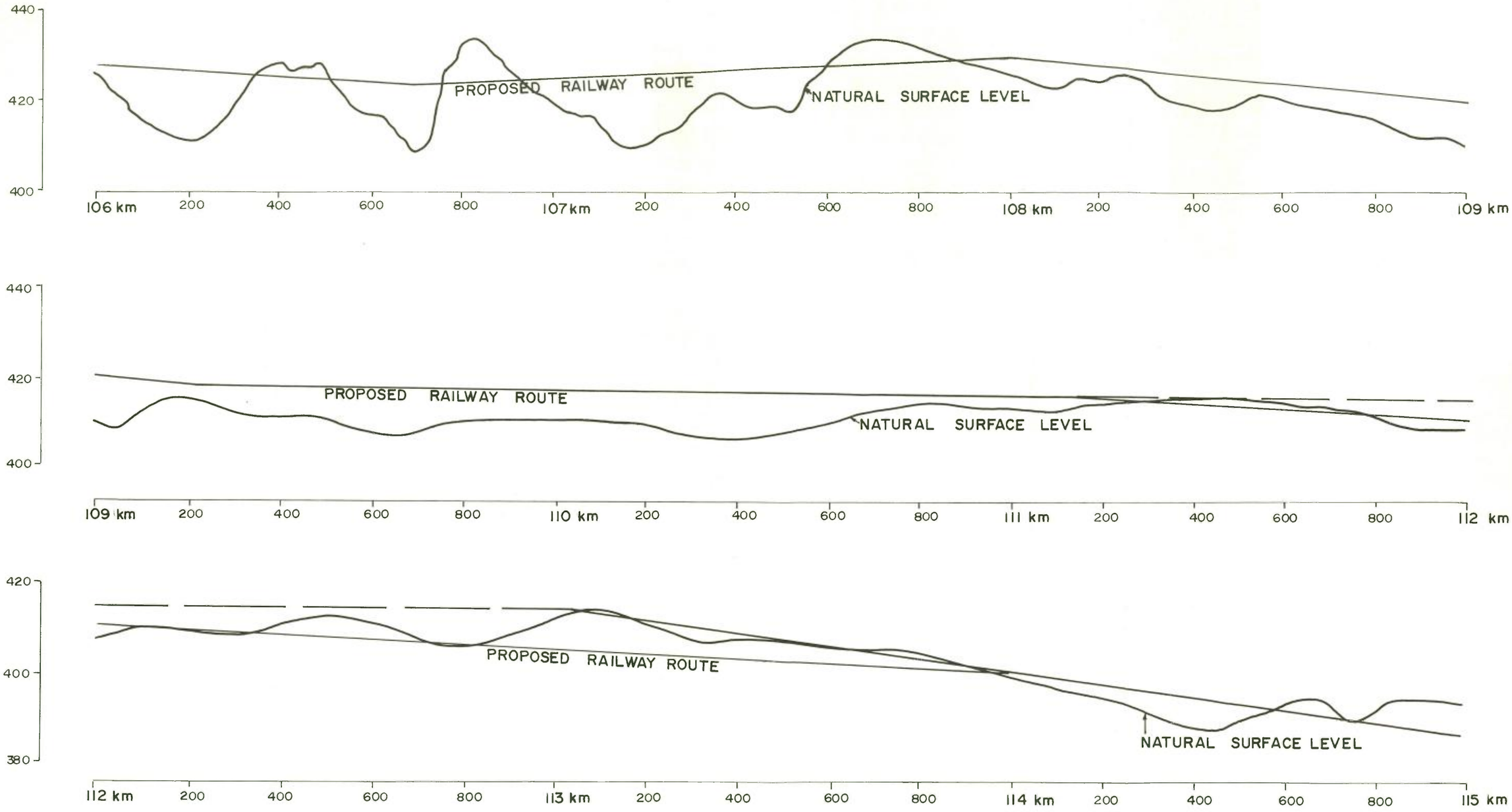


STATE RAIL AUTHORITY	
TITLE: LONG SECTION LOCATION: MALDON–DOMBARTON	FIGURE: A-16(1)
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A.	Dames & Moore



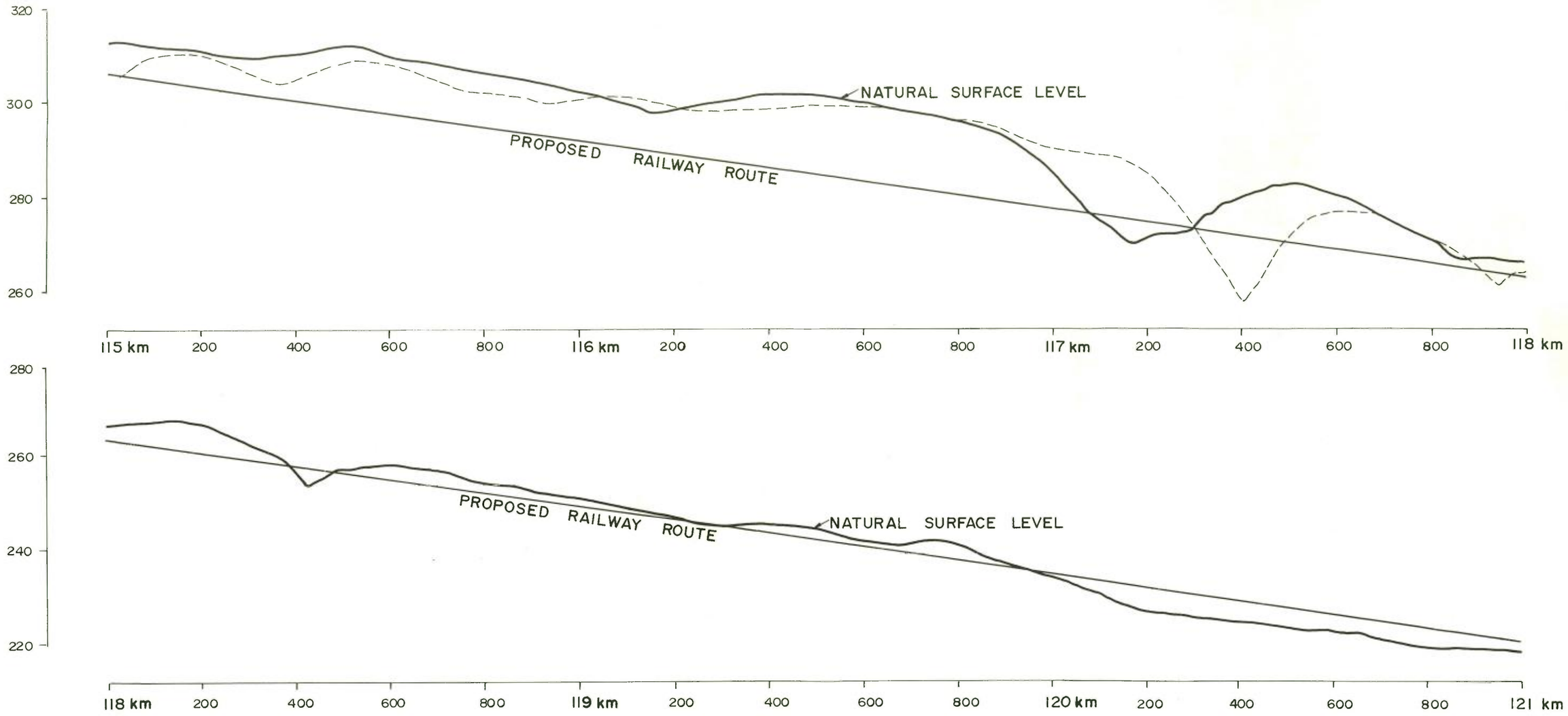
STATE RAIL AUTHORITY

TITLE: LONG-SECTION LOCATION: MALDON-DOMBARTON	FIGURE: A-16(2)
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A	Dames & Moore

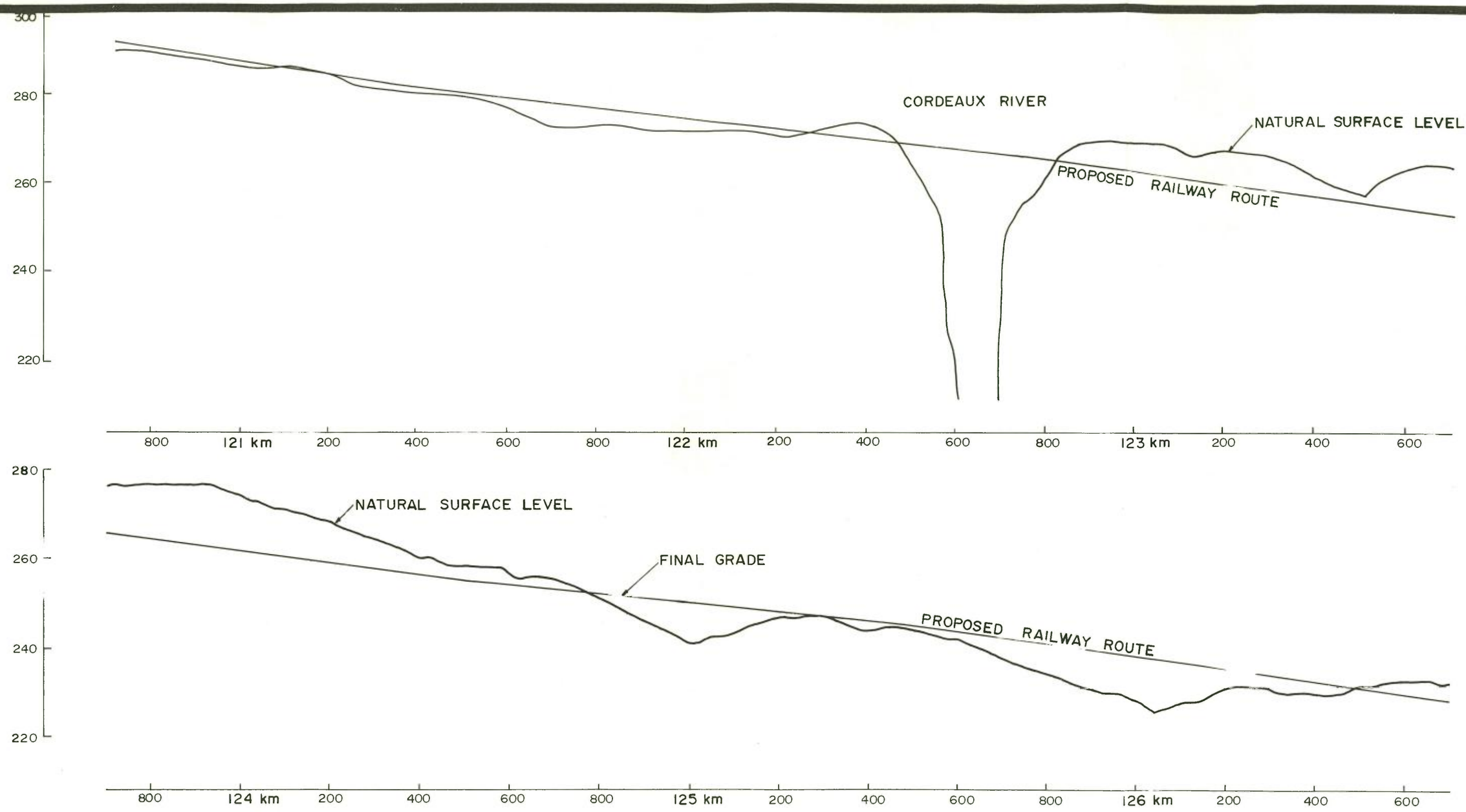


STATE RAIL AUTHORITY

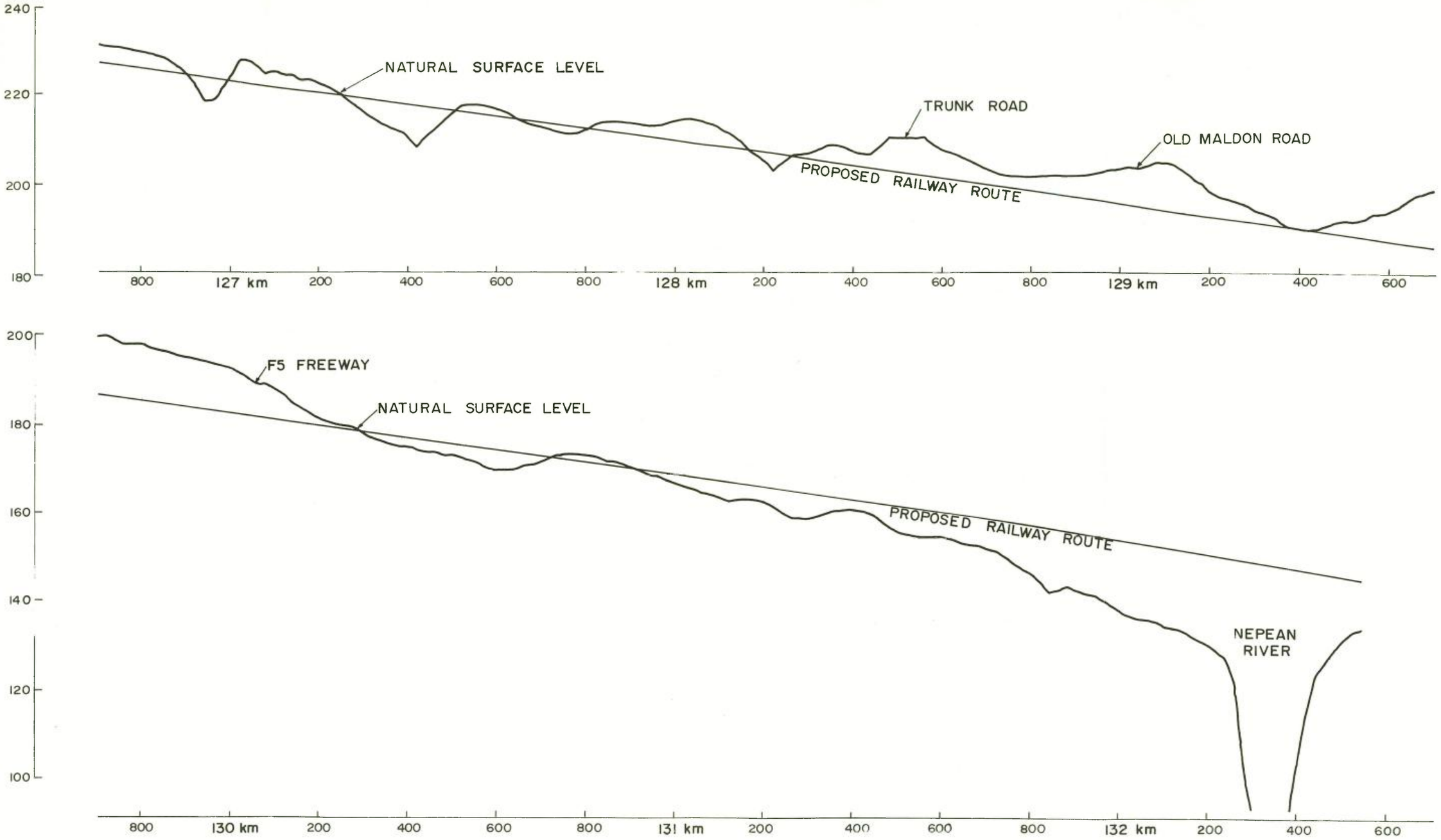
TITLE: LONG SECTION LOCATION: MALDON - DOMBARTON	FIGURE: A-16 (3)
SCALE AS SHOWN	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A.	**Dames & Moore**



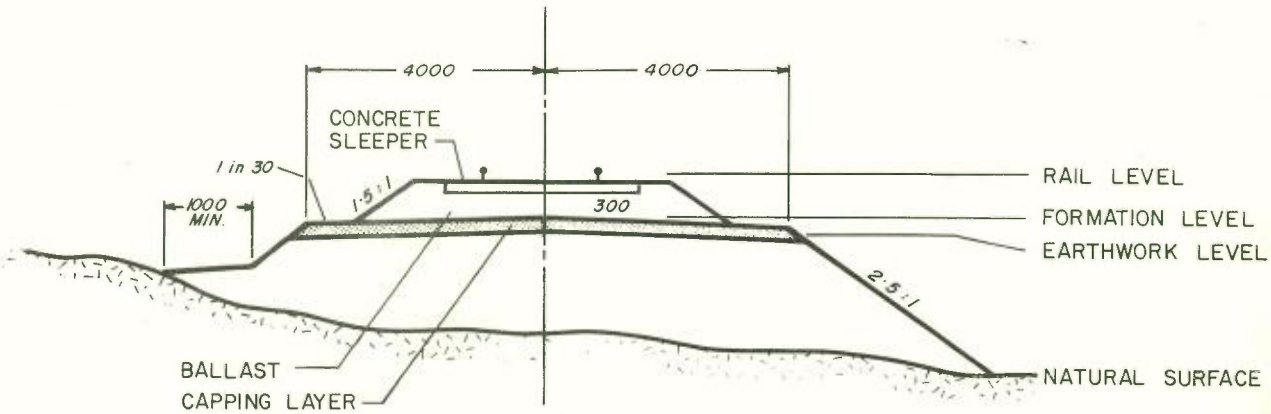
STATE RAIL AUTHORITY	
TITLE: LONG - SECTION LOCATION: MALDON - DOMBARTON	FIGURE: A-16 (4)
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A	Dames & Moore



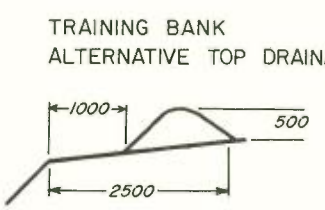
STATE RAIL AUTHORITY	
TITLE: LONG – SECTION LOCATION: MALDON – DOMBARTON	FIGURE A-16 (5)
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A.	Dames & Moore

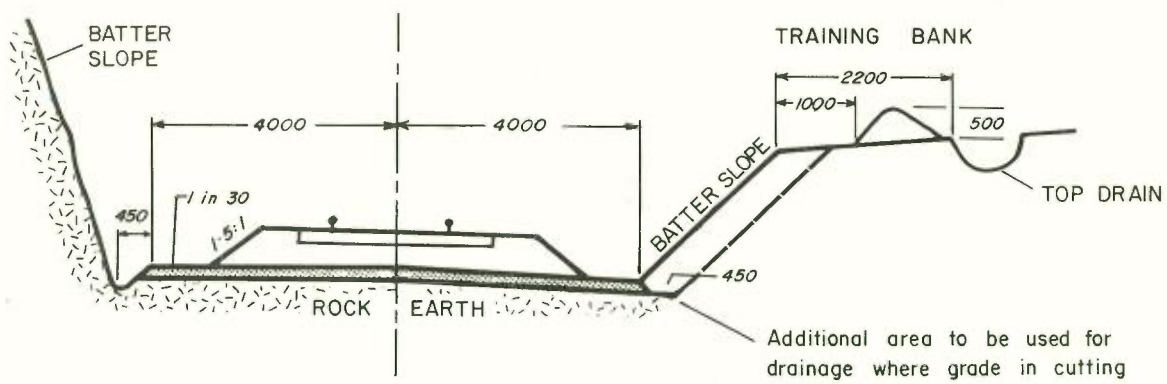


STATE RAIL AUTHORITY	
TITLE: LONG – SECTION LOCATION: MALDON – DOMBARTON	FIGURE A-16(6)
SCALE: AS SHOWN	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A.	Dames & Moore



EMBANKMENT

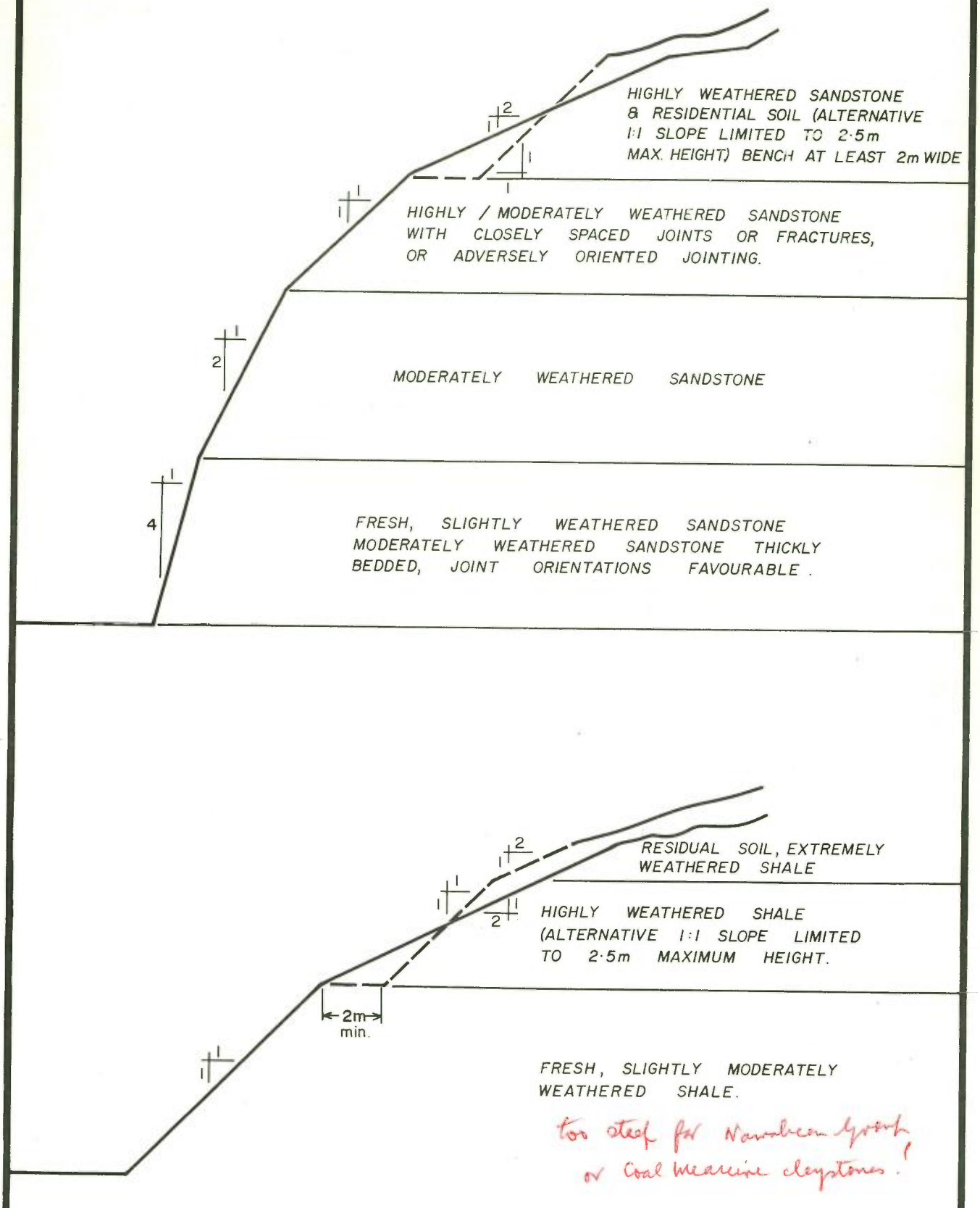




CUTTING

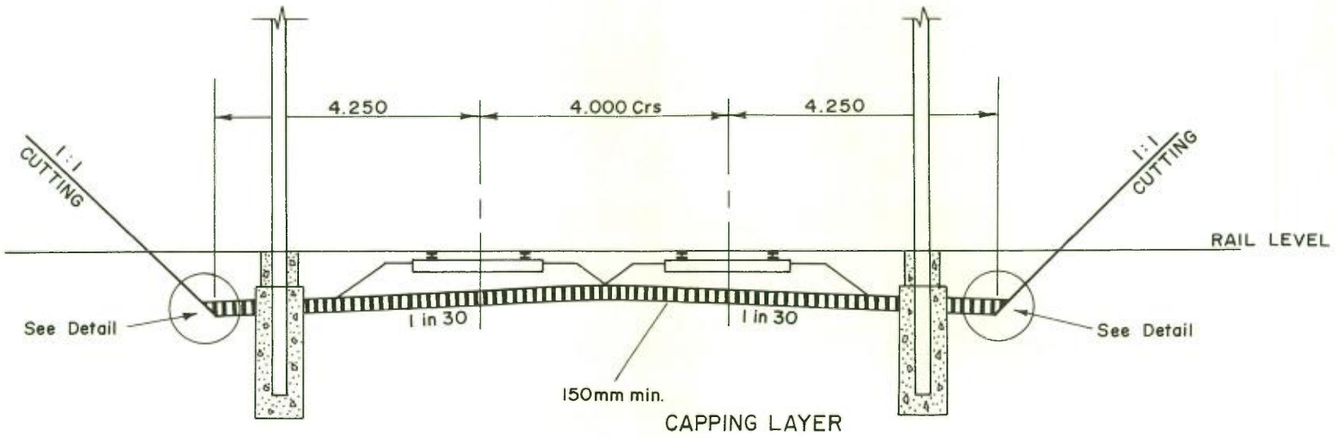
NOTE : All dimensions are in millimetres unless other wise shown.

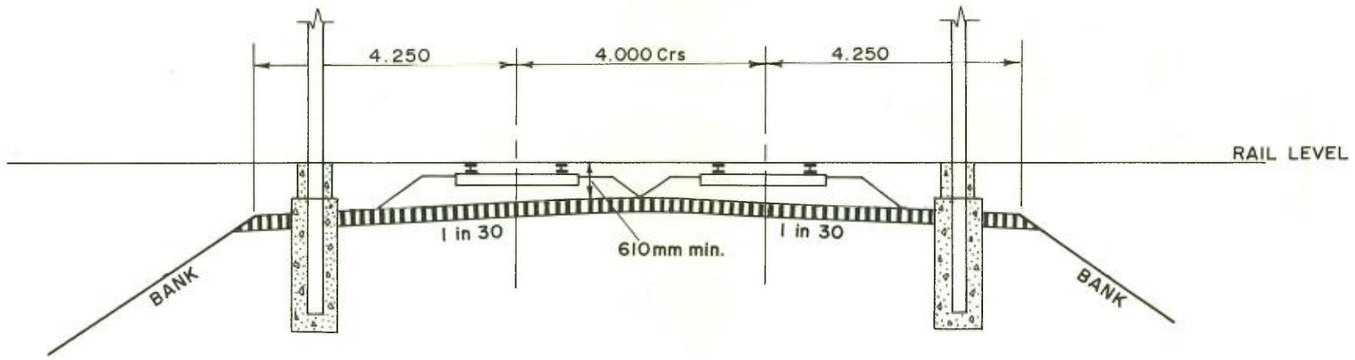
STATE RAIL AUTHORITY		
TITLE : SINGLE TRACK - STANDARD SECTION LOCATION : MALDON - DOMBARTON ROUTE		FIGURE A–17
SCALE 0 5000mm		JOB No. : 09886-004-70 DATE : MAY 1983
REF. :		



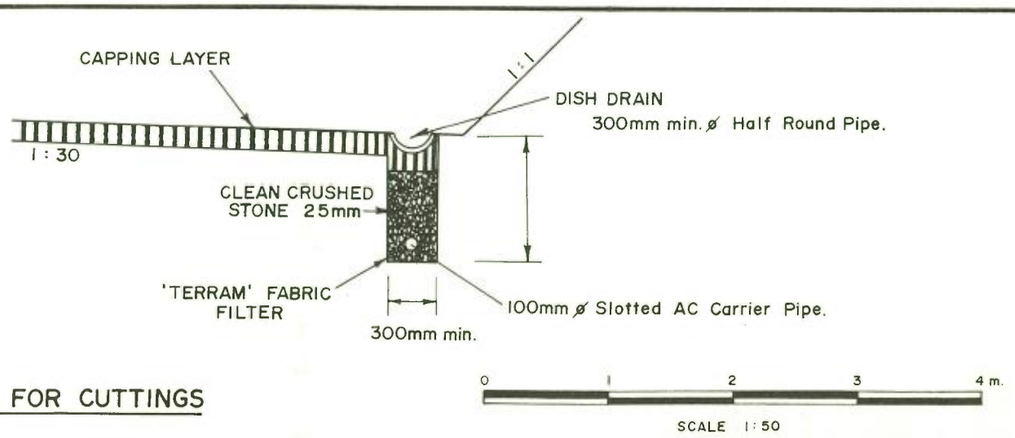
STATE RAIL AUTHORITY

TITLE : RECOMMENDED BATTERS FOR ROCK CUTTINGS LOCATION : MALDON - DOMBARTON ROUTE	FIGURE A–18
SCALE	FILE No. : 09886-004-70 DATE : MAY 1983
REF. :	Dames & Moore





NOTE: SUB SOIL DRAIN TO BE CONSTRUCTED IN CUTTINGS WHERE THE SUBGRADE MATERIAL IS CLAY SILT OR WHERE THERE IS ANY POSSIBILITY OF THE SUBGRADE BECOMING SILTY UNDER WORKING CONDITIONS. (MIN GRADE 1%) THIS WILL BE DETERMINED BY A SOILS INVESTIGATION



DETAIL FOR CUTTINGS

STATE RAIL AUTHORITY

TITLE: TYPICAL CROSS SECTION	FIGURE A-19
LOCATION: MALDON - DOMBARTON ROUTE	
SCALE: 0 1 2 3 4 5m.	JOB No. 09886-004-70
	DATE: MAY 1983
REF.: S.R.A. drawing no. P80-526	DAMES & MOORE

The route of the line has been planned to enable any future balloon loop from the proposed West Bellambi Colliery to be connected to the new line.

4.8 SIGNALLING SYSTEM

The signalling system for the proposed line and duplication section will be track - circuited automatic colour light signals and will form part of the SRA Centralised Traffic Control (CTC) Network.

The Network will be dual controlled. The Campbelltown Centre will control the working of trains between Campbelltown and Wilton.

The Wollongong Centre will control the section from the exchange siding at Wilton to Port Kembla. This will enable the efficient control and the interaction of movements between Illawarra traffic and traffic from Maldon.

Power supply to signalling will be fed by two supply systems, a main and back-up.

Cables along both sections of the line will be located underground and will be installed concurrently with line construction.

4.9 FENCING

The proposed new railway line and the duplication section of the line between Dombarton and Port Kembla will be fenced except where special considerations apply. The line will not be fenced in the Catchment Area.

Permanent fencing will normally be at a standard to contain stock. Land users will be consulted prior to construction work commencing, with regard to their requirements for fencing and gates for level crossings.

5.0 RAILWAY CONSTRUCTION

5.1 SCHEDULE AND EMPLOYMENT

The construction programme as shown in Figure A-20 indicates a desirable construction period of 33-36 months and

employment levels. Critical items in the pre-construction time are considered to be the design and documentation of the Cordeaux and Nepean River bridges. Both bridge designs can be carried out concurrently.

Current planning allows for the design and construction of the total railway, i.e. Maldon to Port Kembla. This would enable a greater proportion of western and southern coalfield coal to proceed by rail to the Coal Loader.

To get the greatest benefits from construction funds, preliminary planning indicates that the project should be constructed and commissioned in the following stages:

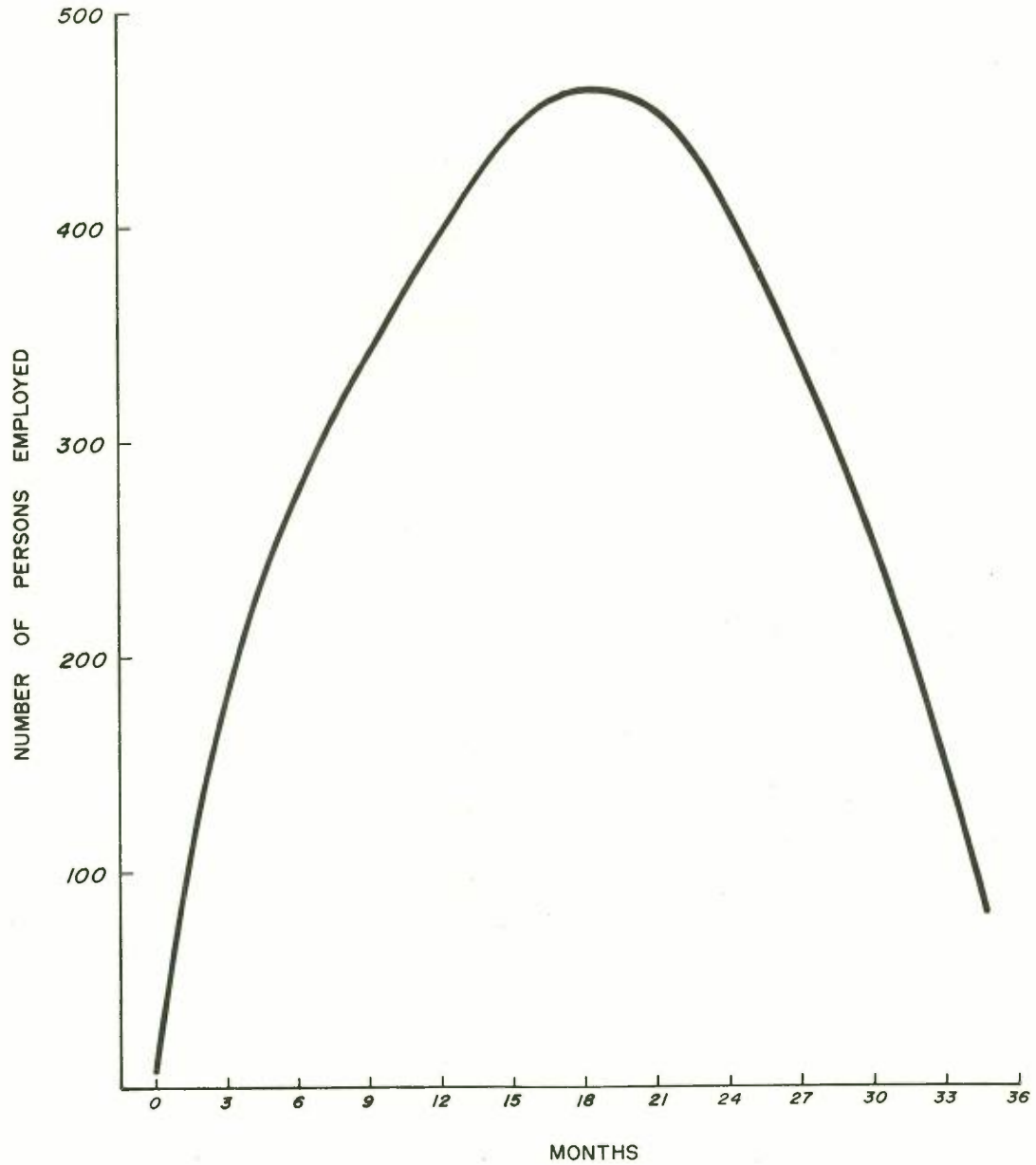
- single line construction from West Bellambi to Dombarton, to enable West Bellambi coal to be taken by rail to Port Kembla;

- Maldon to West Bellambi plus duplication of the Dombarton to Port Kembla section of railway. This will complete the project and allow for re-routing of western coalfields coal and enable Tahmoor coal to be railed to Port Kembla.

Construction operations will not require the erection and maintenance of construction camps for living quarters. Most of the construction workforce will come from nearby areas or will be able to reside in nearby urban areas.

However, contractor's working and storage areas will be required along the route. These will be fenced and catch drains provided to intercept dirty run-off water. The location of these areas will be decided in consultation with local landholders in the Maldon - Wilton area, the MWS&DB in the Catchment Area and other appropriate authorities, including the National Parks & Wildlife Service and Forestry Commission outside this area.

Once contractors have become active in the Catchment Area and adjacent to the State Recreation Area near Dombarton, controlled access points will be established to each site.



Same as Fig 5.13 Vol 1.

STATE RAIL AUTHORITY	
TITLE: ON-SITE CONSTRUCTION WORKFORCE LOCATION:	FIGURE A-20
SCALE:	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A.	Dames & Moore

5.2 CONSTRUCTION ACTIVITIES AND SUPPORT REQUIREMENTS

Many of the construction details have not yet been finalised, which therefore precludes a precise assessment of environmental impact. The SRA will retain an environmental control officer on the project management team to ensure that environmental management is effected throughout the duration of the railway design and construction.

During the construction of the railway, the SRA will maintain constant supervision of the works undertaken by the construction contractors. A superintendent will be appointed to maintain continuous inspection and ensure that all work is done to the satisfaction of the SRA. Survey checks to ensure the work is laid to the design geometry will also be carried out prior to commissioning of the line.

Major civil works will include clearing, bridging, cutting, filling, tunnelling, and spoil disposal. These are discussed below.

5.3 CLEARING

All large vegetation, stumps, logs, and property improvements within the 40 metre railway easement will be removed. Substantial trees which do not effect driver visibility or could not fall onto the lines can be left. Any of this combustible material will be removed to disposal areas and burnt. In discussions with the MWS&DB, it was agreed that, where appropriate, timber will be cut into reasonable lengths and stacked neatly for future use by the MWS&DB in picnic area fire places. Foliage and unusable timber would be reduced to ashes by burning, with excess matter being removed to a tip. Vegetation outside the Catchment Area will be burnt and excess disposed of at the local tips. Statutory requirements relating to the lighting of open fires to burn this material will be adhered to. The location of the disposal areas will be selected by the construction contractor and will not be within the MWS&DB Catchment Area. Smaller vegetation can be used as mulch to assist stabilization and revegetation.

Topsoil along the route will normally be stripped to a line about three metres outside the toes of the embankments or tops of cuttings. Care will be taken to minimise the

disturbance of areas beyond this width. The stripping will normally remove topsoil to a depth of 30 cm. Stripped topsoil will be stored in appropriate areas for later use for rehabilitation of disturbed areas, embankments and cuttings.

5.4 BRIDGES

Between the Main Southern Line and the upper portal, major bridging will be required over the Nepean and Cordeaux Rivers, the F5 Freeway and other roads near Wilton. As discussed in Section 4.3, a number of other crossings are proposed.

The SRA do not envisage any major disruption to existing traffic flows during construction of bridges and crossings.

Detailed engineering design for the major bridges and crossings have not been completed at this time. Consequently a detailed outline of the construction activities associated with these works cannot be provided. Concrete for bridge construction and concrete culverts will be supplied by commercial operations in adjacent centres.

5.5 EARTHWORKS

To maintain the required design gradients along the railway route, a considerable amount of earthwork must be conducted in the form of cut and fill. Heavy earth moving equipment will be used for this purpose as specified in the detailed design of the line. Front-end loaders, scrapers, bull-dozers and trucks are commonly be used for earthworks. As far as practicable, this equipment will be restricted to the route during the construction period.

For the single line, the width of the shoulder on which the ballast and rails will be laid and a parallel access track contructed is about 12 metres. The shoulder width for a single line and siding is about 16 metres. Half-metre wide drains will be established at the base of both sides of the shoulder in the cutting.

Details regarding the method of duplication of the railway between Dombarton and Unanderra can only be determined following a geotechnical investigation of the slope stability of rock cuttings and the large embankment widenings necessary for duplication. This investigation is being undertaken and

will primarily indicate which side of the existing track duplication will occur.

Areas of steep side slope near the eastern tunnel portal may require a structural solution instead of earthfill for track support. Instability of talus slopes in cut areas may dictate duplication of trackwork on the downhill side rather than the uphill side where duplication at present is considered more likely.

Excavating techniques used will be suited to the geological formation being excavated. Where explosives are used, the charges will be so proportioned and placed that they will not loosen material outside the excavation profile. Many deep cuttings are rippable by dozer, a technique which will be adopted wherever feasible. The Sydney Water Supply Tunnel which crosses under the proposed line in the Wilton area, is an inclined rock tunnel and is sensitive to blasting. No blasting will be undertaken in the vicinity of this tunnel.

No blasting will be undertaken in the Wilton area, the area between Farmborough Heights and Port Kembla and in the vicinity of other residences, except for minor "popping" of any floating boulders encountered.

Excavated material from the cuttings and tunnel will be loaded onto trucks by front-end loaders and used as fill for embankments. The excess material will be placed on embankment batters to flatten their angle and thus reduce the erosion potential. Some excess material will be placed in disposal areas.

Construction of the embankments will be done in several stages. After clearing, the entire areas on which the embankments are to be placed will be throughly scarified. A layer of foundation material will be spread over the scarified bed and compacted to specific requirements. Suitable fill material will be placed in horizontal layers and compacted. Where necessary, water will be sprayed over embankment material to obtain the to enable the specific degree of compaction to be obtained.

At the intersection of cut and fill, the soil exposed at formation level will be removed for the width of the formation, to a depth of about 80 cm. This excavation will

be replaced by suitable material and compacted to the specified density.

Excavated material from the tunnel is required to be disposed of from both ends of the tunnel. It is proposed to fill some areas of SRA land around the Dombarton Loop with excavated material.

The cut and fill balance and the requirement for disposal of material from the tunnel within the MWS&DB Catchment Area, indicates there will be surplus fill near the tunnel portal and a deficit at the Wilton end. Material will be transported to minimise the need for borrow areas and spoil disposal areas. Areas, indicated in Figure A-5 have been identified for the location of spoil disposal and possible borrow areas.

Excess cutting material will require transportation to the nominated spoil disposal areas on the ridge tops within the Catchment Area. It is expected that the principal access route will be along the existing road servicing the Wongawilli Colliery fan shaft.

During the detail design phase, refinements in earthworks will occur to achieve a balance. The railway cuts and fills will be balanced economically where possible.

Between Maldon and the Cordeaux River Crossing cut and fill areas will, if possible, be adjusted in width to ensure balance. The details of balance at this stage are however not available, as they will be dependent on detailed designs. A preliminary evaluation is given in Table A.1.

5.6 TRACK LAYING

The new track structure will be constructed by a mechanised track-laying procedure based on large machines handling rails, sleepers and fastenings.

The ballast will be packed and profiled under and around the sleepers using precise lifting, packing, levelling and lining equipment. This will be followed by the temperature stressing and welding of rails into a continuous length.

Rails and sleepers are loaded onto the track laying machines directly from rail wagons which are positioned on the

TABLE A.1

PRELIMINARY EARTHWORKS QUANTITIES

LOCATION	CUT (m^3)	FILL (m^3)
Maldon - Tunnel		
Main South - Nepean River	1,000	105,000
Nepean River - F5	100,000	140,000
F5 Freeway - Wilton Sidings (north end)	245,000	40,000
Wilton Sidings - Cordeaux River	375,000	0
Cordeaux River - 119.900 km	5,000	60,000
119.900 km - 114.800 km	560,000	10,000
114,800 km - 111.300 km	85,000	35,000
111.300 km - 107.880 km	0	330,000
130.640 km - West Portal of Long Tunnel (includes quantities from short tunnel)	770,000	35,000
TOTAL	3,271,000	1,200,000
Tunnel - Unanderra		
Unanderra Stn - Princes Highway	2,300	1,000
Princes Highway - Farmborough Heights (89.2 km to 92.5 km)	61,500	15,800
Farmborough Heights - East Tunnel Portal (92.5 km to 98.3 km approx.)	65,000	20,1000
TOTAL	128,800	37,000

Tunnel 3·5km x 6·5 x 6·5m = 150,000 m^3

recently laid line behind the laying machine. These wagons will have transported the rails from the major stacking area.

The work will be carried out during daylight hours with minimum noise levels from the machines.

Some material handling areas will be required while the work is in progress.

5.7 DRAINAGE AND EROSION CONTROL

Construction and operation of the proposed railway must be within the statutory requirements regarding water quality of the SPCC and MWS&DB. Consultations have been held with officials of both organizations concerning these requirements. The environmental control officer on the project management team will be required to liaise with the civil design team and relevant authorities to ensure that drainage and erosion control are to acceptable environmental criteria and standards. Once design of the proposed railway is completed, it will be reviewed by the MWS&DB, SPCC and Soil Conservation Service to check that their requirements have been incorporated in the design.

Throughout the entire works, a drainage system will be established which at all times will drain water directly off or keep water away from all structures, formation, access roads, cuts and fills, and work areas. The drainage system will ensure that no damage is caused to structures associated with the railway, the pattern of flow on neighbouring land is not adversely altered, soil erosion is minimised, and that water rights of neighbouring landowners are not affected.

As part of the drainage control system, drains will be formed at the toes of batters on both sides of all cuttings and in benches of cuttings. Drains will also be established at the tops of cuttings where land slopes towards the cutting, to divert water from the cutting faces. Similarly, drains will be established at the toes of embankments where land slopes towards the embankments. Outlets will be directed to natural waterways.

Apart from provision of adequate drainage to channel water away from exposed earth, soil erosion measures will also include grassing of all earth-faced embankments and cuttings, and all major earth drains and levee banks. Grassing will

minimise the possible failure of cuttings or embankments by slumping which would then disrupt railway movement. Grassing will also minimise any increase in turbidity levels in farm dams and MWS&DB stored waters caused by erosion.

All areas to be grassed will be covered with about a 15 cm layer of topsoil. The topsoil will be taken from storage dumps where it had been previously deposited during clearing operations. After spreading, the topsoil will be treated with fertiliser and then consolidated. A grass seed mixture approved by the Soil Conservation Service will be applied at an approximate rate of 50 kg/ha to provide a rapid vegetation covering. Following sowing, the seeded areas will be well-watered. Watering will be conducted in such a manner as to avoid excessive localised ponding which could wash-away the newly sown seeds. Upon completion of grassing, maintenance will be continued to ensure that the grass seeds have germinated and commenced to form a vegetative cover which will miminise soil erosion.

Within the MWS&DB boundary, the SRA will examine the feasibility of using native grasses and plants to vegetate the exposed earth in order to eliminate the introduction of exotic species into the large area of predominantly natural habitat. No mulch material will be introduced into the area which could contain weeds or exotic plant species. Small native vegetation cleared from the area before construction will be used as mulch.

Any necessary borrow areas will be restored by grading to permit normal surface drainage, covered with topsoil, and vegetation. Upon removal of temporary buildings from construction areas, these sites will also be covered with topsoil and vegetated.

The land in the Maldon to Wilton area remaining within the 40 metre railway line easement, not taken up by the formation or batters, will be cleared to serve as a firebreak, as there is a very slight fire risk caused by sparks from the locomotive and wagon brakes. The SRA is required to take practical measures to prevent the occurrence of fires, and to minimise the danger of the spread of fire, on or from its land.

In the Catchment Area, the extent of clearing will be determined in consultation with the MWS&DB. On the section of duplicated line between Dombarton and Farmborough Heights,

clearing will be on a selective basis with due regard to environmental and stability requirements.

5.8 CAPPING AND BALLASTING

After finishing the cut and fill to the required profile and establishment of the formation to the specified grade, a natural or processed gravel capping will be placed on the formation to a compacted thickness of about 20 - 30 cm to enhance formation stability and minimise erosion. If suitable capping material cannot be gained from the cutting and tunnelling works, it will be obtained from readily-available commercial sources.

Ballast material will be placed over the capping into which concrete sleepers will be laid.

5.9 TUNNELLING AND VENTILATION

Tunnel construction is envisaged as being driven from the western portal for half the tunnel, the other half driven from the eastern portal in conjunction with trackbed being placed in the western half. After holing through, trackbed construction would continue into the eastern half of the tunnel.

Stannell Park

In claystone strata, shotcrete will need to be applied at the tunnel face with the remainder of shotcrete lining (on sandstones and shales) applied after excavation is completed.

As indicated previously, the need for tunnel ventilation has yet to be determined. Several alternatives are being considered, ranging from no forced ventilation and examining its requirement under operational conditions, to installation of three forced air ventilation shafts at roughly equal intervals along the tunnel route.

5.10 ACCESS ROADS

All-weather access roads to all parts of the route from public roads will be established for both railway line construction and maintenance purposes. Their routes have not yet been finally determined but will be in accordance with the requirements of relevant Authorities.

If necessary, permission will be sought from landowners to use private roads and tracks to gain access to the construction site. Where these private roads are used, they will be properly maintained during the railway construction and restored to the property owners's satisfaction upon work completion. Use of these roads by their owners will not be restricted.

Within the Catchment area, construction access will be obtained from existing roads and fire trails. These will be upgraded to enable use by heavy equipment. Where existing roads have to be relocated because of construction activity, alternative access roads will be provided. New access roads will be required to the Cordeaux River Crossing and the area around the Western Tunnel Portal.

Access during construction to the Western Tunnel Portal will be via Wongawilli Colliery ventilation shaft access road and then a short new track generally following grades of less than 10% to the western portal. At the Dombarton end access would be via local roads to the railway and then along the railway reserve near the portal. A flat area to the north of the existing line near the portal would be used as an establishment area.

Access to the portal at Flying Fox No.1 Creek would be by means of a track extending from the existing tracks under the high voltage power lines to the Avon Pump Station at a grade of about 1 in 8 to the portal area.

5.11 RELATIONS WITH ADJOINING LAND USERS

During construction of the proposed railway line every effort will be made to avoid causing inconvenience to land users through whose land the line will pass. Construction activities will not conflict with the normal activities of land users adjoining the line. Access roads and crossings will be provided early in the construction period to avoid any disruption to landholder activity. Private rail crossings will be installed where required to permit safe crossing of the site.

The SRA or its construction contractors will assume responsiblity for the safety of stock on and near the site. Every effort will be taken to prevent pollution of waterways, dams and grass areas which may in turn affect the value or

health of stock. Where such damage does occur, it will be rectified.

5.12 LAND ACQUISITION

It will be necessary to acquire land in the Maldon - Wilton area to provide an easement for and access to the proposed new railway line.

Land acquisition cannot take place until approval is granted to construct the line.

Acquisition is generally through an offer to purchase and the negotiation on price. However the SRA does have the authority to proceed with resumption where necessary under the Public Works Act. In this case the landholder claims for compensation.

Compensation monies are calculated and paid under the following categories:

- market value of land resumed at the date of resumption;
- severence including compensation for bisecting a property;
- disturbance or inconvenience caused during construction and/or operation of the railway.

Through the MWS&DB Catchment Area the land on the route will probably be a reservation or easement subject to Board conditions. At this stage it is not proposed to acquire any land along the Dombarton to Port Kembla section of the line except for a small portion of land at Dombarton.

A Schedule of Conditions Applicable to The Construction, Operation and Maintenance of Railway Lines on Catchment Areas has been prepared by the MWS&DB. A copy of this Schedule is included as Appendix J.

6.0 RAILWAY OPERATIONS

Enabling legislation in respect to the railway is currently being prepared. The construction programe will commence in December 1983 for completion about 3 years later, subject to satisfactory funding arrangements.

6.1 CAPACITY

The capacity of the proposed new railway is based upon its designation as a single line with passing loops. The line's ultimate capacity is 24 train paths per day each way.

The line is designed to be able to carry 24 loaded trains to the Port and return the 24 empty trains in a 24-hour day. In practice, this may be less, and will operate as required seven days per week. Trains will generally be spaced evenly. Of these 24 loaded trains, a maximum of seven will come from the Tahmoor - Bargo coalfields.

The single line section, Maldon to Dombarton has a capacity for 24 trains per day in each direction but this track capacity will not be reached until after the year 1990.

On current projections, the number of coal trains using the Maldon Port Kembla Railway, pre 1991 will average eight or nine trains per day in each direction, giving a total haulage of 6 to 6 1/2 million tonnes/annum.

Of these coal trains, one or two would load at West Bellambi (if operating) with a further one or two from Tahmoor and the remainder from the Burragorang and western coal fields.

As well as coal trains, the section from Dombarton to Unanderra would carry the trains proceeding to and from Moss Vale.

The SRA will, when desirable, operate other freight trains over the line.

The traffic between Unanderra and Moss Vale will continue to use that line and will match in with coal trains between Unanderra and Dombarton.

6.2 TRAIN OPERATIONS

Coal trains will be powered by two or three main line locomotives. They will be either diesel/electric or electric.

No additional rolling-stock will be purchased for the line. The locomotive fleet both present and future will be used as

required on it. Three locomotives coupled together will haul 31 x 100 tonne gross coal wagons.

Locomotives will be equipped with two braking systems, each individually capable of stopping the train. Normal air-operated friction braking systems will operate on the wheels of both locomotives and wagons. Each electric locomotive will have regenerative braking whereby the braking effort is applied by the locomotive traction and the electric power so generated is fed into the overhead wiring system.

As well as friction brakes, diesel-electric locomotives have dynamic braking whereby the electric traction motors are used as generators, with energy being dissipated in a fan cooled bank of resistors.

The SRA's standing instructions on train braking will apply to this line to ensure safe train operation.

6.3 MAINTENANCE

Preventative maintenance of rolling stock will be undertaken at Port Kembla. Other maintenance will be carried out at Lithgow or Enfield depending on the type of work required. No expansion of existing facilities will be required.

As the line is constructed of concrete sleepers, minimum maintenance will be required. Regular line inspections will be made by a two man gang rail car. This will attend to minor matters involving small hand tools. Once a year a more comprehensive maintenance inspection will be undertaken.

Longer frequency maintenance at two and four year intervals consisting of large track tamping and lining machines proceeding along the entire track and progressing at a rate of six km per week. These machines conform with noise and safety requirements for industrial machinery.

The SRA will maintain the boundary fencing on either side of the line where constructed. Repairs will be undertaken in conjunction with routine line maintenance or as soon as possible after any accidental damage to the fence. Access gates will be similarly maintained.

There will be track maintenance staff of about six to regularly examine and perform minor repairs. This gang will be employed and based at Unanderra.

Movement of trains over the line will be controlled from an operator at Campbelltown and at Wollongong.

6.4 VEGETATION CONTROL

Vegetation control, including weeds, is an important aspect of on-going operations.

As part of safety requirements and action taken to minimise bushfire risk, vegetation is controlled adjacent to railway lines. The provision of clear vision and an uninterupted line of sight for the locomotive driver is of prime concern.

Vegetation is controlled chiefly by chemical treatment. An annual control programme will be implemented once construction of the line has been completed. The SRA has experience with the selection of vegetation control chemicals. Only chemicals approved by the MWS&DB will be used in or on land adjacent to the Catchment Area.

Noxious weed control will be undertaken as appropriate. Within the Catchment Area, provided care is exercised in relation to any soil mulch material introduced during the construction phase, little difficulty with weeds is anticipated. In agricultural areas, similar practices to those employed by local landholders will be followed.

Because of the sensitivity of the undeveloped areas between Dombarton and Unanderra, special care will be taken to ensure a satisfactory vegetative cover is retained adjacent to the line. Vegetation control along the line adjacent to residential and commercial areas from Farmborough Heights to Port Kembla is important from a visual concern and for safety purposes.

6.5 BUSHFIRE CONTROL

The Clean Air Act, 1961 is binding on the SRA. All railway property is listed as "scheduled" premises and the provisions of the Act apply.

The effect of this is to restrict the use of fire for the disposal of matter in specified areas by the SRA. It also requires the reduction of bushfire hazard by mechanical means whenever practical. However burning-off as a means of reducing the fire hazard in non-urban areas is not affected by the Clean Air Act conditions.

This means that fire hazard reduction in or adjacent to urban areas is generally achieved by moving and cutting vegetation. In rural areas controlled burning-off is the most common practice.

Burning-off practices are carried out in accordance with the Bush Fire Act 1949. Railway regulations require the construction and maintenance of a firebreak on all property boundaries of at least two metres wide with cross breaks at 500 metre intervals.

Fire control and prevention measures will be developed and implemented in association with local landholders, bushfire authorities and the MWS&DB. In the areas adjacent to the Kembla State Forest and State Recreation Area, work will be undertaken in conjunction with the Forestry Commission and National Parks and Wildlife Service.

Sufficient suitable fire fighting equipment will be kept on the site ready for use at all times. Any fire bans will be strictly observed. In the MWS&DB Catchment Area, existing fire trails will be maintained or replaced. Level crossings will be constructed at appropriate intervals to enable access to both sides of the track. This will be undertaken in consultation with the MWS&DB.

Elsewhere, existing access tracks will be maintained or improved and will continue to provide access for fire control.

During the construction period, all necessary precautions for the safety of the construction workforce appropriate to the nature of work performed, and in compliance with all statutory requirements, will be undertaken. Adequate first-aid facilities staffed by a qualified person will be established in a convenient location having regard to the construction operations and distribution of the workforce.

APPENDIX B

LAND STUDIES

APPENDIX B : TABLE OF CONTENTS

APPENDIX B : LIST OF FIGURES

APPENDIX B : LIST OF TABLES

1.0 GEOLOGY

1.1 STRATIGRAPHY

The generalised geology of the region in which the proposed new railway line is located has been mapped by the Department of Mineral Resources. A generalised stratigraphic sequence is presented in Figure B-1.

The proposed railway line is located within the southern part of the Sydney Basin. The dominant surface lithology is sandstone of the Hawkesbury Sandstone Formation. This material is characterised by massive and bedded quartzose sandstone with a high resistance to weathering. Interbedded claystones and siltstones occur within the Hawkesbury Sandstone.

Overlying the Hawkesbury Sandstone and capping the crests of hills are the shales and minor siltstones of the Wianamatta Group. Underlying the Hawkesbury Sandstone are the shales, claystones and sandstones of the Narrabeen Group. Underlying this Group are the Illawarra Coal Measures which consist of sandstones, shales and coal seams. At the base of the escarpment the Illawarra Coal Measures are covered by a combination of material eroded from the escarpment and material deposited from marine sources.

1.2 STRUCTURE

Structural interpretation based on drilling results and on the distribution of the Wianamatta Group sediments indicated that the regional bedding of the sedimentary strata of the plateau is relatively uniform, and dips towards the north-northwest with an average dip of two degrees (2°).

Along the Illawarra Escarpment several large and numerous small faults and folds have been identified, both along and at right angles to the escarpment. Flying Fox No.2 Creek, at the western portal of the proposed Dombarton tunnel has developed along two parallel faults. Two basic dykes within the Wongawilli Seam (1.2 m and 0.9 m wide respectively) cross the tunnel alignment (SRA and GHD, 1982).

Major joint patterns in the Hawkesbury Sandstone have strongly influenced major water course alignments (e.g. the Nepean River) within the Sydney Basin.

Subsidence in the study area, resulting from underground mining, is a potential impact and minor constraint upon the project design. The engineering aspects of this impact have been discussed in Appendix A.

1.3 SEISMICITY

Since 1900 there have been 17 earthquakes of magnitude 6 or greater on the Modified Mercalli Scale within the Australian continent (Denham 1976a). Seismic events which occur in eastern Australia tend to be associated with the Tasman Geosyncline. There are no significant major lineations of earthquakes within this geosyncline; instead a diffuse distribution of shocks have occurred. One area of these clusters is the southern margin of the Sydney Basin, over which the proposed railway line will pass.

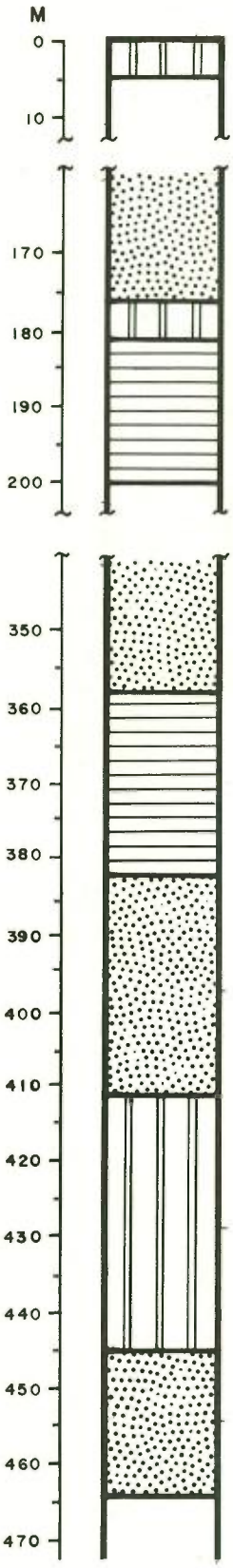
Two earthquakes of signficance have been recorded in relatively close proximity to the proposed line. On May 21, 1963 an earthquake of 5.5 magnitude (Modified Mercalli Scale) occurred at a depth of 19 km with its epicentre about half way between Robertson and Bowral (Cleary and Doyle 1976). Another earthquake of the same magnitude occurred on March 9, 1973 which was centred some 20 km below the southern end of Lake Burragorang (Denham 1976b).

Although the southern margin of the Sydney Basin is recognised as being one of two areas of high seismic activity within N.S.W., the order of magnitude and frequency of occurrence of earthquake activity is low when compared to other parts of the world with high seismicity. The seismic risk below Lake Cordeaux of an earthquake of magnitude greater than 6 on the Modified Mercalli Scale, a magnitude at which severe damage could occur, is about 1:1000.

1.4 ENGINEERING GEOLOGY

As part of earlier railway route feasibility investigations, geotechnical assessment used available geological and geotechnical data supplemented by some site inspection, limited seismic surveying at deep cutting locations and air photo interpretation at all major structure locations, especially the bridges and the tunnel.

This assessment examined geological features such as strata types and characteristics, the incidence of fracturing and



WIANAMATTA GROUP	5 m	Occurs as capping on crests of hills. Predominantly shale but with some siltstone.
HAWKESBURY SANDSTONE	170 m	Occurs over most of the area. Consists of massive bedded quartzose sandstones with minor shale lenses and bands.
GOSFORD FORMATION	6 m	Shales with a few beds of quartz lithic sandstone.
BALD HILL CLAYSTONE	19 m	Claystones with a few bands of lithic sandstones.
BULGO SANDSTONE	158 m	Lithic and quartz lithic sandstone with minor shales.
STANWELL PARK CLAYSTONE	24 m	Claystone, siltstone and minor lithic sandstones.
SCARBOROUGH SANDSTONE	29 m	Quartz lithic and lithic sandstones and lithic conglomerate.
WOMBARRA SHALE	34 m	Shales and siltstones
COAL CLIFF SANDSTONE	19 m	Quartz lithic sandstone with minor shale lenses.

NOTE – EXCEPT FOR THE WIANAMATTA GROUP, DEPTH MEASUREMENTS ARE FROM DIAMOND DRILL HOLE I-32, WHICH IS 350 m WEST OF THE WEST CLIFF-4 SHAFT.

STATE RAIL AUTHORITY

TITLE: STRATIGRAPHIC SEQUENCE - LOCAL GEOLOGY LOCATION: MALDON - DOMBARTON ROUTE	FIGURE B-1
SCALE	JOB No. 09886-004-70 DATE: MAY 1983
REF.: GHD	Dames & Moore

joint patterns, bedrock and surface weathering and potential erosion and stability behaviour.

Thorough field investigations will be conducted during the detailed design stage to confirm conclusions upon which the preliminary design has been based.

The following discussion outlines the preliminary engineering geology assessment, which was undertaken as part of railway feasibility investigations by Gutteridge Haskins and Davey Pty Ltd (1982), and major structures and features of the proposed railway.

1.4.1 Surface Route

The route within the Metropolitan Catchment Area is generaly flat to gently sloping elevated terrain, ridge crests and low hills of Hawkesbury Sandstone.

An influence on the stability of the surface route is that of potential subsidence induced by coal mining. This issue is discussed in Section 5.0.

1.4.2 Nepean River Bridge

The Nepean River at the locality of the proposed bridge has cut a deep narrow valley course down into the Hawkesbury Sandstone. The height of the valley sides ranges between about 55 metres (northern side) and 63 metres (southern side). A cross-section of the inferred geology at the crossing is shown in Figure B-2 (GHD 1982).

Massive to thickly bedded Hawkesbury Sandstone, up to about 2 metres thick, outcrops in both sides of the valley. The sandstone forms prominant vertical cliffs, with the river alignment being controlled by regional joint patterns.

The lower slopes of the valley sides slope at about 25° to the river and are covered by large sandstone boulders and very sandy talus debris. There are no signs of any large-scale instability of the valley sides. The presence of weaker rock units, most likely more thinly bedded sandstones or possible shales, within the vertical stratigraphic sequence has been responsible for the present slope characteristics.

Slightly faster weathering of the weaker layers results in undercutting of the stronger cliff forming sandstones and the ultimate collapse of large joint controlled blocks of rock to the base of the cliff.

Frequent or continuous removal of the talus from the base of the valley, by river action, allows the cycle of undercutting and collapse to continue at a very slow rate. The long term result is a "parallel retreat" of the cliffs away from the river, and the formation of more extensive slopes and thicker talus cover on the less resistant rock layers.

1.4.3 Cordeaux River Bridge

The geological and geomorphological conditions at the proposed Cordeaux River crossing are similar to those at the Nepean River crossing.

The location of the proposed Cordeaux River bridge is suitable for the form of construction envisaged, and is free of major foundation stability problems. The river alignment at the location is strongly controlled by regional joint patterns in the sandstone and the existence of vertical rock joints parallel to the river should be expected. A schematic section of inferred geology of the river crossing at this location is shown in Figure B-3 (GHD 1982).

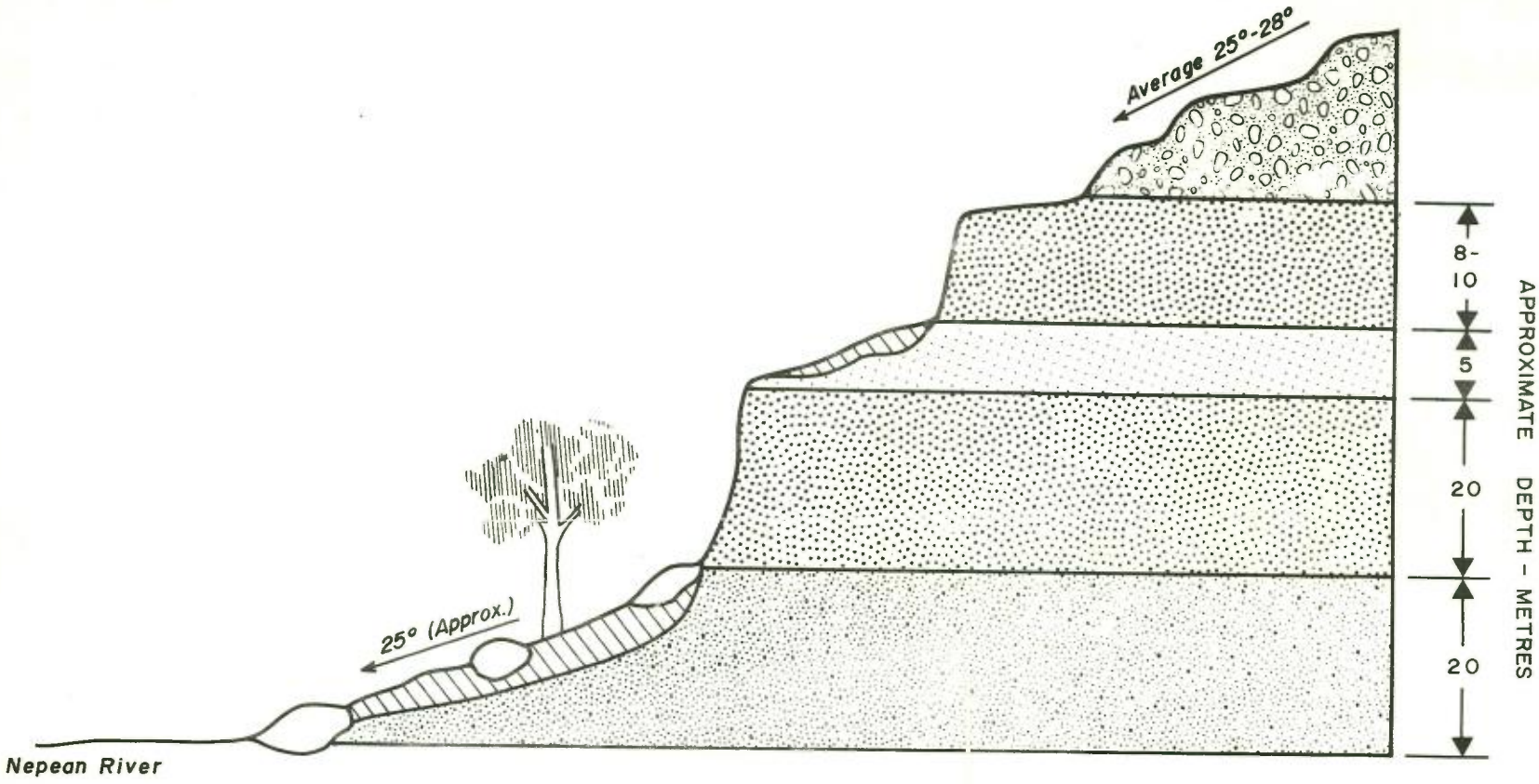
1.4.4 F5 Freeway Crossing

At the crossing of the F5 Freeway, the topography is characterised by denuded rolling hills of gentle to moderate slope and moderate relief (10-20 metres), underlain by Ashfield shale.

The route passes under the F5 Freeway by means of a "cut and cover" underpass which will involve excavation to a depth of about 8 metres.

1.4.5 Cuttings

Along the proposed route there are a number of areas of significant cuttings. The route is described in Appendix A.



THIN TALUS

WEATHERED SANDSTONE WITH THIN SANDY SOIL & BOULDERS

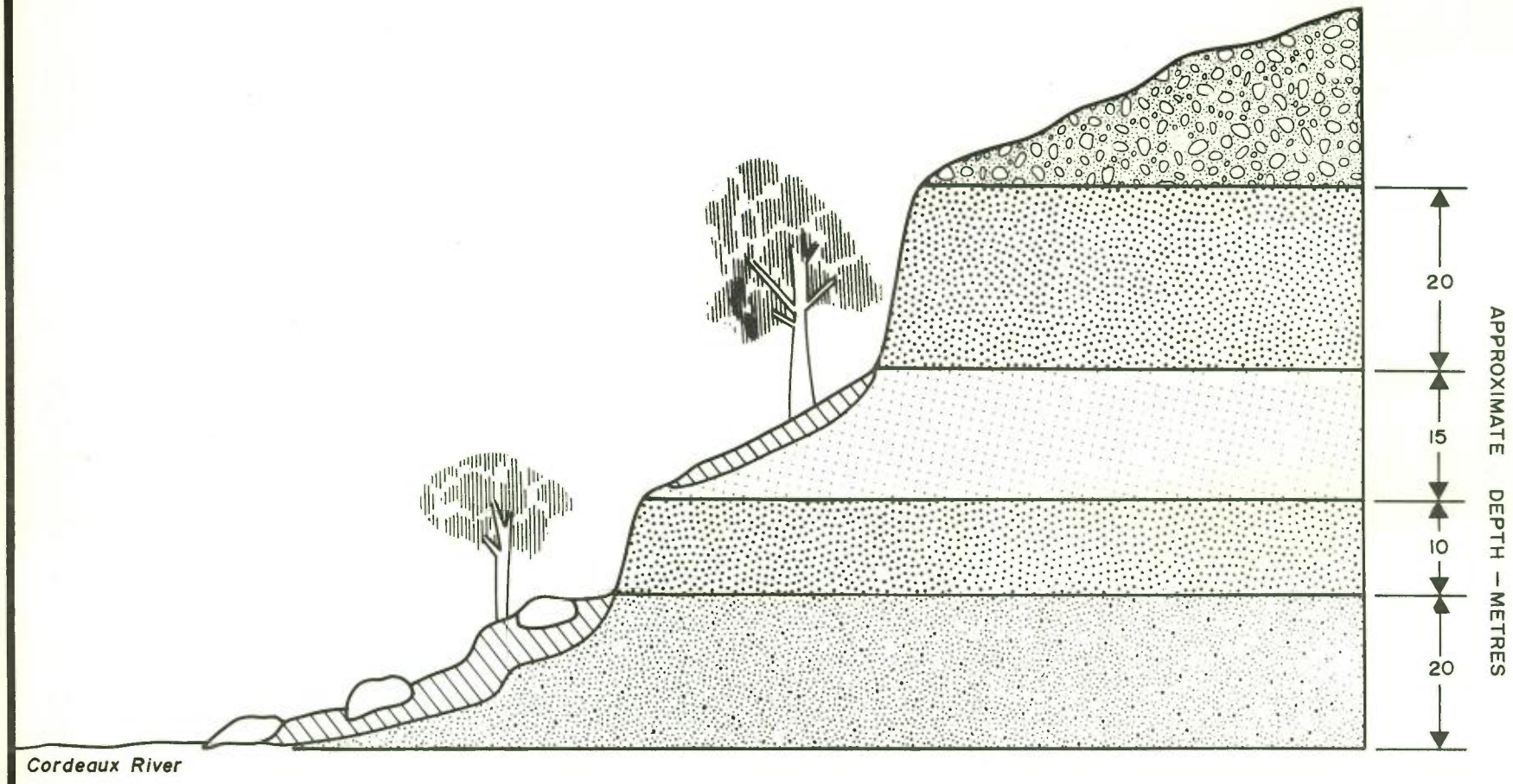
STRONG SANDSTONE

WEAK SANDSTONE POSSIBLY CONTAINING SHALELY LAYERS

WEAKER & STRONG SANDSTONE INTERLAYERED, MASKED BY TALUS & SOME FLOOD DEBRIS

STATE RAIL AUTHORITY

TITLE / LOCATION	INFERRED GEOLOGY - NEPEAN RIVER, SOUTHERN BANK MALDON - DOMBARTON ROUTE	FIGURE B-2
SCALE		JOB No.: 9886-004-70 DATE: MAY 1983
REF.: GHD		Dames & Moore



TALUS

WEATHERED SANDSTONE WITH THIN SANDY SOIL & BOULDERS

STRONG SANDSTONE

WEAKER SANDSTONE (THIN TALUS COVER)

WEAKER OR SHALELY SANDSTONE, POSSIBLY WITH STRONGER BEDS INTERLAYERED, MASKED BY TALUS.

STATE RAIL AUTHORITY

TITLE / LOCATION	INFERRED GEOLOGY - CORDEAUX RIVER, WESTERN BANK MALDON - DOMBARTON ROUTE	FIGURE B-3
SCALE		JOB No. 9886-004-70 DATE MAY 1983
REF.: G H D		Dames & Moore

1.4.6 The Dombarton Tunnel

The proposed alignment passes under the Illawarra Range by means of the Dombarton Tunnel which for much of its length has over 100 m of cover. The western portal is located in Flying Fox No.1 Creek and the eastern portal in the valley of a small creek along-side the Moss Vale - Unanderra Railway, 1 km west of Dombarton Crossing Loop. The conceptual design is discussed and alternatives outlined in Appendix A.

The Flying Fox western portal site is near the bottom of a V-shaped valley with numerous sandstone outcrops. Negligible quantities of talus lie on the valley sides, and minimal thicknesses of sandy soil occur in pockets between the sandstone outcrops. The slope at the proposed portal is steep enough for good portalling conditions. Above the portal the slope flattens to about 15 degrees which means negligible chance of rockfalls from above the portal.

The Dombarton eastern portal site is in a vertical face of Scarborough Sandstone beside a small creek whose floor is about 20 m wide alongside the Moss Vale - Unanderra Railway. The rail cutting immediately east of the portal will be widened to give access to the open flat land between this cut and the Dombarton Loop. The portal site itself is comparatively free of talus and the slope flattens off about 10 m above rail level, so that the site is free of landslide risk.

The sequence of strata likely to be encountered in the tunnel is shown in Figure B-4. The proposed tunnel will be excavated in a sequence consisting mostly of sandstone but containing several interbedded claystone beds and numerous shale bands. The mine plans for the Wongawilli Colliery, which underlies the proposed tunnel, provides an indication of the main discontinuities likely to be encountered.

The mine plans show three faults crossing the alignment near the eastern portal and one fault under the creek immediately east of the portal site. None of these faults involve large displacements and the likely effect will be to give closely-

spaced joint sets requiring careful excavation, and supported by closely-spaced pattern rockbolting.

The tunnel will be excavated through ground loosened due to the effects of mining under the tunnel and with some jointing due to faulting. Tunnel excavations will be undertaken by a tunnelling machine. This will result in reduced ground disturbance and minimised overbreak.

A preliminary assessment indicates that a tunnelling machine will cut nearly the entire tunnel with the exception of dolerite dyke rocks and an occasional hard sandstone bed in the Bulgo Sandstone and Scarborough Sandstone Formations. These materials will be broken by drill and blast techniques.

This tunnelling machine with a limited blasting requirement, will minimise surface vibrations, noise and excess spoil generation.

2.0 SOILS

2.1 SURVEY OBJECTIVES AND METHOD

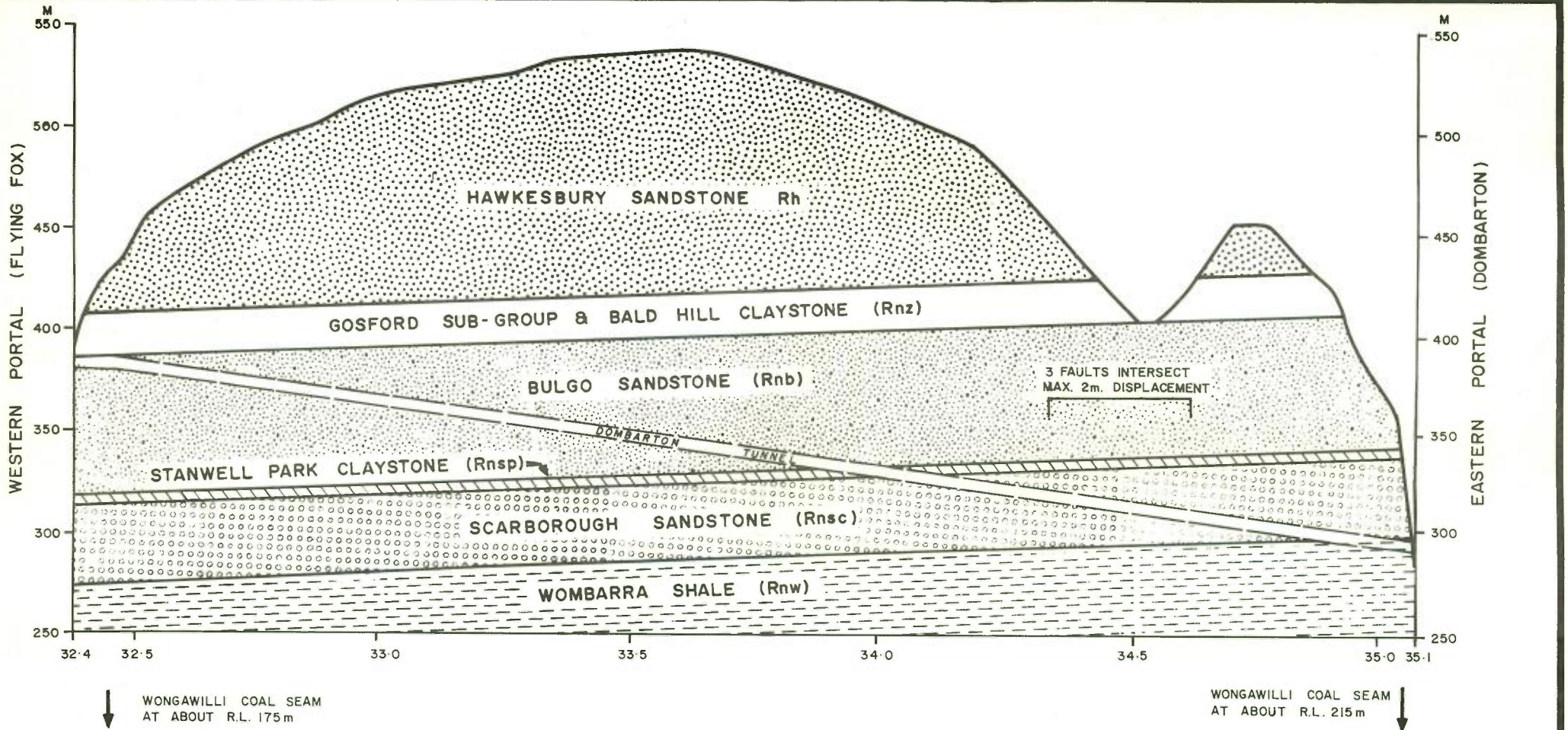
As a part of EIS procedure, the soil resources of the study area were documented using a combination of aerial photograph interpretation and field survey. A total of eight soil types were identified. Each has been assigned a Great Soil Group (GSG) name and the major types were surveyed using full Northcote (1979) descriptions and the soil data card system of the Soil Conservation Service of N.S.W.

There is a strong relationship between geology, terrain and soil type. Consequently, the soil types identified are discussed in terms of their occurrence in the landscape and the terrain map, (Figure B-5) can be used in conjunction with the following descriptions.

2.2 SOIL TYPES

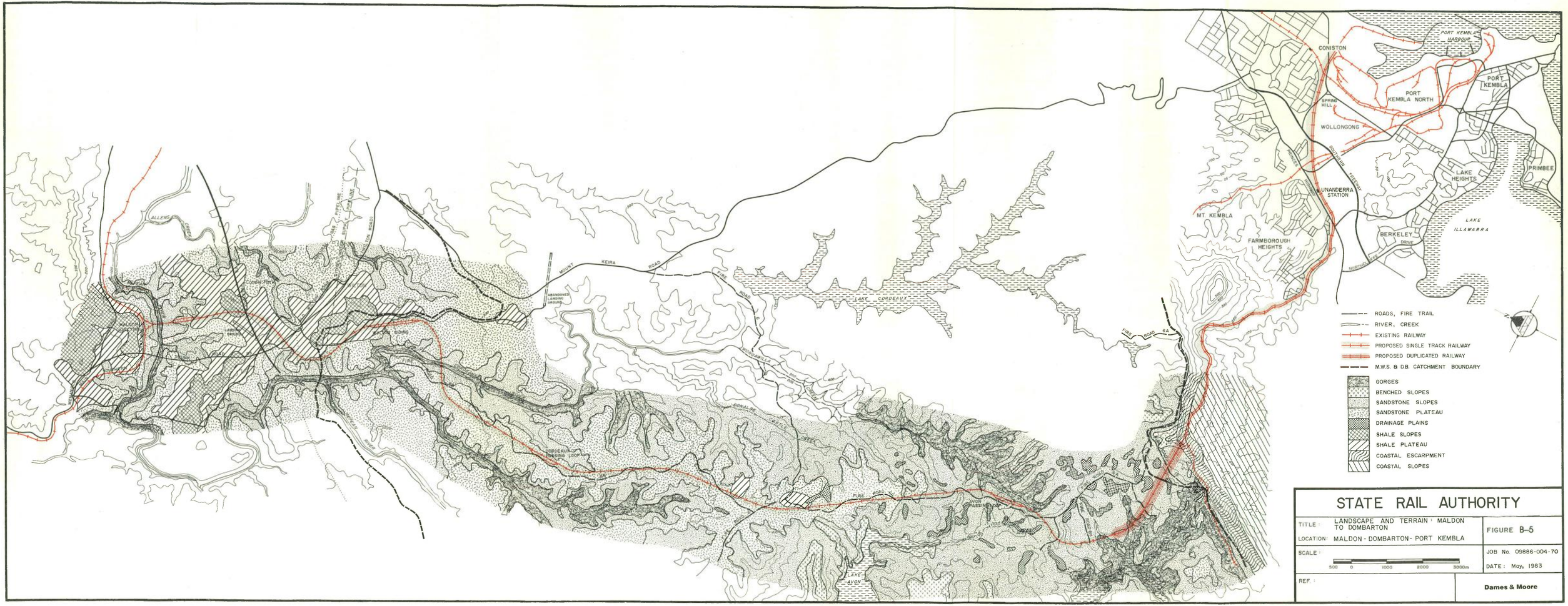
A. Soil Type (GSG Red Podzolic; PPF Dr 3.31)

This soil type and its variants are mainly confined to the northern end of the study area, in association with fine grained sediments of the Narrabeen Group. The dominant land use on these soils is grazing on improved pastures. The



STATE RAIL AUTHORITY

TITLE : INFERRED STRATIGRAPHY : DOMBARTON TUNNEL - LONGITUDINAL SECTION LOCATION : DOMBARTON	FIGURE B-4
SCALE NOT TO SCALE	JOB No. : 09886-004-70 DATE : MAY 1983
REF. : GHD	**Dames & Moore**



STATE RAIL AUTHORITY

TITLE : LANDSCAPE AND TERRAIN : MALDON TO DOMBARTON	FIGURE B-5
LOCATION: MALDON - DOMBARTON - PORT KEMBLA	
SCALE : 500 0 1000 2000 3000m	JOB No. 09886-004-70
	DATE : May, 1983
REF. :	Dames & Moore

terrain groups with which this soil type is associated are the shale slopes, shale plateaux and coastal slopes.

A typical profile of this soil type consists of a brown A_1 horizon (7.5 YR 4/3 VC5) of fine sandy clay loam approximately 20 cm deep. There is a clear, even boundary to a slightly redder coloured (5 YR 4/4 VC5) silty clay loam A_2 horizon approximately 20 cm deep. The fabric in both A_1 and A_2 horizons is pedal and rough faced. The B horizon consists of a red-brown mediumclay (2.5 YR 3/4 VC 5) with smooth-faced peds. The profile is acid throughout, having a pH of 4.5 in the A_1 horizon and a pH of 5.5 in the A_2 and B horizons.

B. Soil Type B (GSG Yellow Earth PPF Gn 2.21)

This soil type has widespread occurrence throughout the northern and middle sections of the study area. It is intimately associated with the sandstone crests of Hawkesbury Sandstone Plateaux where the dominant vegetation class is dry sclerophyll forest.

The A horizon is shallow (19 cm or less) and consists of a gravelly, grey-brown light sandy clay loam (7.5 YR 4/4 VC 5) which grades over a sharp, wavy boundary to a brown sandy clay loam (7.5 YR 5/8 VC 4) B_1 horizon approximately 40 cm deep. The B_2 horizon consists of a brown sandy clay loam (7.5 YR 5/6 VC 4) which is less weathered than the B_1 and contains a greater amount of insitu sandstone fragments.

Structure throughout the profile is weakly pedal and the fabric throughout all three horizons is rough-faced. Peds are porous. The pH of the soil decreases from 6.0 in the A horizon to 5.0 in the B_2 horizon.

C. Soil Type C (GSG Lateritic Earth/Lateritic Podzolic)

These soils occur on crests within the general vicinity of the yellow earths and, in particular, close to the contact between the Hawkesbury Sandstone and the overlying Wianamatta Group. They are morphologically similar to the yellow earths with the exception of large amounts of iron-coated, platy sandstone and siltstones ("laterite") and, in places there is more clay in their sub-soils. Much of the "laterite", when viewed in a good lateral exposure, appears insitu and also appears to display a remnant sedimentary structure which is often deformed along old bedding planes. Profiles are gravelly throughout.

Because of the variations in Wianamatta Group lithology, profile drainage and the amount of rock fragments in the soil profile, it is difficult to typify these soil types in profile and equally difficult to predict profile characteristics at any one site on Wianamatta sediments without thorough investigation. The lateritic podzolics described by Walker (1976) which had thin mottled sandy loam A_1 horizon, a narrow A_2 horizon overlying red-yellow mottled B horizon clays with iron stone nodules and a deep weathering kaolinitic clay C horizon were not found within the study area. However, their presence in the area as isolated soils types is probable.

D. Soil Type D (GSG Lithosol PPF Uc 1.22)

These stoney or gravelly soils are found on the ridge tops, steeper benched slopes and gorges, in association with Hawkesbury Sandstone.

Apart from some structural development in the surface A_1 horizon, which tends to be less than 5 cm thick, these soils lack structure and pedological organisation and are rarely more than 20 cm deep. Textures range from sands and loams to clay loams and large amounts of coarse grained material. Rock fragments are common.

E. Soil Type E (Gleyed Soils, PPF Uc 6.12)

Located on the sandstone plateaux and low angle slopes these soils are found on the subtle depressions in Hawkesbury Sandstone where heath is the dominant vegetation.

Below the dense surface mat of marsh grasses, there is a shallow organic horizon approximately 5 cm thick. There is a sharp even boundary to a black (5Y 2/1 VC 1) light sandy clay loam in which the sands are coarse. The A horizon extends for approximately 50 cm and is acid (pH 5.5). There is a clear, even boundary to a slightly acid (pH 6.0) B horizon which consists of grey light sandy loam or clay (2.5Y 4/1 VC2). A number of rusty streaks and fine root tracings exist, indicating isolated oxidation within the reducing environment, increasing with depth. Fine roots abound throughout the profile, and a weak pedality consisting of porous rough-faced peds. These soils are flooded for short periods and the watertable fluctuates greatly, periodically rising almost to the surface. With the watertable at shallow

depths, water is available for plant growth. The decomposition and incorporation of vegetative detritus into the profile is facilitated.

F. Soil Type F (Skeletal Soils)

Skeletal colluvial soils - are associated with steeper slopes (benched slopes and gorges) and are the dominant soil type on the steep slopes of the incised valleys. The upper sections of these slopes are covered with the skeletal soils which generally increase in depth downslope. The colluvial soils occur towards the base of the slope and are associated with those areas where there are plentiful supplies of rock fragments. Siltstone beds that occur within the Hawkesbury Sandstone give rise to minor benches which promote land slippage and rockfall. The high erodibility of these soils (SPCC, 1979) is a result of their shallow depth, lack of structure, susceptibility to vegetative-cover destruction by fire, and their occurrence on steep slopes.

G. Soil Type G (Siliceous Sands)

Shallow sands occur on the sandstone plateau landform unit where the parent material is Hawkesbury Sandstone. They show minimal profile development, are deficient in nutrients and show poor water holding capacities. Texture is uniform, coarse sandy with profile depth rarely greater than 60 cm. These soils are less prone to erosion than skeletal/colluvial soils because of the low angle of the slopes on which they occur.

2.3 EXISTING SOIL EROSION

On the grazing lands, particularly in the northern regions of the study area, moderate levels of sheet erosion occur on red and yellow podzolic soils. In localised patches, overgrazing of the steeper slopes (to 5°) has resulted in severe sheet erosion.

Within the protected Catchment Areas controlled by the MWS&DB, the general status of erosion is very low due to the uncleared and undisturbed state of the surface. Moderate to severe gully erosion occurs on the vehicular tracks formed on the yellow and lateritic earths and the skeletal colluvial soils.

The geological erosion rate of the insitu material on the sandstone plateau is high. This is due to the uniformity of quartz material, lack of resistant interstitial cementing agents and the large amount of exposure of bare rock that occurs and that causes high rates of runoff.

Surface runoff and erosion rates within the protected catchments are greatly increased following bushfires. Following the destruction by fire of surface litter and vegetation, the sandy, non-coherent surface soils of the catchments are subjected to severe erosion.

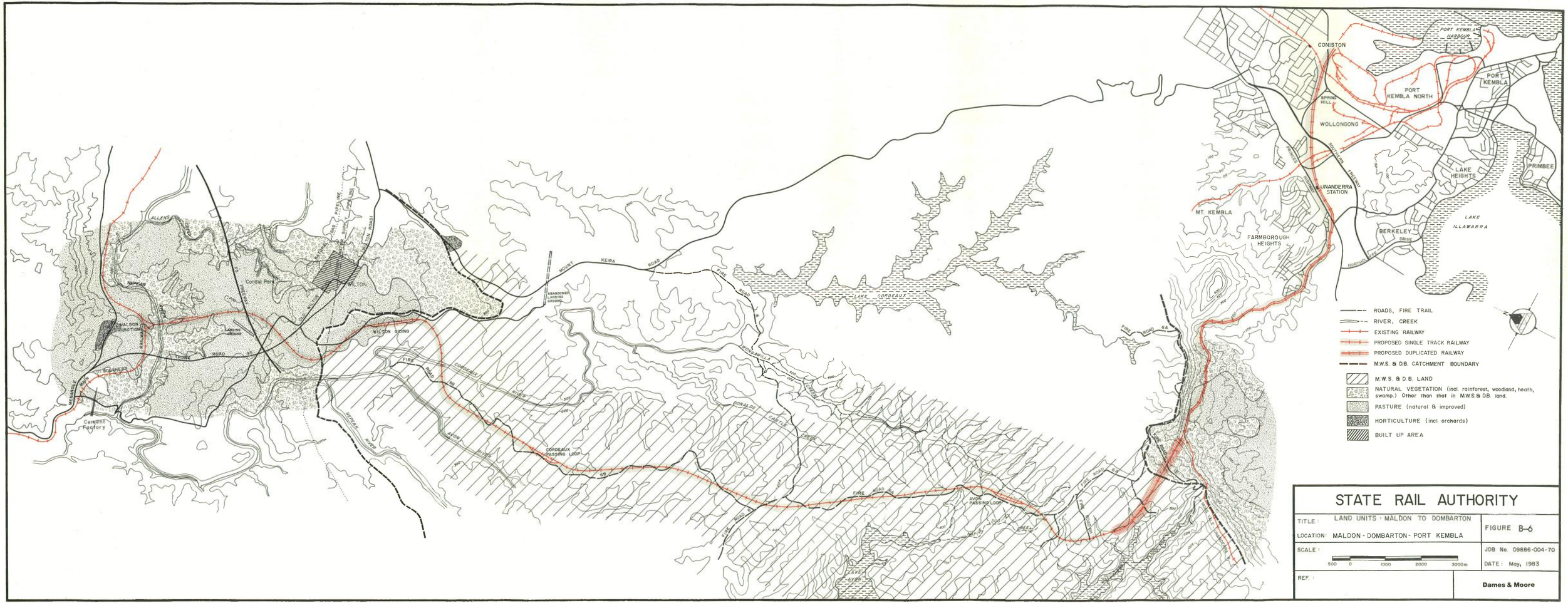
On grazing lands below the escarpment, erosion is inhibited by the maintenance of a good protective cover of improved pasture. However, where overgrazing or insensitive track location has occurred, erosion can be severe in the light-textured, porous soils that occur.

3.0 LAND EVALUATION

The primary characteristics of the physical environment which combine to define a land unit include landform, slope, geology, soils and vegetation. In most cases these variables are interdependant. For example, the geology influences the soil type; landform is strongly controlled by the structure of the rocks; vegetation is dependant upon soil type and landform characteristics such as aspect and drainage. When environmental characteristics are largely interdependant they can be mapped concurrently with each terrain unit being characterised by its geology, landform, slopes, soils and vegetation. A mapping study of this nature was implemented to present concisely the characteristics of the area to be affected by the development.

Mapping was carried out by examining aerial photographs, topographic maps and other relevant data. Each unit was then checked in the field and appropriate changes made. The final map (Figure B-6) is at a scale of 1:50,000. The dominant feature of this area is the landform and this forms the basis of the mapping units. In addition to the physical characteristics of each unit there has been some discussion of the stability of each unit for construction purposes and limitations where applicable.

Nine distinct land units have been identified. They are:



STATE RAIL AUTHORITY

TITLE: LAND UNITS - MALDON TO DOMBARTON

FIGURE B-6

LOCATION: MALDON - DOMBARTON - PORT KEMBLA

SCALE:

JOB No. 09886-004-70

DATE: May, 1983

REF.:

Dames & Moore

- gorges;
- benched slopes;
- sandstone slopes;
- sandstone plateau;
- drainage plains;
- shale slopes;
- shale plateau;
- coastal escarpment;
- coastal slopes.

The characteristics of each unit are summarized in Table B.1.

4.0 IMPACTS AND SAFEGUARDS

4.1 SOIL EROSION - IMPACTS

4.1.1 Impacts

An unavoidable impact of surface clearing is increased runoff and soil erosion.

Soil erosion is a complex process depending on the interaction of many factors such as rainfall intensity, rainfall amount and duration, vegetative cover, landform, land slope and land use and management factors. However, apart from all these "external" factors, there are intrinsic differences between soils with respect to their susceptibility to erosion, that is their erodibility.

This resistance is made up of two factors:

- the basic resistance of the soil material in the field state to detachment by falling raindrops and splash, flowing runoff, dispersion or wind;

- a combination of the soil material characteristics and soil profile characteristics which allow the soil to absorb rain as it falls and thus prevent runoff.

The likely nature of sediment yielded by a soil is related to its texture or particle size distribution. Using soil particle size terminology, sediment can be described as gravels, sands, silts and clays. Clays can be further divided into dispersible (illites, monmorillonites) and non-dispersible types (kaolinite).

TABLE B.1

TERRAIN UNIT CHARACTERISTICS

A. GORGES

TOPOGRAPHY

Landform	- Erosional, deeply incised valleys which typically have a bounding broken cliff line above a benched slope. A constrained channel which has minor depositional features flows through the centre except in the eastern section where reservoir impoundments occur.
Slopes	- Cliffs are vertical, slopes are steep (> 18°)
Relief	- Maximum: 100 m
Drainage	- Constrained; perrenial and ephemeral

GEOLOGY

Classification	- Hawkesbury Sandstone, Narrabeen Group
Lithology	- Sandstones, siltstones and claystones. Sandstones dominate in the Hawkesbury sediments while the finer grained rocks are of more importance in the Narrabeen sediments

SOIL

Parent Material	- Sandstone, siltstone, claystone, colluvium
Surface Texture	- Sandy loam, loamy sand, rock outcrops common
Profile Depth	- From few millimetres to 1 m; average of 10 cm
Great Soil Group	- Skeletal, Lithosol, (sandstones), Red Podzolic (siltstone, claystone)

VEGETATION	Low open forest or low woodland on the upper slopes with open scrub on the lower slopes and stream fringes. Small pockets of rainforest occur in the eastern occurrences of this unit where red podzolic soils are present.
COMMENTS	During construction, care has to be taken within this unit particularly with regard to loose boulders and the erodible nature

TABLE B.1 (cont)

of soils. It is essential the streams and their immediate fringes have the minimum of disturbance. Minimal clearing of the rainforest is essential.

B. BENCHED SLOPES

TOPOGRAPHY

Landform	- Erosional, isolated slopes which are crossed by horizontal benches. Similar to sideslopes of the gorges
Slopes	- Steep (> 18°)
Relief	- Maximum: 70 m
Drainage	- Illdefined; mostly sheet flow with a few minor ephemeral channels

GEOLOGY

Classification	- Hawkesbury Sandstone
Lithology	- Sandstone with very minor claystone and siltstone lenses;

SOIL

Parent Material	- Sandstone, siltstone, claystone, colluvium
Surface Texture	- Sandy loam, loamy sand, rock outcrops common
Profile Depth	- From few millimetres up to 50 cm; average 10 cm
Great Soil Group	- Skeletal, Lithosol
VEGETATION	- Mostly open forest with some pockets of rainforest adjacent to the Illawarra escarpment
COMMENTS	- Care is necessary within this unit because of loose rocks, steep slopes and the highly erodible soils

TABLE B.1 (cont)

C. SANDSTONE SLOPES

TOPOGRAPHY

Landform	- Erosional, dissected slopes with constrained streams. Slopes essentially rectalinear.
Slopes	- Range from moderate to moderately steep (5° - 18°)
Relief	- Maximum: 70 m
Drainage	- Structurally controlled. EES-WWN or NNE-SSW orientation

GEOLOGY

Classification	- Hawkesbury Sandstone
Lithology	- Sandstone with minor claystone and siltstone lenses

SOIL

Parent Material	- Sandstone, siltstone, claystone
Surface Texture	- Sandy loam, loamy sand, rock outcrops common
Profile Depth	- From a few millimetres up to 1.5 m; average 15 cm
Great Soil Group	- Lithosols, Skeletal, Silicious Sands, Earthy Sands, Yellow Podzolics, Podzols
VEGETATION	- Dry sclerophyll and mostly open forest
COMMENTS	- This is a stable unit for construction. Soils are prone to movement if disturbed or drainage changed.

D. SANDSTONE PLATEAU

TOPOGRAPHY

Landform	- Erosional, slightly undulating plain which is weakly dissected

TABLE B.1 (cont)

Slopes	- Range from level to gentle (0° - 5°), slightly convex
Relief	- Maximum: 30 m
Drainage	- Dendritic; sheet flow dominant, all streams ephemeral
GEOLOGY	
Classification	- Hawkesbury Sandstone
Lithology	- Because this unit bounds the overlying Wianamatta Shales, siltstones and claystones are common although sandstone is dominant
SOILS	
Parent Material	- Sandstone, siltstone, claystone
Surface Texture	- Sandy loam, fine sandy loam
Profile Depth	- Ranges from 10 cm to 1.5 m; average 40 cm
Great Soil Group	- Earthy sand, yellow earth, yellow podzolic, lateritic podzolic
VEGETATION	- Predominantly dry schelerophyll
COMMENTS	- This is the most stable unit for construction. The only necessary precaution is protection of the surface soil

E. DRAINAGE PLAINS

TOPOGRAPHY	
Landform	- Depositional, level to gently inclined, open depression
Slopes	- Range from level to gentle (0° - 5°), slightly concave
Relief	- Maximum: 10 m
Drainage	- Not defined, streams rare, mainly sheet flow. Soils are saturated for a large part of the year

TABLE B.1 (cont)

GEOLOGY

Classification - Hawkesbury Sandstone, Quaternary Alluvium

Lithology - Sandstone, alluvium, claystone, siltstone

SOIL

Parent Material - Sandstone, claystone, siltstone; sand deposited from upslope

Surface Texture - Sandy loam; loamy sand; fine sandy loam; fine sandy clay loam; light sandy clay loam

Profile Depth - Ranges from 10 cm to 1.5 m; average about 40 cm

Great Soil Group - Organic Sands, Gleyed Podzolic

VEGETATION - Variously classified as swamp, sedge and heath. Type is dependant upon soil moisture throughout year.

COMMENTS - This unit should be avoided wherever possible. Problems are related to excess moisture and susceptibility to erosion. Also contains a number of rare plants.

F. SHALE SLOPES

TOPOGRAPHY

Landform - Erosional, undulating, moderately dissected terrain

Slopes - Greater than 3° and up to 20° with an average of about 7°. Slope profiles are convex - concave

Relief - Maximum: 45 m

Drainage - Dendritic; streams ephemeral, some erosional gullies present

GEOLOGY

Classification - Ashfield Shale

Lithology - Siltstone

TABLE B.1 (cont)

SOIL

Parent Material - Siltstone, colluvium

Surface Texture - Loam, fine sandy; light sandy clay loam; sandy clay loam; fine sandy clay loam

Profile Depth - 20 cm to 3 m; average 45 cm

Great Soil Group - Red Podzolic

VEGETATION - Mostly cleared for grazing purposes with grasslands dominant. Some natural areas remain with a cover of woodland or open forest.

COMMENTS - Stability depends upon depth of profile and slope angle. On the steeper slopes care needs to be taken to prevent mass movement and sheet and gully erosion. The surface needs to be protected from sheet erosion. The B horizon is difficult to revegetate.

G. SHALE PLATEAU

TOPOGRAPHY

Landform - Erosional; gently undulating, weakly dissected terrain

Slopes - Level to gentle (0° - 3°) with an average of approximately 2°. Slope profiles are mostly concave

Relief - Maximum: 50 m

Drainage - Dendritic, streams ephemeral

GEOLOGY

Classification - Ashfield Shale

Lithology - Siltstone

SOIL

Parent Material - Siltstone

TABLE B.1 (cont)

Surface Texture - Loam, fine sandy; light sandy clay loam; sandy clay loam; fine sandy clay loam

Profile Depth - 20 cm to 2 m; average 40 cm

Great Soil Group - Red Podzolic

VEGETATION - This unit has been almost entirely cleared therefore grasslands are dominant

COMMENTS - Relatively stable unit due to low slope angle although it is necessary to protect the surface soil. Drainage needs to be controlled.

H. COASTAL ESCARPMENT

TOPOGRAPHY

Landform - Erosional; cliffs leading to talluvium slopes[1]

Slopes - Cliffs are near vertical to vertical, talluvium slopes range from 15° to 50°;average approximately 25°

Relief - Maximum: 250 m

Drainage - Ill defined, mostly sheet flow with a few ephemeral streams. Seepage zones are present

GEOLOGY

Classification - Hawkesbury Sandstone, Narrabeen Group, Illawarra Coal Measures

Lithology - Sandstone, siltstone, claystone

SOIL

Parent Material - Sandstone, siltstone, claystone, colluvium

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1 Talluvium slopes consist of talus and colluvium mixed in varying proportions

TABLE B.1 (cont)

Surface Texture - Fine sand clay loam; light sandy clay loam; sandy clay loam; loam, fine sandy

Profile Depth - Ranges from a few millimetres to many metres to many metres on colluvial deposits; average of around 0.5 m

Great Soil Group - Red Podzolic

VEGETATION - Essentially undisturbed subtropical rain-forest

COMMENTS - This unit has a past history of slope instability. Extreme care is necessary to prevent mass movement. Drainage needs to be very efficient, and cut and fill limited.

I. COASTAL SLOPES

TOPOGRAPHY

Landform - Erosional; hilly, heavily dissected terrain

Slopes - Range from gentle to very steep (3° - 35°) with an average of about 10°. Slope profile is irregular due to structural characteristics

Relief - Maximum: 200 m

Drainage - Aligned in a NW - SE direction, all streams are ephemeral

GEOLOGY

Classification - Quaternary talus, Illawarra Coal Measures

Lithology - Sandstone, siltstone, claystone, talluvium

SOIL

Parent Material - Sandstone, siltstone, claystone, talluvium

Surface Texture - Fine sandy clay loam; light sandy clay loam; sandy clay loam; loam, fine sandy

Profile Depth - 30 cm to 3 m; average about 70 cm

Great Soil Group - Red Podzolic

TABLE B.1 (cont)

VEGETATION	- Mostly cleared for grazing and urban development - grassland; subtropical rainforest is present adjacent to the drainage lines
COMMENTS	- Areas which have been cleared are prone to mass movement. Surface soils need to be protected because of high runoff volumes that can occur.

Gravels will only move in fast flowing waters, normally only encountered in drainage lines. Sand is easily detached and moved by flowing water but will be deposited as soon as water velocity decreases, particularly in wiers, dams and natural ponds. Silts are evenly more easily detached than sands but are deposited as soon as the water becomes relatively still. Clays are less easily detached than sands and silts, but dispersible clays are more easily detached than non dispersible types. Detached clays may remain in suspension even in relatively still waters, causing turbidity and a resultant drop in water quality.

4.1.2 Safeguards

Much of the proposed railway line traverses protected catchments under the juristiction of the MWS&DB. Consequently, water quality and, therefore, the amount of runoff and erosion generated by the proposed railway line is of particular importance. This is discussed in Appendix C.

The SRA recognizes the high erodibility of soils on the development sites and will implement an effective soil conservation programme to minimise erosion. The details of the programme have been developed in conjunction with the SCS and MWS&DB and is outlined in Appendix A.

Broadly, the three main areas in which safeguards against soil erosion will be implemented are earthworks, surface drainage, and vegetative stabilization during construction and operational phases of the railway line.

4.2 EARTHWORKS, CONSTRUCTION AND SURFACE DRAINAGE

Batters in massive, fresh to slightly weathered sandstone will have slopes of 4 V : 1 H. Batters in recent excavations for roadworks by the Department of Main Roads on the Mt Keira Road east of the Cordeaux Area are cut at this angle.

In fresh to moderately weathered shale, slopes of 1 V : 1 H will be constructed. In moderately weathered sandstone, slopes of 2 V : 1 H can be used although local factors such as fracturing and the effects of subsidence will be taken into account. Close jointing or fracturing, adverse joint directions or other natural features could require flatter slopes.

On highly weathered sandstone and unconsolidated material batters will be constructed at 1 V : 2.5 H. Steep slopes exceeding 2.5 m will require the construction of benches.

Catch drains will be constructed along the tops of all major cuttings with upslope catchments to impede surface flow, thus reducing erosion and failure on batter surfaces. Steeper batters will be constructed with a bench at the base to allow minor soil/rock slump debris to be collected.

In areas where surface drainage is high, the railway line will be constructed on berms to prevent the concentration of runoff and to direct water to safe disposal areas. This procedure has been used to significant effect at the Clarence Colliery (Connelly and Brooks, SCS Vol 39, 1983).

Table drains will be constructed along all new upgraded roads in order to direct road runoff onto stable areas. Roads sloping downhill will be cambered to prevent runoff flowing downslope along the road surface.

Where possible, new roads will be constructed along ridgelines in an attempt to minimise their impact upon the present surface drainage. Multiple drains will be constructed where roads have to be constructed across a slope. This will minimise the discharge from each drain and therefore decrease the possibilty of erosion at the outlet.

Site disturbance will be kept to a minimum throughout the construction period. This is most important as the amount of soil eroded is directly related to the area disturbed. All equipment operators will be instructed not to disturb an area unless it is essential.

During the clearing of those areas to be permanently disturbed, trees and shrubs will be removed and burnt. Ground cover and topdressing material will be stripped simultaneously and stockpiled. The stockpiled material, which contains valuable organic matter and vegetative seed store, will be respread on those disturbed areas which do not have a permanent cover. Once respread, these soils will be fertilized and seeded with native species, then fenced to prevent vehicular access during regeneration.

Because a certain amount of erosion and surface movement will be unavoidable, filter dams will be constructed in drainage

lines downslope of major cut and fill sites. To be effective, these dams will be cleaned out as the amount of sediment in them increases above effective levels.

4.3 VEGETATIVE STABILIZATION

Jute mesh is a useful technique on low traffic areas and where the flow of water is irregular. It has been widely used to stabilize surface drains in the region.

Native species of grasses, shrubs and trees should be encouraged on revegetated sites (i.e. batters, tracks etc) because they are well adapted to the low fertility and low pH soils of the area and encourage the return of native flora, fauna and their habitats. Initial stabilization with temporary exotic, faster growing species may be necessary but these will be selected only after discussion with the MWS&DB. Decisions to fertilize topsoiled areas will be carefully considered since a signficant quantity of fertilizer may runoff into MWS&DB waters or local dams.

Additional stabilization techniques such as hydro mulching, bitumen emulsion and hay mulching on areas requiring special erosion treatment will be considered with the advice of the SCS.

The aims of the programme to minimise soil erosion are to:

- conserve topsoil for rehabilitation;
- construct stable batters;
- construct proper surface water drainage systems and to control erosion by diverting runoff to well vegetated areas and existing drainage lines;
- promote the return of native species possibly after an initial phase of stabilization by temporary exotic species;
- use of specialized techniques for stabilization such as jute meshing, hydro and hay mulching and bitumen emulsions.

5.0 SUBSIDENCE

Surface subsidence and the formation of subsidence cracks is an unavoidable impact in areas where underground mining continues. Where underground coal seams are completely extracted, the strata above the mine roof collapses to fill the void and subsidence movements are transmitted through the overlying strata to the surface. Wave-like subsidence is associated with progressive total extraction of coal seams. It results in a moving wave-like distortion which causes the overlying strata to be subjected to horizontal tensile and compressive strains. As the mine working face progresses, the subsidence wave follows leaving the overlying strata lower.

The impacts of subsidence cracks are related to the impedence of surface flow and the disturbance to habitat and archaeological sites. The engineering impacts of subsidence upon the construction of the railway are not expected to be significant except if subsidence occurred in the vicinity of major structures, like bridges, the tunnel or major steep sided cuttings. Limitations on mining beneath these locations will be necessary.

No signficant safeguards against subsidence can be implemented, with the exception of these limitations and buffering methods in engineering works for the railway line.

The effects of subsidence and possible sterilization of coal beneath the proposed line are discussed in Section 6.3 of this Appendix.

6.0 LAND USE

The existing land uses along the proposed railway can be grouped into three categories:

- largely undisturbed land over the MWS&DB Catchment Area and Illawarra Escarpment;
- agricultural and pastoral from Maldon to Wilton and below the Illawarra escarpment;
- residential and industrial development between Farmborough Heights and Port Kembla.

The SRA will ensure that the construction of the railway line results in a minimum of interference to the land users in the area.

Because much of the proposed line traverses MWS&DB land, close liaison between these two bodies will take place.

The needs of landholders will be considered, particularly in relation to the interference by the railway line to surface water for stock dams, the movements of stock and farm traffic, and the visual impact of the construction itself. This aspect is discussed in Appendix I, in relation to the concerns of the Local Communities.

6.1 ILLAWARRA ESCARPMENT AND MWS&DB CATCHMENT AREA

Two major land uses occur within this area, the most obvious of which is the collection and storage of water to supply Sydney and south coast communities. This land use largely restricts other activities. Below the surface of this area are the Illawarra Coal Measures which have been won by underground mining techniques for many years. In many places, the location of tunnels and shafts of old mine workings are unknown, and these have contributed to the instability of the escarpment. New underground coal mines have recently commenced operations or are planned for the future in this area.

Only restricted public access is allowed to the Catchment Area. Recreation use is confined to picnic areas at the various dam sites. The State Recreation Area, located on the escarpment slopes between Dombarton and Farmborough Heights, provides attractive natural areas and views over the coastal plain.

6.2 PLATEAU BETWEEN MALDON AND WILTON

Land use in this area is primarily rural activity including:

- horse and cattle studs;
- broiler farms and poultry studs;
- cattle grazing;
- rural residential blocks.

Other activities include two landing grounds, a parachute club, and a cement works.

Most of the agricultural pursuits are restricted to gently sloping terrain with a parent material of Wianamatta Shale. On steeper slopes much of the land remains uncleared. Soils developed on the sandstone are so poor that this area remains essentially undisturbed.

The proposed railway crosses many utilities and transport routes in this area, including:

- MWS&DB underground channel from Pheasants Nest to Broughton Pass;
- an underground natural gas pipeline;
- several electric power transmission easements;
- the F5 freeway;
- Trunk Road 95.

One place of historical and cultural interest in this area is the stables and property known as "Wilton Park" near the Nepean River. The land on which "Wilton Park" now stands was originally taken up in 1825. The land ownership changed several times until it was acquired in 1891 by Samuel Horden who with his brother founded the Horden Emporium. "Wilton Park" remained in the Horden family until 1927. The Horden family built a stable in about 1892 at "Wilton Park" which has recently been given a classified recording by the National Trust. A report on the architectural and historical significance of these stables by Reynolds (1978) indicated that they are of high architectural merit and historical significance. According to Reynolds, the architect of the "Wilton Park" stables was probably Albert Bond (1841-1923) who was appointed "Architect to the City of Sydney" in 1874 and who designed, amongst other buildings, the Vestibule of the Sydney Town Hall. The stable roundhouse has been described by Reynolds as a rare and architecturally valuable timber structure, and is one of the few remaining examples of structural carpentry.

After 1927, "Wilton Park" was reduced in size and allowed to decline. The present owners purchased the land in 1972 when it was a run-down dairy farm and have gradually improved the pastures, fencing and stables. The stables are now used for their original purpose.

6.3 COAL MINING

Two aspects of coal mining are important in relation to the proposed railway. If the mining of coal is to be restricted in areas underneath the rail route, consideration will need to be given to the extent of consequent coal steralization. Where coal mining has or does take place, the affects of subsidence on the line have to be determined.

Figure B-7 illustrates existing coal resource holdings in the areas adjacent to the railway line. A large proportion of the route is underlain by coal reserves. While the boundaries of these holdings and leases can be defined, actual areas which will be worked in the future, the methods of mining and the degree of coal extraction cannot be determined at this time.

Figure B-8 shows the extent and type of colliery workings along the railway route. There are only two areas where mining has taken place beneath the line and where subsidence could occur as a result of past or current operations.

Limitations on future mining due to the possibility of subsidence, will be necessary only in specific areas. The SRA has no objection to mining taking place in a controlled manner along the general route, provided that companies consult with the SRA before extraction is planned. Areas where limitation may be necessary include the bridgeworks over the Cordeaux and Nepean Rivers, the tunnel, and specific steep cuttings.

Major bridgeworks are planned for the two river crossings and it will be necessary to limit the extraction of coal beneath these locations. Some restrictions may also be necessary beneath the crossing of the Freeway and Trunk Road 95.

Because of the possible effect of subsidence on the railway tunnel, restrictions on coal extraction will also be necessary along its route. Officers of the Department of Mineral Resources and Wongawilli Colliery indicate that no further coal extracton is intended from either the Wongawilli or Bulli seams underlying the immediate area of the tunnel.

This is because the presence of main access roadways in this area of the pit and because pillar extraction has taken place already which inhibits further extraction.

Beyond the western portal where future workings may extend, provision will be made for subsidence effects.

ON WHAT BASIS?

The Department of Mineral Resources and the Company consider that both the existing two tunnel route and the alternative single long tunnel route have no effect on coal sterilisation.

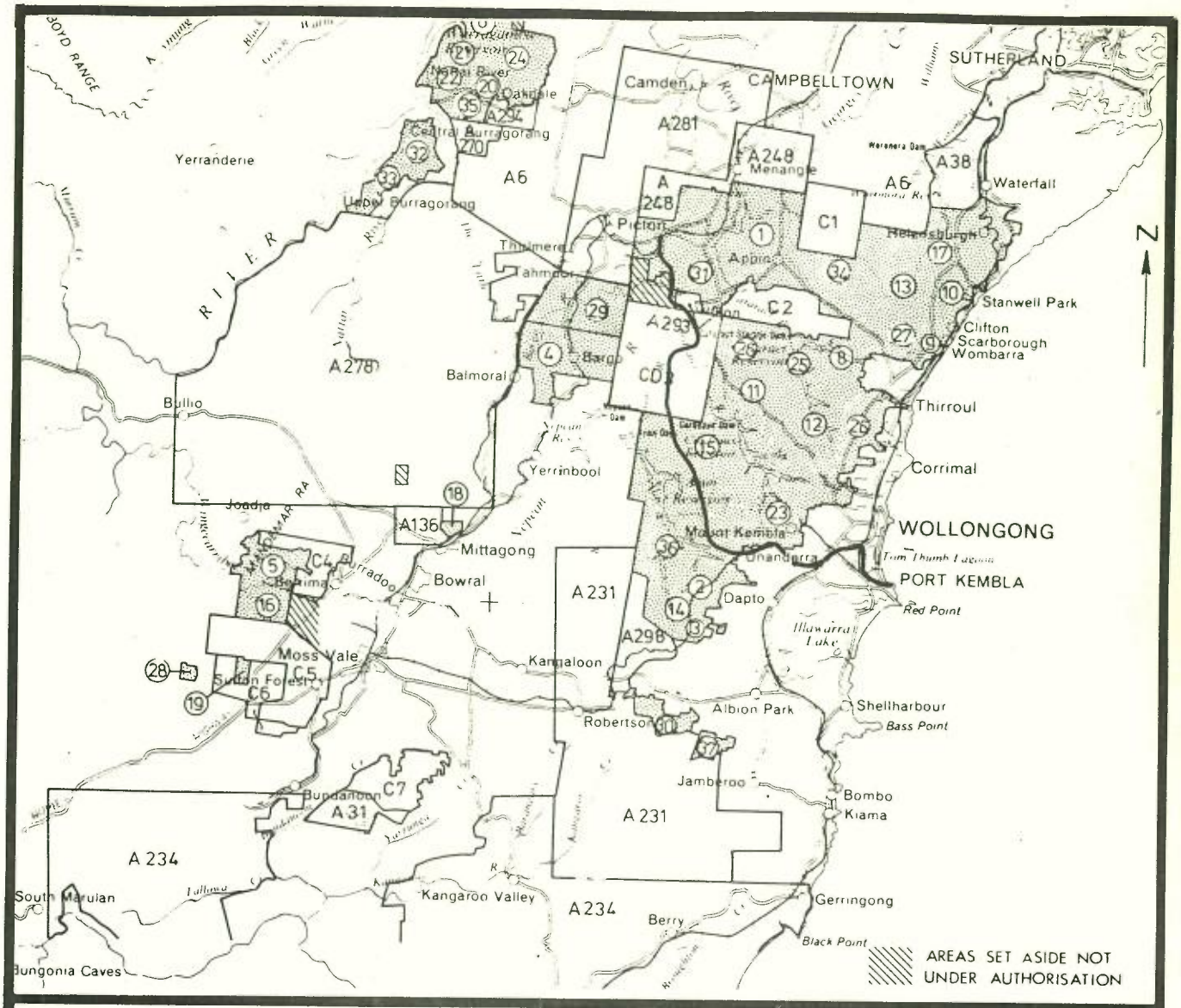
A.I.S.

Minor amounts of coal may be sterilized in areas beneath specific major or steep sided cuttings along the route. These will not be identified until detailed design is undertaken.

6.4 FARMBROUGH HEIGHTS TO PORT KEMBLA

Residential development has occurred on the elevated area south of Unanderra, Farmborough Heights. The local community in this area is described in Appendix I.

Between Unanderra and Port Kembla, the existing railway line passes through areas of commercial and industrial development. It passes in a deep cutting the residential area at Mt St. Thomas.



COLLIERY HOLDINGS

1. APPIN
2. AVON
3. AVONDALE
4. BARGO
5. BERRIMA
6. BRIMSTONE
7. BRIMSTONE No. 2
8. BULLI
9. BULLI MAIN
10. COAL CLIFF
11. CORDEAUX
12. CORRIMAL
13. DARKES FOREST
14. HUNTLEY
15. KEMIRA
16. LOCH CATHERINE
17. METROPOLITAN
18. MOUNT ALEXANDER
19. MURRIMBA
20. NATTAI BULLI
21. NATTAI NORTH
22. NATTAI NORTH No. 2
23. NEBO
24. OAKDALE
25. SOUTH BULLI "A"
26. SOUTH BULLI "B"
27. SOUTH CLIFTON
28. SOUTHERN
29. TAHMOOR
30. TONGARRA
31. TOWER
32. VALLEY No. 1
33. VALLEY No. 3
34. WEST CLIFF
35. WOLLONDILLY
36. WONGAWILLI
37. YELLOW ROCK

COAL LEASE APPLICATION AREAS

REF	APPLICANT
C1	CLUTHA DEVELOPMENT P L
C2	AUSTRALIAN IRON & STEEL P L
C4	SOUTHERN PORTLAND CEMENT P L
C5	BELLAMBI COAL CO P L
C6	SOUTHERN COAL (EXT'D) P L
C7	DOMBARTON COLLIERY P L

AUTHORISATIONS

REF	HOLDER
A6	DEPT OF MINERAL RESOURCES
A31	DOMBARTON COLLIERY P L
A38	BULLI MAIN COLLIERY P L
A136	MACDONALD BROTHERS P L
A231	ELECTRICITY COMMISSION OF N S W
A234	ELECTRICITY COMMISSION OF N S W
A248	AUSTRALIAN IRON & STEEL P L
A270	DEPT OF MINERAL RESOURCES
A278	DEPT OF MINERAL RESOURCES (P)
A281	DEPT OF MINERAL RESOURCES
A293	AUST IRON & STEEL P/L (P)
A294	CLINTONS NATTAI COLLIERIES P/L (P)
A298	THE ELECTRICITY COMMISSION OF NSW
CD3	COAL DEVELOPMENT AREA

(P) Denotes pending applications

not West Bellambi

EHST 13.11.240

STATE RAIL AUTHORITY

TITLE: COAL RESOURCES HOLDINGS: MALDON TO PORT KEMBLA

LOCATION: MALDON - DOMBARTON ROUTE

FIGURE B-7

SCALE 0 50 KM

JOB No. 09886-004-70

DATE: MAY 1983

REF.: B MR

Dames & Moore

AVON PASSING LOOP

FIRE ROAD 6A

FIRE ROAD 6G

DOMBARTON JUNCTION

TUNNEL SECTION

N 1185 300

E 277 500

Gallahers Creek

Flying Fox No. 3

LEGEND:

UNDERGROUND WORKINGS

FIRST WORKINGS

AREAS OF PILLAR EXTRACTION

Bulli ? Wongawilli

STATE RAIL AUTHORITY

TITLE: EXTENT OF COLLIERY WORKINGS MALDON TO PORT KEMBLA LOCATION: MALDON - DOMBARTON ROUTE	FIGURE B-8
SCALE 0 500 1000 1500m	JOB No.: 09886-004-70 DATE: MAY 1983
REF.: B.H.P.	Dames & Moore

APPENDIX C

HYDROLOGY AND WATER QUALITY

APPENDIX C : TABLE OF CONTENTS

APPENDIX C : LIST OF TABLES

1.0 HYDROLOGY

1.1 SURFACE HYDROLOGY

The proposed railway line will pass through the Nepean river systems. The plateau is dissected by the Nepean River and its tributaries which have their headwaters in the Illawarra escarpment and flow north to the Hawkesbury River. The Cataract, Cordeaux and Avon Rivers, all with tributaries to the Nepean, have been dammed by the MWS&DB in order to supply potable water to the Sydney and South Coast regions of N.S.W. The proposed line roughly follows the drainage divide between the Avon and Cordeaux Rivers and crosses the Nepean and Cordeaux Rivers on high level bridges. The line skirts the south eastern part of the Avon Reservoir,crossing the headwaters of a number of small streams which flow into the Avon Dam. Hydrological data for these streams or for the Avon and Cordeaux Rivers are not available. Table C.1 lists flood frequencies for the Nepean River at Pheasants Nest.

Along the section of existing line between Dombarton and Farmborough Heights, drainage is into Robins and Dapto Creeks which flow into Mullet Creek and then into Lake Illawarra. The area between Farmborough Heights and the coal loader drains into Allens Creek and the inner Harbour.

In the area underlain by the Wianamatta Group sediments, surface absorption and internal drainage is very slow. Slopes in this are are gentle, so surface drainage is also very slow. The slow drainage results in widespread ponding in broad depressions, the larger ones retaining a swampy character throughout most of the year. The surface soil derived from the Wianamatta bedrock shows very little evidence of erosion. This is due to the extensive vegetative cover, the low relief and cohesive, non-dispersive nature of the soil material. Even in areas where vegetation has been removed, the effects of erosion have been slight.

In the area underlain by Hawkesbury Sandstone the soils are sandier and surface absorption of water is much more rapid. However the underlying sandstone strata are only slightly permeable and, after prolonged rain, the surface soil becomes saturated and runoff occurs. Surface drainage is usually more rapid in this area due to the greater surface relief. Ponding is not extensive and is relatively short-lived.

TABLE C.1

FLOOD FREQUENCY - NEPEAN RIVER AT PHEASANTS NEST

RETURN PERIOD Years	PEAK FLOW RATE (m^3/s)		STAGE HEIGHT (m)
1	226	19480	2.1
2	491	42328	3.44
5	893	76983	5.02
10	1250	107759	6.22
20	1680	144830	7.38
50	2380	205170	8.78
100	3030	261200	9.92

Source: MWS&DB (G. McDermott)

Note: 0.0 Stage Height = 133.518 m (Std Datum)

Although the sandy soil is relatively susceptible to erosion, the vegetative cover has prevented the occurrence of serious erosion. Slight to moderate erosion of surface soils has occurred in localised areas where ground vegetation is absent.

1.2 GROUNDWATER

The groundwater hydrology of the area is in general poorly known. From geological observations it appears that the near surface groundwater situation is complex. Groundwater probably occurs in numerous small, unconnected or "perched" zones separated by layers of low permeability.

Coal exploration drilling in the area commonly results in a loss of drilling circulation at a depth of approximately 100 metres in the Hawkesbury Sandstone. Apart from this horizon, which is apparently consistent and extensive, the other near-surface sediments appear to have very low or moderately low permeability. The joints are generally broadly spaced and clay coated so that they would not contribute greatly to permeability of the rock mass.

Groundwater is not utilized in this area. It is unlikley that there is any potential for significant groundwater development, unless more substantial aquifers are present at depths below the coal seams.

2.0 WATER QUALITY

Water quality information for the Cordeaux and Avon Rivers is generally lacking. Water in the Avon and Cordeaux Reservoirs is of good quality, being suitable for drinking water and other purposes. The Catchment Areas are relatively unaffected by development. The MWS&DB monitors water quality in the Avon and Cordeaux Reservoirs, but is principally concerned with suspended solids levels, as monitored by colour and turbidity measurements.

There is no monitoring being undertaken of water quality of streams flowing into these reservoirs from the area of the railway route. Monitoring during construction and operation is discussed in Section 3.0 of this Appendix.

Because of the lack of long term impact on water quality of the proposed development, it was not considered appropriate to establish a long term baseline data collection programme at this stage.

As an indication of water quality, data collected in 1974 for the Bellambi Coal Company Ltd (Dames & Moore, 1975) has been summarised.

A water quality sampling and testing programme was conducted at that time. Sampling locations were:

1. Allens Creek - below the stock tank dam on the proposed mine site.

2. Allens Creek - 800 metres downsteam from the site.

3. Allens Creek - east of the Township of Wilton.

4. Cascade Creek - western tributary - north east of the site.

5. Cascade Creek - eastern tributary - north east of the site.

6. Cordeaux River - south of the site.

7. Cordeaux River - north confluence with Avon River, north west of the site.

Duplicate samples were taken at each point during dry weather but after several days of extensive rains. Laboratory tests were performed on the samples to determine pH, Cl^-, SO_4^{--}, total Fe, suspended solids, chemical oxygen demand and grease extract. The results of the laboratory analysis are listed in Table C.2.

As shown in the Table, analyses of the water samples revealed excellent water quality at each sample point. The No.3 sampling point, located downstream from the Township of Wilton, yielded samples with slightly higher values than those from other stations. Water quality at the No.3 sampling point is, in all probability, being slightly altered as a result of domestic runoff from the township. However, there is no suggestion that water quality deterioration to any notable degree has occurred from this source.

TABLE C.2

LABORATORY TESTING REPORT *
WATER SAMPLES

SAMPLE	pH	Cl^- (mg/l)	SO_4^{--} (mg/l)	TOTAL Fe (mg/l)	SUSP. SOLIDS (mg/l)	C.O.D. DICRH. (mg/l)	GREASE EXTRACT (mg/l)
1a	5.3	31	2.9	0.22	0.6	6	1.7
1b	5.4	31	2.8	0.22	0.5	6	1.2
2a	5.4	41	2.8	0.23	0.5	6	<1
2b	5.4	40	2.8	0.21	0.5	7	<1
3a	6.3	56	4.5	0.05	1.8	17	<1
3b	6.3	56	4.6	0.10	2.8	18	<1
4a	5.7	28	4.4	0.44	0.4	13	<1
4b	5.6	28	5.2	0.44	0.6	12	<1
5a	5.5	31	3.3	0.66	1.8	15	<1
5b	5.5	31	4.0	0.66	1.1	14	<1
6a	5.6	16	2.7	0.44	1.3	12	<1
6b	5.7	16	2.6	0.46	1.4	15	<1
7a	5.9	16	2.3	0.42	1.0	14	<1
7b	5.9	16	2.0	0.42	1.0	13	<1

* Sampling and testing conducted by Water and Trade Waters Consultants Pty Ltd.

For the No.3 sampling point the values of pH are closer to the netural point of 7.0; chloride is still well within the maximum potable level of 250 mg/l; sulphate is almost negligible compared with the maximum potable level of 250 mg/l; suspended solids are very low (300 ppm) and the C.O.D. values indicate that an additional amount of organic matter has entered the creek, but not enough to cause concern. The total iron content is on the limit for drinking water standard but the limit is set so that iron deposition in reticulation pipes will not occur.

There is no water quality information available for the area below the escarpment between Dombarton and Unanderra.

3.0 ENVIRONMENTAL IMPACT AND MANAGEMENT

Since the proposed line follows the ridge crest between the Avon and Cordeaux Rivers, and will cross the Nepean and Avon Rivers on high level bridges, the hydrology and water quality impacts of operation are expected to be negligible. The line will cross a number of minor streams which flow into the south eastern portion of the Avon Dam near the entrance to the western tunnel portal, and associated works will cause slight modification to the existing flow regime. This will have no long term impact on flow into the reservoir.

There is potential for significant short term water quality impacts during and immediately after the construction phase. The area of impact is again the north side of the south eastern arm of the Avon Dam. Because of the steep slopes and proximity to the dam, it will be difficult to control runoff of turbid waters from construction areas, and the sediment yield to the dam may increase. The MWS&DB has documented three previous instances where large construction projects have led to serious declines in water quality in its reservoirs in this area (Letter 14 Feb, 1978). The SRA will ensure that this project does not result in similar problems.

Some short term deterioration in water quality can also be expected during and immediately after the construction phase of the duplicated line, on water draining from the escarpment area into Lake Illawarra. It will be difficult to control run-off from disturbed areas.

Water quality impacts will be minimised by retaining the maximum amount of existing vegetation, by implementation of bunds and sediment control dams, and where necessary, by stabilsation through mulching, or other means, of the exposed banks and steep areas.

Prior to work commencing the SRA will establish a monitoring programme on streams which drain areas affected by construction operations. The programme will continue until the effects of operations have been ascertained. In the event that a significant deterioration in water quality is observed, action will be taken to remedy this.

REFERENCE

Dames & Moore (1975), Environmental Impact Investigations, Proposed Coal Mine and Washery Development, Wilton, N.S.W., Bellambi Coal Company Ltd.

APPENDIX D

CLIMATE & AIR QUALITY

APPENDIX D : TABLE OF CONTENTS

APPENDIX D : LIST OF FIGURES

APPENDIX D : LIST OF TABLES

1.0 CLIMATE

The proposed railway line is located near the southern New South Wales Coast, which has a temperate maritime climate with warm to hot summers and cool to mild winters.

This climatic survey is based mainly on Bureau of Meteorology records for Port Kembla and Picton. The Port Kembla recording station is located on the coast at an elevation of 19.8 metres above mean sea level, while the Picton station is 33 km inland at an elevation of 170 m. Addition rainfall information has been obtained from MWS&DB gauges in the Lake Cordeaux Catchment. Differences between the climatic values at each station reflect differences in local topography, distance from coast and so forth. Table D.1 shows the locations and elevations of meteorological stations.

TABLE D.1

LOCATIONS OF METEOROLOGICAL STATIONS

	LATITUDE	LONGITUDE	ELEVATION
Picton	34°11'S	150°37'E	171 m
Port Kembla	34°29'S	150°55'E	11 m
Browns Road	34°24'S	150°43'E	442 m
Iron Bark	34°18'S	150°41'E	300 m
Upper Avon	34°28'S	150°40'E	
Upper Cordeaux	34°25'S	150°47'E	

1.1 TEMPERATURE

Average monthly, maximum, minimum and mean temperatures are presented in Table D.2. The maximum daily temperatures range from 16.8°C in July to 29.3° in January for Picton, and 16.7°C in July to 24.4°C in February for Port Kembla. Average minimum temperatures range from 1.7°C in July to 15.2°C in January at Picton, and 9.8°C in July to 18.7°C in February for Port Kembla. The incidence of frost varies from more than 45 days per year at Picton to nil occurrences at Port Kembla.

The extreme maxima and minima for Port Kembla (over 14 years) ate 42.5 and 1.1°C repsectively, and for Picton the equivalent temperatures (over 19 years) are 42.8 and 22.8°C.

1.2 HUMIDITY

Average monthly relative humidities are presented in Table D.3.

Highest humidities occur in Port Kembla during February and in Picton during June.

1.3 RAINFALL

Mean monthly rainfall and number of raindays are listed in Table D.4. Rainfall occurs throughout the year with maximum falls occurring during the summer and early autumn. The most intense rainfall occurs during summer as afternoon thunderstorms. Drought periods of two to six years are not uncommon and below average rainfall has been recorded over the last three years.

The average number of raindays per month varies with a maximum occurring in January and a minimum in July and August.

1.4 EVAPORATION

Evaporation for the Upper Avon and Upper Cordeaux as measured by the MWS&DB is presented in Table D.5. Maximum evaporation occurs during December with values exceeding 130 mm. Evaporation is least during June with a minimum of 42.7 at Upper Cordeaux. Annual evaporation averages 1083.4 at Upper Avon and 1187.1 at Upper Cordeaux. Annual evaporation has exceeded annual rainfall by as much as 260 mm at Upper Avon (1982) and 450 mm at Upper Cordeaux (1980) and by at least 40 mm in three of the last 5 years (See Table D.6).

1.5 WINDS

Wind frequency analyses are listed in Tables D.7 and D.8 for Picton and Port Kembla for the mid-season months of January, April, July and October. Annual wind roses at 0900 and 1500 hours are presented on Figure D-1. Winds over the region tend to be light and variable particularly during the morning. Stronger winds occur chiefly in the afternoon.

During summer the dominant winds are from the southeast and northwest at Picton and from the northeast and south at Port Kembla. In winter the dominant wind directions are south through west to northwest for both locations.

Estimates of extreme wind-gust intensities for specified return periods are listed in Table D.9. Higher wind gusts are derived for Port Kembla because of its more exposed coastal location.

2.0 AIR QUALITY

2.1 MALDON TO DOMBARTON

There is no historical air quality data for the area close to the proposed route. However an assessment can be made from a knowledge of existing land use and the location of the closest industrial centres.

Between Maldon and a point two to three kilometre south east of Wilton the route passes through land devoted mostly to agriculture and low density residential use, for example residences associated with the town of Wilton and farms. The land for the remainder of the route is managed by the MWS&DB as a catchment area, and is covered mostly with natural vegetation, although it does include several underground coal mines. Apart from the mines and associated road transport of coal there is no significant industrial activity. The coal mines may have elevated particulate deposition rates around their surface facilities but these will be local effects and are unlikely to influence air quality along the route.

It is likely that the more distant industrial centres of Wollongong and Sydney will influence air quality when the diluted urban plumes from these centres are carried over the area. It is likely that low concentrations of sulphur dioxide, oxides of nitrogen, fine particulates, and occasionally moderate to high concentrations of secondary pollutants such as "ozone" will be transported from the urban centres to the area through which the route runs. However none of these factors are likely to give rise to a significant degradation in air quality. Present air quality is best described as excellent.

2.2 DOMBARTON TO PORT KEMBLA

Between Dombarton and Port Kembla the route will run parallel to the existing track, which initially runs through about six kilometres of rural land then through four or five kilometres of low density residential land (Farmborough Heights, Allans, Unanderra, Cobblers Hill, Mount St. Thomas and Coniston) and finally into the heavily industrialized area of Port Kembla. All of these areas are influenced by emissions of particulates, sulphur dioxide and oxides of nitrogen from the Port Kembla industrial area, to varying extents.

According to SPCC data, particulate deposition rates (insoluble solids) in Port Kembla typically lie in the range 1 to in excess of 40 g/(m^2.month), and air quality, with respect to particulates, ranges from acceptable to extremely poor depending on meteorology and the industrial activity for the period of interest. SPCC monitoring data from Mount St. Thomas and Coniston also indicate highly variable deposition rates which would lead to air quality being classed as acceptable to poor. Although there is no deposition data, the residences further from the industrial areas, such as Farmborough Heights could be expected to enjoy good to acceptable air quality.

SPCC data for Port Kembla shows that although concentrations of acid gases have on occasions exceeded WHO standards, the majority of the time, concentrations are well below acceptable concentrations. Although direct data is not available for most of the route, it is likely that air quality will be well within accepted levels for acid gases for most of the time.

3.0 ENVIRONMENTAL IMPACT

Diesel locomotives used to haul coal trains will emit diesel exhaust consisting mainly of oxides or nitrogen and minor traces of hydrocarbons and particulates. These emissions will be of no practical environmental significance.

At loading and unloading points, there will be emissions of coal dust, however the impact of these will be minor and local in effect. Truck design includes sloping rear and front ends so that any splinter coal in the loading process will fall to the ground at the loading point and not be

caught on the sides of the truck. In addition, coal moisture content is kept high to minimise dust generation at any stage in the handling and transport. The effectiveness of these control measures has been tested in extensive monitoring programmes undertaken by the SRA at Austinmer, Bellambi, Sutherland, Hurstville and Kogarah, involving the use of dust deposition gauges analysed in accordance with SPCC standard methods. Monitoring programme results have demonstrated that the passage of coal carrying trains past these areas does not result in degradation of local air quality. In fact microscopic examination of the material collected in the dust deposit gauges revealed only the presence of iron oxide particles and mineral matter. No evidence of coal dust particles were found. Short term high volume sampler studies have yielded similarly negative results as far as coal dust particles are concerned.

These results are supported by other tests in the Blue Mountains area of the main Western Line. Consequently no adverse air quality effects are expected due to operation of the line.

During the construction phase there will be some dust generation however this will be local in effect and of a temporary nature. The SRA and the construction contractors will adopt standard procedures to ameliorate dust generation at the construction sites and along access roads. Where appropriate, this will involve watering of dirt roads and exposed spoil faces prone to dust generation.

TABLE D.2

TEMPERATURE DATA (°C) FOR PICTON AND PORT KEMBLA

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MEAN TEMPERATURES														
Picton	0900	21.7	21.4	19.9	16.8	12.2	9.4	7.7	10.4	14.0	17.4	18.9	20.9	15.9
	1500	26.1	25.7	24.5	22.5	18.3	15.7	15.6	16.2	18.7	21.3	23.0	25.4	21.1
Port Kembla	0900	21.3	21.6	21.0	19.0	15.7	13.5	12.5	13.4	15.6	17.4	19.0	20.4	17.5
	1500	22.5	22.9	22.5	20.9	18.3	16.3	13.6	16.1	17.5	18.5	20.1	21.5	19.2
DAILY MAXIMUM TEMPERATURE														
Picton		29.3	28.6	27.0	23.7	20.2	17.3	16.8	18.2	21.4	24.0	26.3	28.5	23.4
Port Kembla		24.1	24.4	24.1	22.4	19.4	17.5	16.7	17.3	19.1	20.7	22.4	23.4	21.0
DAILY MINIMUM TEMPERATURE														
Picton		15.2	15.4	13.1	9.2	5.7	3.2	1.7	2.9	5.2	8.8	11.5	14.0	8.8
Port Kembla		18.4	18.7	17.9	15.7	12.7	10.9	9.8	10.3	11.8	13.7	15.3	17.1	14.4

TABLE D.3

MEAN RELATIVE HUMIDITY (%) AT PICTON AND PORT KEMBLA

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Picton	0900	71	76	76	74	78	81	74	71	66	69	67	68	73
	1500	50	55	56	51	53	59	49	50	57	54	51	49	52
Port Kembla	0900	76	77	75	69	65	66	61	61	59	66	68	74	68
	1500	74	75	73	67	61	60	55	56	58	65	67	72	65

TABLE D.4

MEAN MONTHLY RAINFALL (mm) AND NUMBER OF RAINDAYS FOR PICTON, PORT KEMBLA AND MWS&DB CATCHMENT SITES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Picton[a]	88.2	105.2	78.5	67.9	37.3	63.3	19.8	55.1	36.5	78.9	107.7	64.1	802.5
Port Kembla[b]	112.7	114.5	184.5	105.1	66.9	130.8	51.1	88.4	50.3	103.4	105.9	111.7	1255.3
Browns Road[c]	116.2	110.2	266.4	83.7	156.7	66.6	23.2	11.3	68.0	60.0	83.9	55.3	1101.5
Iron Bark[c]	78.9	93.0	153.3	57.6	105.9	41.4	19.3	9.1	57.7	53.2	69.4	56.0	794.8
Upper Avon[d]	179.6	113.0	253.5	130.3	165.3	135.2	30.8	13.2	69.6	86.7	139.5	102.4	1419.1
Upper Cordeaux[d]	192.0	99.7	267.7	118.2	147.0	172.1	36.1	15.7	70.2	86.3	126.6	65.6	1397.2
Picton[a]	10	12	11	8	7	9	5	9	7	11	11	10	110
Port Kembla[b]	12	12	14	10	7	9	6	9	8	11	12	11	121
Upper Avon[d]	14	12	13	7	12	11	8	6	8	12	13	13	129
Upper Cordeaux[d]	15	12	15	8	12	12	8	5	8	12	14	13	134

Source:

a Bureau of Meteorology Records covering 10-11 years of observations to end 1975.
b Bureau of Meteorology Records covering 18-20 years of observations to end 1975.
c MWS&DB records covering 6 years of observations from 1977 to end 1982.
d MWS&DB records covering 5 years of observations from 1978 to end 1982.

TABLE D.5

AVERAGE TANK EVAPORATION (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Upper Avon	123.3	108.9	90.5	78.3	56.2	43.9	52.9	72.4	93.8	112.2	118.8	132.2	1083.4
Upper Cordeaux	134.0	124.3	100.4	78.5	54.8	42.7	56.6	75.4	101.8	125.3	142.1	151.2	1187.1

TABLE D.6

RAINFALL/EVAPORATION BALANCE (mm)

	UPPER AVON					UPPER CORDEAUX				
	1978	1979	1980	1981	1982	1978	1979	1980	1981	1982
Total Rainfall	2407.8	1136.0	1184.9	1608.5	744.6	2604.7	1066.0	909.0	1601.6	804.7
Total Evaporation	1049.1	1088.4	1226.1	1047.4	1007.6	1130.6	1184.7	1367.7	1158.8	1093.7
Balance	1358.7	47.6	41.6	561.1	-263.0	1474.1	-118.7	-458.7	442.8	-289.0

TABLE D.7

PRECENTAGE OCCURRENCE OF WINDFLOW FROM EACH DIRECTION AT PICTON AND PORT KEMBLA FOR MID SEASON MONTHS, RECORDED AT 0900 AND 1500 HOURS

		CALM	N	NE	E	SE	S	SW	W	NW
JANUARY										
1900	Picton	34	8	8	2	15	14	3	4	11
	Port Kembla	15	6	26	5	11	25	8	2	2
1500	Picton	8	17	12	4	21	17	3	5	13
	Port Kembla	3	5	37	11	16	22	3	2	1
APRIL										
0900	Picton	57	3	4	1	8	8	6	7	4
	Port Kembla	25	10	6	2	3	12	20	12	8
1500	Picton	16	11	8	5	14	9	5	14	18
	Port Kembla	5	4	32	10	12	20	6	8	3
JULY										
0900	Picton	63	1	-	-	2	7	8	13	6
	Port Kembla	16	8	2	1	2	3	23	35	10
1500	Picton	22	6	-	1	8	13	12	25	13
	Port Kembla	3	6	15	6	9	20	14	21	6
OCTOBER										
0900	Picton	36	8	4	2	10	15	9	8	8
	Port Kembla	11	10	21	4	8	21	13	8	4
1500	Picton	15	9	9	4	16	15	5	14	13
	Port Kembla	2	6	30	10	13	23	4	9	3

Source: Bureau of Meteorology
Picton based on 11 years of records
Port Kembla based on 20 years of records

TABLE D.8

PERCENTAGE OCCURRENCE OF WINDSPEEDS GREATER THAN 20 km/hr FOR PICTON AND PORT KEMBLA FOR EACH MID SEASON MONTH, RECORDED AT 0900 and 1500 HOURS

MONTH	0900		1500	
	Picton	Port Kembla	Picton	Port Kembla
January	5	37	14	58
April	7	28	12	57
July	8	35	13	57
October	12	40	22	57

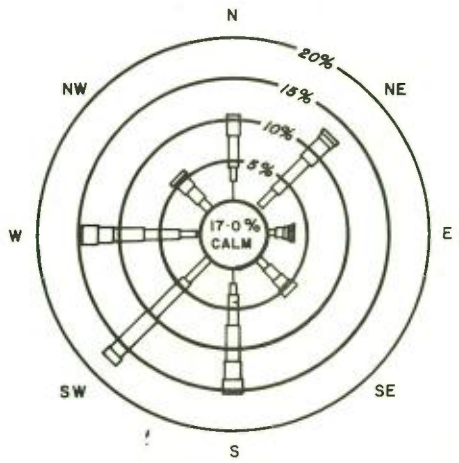
Source: Bureau of Meteorology

TABLE D.9

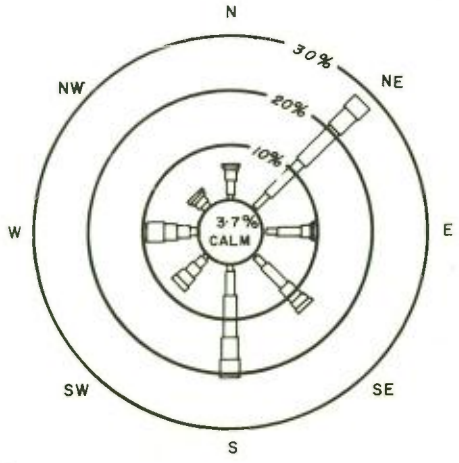
ESTIMATED EXTREME WIND GUST FOR PICTON AND PORT KEMBLA

WIND GUSTS	PICTON	PORT KEMBLA
Modal values of annual maximum gusts (m/sec)	32	33
Extreme gusts for given return period (m/sec)		
10 years	39	40
20 years	43	44
50 years	47	47
100 years	50	50

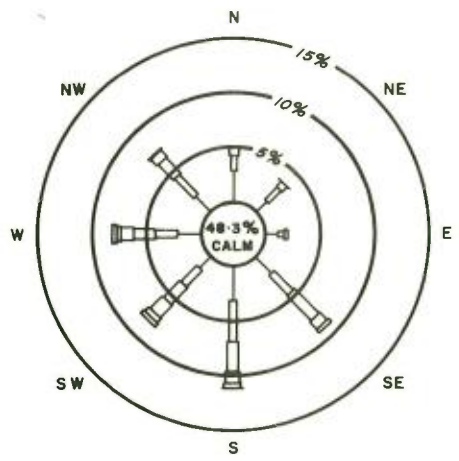
Source: Whittington (1964)



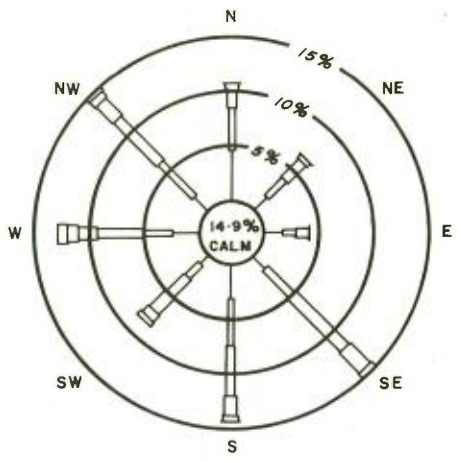
HOURLY AVERAGE SURFACE WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
PORT KEMBLA WIND DATA - ANNUAL 0900 HRS



HOURLY AVERAGE SURFACE WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
PORT KEMBLA WIND DATA - ANNUAL 1500 HRS

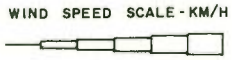


HOURLY AVERAGE SURFACE WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
PICTON WIND DATA - ANNUAL 0900 HRS



HOURLY AVERAGE SURFACE WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
PICTON WIND DATA - ANNUAL 1500 HRS

WIND SPEED SCALE - KM/H



1 TO 6	6 TO 11	11 TO 21	21 TO 31	31 TO 41	OVER 41

STATE RAIL AUTHORITY

TITLE : ANNUAL WINDROSES LOCATION : MALDON - DOMBARTON ROUTE	FIGURE D-1
SCALE	FILE No. : 09886-004-70 DATE : MAY 1983
REF. :	**Dames & Moore**

APPENDIX E

VEGETATION

APPENDIX E : TABLE OF CONTENTS

APPENDIX E : LIST OF FIGURES

APPENDIX E : LIST OF TABLES

1.0 MALDON TO DOMBARTON

1.1 TERRAIN AND SOILS

Most of the route passes over plateau surfaces of Hawkesbury Sandstone, with predominantly sandy soils. The land surface is generally flat to gently sloping, with soils of moderate depth. Steeply incised gorges are found where the route crosses the Nepean and Cordeaux Rivers. Steep slopes, with considerable exposure and often skeletal soils, are found above the Avon Dam. The agriculutural lands between Maldon and Wilton occupy undulating plateau surfaces with soils derived from Wianamatta Shales.

Talus slopes of the Illawarra escarpment at Dombarton are derived partly from the Hawkesbury Sandstone, but are also underlain by Narrabeen group sandstones and shales.

Although not indicated on available maps (Geological Survey of NSW, 1966), there are areas on the Hawkesbury Sandstone in which clayey soils are present, presumably remnants of the original cover of Wianamatta Shale.

Peaty soils are present in a few localities within the MWS&DB land.

1.2 MAIN VEGETATION TYPES

Six main vegetation mapping units are shown on Figure E-1 and summarised in Table E.1. Species noted in all but subtropical rainforest are listed in Table E.2, rainforest species being listed separately in Table E.3.

Agricultural Vegetation

Cleared and largely cleared land contains only remnant native trees (Table E.1). Most of the area is pasture comprising a mixture of introduced and native grasses (Table E.2). Remaining tree species include Eucalyptus fibrosa (Broad-leaved Ironbark) and Angophora floribunda (Rought-barked Apple).

Grassy woodland identifies areas with moderate tree cover remaining, but still subject to modification, usually by grazing. Thickets of small trees tend to be found on sites with relatively shallow shale soils, sometimes with sandstone

TABLE E.1

SUMMARY OF VEGETATION MAPPING UNITS

MAP UNIT	VEGETATIVE STRUCTURE (after Specht 1972)	GEOLOGY	MAIN SPECIES
AGRICULTURAL VEGETATION			
Cleared and largely cleared land	Grassland to open woodland	Wianamatta Shale	Native and introduced pasture species. Remnant sparse tree cover in pasure, eg. Eucalyptus fibrosa, Angophora floribunda.
Grassy woodland	Woodland to open forest	Wianamatta Shale	Grazed or otherwise modified (eg by logging). Native pasture species under E. propinqua, Angophora floribunda, A. bakeri, Acacia decurrens. Layering of shrubs to 2 m where not heavily grazed: Bursaria spinosa, Acacia sp.
NATIVE VEGETATION			
Subtopical rainforest	Closed forest	Narrabeen Group	Numerous rainforest tree species, creepers, ferns on slopes and in gulles along Illawarra escarpment base.
Dry sclerophyll forest	Open forest to woodland	Hawkesbury Sandstone	1. On deeper soil profiles and more protected areas: E. gummifera, E. agglomerata, E. sclerophylla with E. sieberi. E. fibrosa present in areas with residual clay capping. Sclerophyll shrub understorey, frequently with an intermediate tall shrub layer (Hakia, Banksia, Leptospermum). 2. On shallower soil profiles, particularly exposed ridges: E. sclerophylla, E. sieberi often with a tall shrub layer of Banksia, Persoonia, Hakea, Leptospermum.
In gorges and incised streams	Varies from low open forest and woodland (upper slopes Nepean and Cordeaux gorges) to open scrub and tall shrubland on smaller streams and along river beds.	Hawkesbury Sandstone	Angophora bakeri, E. punctata, E. fibrosa (upper slopes, Nepean); Acacia binervia, Tristania neriifolia, Dodoneae triquetra, various other tall shrubs.
Swamps	Open scrub, closed depending on degee of waterlogging	Hawkesbury (peaty soils)	Banksia robur, Leptospermum spp., of Schoenus, Baumea spp., Gleichenia dicarpa frequent.
Heaths (1 area only shown)	Open-heath	Hawkesbury Sandstone	Hakea teretifolia, Leptospermum juniperinum, Epacris microphylla, Schoenus and Lepidosperma spp., Banksia robur present in wetter patches.

TABLE E.2

PLANT SPECIES ENCOUNTERED DURING RECONNAISSANCE

SPECIES	GORGES AND INCISED STREAMS	SWAMPS	HEATH	DRY SCLEROPHYLL FOREST		INTERMEDIATE CASES b	GRASSY WOODLANDS
				DEEPER SOILS	SHALLOWER SOILS		
TREES							
Angophora bakeri	+					+	
Angophora floribunda							+
Eucalyptus agglomerata	+			+		+	
Eucalyptus fibrosa						+	+
Eucalyptus gummifera				+	+		
Eucalyptus piperita				+			
Eucalyptus propinqua	+					+	+
Eucalyptus punctata	+					+	
Eucalyptus sclerophylla				+	+		
Eucalyptus sieberi				+	+	+	+
SMALL TREES, TALL SHRUBS							
Acacia binervata						+	
Acacia binervia	+						
Acacia decurrens						+	+
Acacia linifolia		+	+	+	+		
Acacia longifolia				+	+	+	
Acacia myrtifolia				+	+		
Acacia obtusifolia	+			+			
Acacia suaveolens	+			+	+		
Acacia terminalis				+	+		
Acacia ulicifolia					+		
Banksia robur		+	+				
Banksia serrata				+	+		
Casuarina littoralis	+			+	+		+
a Ceratopetalum gummiferum	+						
Dodonaea triquetra	+						
Dodonaea ?viscosa					+		
Eucalyptus apiculata					+		
Eupomatia laurina	+						
Exocarpos cupressiformis					+		
Hakea dactyloides		+		+	+		
Hakea sericea				+			
Leptospermum attenuatum			+	+	+		
Leptospermum flavescens		+					
Leptospermum lanigerum		+					
Lomatia myricoides	+						
?Notolaea longifolia	+						
Persoonia levis				+	+		
Persoonia linearis				+	+	+	
Persoonia mollis					+		
Platysace linearifolia				+		+	
Polyscias sumbucifolia	+						
Tristania neriifolia	+						
Tristania suaveolens	+						
UNDERSTOREY SHRUBS							
Backhousia myrtifolia	+					+	
Baeckia sp.A		+	+				
Baeckia sp.B		+	+				
Banksia ericifolia		+					
Banksia spinulosa		+	+	+	+	+	
Beyeria viscosa	+						
Bossiaea obcordata				+	+		
Buraria spinosa	+					+	
Calytrix tetragona			+				+
Callistemon linearis	+						
Cassytha sp.	+						
Conospermum longifolium var. angustifolium					+		
Correa sp.						+	
Dillwynia retorta			+		+		
Epacris microphylla		+	+	+			
a Eriostemon australasius				+			

a Protected under the 1976 National Parks and Wildlife Act
b Nepean gorge rims, remnant clay caps on Hawkesbury Sandstone

TABLE E.2 (cont)

PLANT SPECIES ENCOUNTERED DURING RECONNAISSANCE

SPECIES	GORGES AND INCISED STREAMS	SWAMPS	HEATH	DRY SCLEROPHYLL FOREST		INTERMEDIATE CASES b	GRASSY WOODLANDS
				DEEPER SOILS	SHALLOWER SOILS		
Exocarpos strictus				+	+		
Grevillea sphacelata				+	+		
Hakea teretifolia		+	+				
Hardenbergia violacea				+	+	+	+
Hibbertia spp.				+	+	+	
Isopogon anemonifolius				+	+		
Kunzea ambigua						+	
Kunzea parvifolia						+	
Lambertia formosa				+	+		
Leptomeria acida				+	+		
Leptospermum juniperinum		+	+				
a Lomatia silaifolia				+	+		
Micrantheum ericoides					+		
Oxylobium ilicifolium						+	
Petrophile pulchella				+	+		
Pimelea collina		+					
Pomaderris ferruginea						+	
Pultenaea sp.		+	+				
Wollsia pungens	+			+			
HERBS, GRASSES, SEDGES, GRASS-LIKE SPECIES							
Baumea spp.		+	+	+	+		
Baumea juncea	+	+		+	+		
a Blandfordia nobilis		+					
Danthonia spp.	+			+	+	+	+
Dianella laevis				+	+	+	
a Doryanthes excelsa				+			
Eragrostis sp.							+
Gahnia clarkei		+					
Gahnia ?filifolia		+					
Gahnia melanocarpa		+					
Goodenia sp.				+			
Hypolaena fastigiata		+	+	+	+		
Indigofera australis							+
Lepidosperma laterale		+	+				
Lomandra micrantha				+	+		
Lomandra longifolia	+			+	+		
Lomandra sp.		+	+	+	+		+
Paspalum spp.							+
Poa sp.							+
?Ptilantheum deustum				+			
Restio sp.		+					
Schoenus spp.		+	+	+	+		
Sporobolus sp.							+
Verbena hispida							+
Xanthorrhoea australis				+	+		
Xanthorrhoea resinosa				+			
FERNS							
a Adiantum aethiopicum	+	+					
Cheilanthes sieberi	+			+	+		
Doodia aspera	+						
Gleichenia dicarpa	+	+					
Hypolepis sp.	+						
Pteridium esculentum	+			+	+	+	+
a Todea barbara	+						

TABLE E.3

SPECIES NOTED IN SUBTROPICAL RAINFOREST

TREES	SMALL TREES, SHRUBS
Acacia binervata Acacia implexa Acacia suaveolens Dendrocnide excelsa Doryphora sassafras Eucalyptus pilularis Eupomatia laurina Ficus coronata Ficus macrophylla * Livistona australis Pittosporum undulatum Rapanaea variabilis Syncarpia glomulifera Toona australis	Acmena smithii Cassinia longifolia Cassinia sp. Chrysanthemoides monilifera Lantana camara Ligustrum sp. Hibiscus heterophllus Solanum laciniatum Synoum glandulosum Rubus sp. Trochocarpa laurina
CLIMBERS	**FERNS**
Cissus sterculiifolia Geitonoplueium cymosum Marsdenia rostrata Pandorea pandorana Parsonsia straminea	* Adiantum aethiopicum * Adiantum diaphanum * Adiantum sp. Blechnum patersonii * Dicksonia antarctica Doodia aspera Lastreopsis acuminata Pteridium esculentum Pteris sp.

* Protected under the 1976 National Parks & Wildlife Act

and accordingly may contain a mixture of species associated with both Hawkesbury Sandstone and Wianamatta Shale. Trees noted include Eucalytpus propingua (Grey Gum), Angophora floribunda, Angophora bakeri (Narrow-leaved Apple). There may be an intermediate tall shrub layer of Acacia decurrens (Green Wattle) and Bursaria spinosa (Blackthorn), above native and introduced grasses.

Native Vegetation

Subtropical rainforest forms closed-forest on slopes and gullies about Dombarton. The rainforest is characterised by numerous tree species, with a Cabbage Palm Livistona australis emergent. The rainforest has been cleared in places for dairy farming, and is also intersected by the existing railway line. Nevertheless the condition of the stands inspected remains good with little invasion by exotic species. Lantana camara and Privet Ligustrum are present along road and rail easements, together with Boneseed Chrysanthemoides monilifera and Blackberry Rubus spp., but do not penetrate far under the rainforest canopy.

The list of species noted during the reconnaissance is presented in Table E.3, and should be regarded as a sampling of the flora present rather than a complete account. Considerably more species within each group are expected to be present, as the stand appears typical of the rainforest areas found extensively along the lower slopes of the Illawarra escarpment.

Dry sclerophyll forest and woodland is the main vegetation cover of the MWS&DB Catchment Area. Two sub-units are shown on Figure E-1 on the basis of floristics and structure.

Over most of the route, Scribbly Gum Eucalyptus sclerophylla, Blue-leaved Stringybark E. agglomerata and Red Bloodwood E. gummifera form an open forest with a sclerophyllous understorey.

The height of the tree stratum varies. Ridge areas and upper slopes tend to carry low open forest (tree heights 8-10 m). In more protected areas, and lower slopes with deeper soils, height increases to 15-20 m. Other trees commonly present include Sydney Peppermint E. piperita and Black Ash E. sieberi, the latter appearing where sandstone is close to the surface. Clay cappings occur within the mapped area,

although infrequently, carrying E. fibrosa in addition to the species usually associated with Hawkesbury Sandstone.

Plateau dissection is much more pronounced in the Brown's Road area, and both ridges and slopes tend to carry a shallow to skeletal soil with frequent sandstone outcropping. E. sclerophylla and E. sieberi are the main tree species, forming low open forest or low woodland (tree heights 5-8 metres, cover 30 percent). E. gummifera and E. agglomerata may still be present, but only on the deeper soils of protected slopes do they become major tree species.

The understorey in both sub-units largely reflects fire history. The pattern of prescribed burning practised by the MWS&DB together with occasional wildfires has given rise to a mosaic of understorey types.

The most common is an understorey shrub cover of 1-2 metres, comprising sclerophyllous shrubs such as Banksia spinulosa, Banksia serrata, Petrophile pulchella, various Acacia species, Hakea dactyloides and Isopogon anemonifolius. Less common but still frequent is a layered understorey, with Banksia serrata, Hakea sericea, Hakea dactyloides, Leptospernum attenuatum and Acacia species in a tall shrub layer (3-4 metres, cover up to 50 percent), and other sclerophyllous species forming a sparse low shrub layer beneath the taller shrubs. The areas with denser tall shrub layers appear to have escaped burning by wildfire for some years, although they are included in areas prescribed-burnt by the MWS&DB.

Clay soil caps within the sandstone plateau have a grassy understorey with relatively few sclerophllous shrubs present (Table E.2). A tall shrub layer of Acacia and Persoonia species, with or without the Hakea, Leptospermum and Banksia species already mentioned, may also be present.

Gorges and incised streams carry a variety of vegetation. The rim and upper half of the steep broken slopes of both the Nepean River and Cordeaux River gorges carry low open forest or low woodland of sandstone species already noted for plateau surfaces, with Angophora bakeri and Eucalyptus punctata also present in the Nepean gorge. Lower slopes and the actual stream fringes are generally an open scrub with Water Gums Tristania neriifolia and Tristania suaveolens, Hopbush Dodonaea triquetra, Coast Myall Acacia binervia and

smaller shrubs including Backhousia myrtifolia, Beyeria viscosa and Callistemon linearis.

Incised streams within the MWS&DB catchment have along their courses a sparse cover of small trees and tall shrubs such as Bolwarra Eupomatia laurina, Tristania neriifolia and Polyscias sambucifolia. The King Fern Todea barbara is frequent, and other ferns (Gleichenia, Doodia, Hypolaepis) are common.

Swamps are present on the plateau surface and also in deep and broad gullies above the Avon Reservoir. Swamps on the plateau surface are dominated by sedges (Schoenus, Gahnia, Baumea species), with areas of heath dominated by Banksia robur. The soils are peaty. The swamps above the Avon Reservoir are, more strictly, wet heaths, containing a mixture of swamp species proper and sclerophyllous shrubs, the more frequent of which include Baeckia spp., Banksia ericifolia, B. spinulosa, Eparcis microphylla, Hakea teretifolia, Leptospermum flavenscens and L. langerum.

Heaths are found in small areas on the plateau surface. The only one encountered in the survey was dominated by Leptospermum juniperium and Hakea teretifolia, with Banksia spinulosa and Baeckia spp.

1.3 RARE, THREATENED AND PROTECTED SPECIES

1.3.1 Rare and Threatened Species

The only species listed as threatened by Leigh and others (1981) and encountered during the reconnaissance is the Narrow-leaved Mountain Mallee Eucalyptus apiculata. This species is coded "2V" by Leigh and others ("2", species with a maximum range greater than 100 km; "V", species vulnerable but not presently endangered, at risk over a longer period throuh continued depletion; not known to be protected within the convervation reserve). Pryor (1981) lists it with "species of relatively limited extent which may be threatened in the near future" but not presently endangered. The one specimen noted was growing with Eucalyptus sieberi on sandstone outcropping beyond the area likely to be affected by the rail development.

The species was originally known to be within the district from a single specimen taken at Mt. Keira in 1965. The supposed rarity prompted a survey for the species in association with a proposed development of the Westcliff mine (Coal Cliff Collieries Pty Ltd), with survey undertaken in 1982 by R. Muston. The species was found in the Westcliff area in very small disjunct stands of few individuals, associated with sandstone outcrops in E. sclerophylla woodlands and on the edges of creeks draining swamplands. A recent but as yet unpublished survey by T.J. Fatchen & Associates for the Medway (Berrima) Colliery development found that the species, although occupying a specialised habitat, was frequently encountered on escarpments of the Wingecarribee River and tributaries; to such a great extent that the status assigned the species by Leigh and others is questionable. The finding of a specimen near the present development, in conjunction with the findings of Muston and the surveys about Berrima point to the species being present wherever suitable habitat is found in the region, and in particular, being present along the Illawarra escarpment.

1.3.2 Protected Species

Species protected under the 1976 National Parks and Wildlife Act are indicated in Table E.2 and E.3. They include common species such as Lomatia silaifolia as well as less common species as Ceratopetalum gummiferum. None of the protected species noted appears in the threatened species lists of Leigh and others (1981).

1.3.3 Potential for Presence of Undetected Threatened Species

The information in this report is at a reconnaissance level, and does not include the total flora of the native vegetation traversed by the proposed rail route. No orchid species, for example have been noted, and the list of rainforest species is incomplete. There is some likelihood that threatened species are present along the proposed route, particularly in association with habitats and vegetation types which are uncommon. The swamp areas and the rainforest, discussed below, are the most likely candidates for occurrences of such species.

1.4 SIGNIFICANT HABITATS AND VEGETATION TYPES

The dry sclerophyll forest of the MWS&DB catchment area has considerable conservation significance. It acts as a large, "de facto" conservation reserve because of management policies which exclude most human activites other than the programme of prescribed burning and the creation of fire tracks. The railway easement, however, will remove only a very small proportion of the dry sclerophyll forest. Similarly, the Nepean River gorge provides a strip of more or less intact native vegetation through a largely cleared landscape, but again, the proposed development will remove only a small portion of this.

In terms of extend and physical characteristics, the swamp areas are regarded as the most significant habitat encountered. This opinion stems partly from the species encountered only in the swamps (Banksia ericifolia, B. robur, Gleichenia dicarpa, Leptospermum lanigerum, Blandfordia nobilis). Their absence from other areas may be a function of limited search effort in part, but nevertheless suggests that greater search effort may uncover more species restricted to the swampy areas. As well, the presence in places of peaty soils is likely to result in uncommon, if not rare species being present. There are a number of plant species in NSW known only from one or two collections from peaty swamps (D. Benson pers. comm.) and the protection of swamps is currently of considerable concern to the National Parks and Wildlife Service (P. Keane, pers. comm.). Further, although there are a number of swamps about the area directly observed, their overall extent is not great.

Rainforests are at present a politically contentious issue. In the present case, however, the rainforest areas shown in Figure E-1 are not regarded to be of particular importance, as the stands are only part of the rainforest stands found along the base of the Illawarra escarpment.

2.0 DOMBARTON TO PORT KEMBLA

2.1 TERRAIN AND SOILS

The route from Dombarton to Farmborough heights traverses the lower but still relatively steep slopes of the Illawarra escarpment for most of its length, reaching land with gentler slopes at Farnborough Heights.

The underlying geology is initially Narrabeen group shales, with Illawarra Coal Measures appearing approximately 1 km below Dombarton (Geological Survey NSW 1966). Soils appear to be derived partly from the underlying sediments and partly from the talus of the escarpment; they vary from almost skeletal loamy sands on tops of small ridges to moderately deep, rich chocolate loams in valleys and on gentler slopes.

2.2 MAIN VEGETATION TYPES

Figure E-2 displays three mapping units; rainforest/wet sclerophyll forest, dry sclerophyll woodland and forest, and cleared/largely cleared land. Finer differentiation is not possible at the scle of Figure E-2. At the very much larger scale of the aerial photographs used, these mapping units can be further subdivided.

Subtropical rainforest and wet sclerophyll forest

Subtropical rainforest occupies 30-40% of the area mapped in Figure E-2 as the combined unit. The largest continous stands of rainforest are immediately to the east and north of Dombarton and in the valley of Dapto Creek. The rainforest elsewhere is present as a mosaic of small and large forest. In all cases, the rainforest is found in areas with some degree of protection and usually areas of deeper soils.

The rainforest is a closed forest with a canopy cover of some 90% or more, characterised by numerous tree species of moderate height (7-15 metres). The Cabbage Palm (Livistona australis) is emergent in most rainforest areas, but in the Dapto Creek valley is also accompanied by the Bangalow Palm (Archontophoenix cunninghamiana). Common tree species include Sassafras (Doryphora sassafras), Acronychia oblongifolia, Red Cedar (Toona australis) and the Giant Stinging Tree (Dendrocnide excelsa). Figs (Ficus spp.) are frequent. Vines and creepers are frequent, for example Wonga Wonga Vine (Pandorea pandorana) and Water Vine (Cissus sterculiifolia).

The condition of the rainforest above the rail easement is good. Openings in the canopy such as the easement itself have allowed the establishment of Lantana (Lantana camara) and Blackberry (Rubus spp.) with other aliens, but there is almost no penetration into the rainforest beyond the opening. The palms are rather thinly dispersed, however

seedlings are frequently encountered. Below the rail easement, land clearing has reduced the extent of remnant stands and the remnants tend to contain a higher proportion of alien species.

The wet sclerophyll forest merges into the subtropical rainforest, and shares many of the rainforest species particularly along its margins (Table E.4). It reaches its best development, however, on the small ridges about the easement. These ridges are less protected than the areas carrying rainforest and generally have poorer soils.

Wet sclerophyll forest is characterised by eucalypts (particularly Blackbutt-Eucalyptus pilularis and other boxes) usually with a higher but less dense canopy than the rainforest (20-25 metres high, cover 60 - 80%). A small tree/tall shrub layer is usually present, often containing species also found in the rainforest (e.g. Doryphora sassafras) but on more exposed sites dominated by Acacia species, particularly Two-veined Hickory (Acacia binervata). This intermediate layer is generally about five metres high, with cover 50-70%. Tree-ferns (Dicksonia antarctica) are present along small streams.

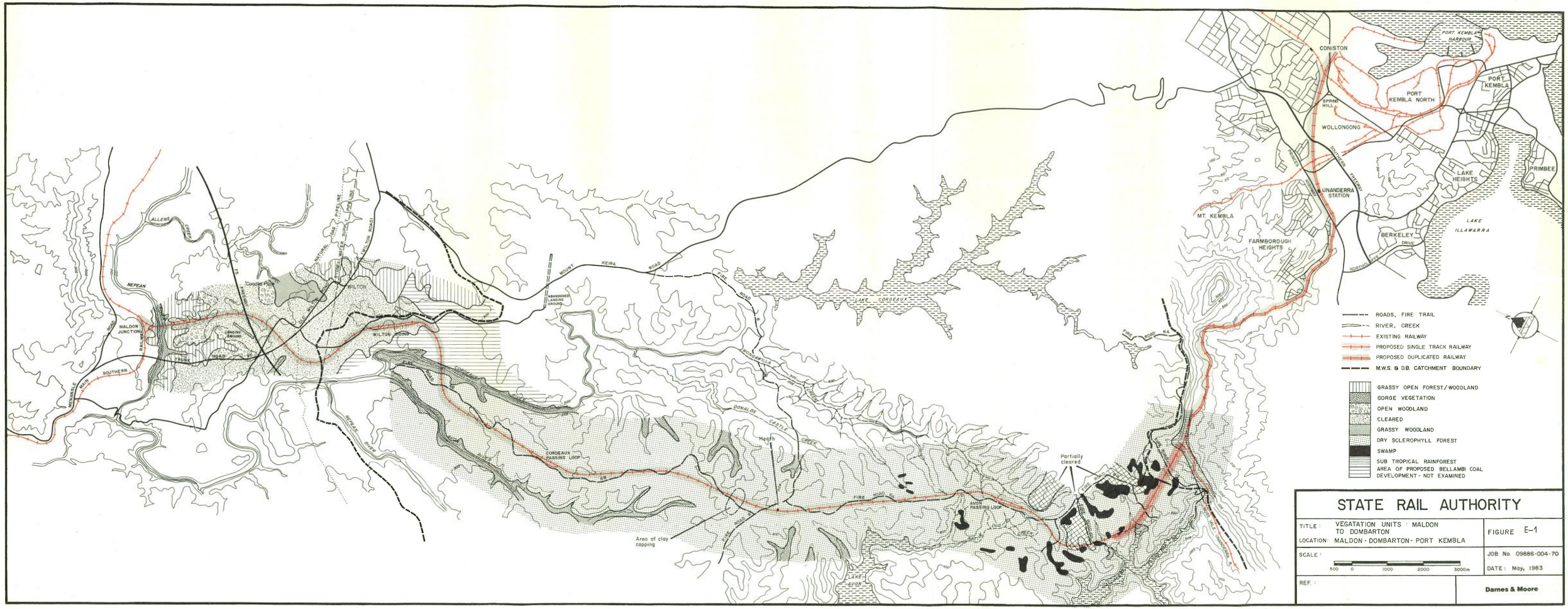
Dry Sclerophyll Woodland and Forest

Upper slopes of Illawarra escarpment carry an open forest of Black Ash (Eucalyptus sieberi) and other species.

Small remnant stands of lowland forest are present near Farmborough Heights; these have not been examined as they are beyond the area of impact of the rail duplication.

Cleared Land and Induced Open Woodlands

Much of the land on the escarpment lower slopes, below the rail easement, has been partically cleared. This has resulted in a mosaic of completely treeless land, open woodlands with wet sclerophyll or rainforest trees as remnants, and areas where the rainforest canopy has been partly opened. In the last, extensive thickets of Lantana camara are established, but in many cases the rainforest species appear to be re-establishing.



STATE RAIL AUTHORITY

TITLE : VEGATATION UNITS : MALDON TO DOMBARTON

FIGURE E-1

LOCATION: MALDON - DOMBARTON - PORT KEMBLA

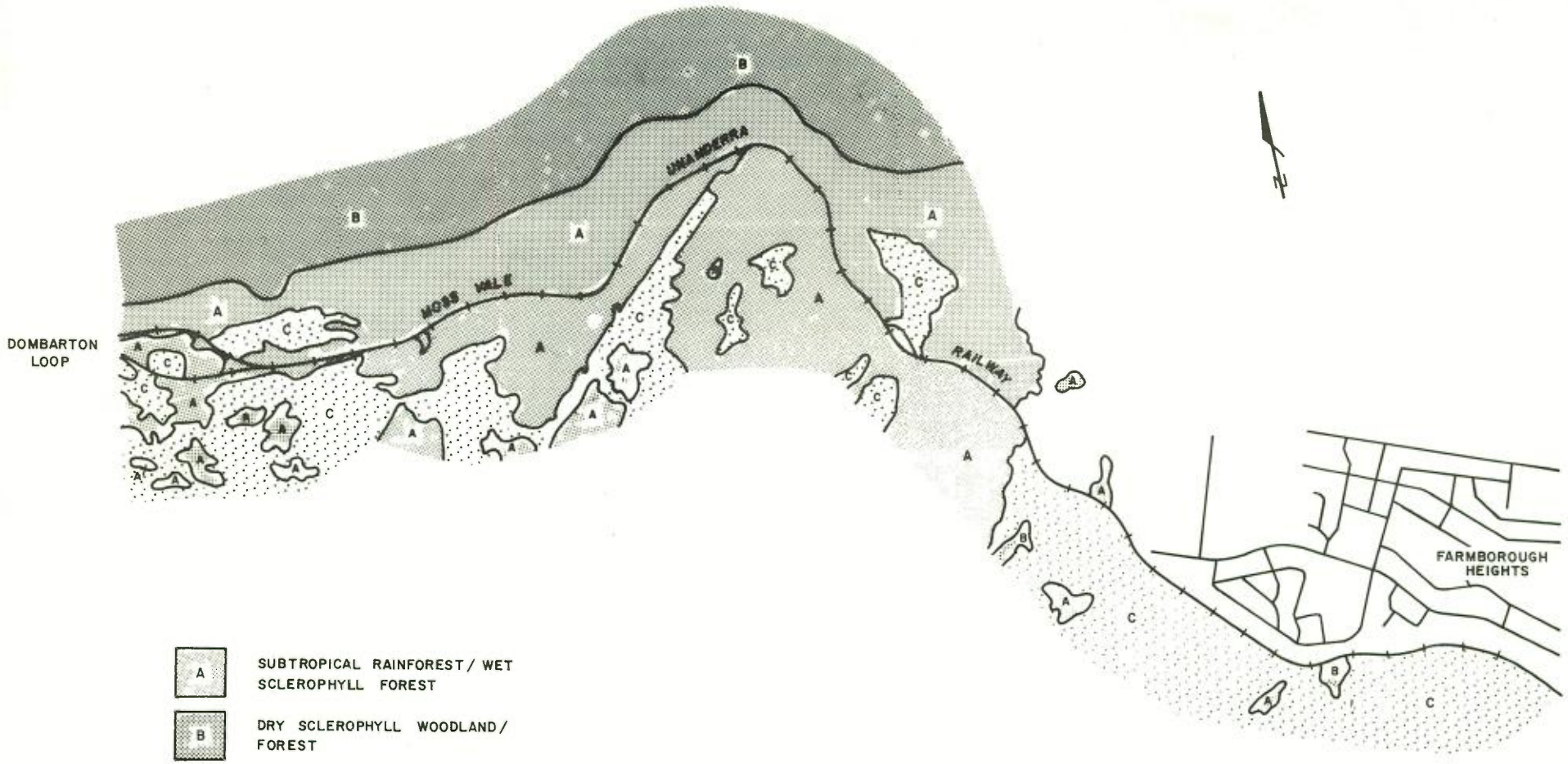
SCALE : 500 0 1000 2000 3000m

JOB No. 09886-004-70

DATE : May, 1983

REF. :

Dames & Moore



STATE RAIL AUTHORITY

TITLE:	DOMBARTON to FARMBOROUGH HEIGHTS - VEGETATION UNITS	FIGURE E-2
LOCATION:	MALDON - DOMBARTON ROUTE	
SCALE	1:25,000	FILE No.: 09886-004-70
		DATE: MAY 1983
REF.:	T.J. Fatchen & Assoc.	Dames & Moore

TABLE E.4

SPECIES ENCOUNTERED DURING RECONNAISSANCE

* = alien

SPECIES	RAIN FOREST	WET SCLEROPHYLL	REMNANTS, CLEARED LAND
TREES			
Acronychia oblongifolia	+	+	-
Archontophoenix cunninghamiana	+	-	-
Dendrocnide excelsa	+	-	-
Doryphora sassafras	+	+	+
Eucalyptus bosistoana	-	?	-
Eucalyptus pilularis	-	+	+
Eucalyptus rudderi	-	+	-
Eucalyptus sp.	-	+	+
Ficus henneana	+	-	-
Ficus macrophylla	-	-	+
Livistona australis	+	-	-
Pittosporum undulatum	+	-	-
Toona australis	+	-	-
SMALL TREES/TALL SHRUBS			
Acacia binervata	+	+	+
Acacia implexa	-	+	+
Acacia maidenii	-	+	+
Acacia suaveolens	+	+	+
Acmena smithii	+	+	+
Eupomatia laurina	+	-	-
Exocarpos cupressiformis	-	-	+
Ficus coronata	+	-	-
Hibiscus heterophyllus	+	+	-
Rapanaea variabilis	+	+	+
Synoum glandulosum	+	-	-
Trochocarpa laurina	+	+	-
SHRUBS			
Bursaria spinosa	-	-	+
Cassinia longifolia	-	+	+
*Chrysanthemoides moniliferum	-	-	+
Commersonia fraseri	+	+	-
*Lantana camara	+	+	+
*Ligustrum sp.	-	+	+
*Rubus spp.	+	+	+
Solanum laciniatum	-	-	+
CREEPERS, VINES			
Cassytha sp.	-	+	+

TABLE E.4 (cont)

SPECIES	RAIN FOREST	WET SCLEROPHYLL	REMNANTS, CLEARED LAND
Cayratia clematidea	+	+	-
Cissus sterculiifolia	+	-	-
Eustrephus latifolius	+	+	-
Geitonoplesium cymosum	+	+	+
Pandorea pandorana	+	+	-
Parsonsia straminea	+	+	+
*Passiflora subpetlata	+	-	+
Sarcopetalum harveyanum	+	+	-
HERBS, GRASSES (cleared areas not listed)			
Helichrysum bracteatum	-	+	
Pollia crispata	+	+	
FERNS			
Adiantum aethiopicum	+	+	+
Adiantum diaphanum	+	+	-
Adiantum sp.	+	-	-
Blechnum patersonii	+	-	-
Dicksonia antarctica	+	+	+
Doodia aspera	+	+	-
Lastreopsis acminata	+	-	-
Marsdenia rostrata	+	-	-
Microsorum diversifolium	+	-	-
Pteridium esculentum	-	+	+
Pteris sp.	+	-	-

2.3 RARE, THREATENED AND PROTECTED SPECIES

2.3.1 Rare and Threatened Species

We have identified one specimen taken from wet sclerophyll forest at Dombarton as Rudder's Box (Eucalyptus rudderi). Pryor (1982) records this species as one of relatively limited extent which may be threatened in the near future with continued land clearing. The species is not listed as threatened by Leigh et al. (1981).

2.3.2 Protected Species

Species protected under the N.S.W. National Parks and Wildlife Act are listed in Table E.5. The ferns listed are common within the rainforest.

Bangalow Palm is restricted to the gully of Dapto Creek, with the nearest individual occurring well beyond the area of immediate impact. Several individuals of Cabbage Palm are present next to the existing easement. None of the species noted appear in the threatened species lists of Leigh et al. (1981).

2.3.3 Potential for Presence of Undetected Threatened Species

The species listing, particularly for the rainforest, may not contain the total flora along the rail easement. There is a possibility that occasional individuals of threatened species may be present.

2.4 SIGNIFICANT HABITATS AND VEGETATION TYPES

Rainforests generally assume considerable conservation significance beause of the small proportion of the State's area they occupy. However, the stands intersected by the railway are only a small portion of the total rainforest remnants along the base of the Illawarra escarpment, and of themselves do not have particular regional importance. They do however contribute to the retention of floristic and habitat diversity in the locality, and may be of considerable local value for the maintenance of wildlife partially or wholly dependent on the presence of at least islands of rainforest. For example, the Dapto Creek stand provides both roosting and food sources for a large colony of Red Flying Fox.

TABLE E.5

PROTECTED SPECIES NOTED IN AREA
(National Parks and Wildlife Act)

SCIENTIFIC NAME	COMMON NAME
Adiantum aethiopicum	Maidenhair fern
Adiantum diaphanum	Filmy maidenhair fern
Adiantum sp.	
Archontophoenix cunninghamiana	Bangalow palm
Livistonia australis	Cabbage trees

The occurrence of a local concentration of Archontophoenix cunninghamiana (about Dapto Creek) is unusual, but this area is well beyond the area of direct impacts.

3.0 FIRE

3.1 WILDFIRES

Risks of severe bushfires along the proposed route are greatest in the Cordeaux catchment area, in forested lands under the control of the MWS&DB. Accurate fire records have been maintained since 1972, with information on the ignition source, location and area of wildfires.

Most of the route was burnt in wildfire in summer 1977-1978, with the ignition source being multiple lightning strikes. The area to the west of Fire Road 6B, which approximates part of the proposed rail route, had been burnt by wildfire in the mid-1960's. One area near the route was also burnt by a wildfire in the 1980-1981 season, the ignition source in this case being a prescribed-burn out of hand.

3.2 PRESCRIBED BURNING

Since 1973, the MWS&DB has conducted prescribed burning within the catchment to reduce the fuel available to a wildfire (Max Wooton, MWS&DB, Pers. comm.). Prescribed burning is conducted on a "5-year return" basis, that is, with a minimum span of 5 years between subsequent burns, and the actual time span beyond 5 years being determined on the basis of level of fuel accumulation. In practice, the actual span between repeat burning is 6-7 years.

The specific effects of the prescribed-burning regime on the flora is the subject of a continuing research programme by Dr S. Clark, Centre for Environmental Studies, Macquarie University. There have as yet been insufficient consecutive burning cycles to support any firm conclusions on the long-term effects of the prescribed burning regime; however, the relatively high frequency of low intensity fires appears to maintain a low (1-2 m) shrub understorey. Reconnaissance observations do not suggest any significant shift from shrubby understoreys to grassy or bracken fern understoreys of lower diversity.

3.3 FIRE IN AGRICULTURAL LANDS

The natural vegetation in agricultural areas has been modified by clearing and grazing to such an extent that any loss of remaining natural vegetation will not mean the destruction or major modification of significant habitats or plant communities. The risk of fire is much greater in the agricultural lands than in the catchment area because of the much higher level of human activity.

There is insufficient fuel in the open forest and woodland of the Nepean River gorge to feed a major bushfire, although fire could move through the gorge by means of the patchy shrub layer and, near the stream itself, the fringing open scrub.

4.0 PROJECT IMPACTS AND MITIGATION

4.1 MALDON TO DOMBARTON

The main impacts of the proposed railway construction will be within the MWS&DB catchment. Outside the catchment area, the railway will disturb a small segment of native vegetation in the Nepean River gorge, at the bridge site, and will miss remnant woodland stands in the agricultural lands. The tunnel portal and junction at Dombarton will necessitate the dissection of a stand of subtropical forest, but this will occur wherever a portal might otherwise be sited (within a reasonable range) along the Illawarra escarpment. No known rare or threatened species have been noted outside the catchment area, although it is possible, that such species may be found on closer inspection of the subtropical rainforest. However, the presence of equivalent rainforest for some considerable distance north and south of the proposed portal and junction at Dombarton should mean that such species would not be immediately threatened by the proposal.

Within the catchment area, the railway construction would require some easement clearing additional to the areas already cleared for the MWS&DB fire roads. Over most of the route, this is not seen as ecologically significant because the dry sclerophyll forest and woodland through which the route passes extends over most of the catchment area and the clearing would remove only a very small proportion of the total occurrence.

However, the proposed route intersects two and perhaps three swamp areas. Easement clearing, provision of access and line construction could result in a complete change of the swamp habitat and probably an almost complete loss of swamp vegetation and flora in this case. The potential significance of the swamp areas as a source of rare species and the comparative infrequent occurrence of the particular vegetation type present have both been mentioned in preceding sections. As well, there are other values associated with the swamps which should also be considered. First, such areas are important sources of permanent water in the Hawkesbury Sandstone environment (Forster and others, 1977), acting as a focus for wildlife. Second, they also act as filters by retaining sediments eroded and transported downslope during heavy rainfall. These sediments would otherwise enter stored water and adversely affect their clarity.

The location of the proposed route should be planned to avoid larger swamp areas. If this is not possible because of engineering restrictions, a detailed examination and evaluation of swamps in the area should be undertaken, with objectives first to confirm the presence or absence of rare species within the affected swamps and second to determine the degree to which individual swamps in the area are replicates of each other (and so, to determine the importance of the affected swamps on a district basis). Where the line passes through these areas, culverts and pipes should be incorporated in the formation to ensure drainage is not impeded.

Tunnelling and cutting for line construction will require temporary storage of landfill. Storage sites should utilize open ground wherever possible, and in particular, about the Dombarton area. No rainforest should be damaged for temporary storage purposes.

Construction may result in some weed introductions to the weed-free MWS&DB catchment. A weed control programme will be necessary to limit their spread, and where possible to eliminate any introductions.

In a similar vein, changes in vegetation composition within the MWS&DB catchment can be expected if exotic grasses are introduced to stabilse earthworks. The use of native species (and particularly low shrubs) should be considered for this purpose.

4.2 DOMBARTON TO PORT KEMBLA

The major direct impacts on native vegetation are expected to be the clearing of additional areas of vegetation for line duplication and in places cutting and filling to a greater distance, within the SRA reserve.

Line clearing and cutting will remove no more than ten hectares of subtropical rainforest and wet sclerophyll forest along the easement. The impact will be slight: the extent of the impact is too limited to show in Figure E-2. Clearing will entail removal of some individuals of the protected Livistona australis, but this should not affect the viability of the local population. Individuals may be relatively dispersed, but are still numerous in the immediate locality, and the population is recruiting well. The clearing is unlikely to result in the introduction of more aliens than are present now, their distribution along the rainforest and wet sclerophyll forest fringes will simply be moved to the edge of the new clearing. The rainforest in particular apears to be capable of preventing or resisting alien invasions provided the canopy is not opened beyond the easement.

Impacts of vegetation upslope from the easement will be negligible provided construction vehicles do not stray from the development area.

The potential for indirect impact is greater downslope from the easement, through alteration or blocking of stream flows or "spillover" of cutting and fill material. Streams, particularly those feeding into remnant rainforest areas, should not be blocked or diverted unless some provision is at the same time made for their re-direction into original courses below the easement.

Cutting and filling for line duplication will require temporary storage of landfill. Storage sites should utilise open ground wherever possible, and in particular, about the Dombarton and Dapto Creek areas. Forest should not be damaged for temporary storage purposes, and care should be taken to avoid the damming or filling of streams through rainforest.

There is a slight risk of fire in the rainforest, a moderate risk in wet sclerophyll and a high risk in other vegetation

during line construction. Potential ignition sources include slash burning, lunch-time fires and machinery and vehicles with faulty or unsuitable exhaust systems. Although rainforest will not usually burn, in an extended dry period a fire can result in its complete destruction and eventual replacement with another plant community.

Considerable effort will be needed to ensure that contractors conform with fire regulations, but in addition, provision should be made for rapid attack on any fire which may start at the construction site. Cleared slash and timber should be removed from the construction area, not burnt on site. As a further precaution, it is suggested that operations be suspended on days of extreme fire danger.

4.3 BUSHFIRES

Risk of wildfires will be very greatly increased within the MWS&DB catchment during line construction. Potential ignition sources include lunch-time fires, cigarettes and machinery and vehicles with faulty or unsuitable exhaust systems. Considerable effort will be needed to ensure that contractors conform with fire regulations, but in addition, provision should be made for rapid attack on any fire which may start at the construction site. As a further precaution, operations may need to be suspended on days of extreme fire danger.

Once the line is in operation, risks will be very slight (resulting primarly from train braking) and should be effectively minimised by maintenance of fire breaks within the railway reserve.

4.4 OTHER IMPACTS

Although unaware of the exact locations, we understand that a number of experimental plots along Fire Road 6B could be removed in the course of line construction. These plots have been in existence for some years and are part of the programme of prescribed-burn monitoring run by Dr S. Clark.

The NP&WS were consulted on the significance of vegetation types during the conmpilation of this report.

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APPENDIX F

WILDLIFE

APPENDIX F : TABLE OF CONTENTS

1.0 INTRODUCTION

In 1978 environmental studies were carried out for the then Public Transport Commission of NSW, by D&M to assess the impact to native wildlife of the then proposed Maldon to Port Kembla railway. The currently proposed Maldon to Dombarton route passes through the same general region, following a portion of the old route near Maldon and following the ridgeline within 10 km south of the previous proposal.

The Maldon to Dombarton route passes through wildlife habitats that are representative of the region and have remained largely undisturbed. Because of the close similarity to the original route, the results of the previous study have provided the basis for this report.

A literature review and 2-day field survey of the natural habitat on the Illawarra plateau, through which the proposed railway line will pass, was conducted. Birds and mammals were recorded at three sites in the Cordeaux catchment area between the Cordeaux Reservoir Road and the Picton-Wollongong Road (Trunk Road 95), and the Nepean Gorge near its crossing by the proposed railway. Bird species abundance was subjectively estimated during two morning observation periods and whilst surveying for mammals. Bird nests were rated, as was the presence of young out of nests.

Mammals were identified by their faeces or during transects with spotlights at night. Small mammals were also trapped at one site.

No account was made of terrestrial wildlife on the Wollongong Plain as most of this area across which the railway line will pass, has been largely cleared of natural habitats.

As a result of previous patterns of land use, and the management regime imposed on the area by the MWS&DB, an ideal situation has been created for the herbivorous marsupials. Food, water and cover are juxtaposed in a particularly favourable way, and the above areas have to be understood as a system rather than a set of independent parts.

2.0 HABITAT

The following habitat types were identified according to the structure and species composition of vegetation:

- scribbly gum, bloodwood low open forest/woodland;
- swamp heath: paperbark and swamp gum complex;
- dry heath: Banksia and Leptospermum;
- ironbark, bloodwood tall woodland;
- mixed low open woodland;
- riparian: watergum.

It is the MWS&DB's policy to burn grassland annually. An unusual fire pattern develops in the grassland burn, according to the ranger. There is usually good combustion in the grasslands, and the fire enters the forest, burning in a few hundred metres before it goes out. In this way litter is removed and there is rapid return of inorganic material to the soil and very rapid regeneration of the grasses. This is a favourable management programme for herbivores, and is reminiscent of the management practised by the Tasmanian Aborigines in the establishment and maintenance of the "hunting glades".

This same management programme has rendered the burnt areas less favourable for the ground-dwellers that depend on close ground cover. It is probable that their numbers would increase greatly where fire has not penetrated and ground cover is much thicker.

In summary, a system containing a permanent watering point and high quality grazing, is probably responsible for population sizes of herbivorous mammals. This is an artificial situation brought about by previous agriculture, and the present management policies of the MWS&DB.

3.0 BIRDS

Bird counts at various points were totalled and compared. The total species number in the dry forests indicated a low to moderate density which would probably have been higher if a longer survey had been conducted. The abundance of honeyeaters would also probably increase during flowering of plants.

Bird censum rely heavily on good sighting conditions and also on the identification of calls. Both the ability to see, and the extent of calling are very much influenced by weather conditions.

The species composition had been influenced by boundary conditions alongside roads. For example, birds such as the Jacky Winter, Grey Butcher Bird and Buff-rumped Thornbill were largely associated with the more 'open park-like' conditions caused by clearing of the roadside verges and along the gas pipeline route.

An unusual sighting was made of the White-breasted Sea Eagle which, although of academic interest, is of no importance to the impact assessment since this species breeds along the coast.

All birds recorded in the study are widely distributed in similar habitats of NSW. However, some species which require attention are those preferring wet habitats and heath or heath-like conditions, as these habitats are limited in number and extent and are coming under increasing pressure elsewhere in eastern Australia. These species are the:

- Eastern Whipbird
- Variegated Wren
- Pilot Bird
- Chestnut-rumped Hylacola
- New Holland Honeyeater (although this species is more able to adapt to other habitats).

4.0 MAMMALS

The populations of each mammal species recorded was considered to be stable, though subject to long term natural fluctuations, so long as their habitats remain unaltered by human interference. Interchange between parts of the mammal population north and south of Trunk Road 95 occurred to a varying extent. The macropods were subject to a more local reduction of their population than other mammal groups, as they are attracted to the roadside where their mortality rate is increased by collision with vehicles. Of the macropods, the Grey Kangaroo requires the largest area to support a viable population.

Road kills of macropods in recent years had appeared to stabilise at a low level, which suggested that the macropod populations were low within the immediate vicinity of the road and were in equilibrium with those of the hinterland. Habitat changes in the future could alter this situation. Fires could open the understorey, causing an increase in Grey Kangaroo and Red-necked Wallaby numbers.

A fauna survey carried out for the Bellambi Coal Company Limited in 1974 (D&M, 1975) found that larger mammals tend to reside during the day in areas of heavier cover. During the late afternoon and night, these animals emerge and are found feeding along edges of forested areas. It is suspected that a significant proportion of animals come from areas of the catchment remote from the feeding grounds. This is entirely consistent with what is known of macropod behaviour.

Wombats favoured feeding sites appeared to be beneath Acacia stands where grass has a mown lawn appearance, and also in areas with an abundance of soft green feed. Evidence suggested that wombat populations depend on grassland areas and grass beneath trees for feeding and habitation.

5.0 KOALA OBSERVATION SURVEY

An informal observation survey has been undertaken within the catchment area over the past three years by staff of the MWS&DB. Koala spottings are noted and locations recorded.

The main concentration of animals observed lies in the area west of the Avon Dam. However some spottings have occurred in scattered locations in the area east of the Dam. The most relevant to the proposed railway are two sitings near the junction of the line with the proposed West Bellambi coal development loop.

6.0 IMPACT ON WILDLIFE

The impact on wildlife was evaluated by comparing the known general distribution and status of species, with that observed or recorded within the areas under investigation. The impact of the railway was considered on the basis of:

- the regional effect on population subdivision caused by establishment of a barrier to movement within a habitat;

- local effects on restricted, sensitive habitats such as wet heaths.

It is not envisaged that construction of the proposed railway will cause any major adverse impact on regional fauna populations since the new line will only destroy a thin line of their habitat. The new line will mostly be located in habitats previously disturbed by Trunk Road 95, minor roadways and a natural gas pipeline. The duplicated line will be adjacent to an existing line, hence it is not considered that the proposed line will further seriously affect the quality of the habitats.

To minimise the obstruction to macropod fauna movement, the SRA will install, underneath the line, several large box culverts (some 2 m high) to permit movement where appropriate. Furthermore, the railway line will not be fenced through the MWS&DB catchment area, which will also permit some faunal movement across the proposed line.

The wetland heath community near the western tunnel portal is a small and comparatively rare habitat which is important because of the a local profusion of bird life, that in turn serves as a drought refuge for non-resident reptiles, and has water during non-flow periods of the creek. This habitat is threatened by siltation during construction of the railway if extra erosion-control measures are not undertaken. However, in view of the strict requirements to minimise erosion within the MWS&DB catchment area, the likelihood of damage to this habitat is small.

The firebreak and maintenance track alongside the proposed railway line will provide better access for bushfire control, which may in turn reduce the numbers of wildlife lost in a large fire. This gain may well be nulified by the increased bushfire potential associated with additional personnel within the catchment area, and the very small risk of fire caused by sparks from the application of locomotive and wagon brakes.

REFERENCE

Dames & Moore, 1975, Environmental Impact Investgiation, Proposed Coal Mine and Washery Development, Wilton, N.S.W., Bellambi Coal Company Ltd.

APPENDIX G

ARCHAEOLOGY

APPENDIX G : TABLE OF CONTENTS

APPENDIX G : LIST OF FIGURES

APPENDIX G : LIST OF TABLES

1.0 INTRODUCTION

The appendix integrates data provided by two archaeological surveys carried out by sub-consultants to D&M (Attenbrow and Happ 1983, Kamminga 1983). During the period of planning the proposed Maldon - Port Kembla railway, a total of three archaeological surveys have been undertaken for the purpose of preparing the EIS (See Figure G-1). These surveys are as follows:

1. J. Kamminga, 1978. A route from the Main Southern Railway near Maldon to proposed portal NW of the Cordeaux Dam. This proposed route crossed the Nepean River gorge directly adjacent to the Trunk Road 95 bridge and thereafter passed across pasture land and a portion of the Cordeaux Catchment Area. Approximate length of the proposed line was 19 km with a corridor of 50 metres, and at the Nepean gorge 60 metres. Archaeological sites or relics were not encountered during the survey.

2. V. Attenbrow and G. Happ, 1983. A revised route commencing at the Main Southern Railway (immediately east of the earlier route) and extending to the eastern portal of the proposed railway tunnel at Dombarton Loop. The length of the proposed route was approximately 33 km.

3. Kamminga, 1983. The further revised route commences on the Main Southern Railway at a point that is immediately east of the second proposed route; it thereafter crosses the Nepean River gorge and deviates almost entirely from the previous proposed routes until it passes over the Cordeaux River gorge. For the purposes of the archaeological report, this segment is designated Section 1. After crossing the Cordeaux River gorge, the route proceeds to the western portal of the proposed tunnel near the upper reaches of the Avon Reservoir, approximately following a route surveyed by Attenbrow and Happ (1983). This segment, which is designated Section 2, was not examined. A further extension of the route commences at the eastern portal of the proposed tunnel at Dombarton Loop, and follows the existing Moss Vale - Unanderra Railway through sub-tropical rainforest and urban areas of Wollongong - Port Kembla to its present terminus. This segment, called Section 3, has not previously been examined by an archaeologist.

This report has been compiled in consultation with NP&WS.

2.0 HISTORICAL BACKGROUND

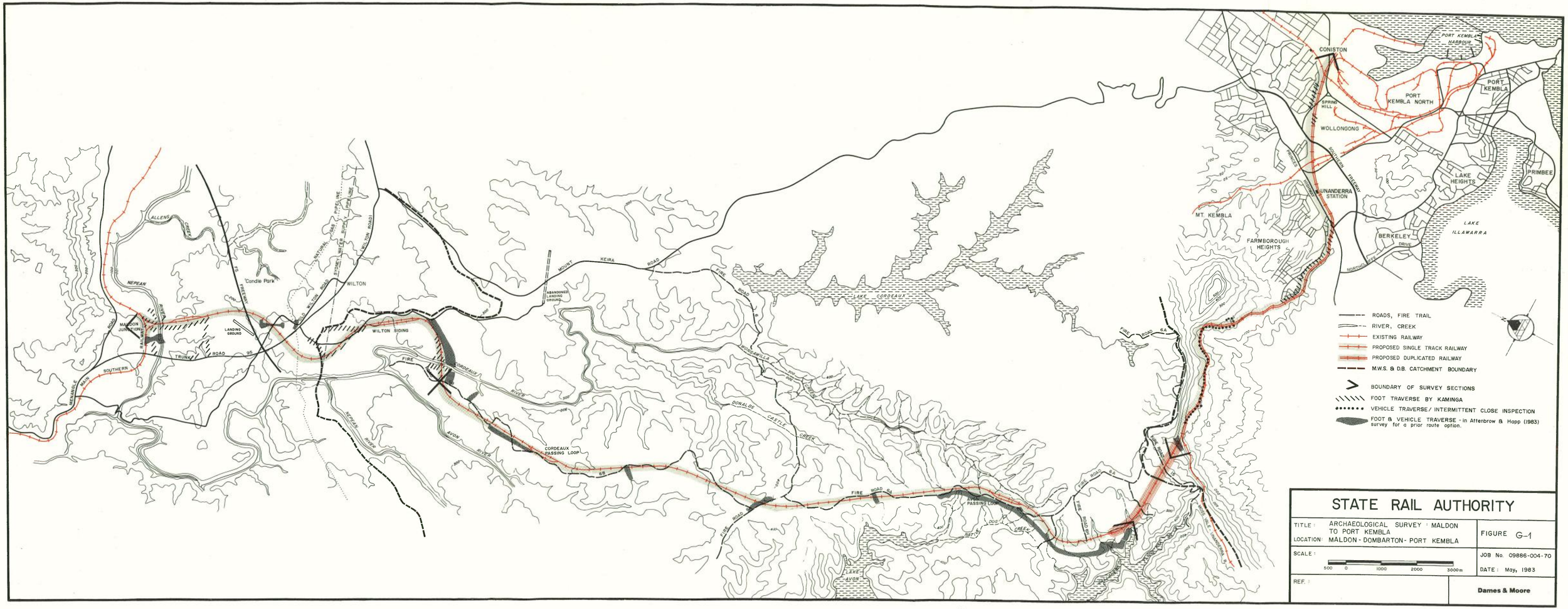
According to Tindales map of tribal areas, the proposed route of the railway line lies within the territory of the Wodi Wodi "tribe" or dialect group (Tindale 1974, Mathews, 1898). Along the coast these people were also known as the Illawarra tribe and their territory encompassed an area of some 2,600 km^2, extending from Wollongong to north of the Shoalhaven River.

Being close to Sydney, the fertile land around Picton and Wollongong was settled by Europeans at a comparatively early time, following initial exploration in the late eighteenth century. The French explorer Barralier passed between Maldon and Wilton in 1798 and remarked on the large numbers of kangaroos, wallabies and emus in the district and on the co-operative hunting of this fauna by local Aborigines.

A recorded retaliatory massacre occurred at Broughton's Pass on the Cataract River in 1816 where the Aborigines were attacked by troops under the command of Captain W. Shaw. This incident is considered as marking the beginning of tribal destabilisation which intensified in the following years. The first movement of stock into the Illawarra district appears to have been in 1815 with the first land grants were issued in 1817, although large numbers of settlers were not present until the late 1820's (Sullivan, 1982: 9).

By 1889, it was recorded that there were only six "full-blooded" Aborigines remaining in the general Picton region, and all Aborigines were settled on non-Aboriginal owned farms (NSW Aboriginal Protection Board; Picton census, 1889).

Prior to this event, no systematic records by anthropologically trained persons occurred and the only knowledge we now have of pre-historic Aboriginal lifestyles comes from the ethno-historical records, archaeological sites which contain the non-perishable aspects of their material culture, and the often unwritten traditions which have been passed down from generation to generation of the Aboriginal descendants who still live on the South Coast.


CONISTON
PORT KEMBLA HARBOUR
PORT KEMBLA
PORT KEMBLA NORTH
SPRING HILL
WOLLONGONG
PRINCES
SOUTHERN FREEWAY
LAKE HEIGHTS
PRIMBEE
UNANDERRA STATION
MT. KEMBLA
FARMBOROUGH HEIGHTS
BERKELEY
DRIVE
NORTHCLIFFE DRIVE
LAKE ILLAWARRA
ALLENS CREEK
NEPEAN RIVER
MAIN SOUTHERN RAILWAY
MAIN SOUTHERN ROAD
MALDON JUNCTION
TRUNK ROAD 95
LANDING GROUND
Condle Park
F.D. PIPELINE
NATIONAL PARK
STONEY WATER SUPPLY PIPE LINE
OLD WILTON ROAD
WILTON
WILTON SIDINGS
MOUNT KEIRA ROAD
ABANDONED LANDING GROUND
FIRE ROAD
LAKE CORDEAUX
CORDEAUX RIVER
CORDEAUX PASSING LOOP
AVON RIVER
DONALDS CASTLE CREEK
LAKE AVON
FIRE ROAD 6A
FIRE ROAD 6B
FIRE ROAD 6C
FIRE ROAD 6D
FIRE ROAD 6E
FIRE ROAD 6F
FIRE ROAD 6G
FIRE ROAD 6H
FIRE ROAD 6J
FIRE ROAD 6K
FIRE ROAD 6L
FIRE ROAD 6M
FIRE ROAD 6N
FIRE ROAD 6P
FIRE ROAD 6Q
FIRE ROAD 6R
FIRE ROAD 6S
FIRE ROAD 6T
FIRE ROAD 6U
FIRE ROAD 6V
FIRE ROAD 6W
FIRE ROAD 6X
FIRE ROAD 6Y
FIRE ROAD 6Z
LINE ROAD
SCRUB HILL MOUNTAIN
ROADS, FIRE TRAIL
RIVER, CREEK
EXISTING RAILWAY
PROPOSED SINGLE TRACK RAILWAY
PROPOSED DUPLICATED RAILWAY
M.W.S. & D.B. CATCHMENT BOUNDARY
BOUNDARY OF SURVEY SECTIONS
FOOT TRAVERSE BY KAMINGA
VEHICLE TRAVERSE/ INTERMITTENT CLOSE INSPECTION
FOOT & VEHICLE TRAVERSE - in Attenbrow & Happ (1983) survey for a prior route option.
N
STATE RAIL AUTHORITY
TITLE : ARCHAEOLOGICAL SURVEY : MALDON TO PORT KEMBLA
LOCATION: MALDON - DOMBARTON - PORT KEMBLA
FIGURE G-1
SCALE : 500 0 1000 2000 3000m
JOB No. 09886-004-70
DATE : May, 1983
REF. :
Dames & Moore

3.0 EXISTING ARCHAEOLOGICAL ENVIRONMENT

Within the Wilton - Cordeaux district, the sandstone rock shelters containing Aboriginal drawings and stencils have been the subject of interest to art specialists for many years (e.g. Sim 1964, McCarthy 1961).

Examinations of the National Parks and Wildlife Service's Site Register indicated that no sites had previously been recorded within the proposed route, although one site (52-2-459), a rock shelter with art, is immediately adjacent (Site 5). The other sites recorded in the area were 12 rock shelters with art, one hatchet grinding groove site and one stone arrangement deposit (See Figure G-1 for locations).

None of the previously recorded shelters with archaeological deposits have been excavated; the evidence was in the form of stone artefacts present on the shelter floor or amongst disturbed deposits. Some of the recordings do not give details of the art in the shelters, i.e. the number of motifs or the type of motifs.

Motifs in these sites number between six and 72, while three of the shelters have at least 60. Pigments consist of charcoal, and red and white ochre.

The subjects of the motifs recorded include local wildlife such as kangaroos, fish, bats, bandicoots, echidnas and emus as well as human figures and the ubiquitous indeterminate forms. Only one site has anthropomorphs. The most common motifs are variations of the human figure.

Hand stencils are present in only two of the shelters, one of which is 52-2-459 adjacent to the proposed rail route. This is the only site which has lizards recorded. The hand stencils in 52-2-459 are white ochre, whilst at the other site they are red.

Sim (1964, 64) also mentions an axe grinding groove site downstream of the Wilton art site and an "extensive Aboriginal camp site" (open scatter of stone artefacts) located on the high ground to the west. He was told about the latter by local residents who related that it had been uncovered in the early 1900's by ploughing. Sim commented further "cultivation over many years and the final use of the land for pasture has obliterated the surface signs of this site".

Other than those surveys, on which the present report is based, there are three systematic archaeological surveys for EIS purposes which have been undertaken in the area of the proposed rail route. All of these are transects for the natural gas pipeline. One of these surveys cuts across the proposed rail route. The surveys are as follows:

- Wilton to Horsley Park by L. Haglund (1974);
- Wilton to Wollongong by K. Longhurst and A. Kelly (1974);
- Wilton to Bowral by L. Haglund (1974).

None of these surveys reported additional sites in the immediate vicinity of this proposed rail route, nor did they record potential occupation sites. At the time of the surveys, however, it was not required by the National Parks & Wildlife Services that potential occupations sites be recorded.

To the north of the Wilton - Cordeaux district, in the Woronora/O'Hares Creek Catchments, the Illawarra Prehistory Group have carried out intensive systematic surveys for archaeological sites over the large area of highly dissected sandstone topography. Some hundreds of siteshave been recorded which are predominantly rock shelters with art. Some of these have archaeological deposits. These shelters are located in cliffs and low outcrops of sandstone or at the base of large boulders. Hatchet grinding grooves were located on exposed sandstone in creeks and by pools on ridge tops and ridge sides, and engravings were located on flat expanses of sandstone or ridge tops or ridge sides. The density of sites recorded during these surveys is four sites per km^2 (Sefton 1981).

Although archaeological sites have not been recorded on the Illawarra escarpment in the vicinity of the proposed route/tunnel, during discussions with Ms. Caryll Sefton of the Illawarra Prehistory Group, it was advised that rock shelter sites have been recorded on the escarpment further to the north, and it was therefore considered worthwhile checking the escarpment area from Dombarton Loop to the coastal plain.

From the above brief discussions it can be seen that the majority of sites (rock shelter sites, engravings and hatchet grinding grooves) located in this general region are found in

areas of sandstone outcropping. Even sites recorded in the flat agricultural/pastoral land (except the open site mentioned by Sim) are found in places where sandstone is exposed, i.e. the gullies and gorges, (e.g. Site 52-2-11 near Wilton).

Other types of archaeological sites, such as stone arrangements, open sites, scarred trees, quarries, ceremonial sites and so on, are scarce or have so far not been located. The only open site (which is now destroyed) was on the agricultural/pastoral land.

4.0 FIELD PROCEDURES AND SURVEYS

For the purposes of the archaeological report, the proposed rail route is divided into various zones:

- the Nepean and Cordeaux River gorges;
- grazing land and open forest of moderate relief on the plateau between the Main Southern Railway and the western portal of the proposed railway tunnel;
- sub-tropical rainforest of the Illawarra escarpment, from Dombarton Loop to Farmborough Heights; and
- Wollongong - Port Kembla urban region.

The survey by Attenbrow and Happ (1983) of Sections 1 and 2 of the previously proposed route, to some extent overlaps with the final route (See Figure G-1). Their survey was preceeded by a general inspection of the route, from the Main Southern Railway to Wongawilli Colliery Ventilation Shaft. Archaeological reconnaissance was carried out in four days by a field team of two. Because of the nature of the types of archaeological sites previously recorded in the region, all areas where sandstone outcrops and exposures could potentially occur were inspected on foot. These areas were as follows:

- cliff lines and outcrops where shelters were likely to have formed;

- flat expanses on the plateau/ridge tops where engravings were likely to occur, as well as hatchet grinding grooves around rock pools or seepage areas; and

- the beds of creeks and gullies where the water may run over exposed sandstone and hatchet grinding grooves could be present.

Although there was a low likelihood of open camp sites (artefact scatters) being present and/or detected because of poor ground visibility in most areas, spot checks were made along several sections. Trees mature enough to bear the scars of Aboriginal removal of bark were also inspected when seen, and stone arrangements were sought in areas where rocks would have been available to build them. Given the bedrock geology of the area, it was not considered likely that stone quarry sites would be present.

In general, a width of 40 metres along the route as inspected, except in the sections where it was planned to build bridges and tunnel portals, and where it was considered that the line might have to be shifted because of the presence of archaeological sites. Because of time constraints, reconnaissance around existing archaeological sites was kept to a minimum. The areas surveyed are shown in Figure G-1.

Special attention was given to the proposed corridor over the Nepean and Cordeaux River gorges and gullies leading into them. Both gorges are about 55-60 metres deep and are characteristically highly precipitous.

Deep incision of the gorge walls has occurred because of weathering along the weaker rock units, such as thinly-bedded sandstone and shales. Weathering remains highly active. The walls of the gorges contain innumerable rock shelters, some of which are quite capacious.

Because of the general paucity of sandstone exposures away from the gorges and gullies, and poor ground visibility over most of the earlier proposed route where it deviated from the road and adjacent cleared areas, it was not entirely covered on foot but was sampled instead. The areas of agricultural land and open forest did not have high potential for prehistoric relics.

The distribution of sandstone, and the lack of it in the flat agricultural/grazing land away from the gullies and gorges, had already been commented upon in previous archaeological reports (Sim 1964, Kamminga 1978, Haglund 1974a).

Ground visibility in most areas surveyed by Attenbrow and Happ on the plateau was low (0-1 on a scale of 1 to 10). In the forested areas, thick leaf litter and/or dense understorey vegetation inhibited ground visibility once away from the road and its adjacent cleared strip. In the cleared areas south of the Nepean, a thick cover of grass was present with only a few areas where this had been denuded. North of the Nepean, grass cover was sparser, with reasonably sized bare areas within the upper drainage basin of the gully; this was the only area where visiblity was greater than 0-1.

When the spots checks in areas on the plateau south of the Cordeaux River produced no archaeological sites, the remainder of the proposed route in this environmental zone was surveyed by vehicle and a watch kept for outcrops of sandstone, bare areas where artefacts might be visible, mature trees, etc. which would be within the route of the proposed railway. The previously recorded site 52-2-459 was visited in order to determine its location in relation to the proposed route.

In the archaeological survey of Sections 1 and 3 of the final proposed route carried out by Kamminga (1983), air photographs of the corridor and its surroundings were examined prior to field reconnaissance. The survey was undertaken over five days in April and May, 1983 (See Figure G-1).

Approximately half a day on foot was spent examining the corridor within grazing land and open forest. Direct access to the survey areas was obtained via negotiable roads. Ground visibility conditions for the detection of open sites within the grazing area, was poor due to the recent pasture growths following drought-breaking rains. Since the general area has been covered by foot and vehicle traverses in the previous two surveys with negative results, it was considered necessary only to sample parts of the corridor.

Approximately a day and a half was spent examining each of the two gorge areas that lie within the proposed corridor. At the Nepean, the 400 metre corridor was adjacent to the

area examined by Attenbrow and Happ, which itself overlapped with the 60 metre corridor examined in 1978 for the first proposed route. Thus over the last four years, a length of the Nepean River gorge in excess of 600 metres has been archaeologically reconnoitred for the proposed railway crossing. On the Cordeaux, the area examined was also adjacent to the corridor checked by Attenbrow and Happ for the second proposed route.

Inspection of the potential archaeological sites along the walls of the two gorges was at the time hazardous. Visibility varied from very good to poor - often sites that were visible at a distance were not easily observed at close quarters, and vice-versa. Despite the difficulties presented by the terrain, the degree of coverage was considered good. It is possible, however, that some small shelters obscured by thick vegetation were not located.

In the previous survey by Attenbrow and Happ, hand stensils and other drawn motifs were detected in rock shelters along the Nepean and Cordeaux, and at localities in gullies on the plateau near the proposed corridor. For this reason, Kamminga's survey of the gorge areas encompassed rock shelters of all kinds, not just those suitable for habitation. Because of the relatively high frequency of hatchet grinding groves along creeks in the plateau area, attention was given to sandstone exposures at watercourses leading into the gorges.

Foot traverses in the Nepean River gorge were aligned both horizontally, along ledges and wallaby tracks terraced down the slopes, and vertically through dense vegetation down to the river. As the Cordeaux River gorge was especially steep-sided, a descent could only be made down the gully previously examined by Attenbrow and Happ. As there was still some runoff from the previous rain, the path of descent was unsafe.

The banks and bed of the Cordeaux River were choked with large boulders and other debris, with dense vegetation. Consequently, as in the previous survey, it was found too difficult to reconnoitre this part of the gorge. In any event both the Nepean and Cordeaux Rivers are subject to periodic flooding and it is considered that prehistoric relics would not survive in the lower-most portion of the gorges. Flood damage in the form of scouring and the

redeposition of sand and vegetation was observed. As an indication of the severity of flooding, the MWS&DB figures for the Nepean at Pheasant's Nest can be cited:

TABLE G.1

FLOOD FREQUENCY FOR THE NEPEAN RIVER

RETURN PERIOD (years)	PEAK FLOW (m^3/s)	INCREASED HEIGHT (m)
1	226	2.1
10	1250	6.22
50	2380	8.78
100	3030	9.92

One day was spent examining the proposed railway within the area of sub-tropical rainforest east of Dombarton Loop. The traverse was done largely by vehicle with foot inspections at soil exposures and railway cuttings. Ground visibility was extremely poor within the urban region of Wollongong - Port Kembla. Foot traverses were made along the proposed corridor from above Farmborough Heights to the Princes Highway and at two localities further towards the terminus of the present railway.

5.0 SURVEY RESULTS

During the survey by Attenbrow and Happ, four archaeological sites were recorded while one previously located site (52-2-459, called Site 5) was re-inspected. No archaeological sites were encountered during the subsequent survey by Kamminga.

The five archaeological sites are described briefly below. Additional information on the sites has been provided, with one of the sites being provided on site cards for the National Parks and Wildlife Site Register.

SITE 1 : NEPEAN RIVER SHELTER: SHELTER WITH ART AND POTENTIAL ARCHAEOLOGICAL DEPOSIT

Location: The shelter is located is a small outcrop of sandstone on the western side of a small gully which flows into the Nepean gorge from the north. It is about 10 metres above the gully floor.

Description of Shelter: A small to medium sized shelter formed by cavernous weathering, with some honeycombing and rockfall. The maximum dimensions of the shelter are approximately 11 x 4 x 3.5 metres.

Two metres of the depth of the shelter consists of a rock shelf at the back about a metre above the ground. The floor area has a few large boulders and the area of deposit inside the shelter is only 9 x 2 metres.

The deposit was silty sandy sediment, brown at the southern end and grey-brown at the northern; at the southern end it was less than 10 cm deep, but at the northern end it was at least 20 cm. Small shrubs and grasses grow along the dripline. Once outside the dripline, the ground drops sharply away to the gully below. The shelter has also been used by Europeans and cattle as there are bits of wooden box, metal strips, wire and steel. This occupation, however, as far as could be seen, has not disturbed the deposit.

Archaeological Evidence: No sign of Aboriginal occupation was seen on the floor of the shelter in the form of stone artefacts, faunal remains, etc. However, several drawings were on the shelter wall above the shelf. The area covered by the drawings was 5 x 0.8 metres. A total of nine motifs was recorded. One was identifiable as a probable human figure. The rest were red and black (charcoal) lines/outlines or areas of charcoal. The drawings were all very faint, but were not vandalized. A more detailed and longer inspection of the shelter under better lighting conditions may identify some or all of the motifs recorded and may discover further drawings.

SITE 2 : CORDEAUX RIVER SHELTER: SHELTER WITH ART AND POTENTIAL ARCHAEOLOGICAL DEPOSIT

Location: The shelter is located in a sandstone outcrop on the southern side of a small gully which runs into the Cordeaux gorge on its eastern side. It is about 30 metres from the junction of the fully and the gorge and about 5 metres above the base of the gully. (Access to the Cordeaux gorge floor can be obtained at this point via an animal track which goes down the talus slope).

Description of the Shelter: The approximate maximum dimensions of the shelter are approximately 11 x 1.5 metres.

It is 0.5 to 1.8 metres high and faces north west. The floor consists of flat sandy brown sediments at least 20 cm deep. Scattered pieces of weathered sandstone occur on the surface.

Archaeological Evidence: No sign of Aboriginal occupation in the form of stone artefacts was seen on the floor of the shelter. However, two faded white hand stencils were on the shelter wall. Some amorphous indeterminate charcoal markings were also present underneath the hand stencils.

SITE 3 : NATIVE DOG CREEK SHELTER: SHELTER WITH ART

Location: In low cliff line in sandstone outcrop on saddle between the headwaters of Native Dog Creek and an unnamed tributary of Gallahers Creek to the west of Bellbird Creek.

Description of Shelter: The shelter has formed by cavernous weathering. Its approximate maximum dimensions are 12 x 2 x 2 metres and it faces north west. The floor was mostly rock or dense rubble with no deposit.

Archaeological Evidence: No stone artefacts or other signs of Aboriginal occupation were noted on the shelter floor. The art on the walls was within a shallow niche and consists of one large hand stencil and one small stencil (both in red pigment) and some indeterminate areas of red pigment. The area was contained within 1 x 0.5 metres.

SITE 4 : FLYING FOX NO.1 SHELTER WITH OCCUPATION DEPOSIT

Location: Within a small sandstone outcrop on south west facing slopes over looking Flying Fox No.1 Creek, just below plateau top.

Description of Shelter: Approximate maximum dimensions of the shelter are 5 x 3 x 2.5 metres. The orientation of the shelter is 170° south. The floor consists of poorly sorted sandy sediments greater than 10 cm in depth. Large boulders were present at the back and under the dripline, so that the area of the floor/deposit is less than the maximum dimensions of the shelter given above.

Archaeological Evidence: One fine-grained silicrete flake, 2 cm long was found on the shelter floor.

SITE 5 : EAST AVON SHELTER: SHELTER WITH ART (National Parks and Wildlife Site No. 52-2-459)

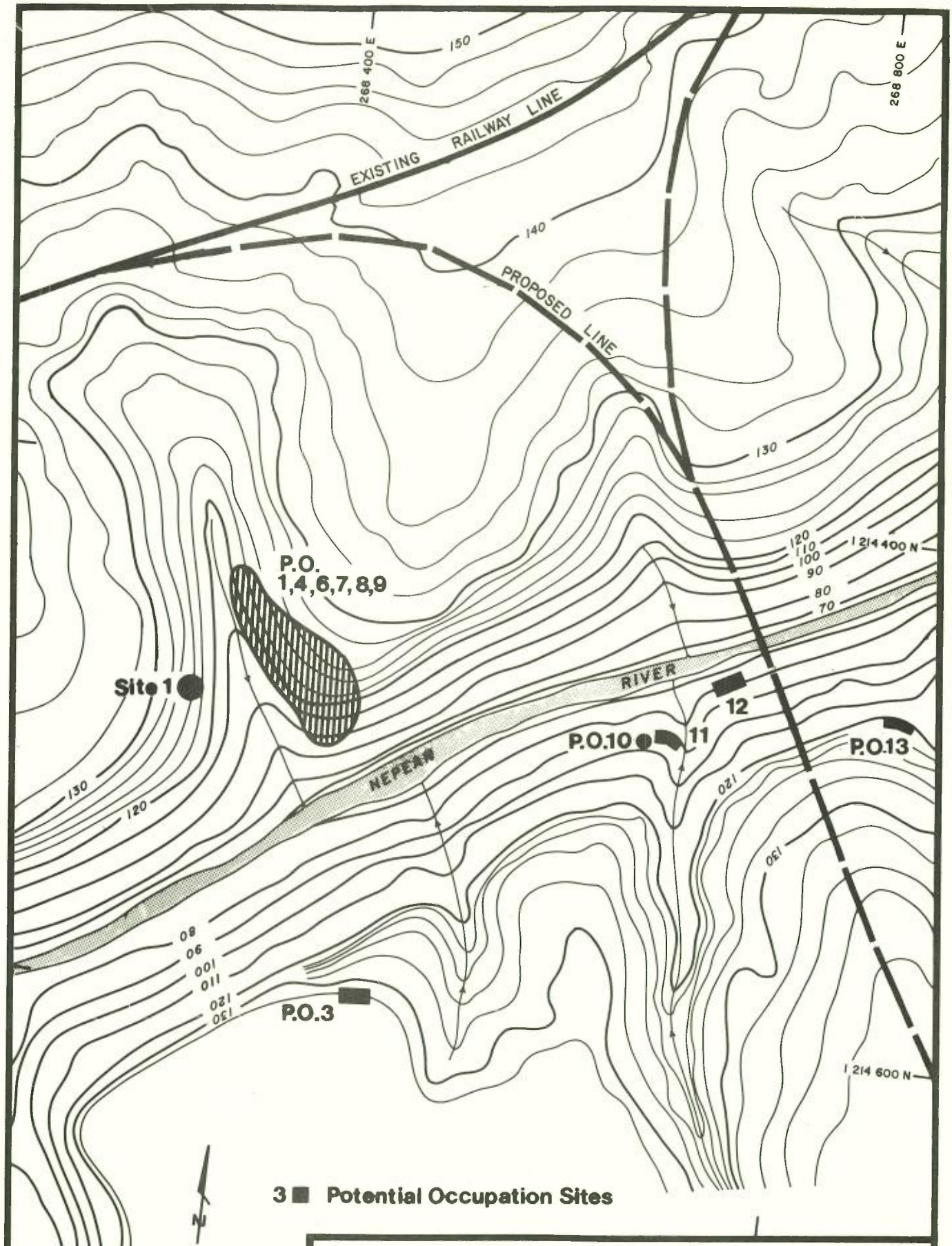
Location: The shelter is in a rocky outcrop on the plateau top and is visible from Fire Road No.6A. It is on the left of an abandonded quarry on the east side of Fire Road No.6A and it is outside the proposed rail route.

Description of Shelter: The site is one of two immediately adjacent shelters. The east facing shelter with are measures 15 x 4.5 x 2 - 3 metres and has a sandy floor.

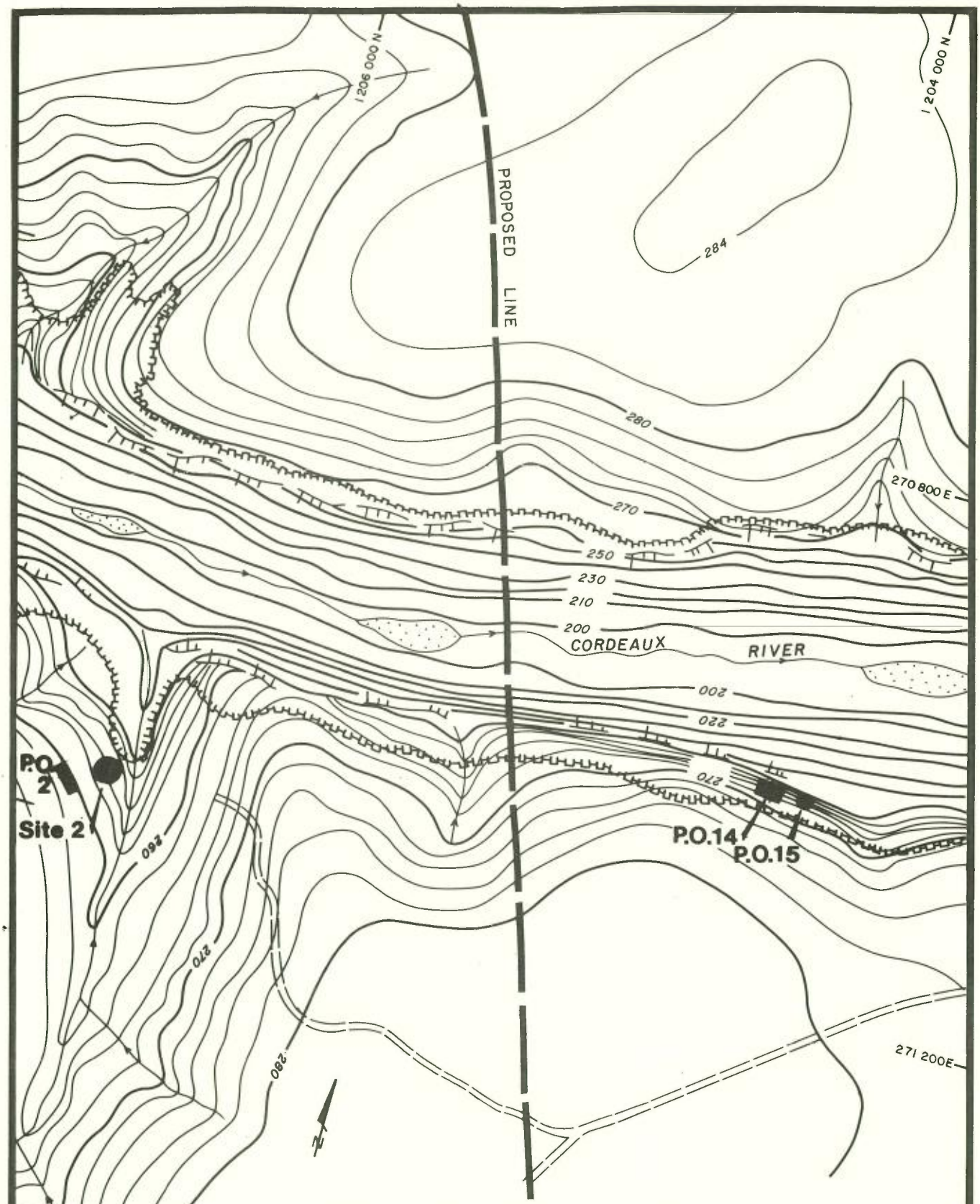
Archaeologial Evidence: No sign of Aboriginal occupation in the form of stone artefacts was noted by previous recorders or during the present survey. The art on the walls consists of hand stencils, two lizards and some charcoal lines. The area covered by the drawings and stencils is 1.3 x 0.75 metres.

As well as archaeological sites, Attenbrow and Happ reported the occurrence of 10 Potential Occupation Sites, which are sites with possible archaeological content. Another six Potential Occupation Sites were located by Kamminga. Of these sites, all but one occur within the Nepean and Cordeaux gorges or in subsidiary gullies. Their locations are indicated in Figures G-2 and G-3. Only Potential Occupation Sites 3, 10, 11 and 12 are considered to have a reasonable potential for having archaeological material of any significance.

All of the archaeological sites and Potential Occupations Sites located along the proposed route were rock shelters and all except one (National Parks and Wildlife Site No. 52-2-459) were located in sandstone outcrops and cliff lines in gully situations or in the slopes below the plateau tops. Site 5 is in an outcrop situated on the plateau top. No open sites were found on the plateau tops in the agricultural/ grazing land or the forested MWS&DB land. Although suitable flat sandstone ocurred in some locations on the plateau tops (e.g. western rim of the Cordeaux) and exposed sandstone occurred in some of the creek beds and gullies near the eastern portal of the proposed railway tunnel (e.g. Bellbird Creek), no engravings or hatchet grinding grooves were located. In the southern area of the Woronora/O'Hares Creek survey, less engraving sites were recorded than in the



STATE RAIL AUTHORITY		
TITLE : NEPEAN RIVER GORGE : POTENTIAL OCCUPATION ARCHAEOLOGICAL SITES LOCATION : MALDON-DOMBARTON ROUTE		FIGURE G-2
SCALE 50 0 100 200m		FILE No.: 09886-004-70 DATE : MAY 1983
REF. : SRA		Dames & Moore



2 ■ Potential Occupation Site

STATE RAIL AUTHORITY

TITLE :	CORDEAUX RIVER GORGE: POTENTIAL OCCUPATION ARCHAEOLOGICAL SITES	FIGURE G-3
LOCATION :	MALDON - DOMBARTON ROUTE	
SCALE	50 0 100 200m	FILE No. : 09886-004-70
		DATE : MAY 1983
REF. :	SRA	Dames & Moore

north. Therefore, it may be that the density of engraving sites and thus the likelihood of finding them in this area is lower than further north.

Archaeological sites or relics were not encountered during reconnaissance of the areas of urban development and sub-tropical rainforest east of Dombarton Loop. Poor ground visibility and the absence of shelter development may have contibuted to this negative result.

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APPENDIX H

NOISE

APPENDIX H : TABLE OF CONTENTS

APPENDIX H : LIST OF FIGURES

APPENDIX H : LIST OF TABLES

1.0 INTRODUCTION

This appendix provides information relating to the noise impact expected from both the construction and operation of the proposed railway. A description of the project is provided in Appendix A. Only those features relevant to noise and its impact are discussed in this Appendix.

2.0 EXISTING ENVIRONMENT

2.1 INTRODUCTION

The existing acoustic environment has been investigated during a 24-hour monitoring programme, and additional measurements have been made at Farmborough Heights, which has been identified as being the most noise sensitive part of the route. To supplement the physical noise measurement data for Farmborough Heights, an attitudinal survey, designed in part to determine attitudes to the existing noise climate, has also been undertaken. The impact in this area will be due to an increase in the frequency of rail traffic noise rather than to the introduction of new noise sources with a different character.

2.2 DATA COLLECTION

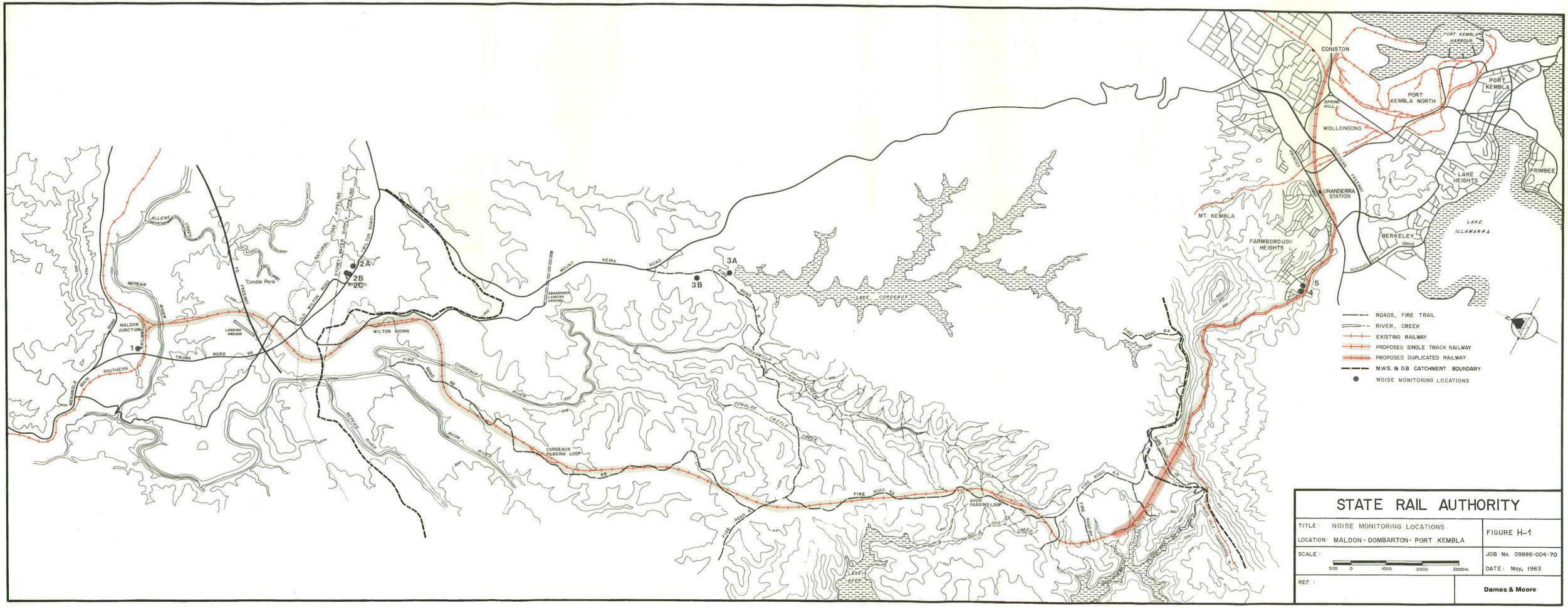
The 24-hour noise survey was conducted on the 3rd and 4th of March, 1983. Four areas close to the proposed route were selected (See Figure H-1). Each area was visited on four occasions throughout the 24-hour period. Area 3 shows two monitoring sites (A and B) because access was not available at night to the site selected during the day, and Area 2 includes three monitoring sites as it was judged as desirable to obtain data representative of different locations in Maldon.

Table H.1 describes the locations of the monitoring sites and Table H.2 summarises the results of the study. Data were collected using a model 2203 Bruel and Kjaer sound pressure level meter connected to a model 4426 Bruel and Kjaer statistical analyser. The sound level metre microphone was mounted at approximately 1.5 metres above the ground and the instrument was set to fast response. Samples were taken at 0.1 s intervals over a 20 minute period after which values of L_{99}, L_{90}, L_{50}, L_{10}, L_1 and L_{eq} were calculated and recorded.

TABLE H.1

DESCRIPTION OF NOISE MONITORING SITES

SITE	DESCRIPTION
1	On the north side of road leading from the Freeway to Maldon approximately 15 metres from the centre of the lane carrying Wilton-bound traffic. Ground surface was compacted earth.
2A	Approximately five metres from the road edge on the eastern side of Peel Street and about 100 metres from the Wilton-Appin Road. Ground surface was grass.
2B	Approximately 15 metres from the centre of the Appin-bound carriage way of the Wilton-Appin road and five metres from the eastern side of Camden Street. Ground surface was grass.
2C	As for (2B) but 34 metres from the Wilton-Appin Road.
3A	On the eastern side of the Lake Cordeaux picnic area. Ground surface was grassed.
3B	On the western side of the Cordeaux Lake access road approximately 30 metres from the entrance gate to the picnic area. Ground surface was grass.
4	On the grass verge on the eastern side of Bardess Road (a short cul-du-sac) and about 10 metres from the Dombarton - Port Kembla railway which passes through a deep (approximately 5 metre) cutting at this point.
5	On grassed area 34 metres from the railway line by Fairlock Road, Farmborough Heights.


CONISTON
PORT KEMBLA HARBOUR
PORT KEMBLA
PORT KEMBLA NORTH
SPRING HILL
WOLLONGONG
LAKE HEIGHTS
PRIMBEE
UNANDERRA STATION
MT. KEMBLA
FARMBOROUGH HEIGHTS
BERKELEY
LAKE ILLAWARRA
PRINCES HIGHWAY
SOUTHERN FREEWAY
MOUNT KEIRA ROAD
ALLENS CREEK
NEPEAN RIVER
MALDON JUNCTION
MALDON-DOMBARTON RAILWAY
SOUTHERN MAIN
TRUNK ROAD 95
LANDING GROUND
Condle Park
OLD WILTON ROAD
WILTON ROAD
WILTON SIDING
ABANDONED LANDING GROUND
FIRE ROAD 6B
CORDEAUX RIVER
NEPEAN RIVER
AVON RIVER
CORDEAUX PASSING LOOP
LAKE CORDEAUX
DONALDS CASTLE CREEK
AVON PASSING LOOP
LAKE AVON
FIRE ROAD 6A
1
2A
2B
3A
3B
4
5
ROADS, FIRE TRAIL
RIVER, CREEK
EXISTING RAILWAY
PROPOSED SINGLE TRACK RAILWAY
PROPOSED DUPLICATED RAILWAY
M.W.S. & D.B. CATCHMENT BOUNDARY
NOISE MONITORING LOCATIONS
STATE RAIL AUTHORITY
TITLE : NOISE MONITORING LOCATIONS
LOCATION: MALDON - DOMBARTON - PORT KEMBLA
FIGURE H-1
SCALE : 500 0 1000 2000 3000m
JOB No. 09886-004-70
DATE : May, 1983
REF. :
Dames & Moore

During the monitoring period meteorological observations of cloud cover (estimate), wind speed and direction (estimate), pressure (measured with an aneriod barometer), temperature and humidity (wet and dry bulb thermometers) were made and recorded (See Table H.1)

Calibration checks were made at the beginning and end of each monitoring session using a model 4230 Bruel and Kjaer sound level calibrator.

2.3 RESULTS OF MONITORING PROGRAMME

The data in Table H.2 shows the typical background noise levels (L_{90} values) and also shows other statistical parameters such as L_1 (a measure of the "maximum" noise levels during the monitoring period), L_{99} (measure of noise levels during the quietest periods) and lists the principal noise sources.

Most of the route passes through either farm land or natural bushland where the recorded L_{90} levels ranged from a very quiet 25 dB(A) at Site 3B to 47 dB(A) at Site 1. At Wilton (Sites 2A, 2B and 2C) L_{90} values ranged from 30 dB(A) during quiet periods at night, to 40 dB(A) during the day. L_1 levels at the monitoring sites in Wilton were in the range 58 to 74 dB(A), with the louder noises being associated with truck traffic along the Wilton-Appin Road.

In the Farmborough Heights area (Sites 4 and 5) L_{90} values ranged from 35 dB(A) (night-time) to 40 dB(A) (day-time), and L_1 noise levels were in the range of 43 to 61 dB(A) and were associated with cars, lawn mowers, aircraft and other artificial noises associated with a suburban environment.

The sound levels reported above are more or less those that would be expected for the respective environments.

TABLE H.2

RESULT OF NOISE MONITORING PROGRAMMES

SITE	DATE	START TIME	WIND SPEED (m/s)	WIND DIRECTION	TEMP (°C)	RELATIVE HUMIDITY (%)	PRESSURE (mb)	CLOUD COVER (eights)	L_{99} dB(A)	L_{90} dB(A)	L_{50} dB(A)	L_{10} dB(A)	L_{1} dB(A)	L_{eq} dB(A)	PRINCIPAL NOISE SOURCES (see footnotes)
1	3 Mar 83	11.58 am	0-5	N	33	42	1006	1	30.3	31.5	38.3	57.5	72.3	58	C, T, I, A, Tr
2A	3 Mar 83	12.45 pm	calm	-	32	39	999	1	33.0	35.0	42.5	56.3	66.3	53	C, T, Br, I
3A	3 Mar 83	2.00 pm	5	SE	28	72	986	4	34.3	37.8	40.8	44.0	48.8	42	F, Br, DT
4	3 Mar 83	3.30 pm	0-5	NE	29	69	1011	1	38.3	39.5	41.8	47.3	56.3	45	I, F, DT (man washing car 20 metres away for last 5 minutes)
1	3 Mar 83	4.50 pm	3-5	SE	30	47	1004	3	39.8	41.0	50.0	68.3	79.3	66	Tr, T, C
2A	3 Mar 83	5.30 pm	0-5	NE	26	71	998	3	32.5	35.0	44.5	59.3	70.3	58	C, T, Br, V, DLM
3B	3 Mar 83	7.20 pm	calm at surface, some wind in trees	NE	24	73	983	3	30.0	31.5	35.0	40.3	45.3	37	DT, Br, F, Co
4	3 Mar 83	10.10 pm	calm	-	25	70	1012	1	34.3	35.0	36.5	44.3	54.8	42	Dg, I, DT, A
1	3 Mar 83	11.28 pm	calm	-	23	83	1007	6	31.8	32.8	34.5	50.5	72.3	57	C, I, T
2B	4 Mar 83	12.05 am	calm	-	20	91	1000	3	29.3	30.0	33.8	48.3	58.3	45	Fr, I, A, Dg, DT, C, T
3	4 Mar 83	12.50 am	calm	-	21	91	984	2	24.3	25.3	27.5	34.5	38.8	30	DT, I
4	4 Mar 83	5.45 am	calm	-	22	88	1010	2	34.5	35.3	37.5	39.8	42.8	38	I, T, DT, R, Dg
1	4 Mar 83	7.02 am	0-1	N	18.5	95	1006	4	43.5	46.8	46.8	72.5	80.0	78	T, I, Tr
2C	4 Mar 83	7.35 am	calm	-	21	91	998	8	38.3	39.5	46.0	64.3	74.3	61	T, C, R, Dg, DT
3	4 Mar 83	8.15 am	0-4	N	21	91	988	7	37.8	38.8	40.5	43.3	47.5	41	F, DT, Br
4	4 Mar 83	9.20 am	0-4	N	27	71	1012	3	36.3	37.8	43.3	49.5	54.3	46	Br, C, DT, OLM
5	12 May 83	3.00 pm	0-1	N	18	73	1020	0	37.8	39.0	32.0	53.0	60.8	49	C, MC, Br, V, I

V = VOICES
R = ROOSTER
DT = DISTANT TRAFFIC
Tr = TRAIN
C = CARS
T = TRUCKS
I = INSECTS
Br = BIRDS
DLM = DISTANT LAWN MOWER
F = WIND IN FOLIAGE
Dg = DOG BARKING
A = AIRCRAFT
Fr = FROGS
Co = COLLIERY
MC = MOTOR CYCLES

3.0 ANALYSIS OF IMPACT AND MITIGATING MEASURES

3.1 CONSTRUCTION PHASE

The major noise producing items of equipment that will be used in the construction phase, and their maximum noise levels (at 15 metres) are listed below:

- one D10 dozer (equipped with blade and ripper - 90 dB(A));
- one front-end-loader - 87 dB(A), and;
- two 25-tonne trucks - 88 dB(A).

These noise levels may be subject to reduction following the findings of a study, into the minimization of noise levels for this project.

Assuming a 6 dB(A) attenuation per doubling of distance, the maximum noise levels at the closest residences in Wilton (see Figure 5-12, Volume 1), which is 1,300 metres away, can be expected to be 55 dB(A).

The surface of the land rises at least 10 metres above the level of the line, about 400 metres from the line, in a direction towards Wilton. Therefore topographical shielding could be expected to reduce the L_{max} level of 55 dB(A) by at least 11 dB(A) to 44 dB(A). The estimated L_1 and L_{10} noise levels are (based on typical relationships between these parameters and L_{max} levels for construction sites) 40 and 34 dB(A) respectively. The L_{max} and L_1 noise levels are therefore estimated to be 9 and 5 dB(A) above the existing L_{90}, level and the L_{10} level is estimated to be 1 dB(A) below the existing L_{90}.

Construction will be confined to day-time hours only, 7 am to 6 pm. Considering these relatively low predicted noise levels, the short duration of the construction period, (the line will on average be built at a rate of 1 km per month) and the restricted hours of work, it is not expected that construction will give rise to significant inconvenience.

It is not envisaged that blasting will be needed during construction, however if some small charges are required, then work will be undertaken under conditions specified by the SPCC.

In addition to the residences in Wilton, there are four residences within 190 to 380 metres of the proposed track (see Figure 5-12, Volume 1) and the maximum noise levels experienced at these locations will range from 71 to 65 dB(A), with predicted L_1 and L_{10} noise levels ranging from 66-60 and 62-56 dB(A) respectively. No significant topographical shielding can be expected for the closest residences. However, as before, the temporary nature of the construction work, which will be confined to day-time, should result in only minor inconvenience.

Metropolitan Catchment Area

Because the closest approach that the proposed route makes to any areas regularly used by the public is about 4 km, no adverse noise pollution effects are expected in this area.

Farmborough Heights

The closest residences to the construction area will be about 15 metres away. These residences will experience L_{max} levels up to about 93 dB(A) and L_1 and L_{10} levels of about 88 and 84 dB(A) respectively. Other residences in the 30 to 60 metre range will experience L_{max} noise levels in the range 87-81 dB(A) and L_1 and L_{10} noise levels in the range 82-76 and 78-72 dB(A). Figure 6-5 (Volume 2) shows the location of the line and the affected residences.

No blasting is anticipated for this section of the line. If blasting is required, the SPCC will be informed, and as before, blasting will only take place in compliance with their controls.

Working will be confined to day-time hours, and a special study will be commissioned to determine methods of minimising inconvenience to residents will be further examined.

Factors to be examined in the study will include the fitting of special noise control equipment to the bulldozer and front-end-loader.

3.2 OPERATIONS PHASE

Noise levels associated with trains which will use the line are listed below:

- wheel/rail contact noise;
- engine noise (diesel and electric);
- noise from regenerative braking (diesel/electric locomotives);
- noise from dynamic braking (electric locomotives);
- brake squeal (intermittent), and;
- warning hooter (intermittent).

Typical noise levels associated with the above sources are listed in Table H.3. These data were provided by the SRA and list information about the quality and intensity of noise emissions. Further details concerning the experimental conditions and procedures used to derive the data are presented in a report by Wilkinson Murray (1983).

In normal operations, it is expected that 48 train trips per day will be required for hauling coal and that about 2/3 of these will be hauled by electric locomotives (class-85) and 1/3 by diesel-electric locomotives (class-80). Since the latter are a little noisier, they have been used in the impact assessment calculations. In addition, there are presently about 6 train trips per day associated with transport of limestone past the Farmborough Heights area. Diesel-electric locomotives are used for this work.

Wilton

The closest approach that the railway will make to the higher density residential areas in Wilton is about 1,300 metres (see Figure 5-12, Volume 1). There will be no requirement for braking or use of the horn except in unusual circumstances. On the assumption that noise from the locomotives will decrease at 6 dB(A) per doubling of distance and noise from the coal hoppers will decrease at 3 dB(A) per doubling of distance, then the maximum noise levels will be about 64 dB(A) regardless of the type of locomotive used.

TABLE H.3

MEASURED NOISE LEVELS AND SPECTRAL DATA FOR RAILWAY SOURCES AT 15 METRES

(MEASURED AT 1.2 ABOVE GROUND)

FREQUENCY (Hz)	CLASS-80 DIESEL/ ELECTRIC POWERING (dB)	CLASS-85 ELECTRIC POWERING (dB)	COAL HOPPER AT 64 km/h (dB)	BRAKE SQUEAL ADD TO COAL HOPPER NOISE (dB)
50	82	87	85	-
63	80	80	80	-
80	86	83	81	-
100	91	85	81	-
125	90	81	79	-
160	83	79	77	-
200	88	80	77	-
250	82	83	72	-
315	83	78	73	-
400	85	79	77	-
500	83	79	72	-
630	82	82	77	+15
800	81	79	75	+ 5
1k	79	75	74	+ 5
1.25k	78	74	75	+ 5
1.6k	77	75	72	+ 5
2k	76	75	69	+15
2.5k	77	76	69	+15
3.15k	78	74	63	+ 5
4k	72	73	61	+15
5k	72	68	59	+15
6.3k	71	64	51	+ 5
8k	70	61	50	+ 0
dB(A)	90	88	83	93

1. Horns 78-93 dB(A) at 200 metres directly in front

2. Dynamic braking for Class 80 locomotives 92-93 dB(A) is 92-93 dB(A)

3. Regenerative braking (electric locomotives 88)

Source: SRA/Wilkinson Murray.

This predicted noise level does not take into account the shielding which will be provided by topography. This will be highly variable depending on where the train is, at a particular period, but the minimum shielding effect (provided by ground rising 10 metres above the track about 400 metres away in the direction of Wilton) is estimated to reduce the 64 dB(A) by 11 dB(A) to 53 dB(A). This is 23 dB(A) above the night-time background for the area and 13 dB(A) above the day-time background. This is significantly less than the maximum noise levels that are presently experienced from cars and trucks travelling through the town. Naturally, the noise level will persist for a few minutes (say two to three minutes) rather than a few seconds as with a cars and trucks, but a maximum of 48 train passes per day is unlikely to cause a significant deterioration in the acoustic environment compared to truck and car noise levels that presently exist. In fact, if the removal of coal truck traffic is considered, then the net effect on the acoustic environment will almost certainly be considered by most residents to be beneficial.

There are four residences which will be within the range 190 to 380 metres of the proposed line (see Figure 5-12, Volume 1) and at these distances the maximum noise levels could be as high as 75 dB(A) for the closest residence, and 71 dB(A) for the most distant. This is significantly above the existing day and night-time backgrounds levels (L_{90}) for the area (40 dB(A) and 35 dB(A) respectively) and may cause some sleep disturbance until residents become accustomed to the noise. No time restrictions are planned for routine train operations.

Metropolitan Catchment Area

The closest approach that the line will make to the picnic area on Lake Avon is about four km. At this distance, maximum train noise levels will be about 59 dB(A). Air absorption (assuming a temperature of 20°C and relative humidity of 50%) over this distance could be expected to reduce this level by about 11 dB(A) to 48 dB(A). This is 9 dB(A) above the day-time background observed at the Cordeaux picnic area, which is likely to have a similar noise environment as the Lake Avon area, and 18 dB(A) above the 30 dB(A) which is customarily adopted as the night-time background noise level for very quiet areas (such as this) where measured L_{90}'s are less than 30 dB(A). Thus while trains are travelling past these areas at night they will

dominate the noise environment. However, the low frequency of trains and the short duration nature of the noise makes it unlikely that the recreational amenity of these areas will be diminished.

Warning horns may have to be used but since their use will be infrequent, no adverse environmental effects are likely.

Farmborough Heights

In the residential area of Farmborough Heights prior to the line joining the South Coast Line, there are approximately 100 residences with back gardens leading onto the line. Many of the houses are within 25 to 30 metres of the line (see Figure 6-5, Volume 2).

Because the railway crossing in this area will be eliminated, the necessity to regularly sound horns will be removed. However the slope involved in this section of the track will involve the application of power for uphill runs and brakes for downhill runs.

An attitudinal survey was undertaken in the Farmborough Heights area to determine the type of train sound found most irritating. A synopsis is presented here and further details of the survey are in Appendix I.

In the higher areas of Farmborough Heights, where there are newer houses, people complained they were disturbed by present railway line usage. Complaints came from both those whose houses backed onto the railway line and those whose houses were across the street approximately 200 metres from the railway. They felt any increase in train numbers would disturb them more frequently. The majority of people in the area complained about the high pitched screeching or squealing noise heard from braking on the downhill run as the most disturbing effect. Some complained of the locomotive engine noise from uphill trains, although this comment was most frequent from people who live further down the hill.

The duration and intensity of train noise and its effect on residences, is highly dependent on the location of the house and the surrounding topography. Residences near monitoring site 4 could hear the train approaching and leaving, but experienced very little noise when it was passing. This is because of shielding afforded by the deep (5 metre) cutting through which the line passes in this section.

The proposed route takes the railway line through irregular topography, with variable elevations both above and below the level of the rail bed. In the Farmborough Heights area the railway line will pass through both cuttings and over embankments on its route past the residences in close proximity to the railway line.

The railway noise impact may be assessed in terms of three groups of parameters which are respectively:

- those related to emission of noise sources (train motive source, train rolling stock, extent of traffic and condition of track).

- those associated with the transmission or propagation path which is determined by the topography between rail track and perceiver.

- those associated with the perceiver and specifically whether the perceiver is indoors or outdoors. When indoors, the design of the house and the time of day assume a greater significance.

The specific avenues available to the SRA to provide a reduction of train noise impact on the houses located immediately adjacent to the railway line in the Farmborough Heights area, can be listed as follows:

- the introduction or optimisation of the noise reduction provided by cuttings through which the railway line will pass;

- the construction of wayside acoustical barriers for those sections of the rail line passing over embankments or sections of the line constructed on fill. The height of these barriers would be determined by a critical assessment of the conflicting requirements of attenuation and visual impact. Both of these criteria could reasonably be expected to vary depending on the individual tastes of the resident under consideration. The acoustical efficacy of such barriers is a function of their height as well as being determined by the choice of acoustical absorbing facings utilised on their inner surfaces. Barriers with heights ranging between 1.2 metres and 3 metres are capable of providing attenuations ranging between 7 dB(A) and 16 dB(A) for brake squeal and

wheel rail noise; the low height barriers which are effective in controlling the noise emission from the brakes and wheels are relatively ineffectual in controlling the noise from diesel electric locomotives and electric locomotives. The 3 metre high barriers offering excellent attenuation for the noise emission from brake squeal and wheel rail impact noise, are only moderately effective in reducing the noise emission from electric locomotives and are only marginally effective in controlling the noise from diesel electric locomotives;

- the use of new break shoe technology in order to reduce the problems generated by wheel rail interaction to reduce brake screech and improvements to driver techniques to reduce noise levels;

- the utilisation of rail grinding (ground by a commercial rail grinding machine) to reduce wheel-rail noise interaction. This noise is a significant source of normal railway operational noise emission and is also a significant factor in the generation of rail screech;

- the acoustical treatment of the facades of those residential buildings closer than a specified distance from the railway track. This acoustical treatment of the building facade would need to be supplemented by an acoustically treated ventilation system as and where required; and

- the purchase of houses by the government in appropriate cases.

A separate acoustical study has been commissioned by the SRA to evaluate each of these options in much greater detail (Louis A. Challis & Associates, 1983A). The study is scheduled for completion by the 14th October, 1983.

The nearest of the houses are about 20 metres from the existing railway line. They are therefore exposed to high peak sound levels as a result of train movements on the existing rail track. There are typically six rail movements per day on the existing rail line and following the completion of the new line would result in a maximum of 54 movements per day. The measured peak sound levels from the existing trains at the facades of the closest residences has

been shown to be 92 dB (A) for diesel electric locomotives and typically 8 dB(A) lower for self powered passenger trains using the railway line.

The level of brake squeal is dependent on the condition of the tracks, the type of wheels, the type of brake linings as well as the load being carried by the individual wagons. The measured peak noise level from this source is less than 90 dB(A) and consequently because of the number of wagons on a typical train, the noise from brake squeal is likely to constitute a more significant source than the noise from the diesel electric or electric locomotives. It is for this reason that the supplementary acoustical study has been directed to assess the acoustical options available for the minimisation of future noise impact.

The existing acoustical background noise levels in the Farmborough Heights area have been assessed on a statistical basis. That assessment has confirmed that the daytime equivalent noise levels in the area, based on 20 minute sample periods, ranges between 44 dB(A) and 68 dB(A).

By contrast, the equivalent night-time noise levels range between 35 dB(A) (in the early hours of the morning) to 68 dB(A) for those periods in which trains are operating in the existing rail line.

An alternative criteria for the assessment of community noise impact is based upon the assessment of the equivalent A-weighted noise level which may typically be measured over a 24 hour period. The typical values for LeqA24 at Farmborough Heights are 48-52 dB(A), with the dominant or most significant noise source being the result of the operation of the trains on the exisiting rail track.

The desirable noise level criteria for a residential location may also be specified in terms of the following criteria:

TABLE H.4

NOISE LEVEL CRITERIA

Environmental Noise Acceptability Rating	Daytime Equivalent Level in dB(A)	Night Time Equivalent Level in dB(A)
Clearly Acceptable	Less than 49	Less than 42
Normally Acceptable	Less than 62	Less than 56
Normally Unacceptable	Less than 76	Less than 67
Clearly Unacceptable	More than 77	More than 68

A number of overseas authorities have recommended that the appropriate design criteria, in terms of the value of the equivalent A-weighted sound level for 24 hours for railway noise, when measured outside the facade of the residential properties, should not exceed a value of 55 dB(A) (Louis Challis & Associates, 1983). This criteria results in noise levels which most communities would regard as "Normally Acceptable". More detailed discussion of appropriate criteria are presented in Louis A Challis & Associates (1983) and Challis (1982).

These criteria are based on both overseas and local experience. The views of the SPCC are being sought as to the levels appropriate in this area. If no special mitigating measures were to be taken then the computed A-weighted equivalent noise level at the houses nearest to the railway line with the specified number of trains operating on the line will be equal to a figure of approximately 77 dB(A). This level may be compared with the above criteria on a daytime and night time basis. In terms of those criteria, the level of environmental noise resulting at the nearest residential properties may be regarded as being clearly unacceptable.

It is apparent that it will be necessary to institute one or more of the acoustical options listed above in order to ameliorate the acoustical impact of the proposed railway line. The final recommendations on the most appropriate option is currently being assessed (Louis A. Challis & Associates, 1983A). The SRA will evaluate and as appropriate, implement these recommendations in the detailed project planning.

REFERENCES

Challis L.A. (1982) - Inter Noise Proceedings 1982, San Francisco: Provisional Night Time Criteria for Rating the Acceptability of Community Noise. pp 625 - 629.

Louis A. Challis & Associates (1983A) Acoustical Assessment of the Maldon-Dombarton-Port Kembla Railway Line: 4500-83 (in course of preparation).

Louis A. Challis & Associates (1983B) - Technical Assessment of Noise and Vibration Criteria for Property Redevelopment Adjacent to Railway Lines: 4402-83.

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Wilkinson Murray (1983) - Rail noise prediction model - Train noise measurements: W4362-1

APPENDIX I

LOCAL COMMUNITIES

APPENDIX I : TABLE OF CONTENTS

APPENDIX I : LIST OF FIGURES

1.0 INTRODUCTION

As an integral part of the environmental studies for the proposed Maldon-Dombarton railway line, a survey of the Wilton community was undertaken to establish the concerns of both the townspeople and landholders towards the project. During a meeting of the Wilton Progress Association, representatives from the SRA and D&M discussed the project with the Wilton community. The SRA representative discussed the purpose of the railway line, the three proposed alternative routes from Maldon to the Metropolitan Catchment Area (See Figure I-1), the capacity of the line and operations. D&M discussed environmental studies being undertaken for the EIS. Also present at the meeting were representatives from Wollondilly Shire Council who expressed full support for the project.

The most controversial issue discussed was the three alternative proposed routes of the railway line from Maldon to the Catchment Area. It was indicated at the meeting that the zone of land between the three routes would be studied.

Townspeople were concerned about the proximity of the railway to the township. Many agreed that if the railway passed around the southern side of the town around Thorntons Hill, they would be more in favour of the project.

Landholders were concerned about the effect of the railway on their properties, minimising the effects, and compensation.

The meeting was informed that a final decision regarding the route from Maldon to the Catchment Area would be based on survey, engineering and environmental study results.

The other populated area to be effected by the project is Farmborough Heights, a suburb of Wollongong. The Moss Vale - Unanderra line passes through the area to Port Kembla. The existing line is a single track on which an average of two to six trains travel daily. The proposal is to duplicate the line to accommodate the increased rail traffic from the proposed new line.

In more recent years, there has been an expansion of the urban area to the top of Farmborough Heights hill. Houses have been built on inexpensive land which included land adjacent to the railway.

The types of houses found in Farmborough Heights varies from the top of the hill to the bottom. Generally newer houses, towards the top of the hill, built within the last 10 years are brick, and older houses towards the bottom of the hill, are fibro or wooden. Some of the houses are Housing Commission homes that were built over 20 years ago. The average distance of houses adjacent to the railway line, in both areas, is 25 - 30 metres.

2.0 OBJECTIVES

The objectives of the Wilton Community survey were:

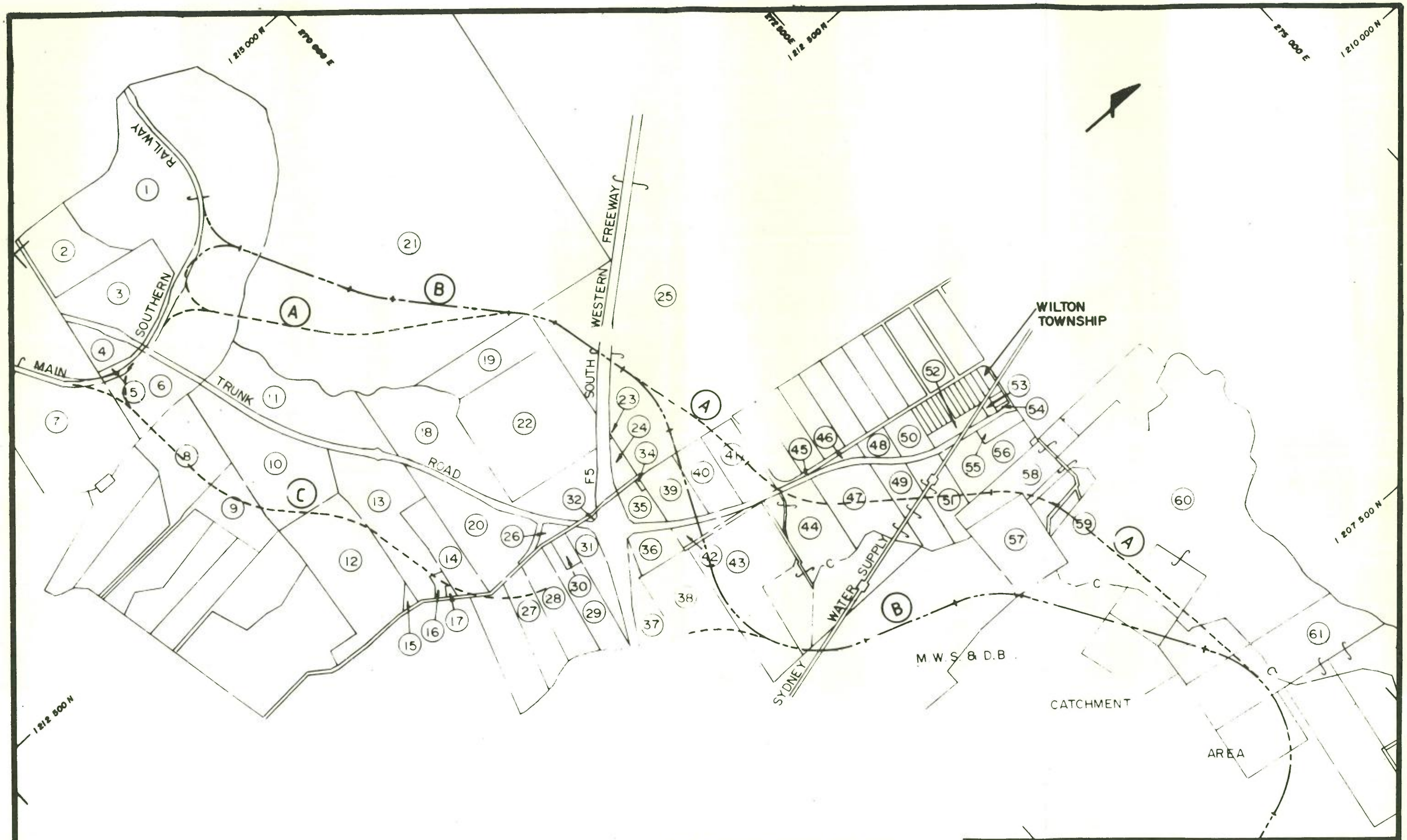
- to establish the concerns of the Wilton townspeople toward the proposed railway;
- to establish the effect of the railway on individual landholders; and
- to establish the percieved effect of the railway on the local community.

The objectives of the Farmborough Heights survey was to:

- establish the type of noise that disturbed residents;
- establish the areas where there was concern about train noise and their attitude towards it; and
- to establish concerns of residents to an increase of trains and their attitude to the duplication of the line.

3.0 SURVEY PROCEDURE

D&M representatives conducted a survey of the Wilton community in the local hall on 17th and 24th March, 1983. A letter and map were distributed to both townspeople and landholders (where possible). A list of landholders was obtained from the Wollondily Shire Council and people were contacted by telephone (where numbers were available). If survey times were inconvenient, people were welcomed to phone to discuss the project or make alternative appointments.



NOTE : SEE LANDHOLDERS NEXT PAGE

STATE RAIL AUTHORITY

TITLE: ALTERNATE ROUTE MALDON TO WILTON	FIGURE I-1
LOCATION: MALDON - DOMBARTON ROUTE	
SCALE: 0 500 1000 1500m	JOB No. : 09886-004-70
REF. : B.H.P.	DATE: MAY 1983
	Pamos & Moore

Farmborough Heights surveys were conducted on 12th and 13th May, 1983. A sample of residents were interviewed throughout the area, i.e. from the top of the hill to the bottom of the hill, and adjacent to the line and away from the line. Prior to the survey, a letter was delivered to households informing residents of the project and the purpose of the survey.

4.0 WILTON TOWNSPEOPLE'S CONCERNS

The Township of Wilton is located relatively close to Picton, Campbelltown, and Wollongong. This allows people to live in Wilton and commute to work.

Many of the people who live in Wilton were attracted to the area by its location, the rural atmosphere of the area, the cost and availability of land, and the quality of life offered by living in a rural environment.

The major concern of the townspeople was the proximity of the railway to the township of Wilton. One of the alternative routes from Maldon to the Catchment Area passed within less than a kilometer of Wilton. People interviewed were concerned about the loss of amenity to the area the railway would cause, and increased noise levels. They were in favour of either the alternative route to the south or north of Wilton but not the route close to Wilton. Other percieved impacts of a railway included loss of visual amenity, dust, vibration, loss of land values, danger to children, and the potential fire hazard.

In response to the three proposed alternative routes, the Wilton Progress Association passed a resolution that the railway route should affect the least number of landholders and be located away from the township. This resolution, and their proposed alternative route was submitted to the SRA.

The SRA responded to the concerns of the Wilton townspeople and considered the township of Wilton when making their final decision. Through the survey results, it was considered that the most satisfactory alternative for the railway line route was to pass around the southern side of Thorntons Hill, minimising the social and environmental impacts of the proposed railway line on Wilton. Route A affected two houses within 200 metres and four houses within 500 metres of the line. It directly effected three dams, and the catchment

area of seven others. Route B is located within 500 metres of three houses, and directly effects one dam and the catchment area of three others. Route C is located within 200 metres of four houses, and directly effects five dams and seven dam catchment areas. In comparison of the three alternative routes, Route B effects the least number of houses, dams and catchment areas.

5.0 WILTON LANDHOLDERS CONCERNS

Landholders in the Wilton area own properties that range in size from six hectares to over 200 hectares. They have lived in the area from less than one year to over twenty years. Some landholders do not presently live in the area but have long term plans to eventually build a house and move to the area. Farming practices vary and are highly dependent on the property size. Land use activities include horse and cattle stud farms, beef cattle grazing, kennels, some crop growing and market gardening. A number of the smaller property owners fall into the category of "hobby farmers". Some live on their land, commuting daily to work in the surrounding area, whilst others spend time on their properties only during weekends.

The majority of landholders surveyed were those directly effected by one of the alternative routes. As part of the survey questionnaire, landholders were asked how the proposed railway line would effect them if, hypothetically, it passed through the middle of their property, or, alternatively, along one side of their property. Responses varied, depending on the size of the property and the location of houses and dams.

Generally, if the railway halved any of the smaller properties, the effects were considered deliterous. In most cases, remaining land on either side of the line was seen to be useless. It would not be farmable and many people saw it as unsaleable. Some property owners had invested money into the land, after the initial purchase, through pasture inprovement and the installation of dams. It was considered that the proposed railway line would nullify any improvements and investments of this kind. Some landholders with newly built or planned houses, were concerned about personal disturbance from increased noise levels and loss of access to their property. Adjacent landholders were also concerned

about loss of access to their property, noise, and disturbed catchment areas of dams. They were concerned that dams on properties adjacent to the railway could potentially become useless if drainage patterns are changed by the construction of the railway.

Landholders with larger properties in the Wilton area generally manage the land as a farm not as a "hobby farm". The property produce is their livelihood. In general, the concerns of these landholders fall into three categories; economic, farm management and personal. They wanted to minimise the effect and disruption of the railway on themselves and their farming practises.

Major economic concerns were loss of investment. Many of the farmers with large properties have up-graded their farms through pasture improvements, farming equipment, erosion controls, dams etc, allowing a higher productivity from the property. The construction of a railway through their farm was considered to result in a loss of investments and depending on the railway location, a possible loss of efficiency and productivity, thus effecting their livelihood. The productivity of the farm is highly dependent on the type of farm and farm management practices. Management practices would have to be changed and replanned if the railway dissected any of the larger properties. These management practices include stock movement, and supervision, water catchment disturbance, fire hazard, replanning, disturbance during the construction phase and weed pollution. Impacts on stock movement can be minimised through the construction of access bridges over or under the railway. If considerations are given to other aspects such as drainage patterns, to minimise the loss of catchment area to dams, the impact of the railway would be reduced on a individual landholder.

Other concerns, of a more personal nature, were expressed by all landholders. These concerns included: loss of access to their property if the railway line crossed their access road, loss of soil due to erosion, loss of visual amenity, increased dust, increased noise levels, and being left with unfarmable and unsaleable pieces of land due to their size and proximity to the railway. Also railway maintenance procedures, night lights, shooters, theft and increased frontage increased access and disturbance to farm animals were causes of concern. Many of these concerns can be

minimised, thus allowing the landholder a satisfactory environment in which to live. Some of these concerns are of sociological nature in which there is a fear of the unknown. For example, people have little knowledge of procedures such as railway maintenance. This causes concerns that they may be disrupted or disturbed by a railway maintenance work team. They are concerned that weed control methods used by the SRA may disrupt farming practises or weedicides used may poison their livestock, crops or pollute a dam.

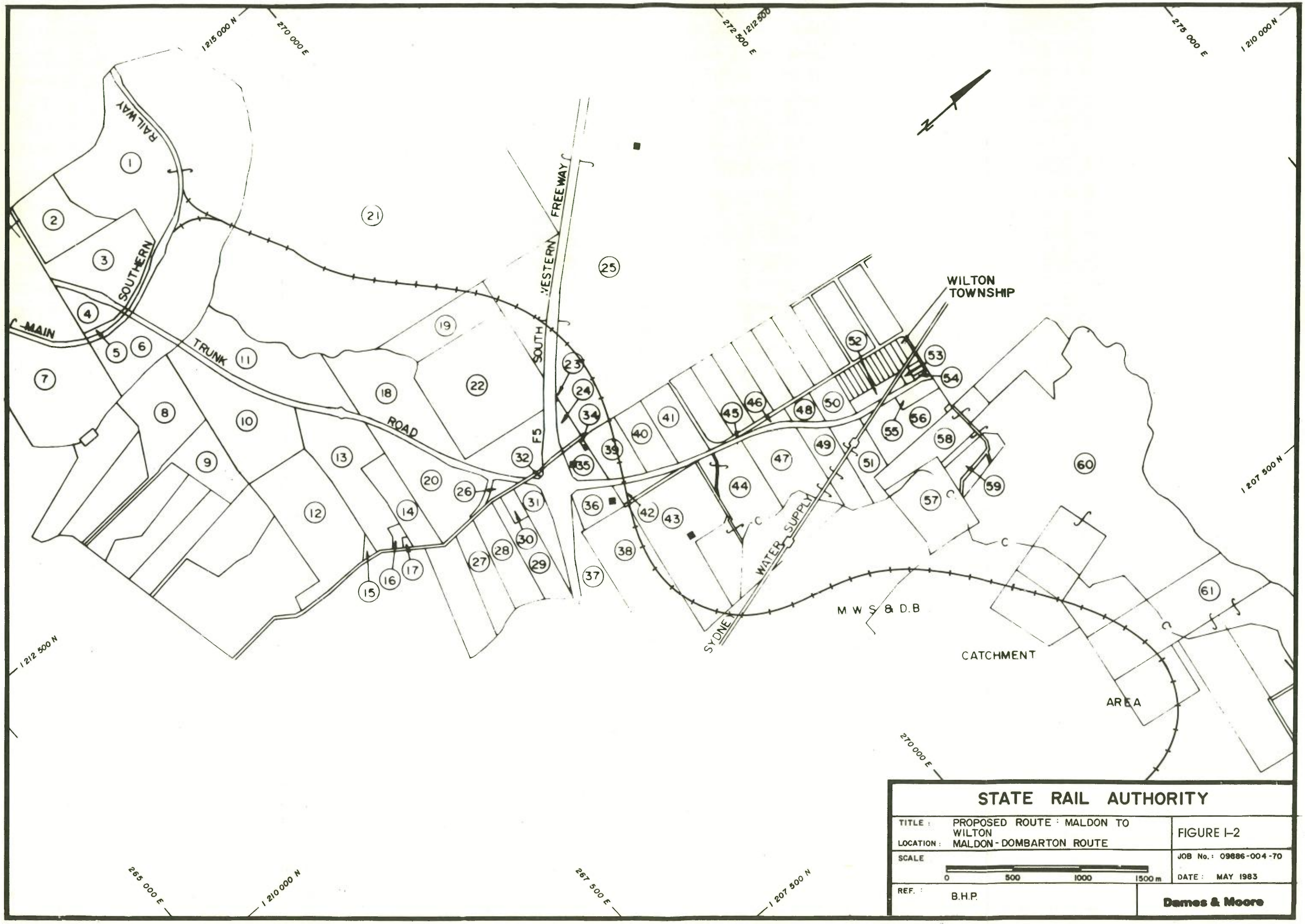
The major concern of the railway line being parallel to any properties was loss of amenity. Many felt that even if the railway did not cross their property, there may be an increase in noise, dam catchment areas would be disturbed, and there was the possibility of a loss of access, and visual amenity.

Individual landholders concerns varied depending on landuse. Stud farm owners were unsure of the effect of railway noise on their animals but felt it was likely to be detrimental. They were concerned that the animals would damage themselves when a train passed, increasing veterinary cost through increased visits. One poultry farmer was concerned with the effect of increased noise on his chickens and their egg laying.

Mr T. Blair is typical of one of the major landholders in the area. His attitude towards the proposed railway was one of wanting to minimise the effect of the railway on his property. As he owns a large parcel of land in the area, he felt sure that the railway would cross his land and preferred that useable pieces of land were left, with access for himself and his cattle across the railway line where necessary. Other landholders with large parcels of land were worried the railway would leave them with land of little agricultural productivity value.

The landholders who will be directly effected by the railway preferred route are J. Nixon, T. Blair, Dalbar Pty Ltd, B. Burge, L. & B. Biggs, M. & C. McCarthy, the Australian Gas Light Company (AGL) and the Department of Main roads. These properties and the proposed railway line are shown in Figure I-2.

The effect on Nixon, Blair and Burge is similar as they all own large parcels of land. The railway cuts through all three properties thus alternative farm management practises will be required. Generally, the effects will be minimal.



STATE RAIL AUTHORITY

TITLE : PROPOSED ROUTE : MALDON TO WILTON LOCATION : MALDON - DOMBARTON ROUTE		FIGURE I-2
SCALE 0 500 1000 1500 m		JOB No. : 09886-004-70 DATE : MAY 1983
REF. : B.H.P.		Dames & Moore

Biggs, McCarthy, Dalbar Pty Ltd and the Department of Main Roads are all smaller properties. Biggs and McCarthy may loose a sufficient amount of land to justify the need to sell the whole property. The railway location will destroy their long term plans to build a house, and minimise the usefulness of the land for farming.

The effect on Dalbar Pty Ltd, the Department of Main Roads property and AGL is minimal as the railway only cuts a portion of the land. The loss of land is unlikely to cause any major impact. At present Dalbar Pty Ltd lease their land to a parachute club. The area contains an air strip and target landing ground used generally on weekends by the parachute club. The location of the railway may restrict the activities of the parachute club.

6.0 FARMBOROUGH HEIGHTS RESIDENT'S CONCERNS

The Farmborough Heights area was initially populated through the development of Housing Commission homes at the bottom of the Farmborough Heights hill over 30 years ago. A gradual expansion of the area has occurred up to the top of the hill and in more recent years, subdivision has occurred. Consequently many of the houses in the area are less than ten years old. Subdivided land was sold inexpensively, thus people moving into the area could afford to build higher standard (brick)houses. Other attractions of the area are the fresh, clean air away from the steel works, the trees, and the relative peace and quiet of the area. It is also relatively close to Wollongong and areas of employment.

From the survey results, it was found that the degree of disturbance experienced by local residents varied. This variation was dependent on house location and the length of time a resident had lived in the area.

The type of noise that disturbed most residents when a train passed is brake squealing and engine noise. The most disturbing noise for the residents at the top of Farmborough Heights is the brake squealing noise. This noise was described by these residents as being most disturbing at night and most annoying while talking on the telephone, during general conversation, and while watching television or listening to the radio. Residents, whose houses were located next to the line appeared to be disturbed more than those who

lived further away from the line. Night trains occasionally woke both adults and children, more often children, when travelling downhill. The brake squealing noise was described as being more audible during night-time than day-time. A few people commented that other disturbing noises were carriages hitting together and engine noise from trains travelling up the hill.

Residents at the bottom of the hill complained more about engine noise than brake noise. People who lived beside the railway were occasionally disturbed by train noise but generally said they got used to it. There were more comments in relation to road traffic noise disturbance than rail traffic noise disturbance, from residents in this area. Some residents felt that a stopped train restarting up the hill was more disturbing than a passing train.

Analysis of the results in terms of house location and rail traffic noise, shows that some residents towards the top of Farmborough Heights who live adjacent to the railway expect an increase of train traffic to be such a disturbance that they would contemplate moving away from the area. Generally, residents living towards the bottom did not consider that an increase in rail traffic would be disturbing.

Another factor that related closely to attitudes to noise, was the length of time a resident had lived in the area. Residents who had lived in the area over 15 years said they were accustomed to noise, and "did not notice the trains anymore". The majority of these people lived toward the bottom of the hill.

Other concerns in relation to increased rail traffic were coal dust; land devaluation; soot from diesel trains; night lights; loss of views; loss of trees, birds and wildlife; vibration from trains passing, and blasting effects during construction.

When asked why residents moved into the area, many said because of the fresh clean air, quite atmosphere and pleasant location. They were concerned that an increase in rail traffic would cause an increase in dust therefore they may as well be living near the steel works. Some residents were concerned that if coal train cars were uncovered, during periods of high wind, the area would be polluted with coal dust. Many felt that all coal train cars should be covered to avoid any dust pollution.

Residents were also concerned by the land devaluation that would occur with an increase of train traffic in the area. Many residents felt that they would not be able to sell their house if they wanted to move, as no one would be interested in moving into an area with heavy rail traffic. Residents were also concerned that after a period of time, plumes of soot" from the diesel locomotives would change the character of the area by covering the houses with a film of dirt.

Residents in houses close to the railway complained of the occasional effect of night lights disturbing children. One resident described seeing a train light as a comforting feeling, but generally they were not concerned.

Of the residents surveyed, only a few people in Bristol Street and Farmborough Road have views of the surrounding landscape. The proposed duplication of the railway would only effect the people in Bristol Street if any trees were cut down. People on Farmborough Road and areas further downhill, generally had views which included the existing railway, thus were not concerned with any loss of amenity in this regard. These residents commented briefly about vibration caused by passing trains. On the whole, these houses are constructed of fibro or wood, and therefore are more likely to be effected by vibration than brick houses at the top of the hill. Some residents were concerned about the effect of vibration on the structure of their house in the long term. However, vibration caused by passing trains was rarely noticed by residents. One resident complained that windows sometimes rattle from the vibrations caused by a passing train. The effect of increased train traffic, in this case, was percieved as more cracked windows. This house was located 50 metres from the railway line.

Residents at the top of the hill were concerned that with a losss of trees from the railway duplication, a loss of birds and wildlife may occur. Even without a loss of trees, some felt the increased noise from train traffic would drive away and endangered birds and wildlife in the area.

Residents at the bottom of Farmborough Heights Hill were concerned about weed pollution increasing the number of snakes in their back gardens. They felt the SRA were not maintaining their land to a satisfactory standard.

Some residents were in favour of the duplication as it would increase employment and decrease coal trucks on roads. Others were totally against the idea.

One resident commented that electrification of the line would not decrease noise levels in the area.

7.0 CONCLUSION

The local community at Wilton should be content with the location of the proposed railway line. It is away from the township and effects the least number of landholders, dams, and catchment areas.

People living in Farmborough Heights will be effected by increased noise. The SRA intend to minimise this effect where possible. This is discussed further in Appendix H.

APPENDIX J

SOCIAL AND ECONOMIC ASPECTS

APPENDIX J : TABLE OF CONTENTS

APPENDIX J : LIST OF FIGURES

APPENDIX J : LIST OF TABLES

1.0 EXISTING ENVIRONMENT

1.1 EMPLOYMENT: LOCAL LABOUR AREA

For the purposes of the socio-economic studies, the local area was assumed to be the Shire of Wollondilly and the City of Wollongong.

1.2 EMPLOYMENT STRUCTURE

The employment structure of the two areas reflects the size and growth rate of their respective economies. Wollondilly Shire's workforce grew by 31% in the 1976 - 1981 period and is in the process of transition from a primarily rural economy to serving as a residential commuter area for both Sydney and Wollongong. In contrast, Wollongong's workforce grew by 7.2% in the same period and is an established metropolitan area based on the manufacturing and mining industries.

Table J.1 shows the breakdown of both economies by industry during the 1976 - 1981 period.

Very little growth occurred in Wollongong's basic industries in the period shown and the vast majority was due to an increase in service industries.

1.3 EMPLOYMENT MULTIPLIERS

Each of the industries in both areas were classified on the basis of a concentration index (compared to the N.S.W. economy) as being either basic or service industries. Basic industries are those that export goods and services from the region thus earning regional income. Service (non-basic) industries are defined as support industries for the basic industries.

Total employment multipliers which express the changes in total employment as a result of changes in basic industries were estimated as 2.6 for Wollondilly Shire and 7.0 for the City of Wollongong for the period 1976 - 1981. The latter abnormally high estimate for the size of the economy is caused by the low growth rate of the City's basic industries compared to its service sector in the period 1976 - 1981. When the multiplier for the total study area was combined, the result was 4.7. This figure means that for each job

TABLE J.1

EMPLOYMENT STRUCTURE
WOLLONDILLY SHIRE AND CITY OF WOLLONGONG

INDUSTRY	WOLLONDILLY SHIRE				CITY OF WOLLONGONG			
	1976		1981		1976		1981	
	NO.	%	NO.	%	NO.	%	NO.	%
Agriculture	756	12.7	735	9.3	305	0.5	259	0.4
Mining	758	12.7	1017	12.9	4525	6.7	5148	7.1
Manufacturing	950	15.9	1134	14.4	25000	37.2	24767	34.4
Electricity, Gas & Water	490	8.2	409	5.2	1625	2.4	1776	2.5
Construction	517	8.7	571	7.3	3775	5.6	3745	5.2
Wholesale, Retail Trade	633	10.6	874	11.1	9754	14.5	9490	13.2
Transport, Storage	238	4.0	384	4.9	3154	4.7	3550	4.9
Communication	96	1.6	101	1.3	769	1.1	872	1.2
Finance, Property & Business Services	166	2.8	380	4.8	3342	5.0	4176	5.8
Public Administration	175	2.9	246	3.1	1718	2.6	1757	2.4
Community Services	578	9.6	1023	13.0	7084	10.5	9012	12.5
Recreation & Personal Services	232	3.9	291	3.7	2801	4.2	3109	4.3
Other, not Classified, & not Staged	389	6.5	708	9.0	3353	5.0	4416	6.1
TOTAL	5978	100.0	7873	100.0	67205	100.0	72077	100.0

Source: ABS

created in the basic sectors of the economy, 3.7 jobs are created in the service industries. The multiplier effect of the project can be expected to be of this order if the majority of the capital equipment and labour can be manufactured or supplied from local sources.

1.4 UNEMPLOYMENT

The Commonwealth Employment Service has provided employment service transactions for the third and fourth quarters of 1982 and the first quarter of 1983.

These are set out in Table J.2

Since early 1983, there has been a continued increase in unemployment in the region, due chiefly to the downturn in the coal and steel industries.

2.0 POPULATION DISTRIBUTION

As shown in Table J.3, the majority of the population of the study area is concentrated in the City of Wollongong. Some 22.4% of the inter-censal growth in Wollondilly Shire has occurred in the small towns listed in the table. The remainder has been scatttered into rural areas of the Shire as small hobby farms and/or farmlets.

3.0 IMPACT AND PROPOSED MITIGATING MEASURES

3.1 CONSTRUCTION PHASE

3.1.1 Workforce

Data provided by the SRA outlined the construction schedule and an estimated number of man-hours to complete the railway line. This data was derived from an estimate of labour as a percentage of total capital cost required for each of the major construction tasks. The percentages of labour involved in each task are shown as Table J.4.

Man-hours were derived by applying a fixed wage rate to each major labour group. Total man-hours by each major labour and task are shown as Table J.5.

TABLE J.2

UNEMPLOYMENT : WOLLONGONG

	PERSONS REGISTERING				VACANCIES NOTIFIED	
	ADULTS		JUNIORS		ADULTS	JUNIORS
	Males	Females	Males	Females		
3rd Quarter 1982	2103	502	969	569	336	557
4th Quarter 1982	2355	540	1410	1254	298	141
1st Quarter 1983	2490	742	979	706	558	389

Note: 3rd Quarter is July, August, September, 1982.
4th Quarter is October, November, December, 1982.
1st Quarter is January, February, March, 1983.

Source: CES Main Business Transactions.

TABLE J.3

POPULATION DISTRIBUTION 1976 - 1981

	TOTAL PERSONS		CHANGE 1976/1981	
	1976	1981	PERSONS	%
Picton	1,715	1,817	102	5.95
Appin	592	740	148	25.00
Wilton	<200	<200	-	-
Thirlmere	683	914	231	33.82
Tahmoor	1,346	1,996	650	48.29
Wollondilly Shire	14,790	19,830	5,040	34.08
City of Wollongong	200,141	208,651	8,510	4.25

Source: ABS

TABLE J.4

LABOUR PERCENTAGES : CONSTRUCTION PHASE

CATEGORY	CAPITAL COST $M	LABOUR AS % CAPITAL COST				
		U	T	O	S	TOTAL
Major Bridges	9,687	14	13	3	8	38
Minor Bridges	3,378	12	11	2	7	32
Tunnel	28,677	14	7	7	12	40
E/W and Drainage	27,862	4	4	16	7	31
Trackwork	25,400	4	2	2	3	11
Sigs/Comm/Elec	28,073	4	12	-	2	18
TOTAL	123,077					

Source: SRA

Note: U = Unskilled
T = Tradesman
O = Operators
S = Staff

TABLE J.5

MAN-HOURS : CONSTRUCTION PHASE

CATEGORY	UNSKILLED	TRADESMAN	OPERATORS	STAFF	TOTAL
Major Bridges	93,530	78,710	18,750	43,050	234,040
Minor Bridges	27,960	23,220	4,360	13,140	68,680
Tunnel	276,880	125,460	129,510	191,180	723,030
E/W and Drainage	76,860	69,660	287,610	108,350	542,480
Trackwork	70,070	31,750	32,770	42,330	176,920
Sigs/Comm/Elec	77,440	210,550	-	31,190	319,180
TOTAL	622,740	539,350	473,000	429,240	2,064,330

Source: SRA

Note: Sigs = Signals
Comm = Communication
Elec = Electricity

3.1.2 Schedule

As shown in Figure J-1, the programme is planned over approximately 33-36 months with the earthworks, bridges and culvert teams assumed to be working in advance of the ballast, track-laying and signalling groups. The latter task does not commence until about 9 months into the schedule because of the two bridges and extensive tunnelling required in the job. As shown in Figure J.1, the peak on-site workforce of about 470 should occur at around month 18. After month 6, the workforce will remain at about 280 until month 30. In addition, there will be an off-site workforce directly associated with the project.

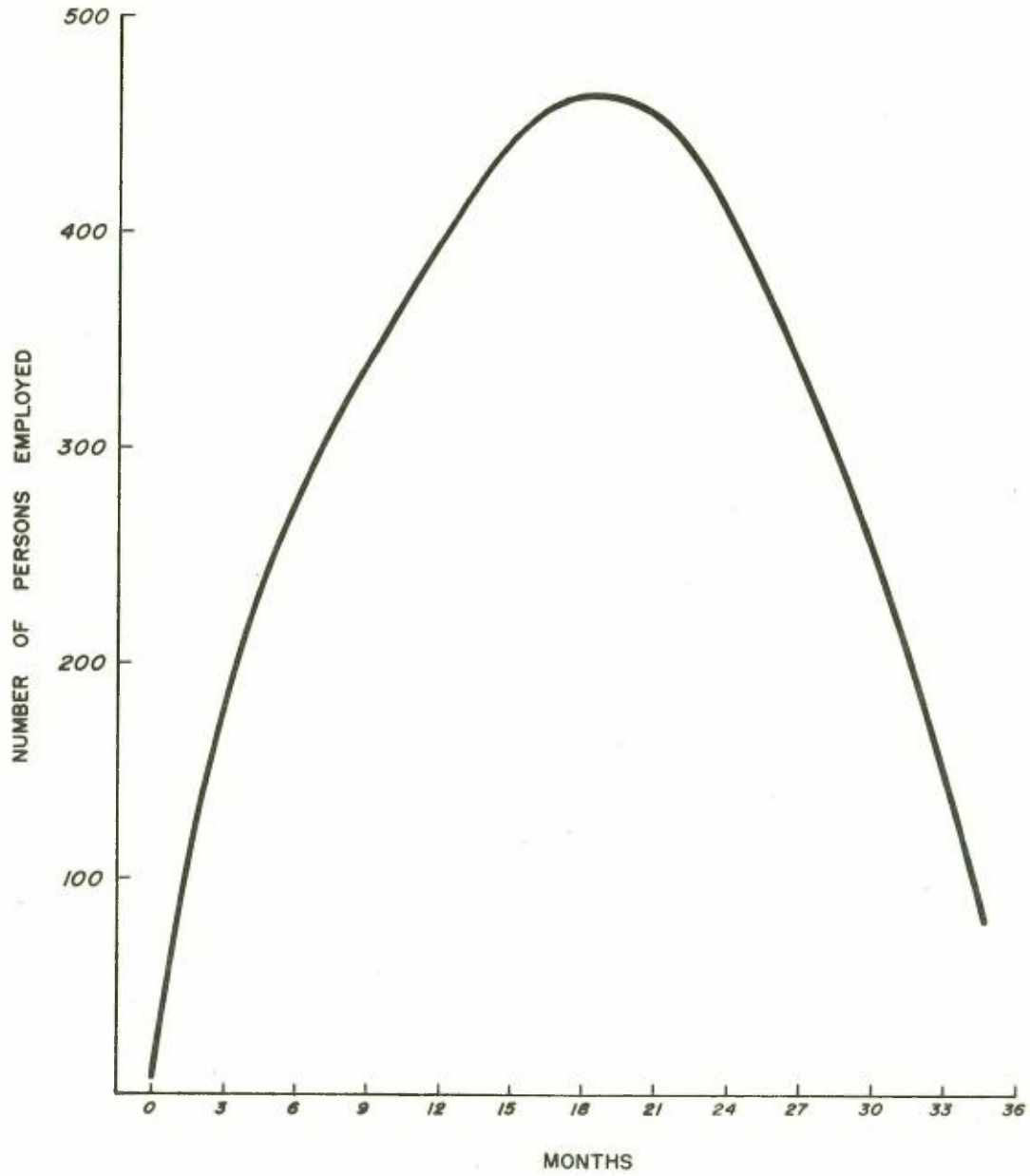
In order to consider the reliability of the SRA estimate of jobs (Figure J-1), reference was made to a previous Dames & Moore report concerning the Alice Springs - Darwin Railway. Estimates of a likely average on-site construction workforce were derived from previous contractors on the Tarcoola - Alice Springs section of the line which was completed in 1980. These numbers were confirmed by the Australian National Railway (ANR) as being reliable estimates. Table J.6 shows the estimate of on-site construction jobs by task and skill-level.

When the ANR figures are compared to the construction workforce and schedule for this project, the estimate of average equivalent jobs is very similar.

3.1.3 Service Employment

As the railway line is located in close proximity to both Wollongong and Sydney, all of the workforce is expected to either commute to the job on a daily basis or stay in hotel or motel accommodation for the work-week. The latter would most probably consist of sub-contractors with shorter tasks to perform. Supplies for the job will either be trucked to the site or a supply train would be utilised.

In the short run, local retailers will be affected by daily purchases of food and miscellaneous supplies. As the job entails construction of two large bridges and major tunnelling, local retailers in the vicinity of the works can anticipate an increase in business activity for up to 18 months. As the focus of construction activity changes, retail purchasing will move to new more convenient locations.



STATE RAIL AUTHORITY	
TITLE: ON-SITE CONSTRUCTION WORKFORCE LOCATION:	FIGURE J-1
SCALE:	JOB No: 09886-004-70 DATE: September, 1983
REF: S.R.A.	Dames & Moore

TABLE J.6

ON-SITE AVERAGE CONSTRUCTION WORKFORCE JOBS BY TASK AND SKILL LEVEL TARCOOLA - ALICE SPRING RAILWAY

	EARTHWORKS BRIDGES CULVERTS	TRACK-LAYING	BALLAST QUARRYING	OTHERS	TOTAL
Skilled (Includes supervisory personnel)	65	22	3	7	97
Semi-skilled	50	32	12	7	101
Unskilled	35	38	5	6	84
TOTAL	150	92	20	20	282

Source: ANR: Darwin - Alice Springs Railway EIS. p56, Dames & Moore, December 1982.

As the workforce will mainly commute to the site, the stimulus to the local labour market and economy is difficult to estimate. Assuming as a minimum that only operator jobs and unskilled jobs are taken by local workers (i.e. 65.6% of the peak workforce), a substantial short-term boost to the Wollongong economy from the re-spending of their income may be anticipated. With total payments to labour for the project at $32.65 M, some $21.42 M would flow to the local economy over the 33-36 months. This figure represents approximately 2 % of total gross annual income in the local area for the year 1981.

There are a relatively high proportion of tradesmen presently available in both the City of Wollongong and Wollondilly Shire because of the downturn in the iron and steel and mining industries. Thus the actual injection of salaries to the local area could be considerably higher than the above figure.

Assuming that pre-cast concrete bridgeworks and concrete railway sleepers and rails would be manufactured locally, the effect on service industries in the City of Wollongong will be substantial. Using the multiplier derived from the relationship between basic and service industries up to 970 short-term jobs can be predicted to result from the stimulus to the construction industry. This figure must be tempered by the present high level of excess capacity in the City's manufacturing sector.

3.2 OPERATIONAL PHASE

3.2.1 Workforce

The operational workforce required to operate the line will be train crews plus a six man inspection and maintenance gang on the line. Additional signalling personnel would be necessary at Wollongong. It is not expected that this labour would be drawn from the smaller centres on the western portion of the line. They are most likely to be from existing staff in Wollongong or Sydney.

3.2.2 Estimate of Capacity

Assuming 24 loaded trains per day for a 300 day work year, with 31 CHS wagons per train (i.e. 2,300 tonnes nett), 17.2 m. tonnes of coal could be transported per year. In order to

TABLE J.7

CHANGE IN MINING EMPLOYMENT COMPARED TO TRANSPORTATION MODE

WOLLONDILLY SHIRE	DEFINED BY OCCUPATIONS		DEFINED BY INDUSTRY	
	1976-1981	Ratio	1976-1981	Ratio
Change in Mining Employment	157	-	259	-
Change in Road Transportation Employment	64	0.4	114	0.44
Change in Rail Transportation Employment	6	0.04	34	0.13

CITY OF WOLLONGONG	DEFINED BY OCCUPATIONS		DEFINED BY INDUSTRY	
	1976-1981	Ratio	1976-1981	Ratio
Change in Mining Employment	218	-	623	-
Change in Road Transportation Employment	36	0.16	166	0.26
Change in Rail Transportation Employment	-15	-0.06	66	0.10

move the same volume of coal per day by truck would require in excess of 5,000 (2 way) trips per day. Industry sources estimated that in 1982 approximately 1 million tonnes of coal was hauled by truck to the Port Kembla Coal Loader.

3.2.3 Employment Impact

Comparison of census data for 1976 and 1981 suggest that there is a more important relationship between the increase in coal production and an increase in road transport in Wollondilly Shire rather than the City of Wollongong. Table J.7 shows the relationships between the increase in coal production and increase in employment of road and rail transport for both local government areas. This data suggest that diversion of coal onto the new railway line will significantly effect the growth of the road transport sector in Wollondilly Shire. In the City of Wollongong, the relationship does not appear to be as significant. There is also much greater opportunity for diversification to other types of transport work in the more urbanised area.

3.4.4 Population Impact

In Wollondilly Shire, household size in the period 1976 - 1981 has remained stable at 3.3 persons per household. As approximately 400 workers are employed in the road transport sector of Wollondilly Shire, up to 1,320 people are directly dependent on this sector for their household income. Diversion of coal haulage to the railway may significantly affect the range of transport work available.

4.0 MITIGATIONS

As there is some 271-400 workers representing 3.4 to 5.1% of the Wollondilly Shire workforce presently engaged in road transportation, opportunities for diversification of truck operations should be investigated. The potential longer-term decrease of employment in this local sector in the operational phase should be balanced against the short-term construction opportunities that will be created and the possible diversification of truck operations.

APPENDIX K

SCHEDULE OF CONDITIONS APPLICABLE TO THE CONSTRUCTION, OPERATION AND MAINTENANCE OF RAILWAY LINES ON CATCHMENT AREAS

METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD

APPENDIX K

SCHEDULE OF CONDITIONS APPLICABLE TO THE CONSTRUCTION, OPERATION AND MAINTENANCE OF RAILWAY LINES ON CATCHMENT AREAS

METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD

In this Schedule, the word:

- "Board", wherever appearing, shall mean Metropolitan Water, Sewerage and Drainage Board.

- "Authority", wherever appearing, shall mean State Rail Authority of New South Wales.

a. The Authority shall carry out the Works in such a way as to conform strictly to all provisions of the Metropolitan Water, Sewerage and Drainage Act, 1924, applying to the prevention of pollution of any catchment area of the preservation of the purity of the water supply provided thereby or derived therefrom, or for the protection of the property of the Board on any catchment area under the said Act or any of the by-laws thereunder for the time being in force.

b. If the lessee shall at any time be using or about to use any process in the construction, operation, maintenance or use of the Works or any part of them which in the opinion of the Board is likely to pollute any catchment area or the water supply or to endanger any property of the Board on any catchment area the lessee upon service of a notice under the hand of the Secretary of the Board so to do shall:

   i) discontinue the use of such process within twenty four hours, or,
   ii) thereafter refrain from adopting such process at any time,

   as the case may require.

c. The Authority shall make such provision for sanitation as may be directed by the Board and shall at all times observe and perform any requirements of the Board respecting sanitation.

d. The Authority shall provide and maintain to the satisfaction of the Board efficient means to prevent the contamination, pollution or siltation of any stream or watercourse or catchment area by the Commission or any contractor, agent, servant or employee of the commission and shall observe any instruction given by the Board with a view to preventing or minimising the

contamination, pollution or siltation of any stream, watercourse or catchment area.

e. The Authority shall not establish any camps or habitation within any catchment or other areas under the control of the Board.

f. The Authority hereby covenants with the Board that the Commission shall at all times hereafter save harmless and keep the Board indemnified from payment of compensation and from and against all actions proceedings claims and demands in respect of any injury loss or damage arising out of or in any way connected with any interference with or deprivation or loss of access to the land and premises hereby demised which may occur by reason of any works or operations undertaken or carried out by the Board or arising out of in any way connected with any discontinuance or alteration of any process consequent upon the service of a notice in persuance of the provisions of subclause (b) of this clause or arising out of or in any way connected with the operation of any by-laws relating to a catchment area in force at the date hereof or made by the Board at any time hereafter.

g. The Authority shall not erect install or use within any catchment area of other area under the control of the Board any plant or process for the purpose of maintaining rolling stock.

h. The Authority shall at all times properly operate, maintain and drain at its own expense to the satisfaction of the board acting as aforesaid the railway and appurtenant works authorised by this demise within any catchment area.

i. The Authority shall observe any requirments of the Board acting as to the order and method of constructing the Works so as to prevent erosion or siltation of any catchment areas, or pollution of any watercourse, creek or the stored water of any dam.

j. The Authority shall carry out to the satisfaction of the Board acting as aforesaid any structural works considered necessary by the Board acting as aforesaid for the protection of the purity of the water supply.

k. The Authority shall ensure that the following requirements are complied with in regard to the method of construction and location of the railway within any catchment or other area under the control of the Board:

i) cutting and filling of the formation shall be kept to a minimum;

ii) all material cut and not required for fill purposes shall be removed from any catchment area if so directed by the Board acting as aforesaid;

iii) all embankments shall be stabilized by such processes as may be approved by the Board acting as aforesaid;

iv) the railway formation shall be provided with suitable concrete-lined drains, silt traps, culverts, dwarf walls or other facility to prevent erosion which shall be of sufficient capaity to permit of cleaning without putting them simultaneously out of commission;

v) no drainage from underground workings shall be pumped up on to the catchment area, unless it is impractical to dispose of it otherwise, and in such case, special treatment may be required of the drainage pumped clear of the catchment area, as the Board may decide.

l. The Authority shall submit to the Board for its approval, full sets of the survey and design plans of all the proposed installations, well in advance of the time intended to commence construction thereof, and no work shall commence until the Board's approval is given thereto.

The Authority shall comply with any restrictions and/or requirements by the Board as to ground surface disturbance, scrub or tree cutting and removal, clearing, burning off, and other related activities.

m. The Authority shall not leave deposited on the surface any excavated material, mine residues, tailings or refuse without specific approval from the Board, and shall, if so directed by the Board, remove any or all thereof from the catchment area.

n. The Authority shall keep all parts of the land hereby demised within any catchment or other area under the control of the Board in a clean condition and maintain ground cover vegetation and establish it artificially where directed to the satisfaction of the Board acting as aforesaid.

o. The Authority shall strictly limit its operations within any catchment or other area under the control of the Board to the width approved by the Board acting as aforesaid to be cleared for the route of the railway and its appurtenant works. The parking of plant, or stockpiling of materials, beyond this width, shall be prohibited except in areas specifically approved, in advance, by the Board acting as aforesaid. Proposals for the provision of access tracks within any catchment or other area under the control of the Board to the route of the railway must also be approved in advance by the Board acting as aforesaid before construction of any track is commenced. Use of such tracks shall cease on completion of construction of the railway unless otherwise approved by the Board acting as aforesaid.

p. The Authority shall limit the use and storage of petrol, diesel fuel, grease, oil and similar materials to the minimum essential for the carrying out of the works, and shall arrange for the use and storage of these materials only in such parts of any catchment or other area under the control of the board as are approved by the Board acting as aforesaid.

q. The Authority shall not establish any workshops, amenities, facilities or offices on any catchment area except with the special permission of the Board acting as foresaid. The Board's approval, in writing, must first be obtained as to location, size and method of operation before any such facility is established.

r. The use of any amenities facilities or other sites on any catchment or other area under the control of the Board by personnel shall be subjected to satisfactory hygiene arrangements including the provision of treatment works designed and constructed to the requirements of the Board. The effluent and any other sullage, including bathroom wastes, shall be disposed of in a manner satisfactory to the Board and, if required,

shall be pumped to a disposal area clear of the catchment lands through mild steel cement-lined pipes. Pumping arrangements shall be to the Board's approval and shall include 100% stand-by arrangements with a holding tank (for emergency use) capable of holding at least three days' discarge. The effluent shall be chlorinated by the lessee at or near the pumping point to the satisfaction of the Board acting as lastmentioned.

s. i) The Authority shall not permit any fire place to be constructed wihtin any catchment or other area under the control of the Board unless protected by stone wallings and fines lit therein shall not be left unattended;

ii) The Authority shall take adequate precautions for the prevention of fire to the satisfaction of the Board acting as aforesaid, and in the event of any fire caused by the operation of the Commission within any catchment area the Commission shall be held responsible for the cost of fire suppression activities incurred by the Board;

iii) No fires shall be lit within any catchment or other area under the control of the Board for the purposes of clearing vegetation or other materials without the prior approval of and to such conditions as may be stipulated by the Board's Senior Forestry Officer.

t. The Authority shall accept responsibility for the control and conduct of its employees or other persons engaged in business with the Authority at all times while they are on any catchment area wich lies within the area demised, whether actually working or not. If any person in the employ of the Authority is guilty of an offence under any of the Board's by-laws governing the control or use of any catchment area, the Authority shall agree upon the request of the Board to transfer that employee to work outside any catchment area.

u. The Authority shall erect and maintain fences and locked gates where determined by the Board, to prevent the entry from the area demised of unauthorised persons on to any immediately adjacent part of any catchment area.

v. The Authority shall permit free and uninterrupted access to officers or employees of the Board at any time for the purposes of their official duties and the production of an "Authority to Enter" card issued by the Board or other official badge shall be accepted by the Authority as sufficient proof of identity.

w. The Authority shall provide and maintain suitable signs at the proposed sites of and at the junction of any access road with any main road, warning all persons that trespassing on the Catchment area, is strictly prohibited.

x. The Board accepts no obligation to provide a source of supply of water for the Authority's works, but, it it does agree to do this, the method and source of supply shall be determined by the Board, and all supply requirements such as pumping equipment and pipelines, shall be designed and constructed under the Board's direction and supervision at the Authority's cost. Storage tanks of adequate capacity shall be required to minimise access to the supply source for operation of the pumping equiment. Adequate precautions to prevent backflow or overflow shall be required.

Such a supply shall be metered and water charged for at the ruling rate per kilolitre of water so supplied.

y. The Authority shall reimburse the Board for any costs of investigation, design ,construction, supervision and maintenance as may be applicable incurred by the Board in connection with the various installations authorised by this agreement, provided that the costs to be paid by the commission shall not exceed five thousand dollars (5,000) in any one calendar year.

APPENDIX K

SCHEDULE OF CONDITIONS APPLICABLE TO THE CONSTRUCTION, OPERATION AND MAINTENANCE OF RAILWAY LINES ON CATCHMENT AREAS

METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD

Duplicate

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