TITLE: **Review of environmental factors for proposed widening of Sunnyholt Road from James Cook Drive to Quakers Hill Parkway, Glenwood**

AUTHOR: **Environmental Planning Pty Ltd; New South Wales. Roads and Traffic Authority;**

YEAR: **2002**

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1. Introduction

Sunnyholt Road is Main Road 642 and generally runs in a north south direction between Blacktown and Parklea in the rapidly growing north-west sector of metropolitan Sydney. The Roads and Traffic Authority of NSW (RTA) proposes to widen Sunnyholt Road for 1.56 km from 100 metres south of James Cook Drive to 260 metres north of Quakers Hill Parkway at Glenwood. The proposal would involve the reconstruction and widening of Sunnyholt Road from 2 to 6 lanes plus turning lanes with a raised median, shared cycleway and pedestrian path on the west side and a footpath on the east side. The widening would accommodate a major interchange with the Western Sydney Orbital[1] (WSO) with space for the proposed rapid bus only transitway[2] (between Blacktown and Castle Hill) with dedicated lanes and stations along Sunnyholt Road on the east side.

Existing intersections at James Cook Drive, Wilson Road, Malvern Road and Quakers Hill Parkway with Sunnyholt Road would also be improved with new traffic signals provided at Wilson Road and Malvern Road as part of the proposal. Access to Meurants Lane would be restricted to buses only. Right turns out of Wilson Road and Malvern Road would be restricted to buses only.

Sunnyholt Road serves local, commuter, business and freight traffic but would not meet road safety and capacity standards with the anticipated large growth in traffic especially after the WSO opens in 2006. It is expected the proposal and any associated noise attenuation measures would be generally confined to within the road reserve although some land acquisition adjacent to the existing road reserve on both sides of the road is required. Some utilities and other infrastructure would also need to be adjusted and/or relocated.

The proposal would improve traffic flow, safety and capacity for motorists, pedal cyclists and pedestrians along this section of Sunnyholt Road. Following favourable environmental assessment, determination of the proposal and detailed design it is anticipated that work would commence in December 2002. The majority of the work is expected to be undertaken by the successful consortium for the WSO project.

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[1] *The concept design and environmental impact assessment has been completed for the WSO and the project was approved by the Minister for Planning in February 2002.*

[2] *A separate environmental impact assessment (in progress) and planning approval are required for the proposed Blacktown to Castle Hill transitway and stations which do not form part of this proposal to widen Sunnyholt Road at Glenwood. The preferred location for the transitway is on the eastern side of Sunnyholt Road and provision has been made in the concept design as shown in this Review of Environmental Factors for a two lane proposed transitway in this location. If required the proposed transitway space could be used as a temporary southbound carriageway for Sunnyholt Road.*

2. Proposal Identification

Name of Proposal:	Widening of Sunnyholt Road between James Cook Drive and Quakers Hill Parkway, Glenwood.
Local Government Area:	Blacktown City Council.
Construction Program:	Private funding by the successful consortium and Western Sydney Roads and Transport Programme.
Registration Number:	0642.040.CD.0005.
RTA Publication	*to be advised by RTA.*
Roadloc Co-ordinates:	Start from link 130 2.520 (100 metres south of James Cook Drive) to link 155 0.260 (260 metres north of Quakers Hill Parkway).

3. Description of Proposal

3.1 Location

The 1.56 km long proposal along Sunnyholt Road is located approximately 100 metres south of James Cook Drive and 260 metres north of Quakers Hill Parkway. Figure 1 (two sheets at page 4) provides a recent aerial photograph of Sunnyholt Road and the surrounding area at Glenwood with a plan of the proposal superimposed plus a longitudinal section and typical cross sections of the widening shown.

3.2 General Features

The general features of the proposal as shown in Figure 1 are listed below.

- reconstruction and widening of Sunnyholt Road for 1.56 km from a 2 lane undivided road to a 6 lane divided road plus turning lanes between James Cook Drive and Quakers Hill Parkway.
- the reconstruction and widening would tie in with the adjoining 4 lane divided road section of Sunnyholt Road to the south of James Cook Drive and 6 lane divided road section to the north of Quakers Hill Parkway.
- the horizontal and vertical alignments would generally follow the existing road including the overpass over the WSO.
- provision for three lanes (two 3.25 metre wide and one 3.5 metre wide) dense grade asphalt pavement travel lanes in each direction generally separated by a 1.2 metre wide low concrete median.
- a shared 3 metre wide cycleway and pedestrian path within a 4 to 5 metre wide verge/footway located on the west side of the road.
- on the east side of the road a 4 metre wide low concrete median would separate the southbound travel lanes from the proposed two lane (one lane each way) transitway.
- a 3 metre wide footway would be provided on the east side of the proposed transitway with a 1.2 metre wide concrete path.
- provision would be made on the east side to accommodate a proposed transitway including stations.
- minor adjustments of the local roads Flint Street and Ali Place.

- one right turning lane would be provided in Sunnyholt Road at the signalised intersections of James Cook Drive, Wilson Road and Malvern Road.
- two right turning lanes would be provided in Sunnyholt Road at the signalised intersections of the WSO and Quakers Hill Parkway.
- one left turn lane in Sunnyholt Road at the signalised intersections of the WSO and James Cook Drive and two left turn lanes in Sunnyholt Road at Quakers Hill Parkway.
- access to and from Meurants Lane would be restricted to buses only.
- vehicles (except buses) would not be able to turn right out of Wilson Road and Malvern Road.
- only buses would be allowed to turn right into Wilson Road.
- *No Parking* and/or *No Standing* restrictions along the length of the proposal. should be NO STOPPING
- provision of landscaping on each side of the road wherever possible.
- increasing the speed limit from 60 and 70 km/hour to 70 km/hour along Sunnyholt Road.
- provision of street lighting along Sunnyholt Road.
- provision of 3 metre high noise walls along 1730 metres of Sunnyholt Road and architectural treatment of 10 dwellings and a church along Sunnyholt Road to reduce traffic noise.
- relocation and adjustment of utilities and infrastructure where necessary.
- provision of kerb and gutter along both sides of the road.
- installation of water quality treatment facilities to be determined during detailed design following liaison with Blacktown City Council.
- provision of a hazard spill containment detention basin able to accommodate 25,000 litres at a location near the WSO interchange to be determined during detailed design.
- strip acquisition from the frontages of privately owned land where required along both sides of Sunnyholt Road.

3.3 Costs and Timing

The cost of constructing the proposal is expected to be in the vicinity of $30 million.

Works are expected to commence in December 2002 and be completed by 2007. The work could be staged to provide early benefits to road users. It may be possible to provided two lanes in each direction by late 2003/early 2004. Opening of the WSO/Sunnyholt Road interchange would not occur until the total widening is complete in order to avoid any congestion or delays approaching the interchange.

Figure 1. Aerial View of Sunnyholt Road and Environs, Plan, Longitudinal Section and Typical Cross Sections of Proposal

Plan Registration No. 02S150-D02, D03 and D04 (3 sheets)

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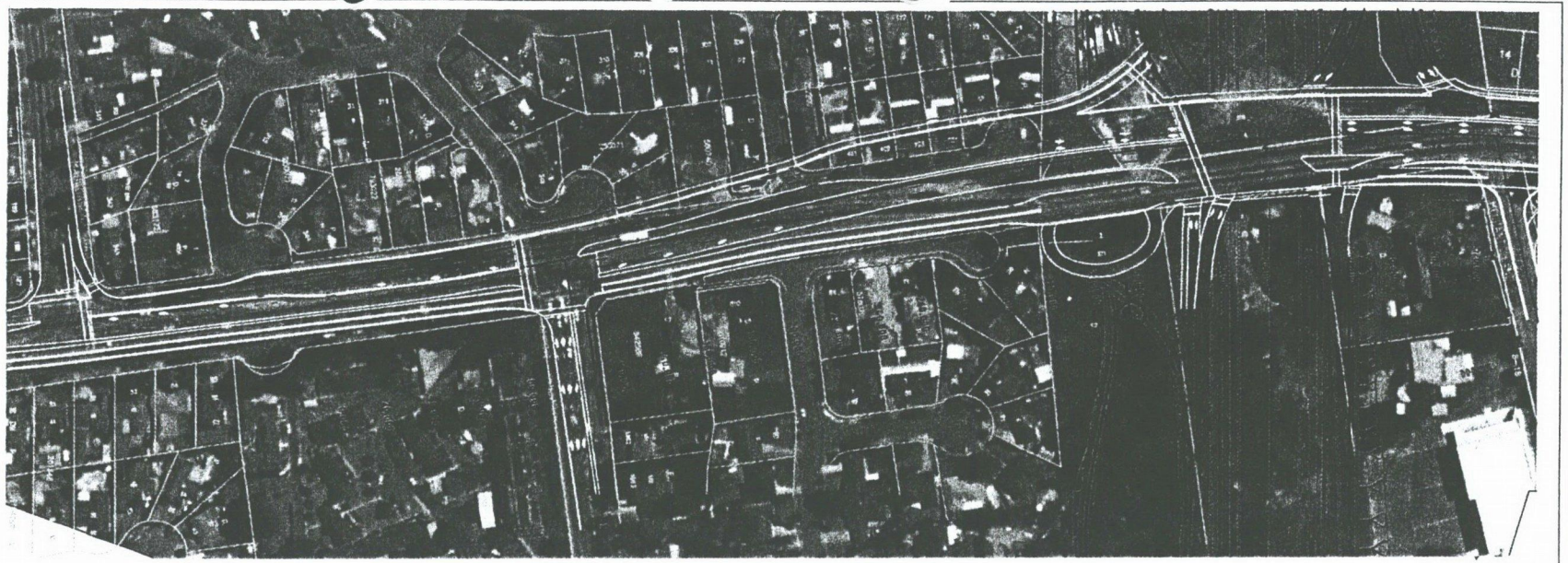

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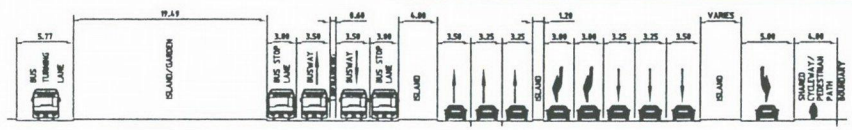

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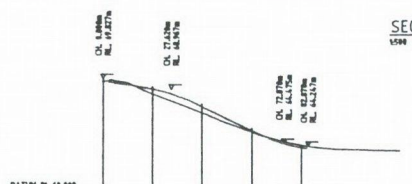
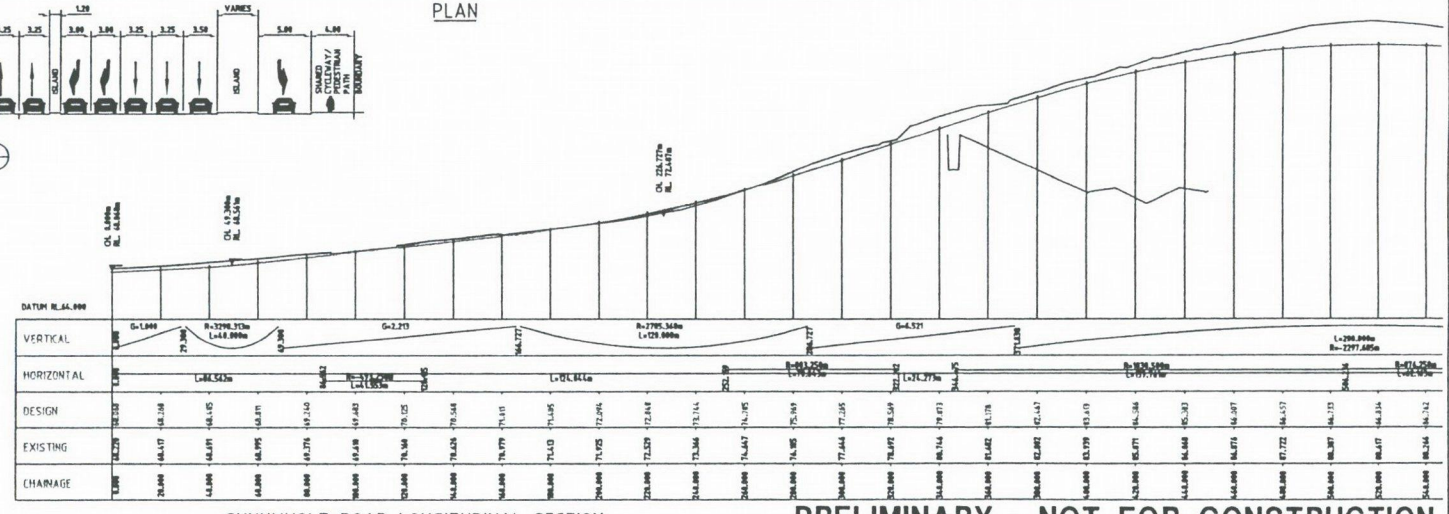


JAMES COOK ROAD LONGITUDINAL SECTION



SUNNYHOLT ROAD LONGITUDINAL SECTION

PRELIMINARY - NOT FOR CONSTRUCTION

Rev.	Amendment or reason for Issue	Date	Drawn	Designed	Verified	Authorised (*)
A	ISSUED FOR INFORMATION	19.11.02	RAS	VJS	X	

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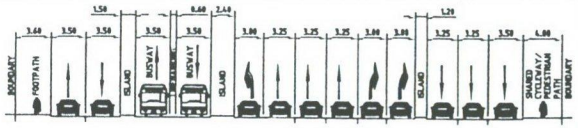
Project	SUNNYHOLT ROAD UPGRADE JAMES COOK DRIVE TO SORRENTO DRIVE
Drawing Title	CONCEPT DESIGN ROAD GEOMETRY AND PROPERTY BOUNDARIES SHEET 1 of 3
Client	ROADS AND TRAFFIC AUTHORITY
Scales	1:2000 (plan/horiz) 1:400 (vert)
Client Project No.	061590
Architect / Project Manager	RTA, PROJECT MANAGEMENT SERVICES
Drawing No.	02S150-D02
Sheet	1 or 3
Revision	A



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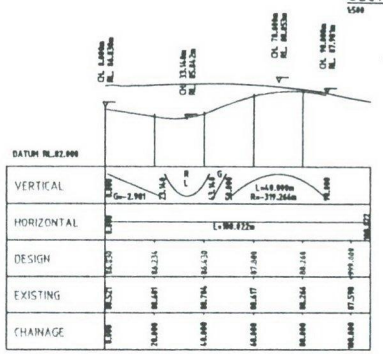

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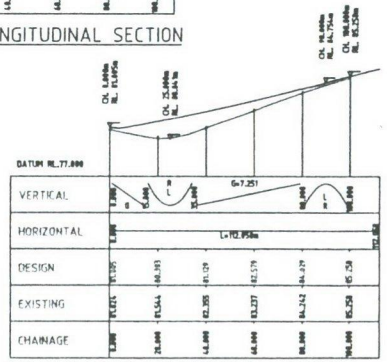

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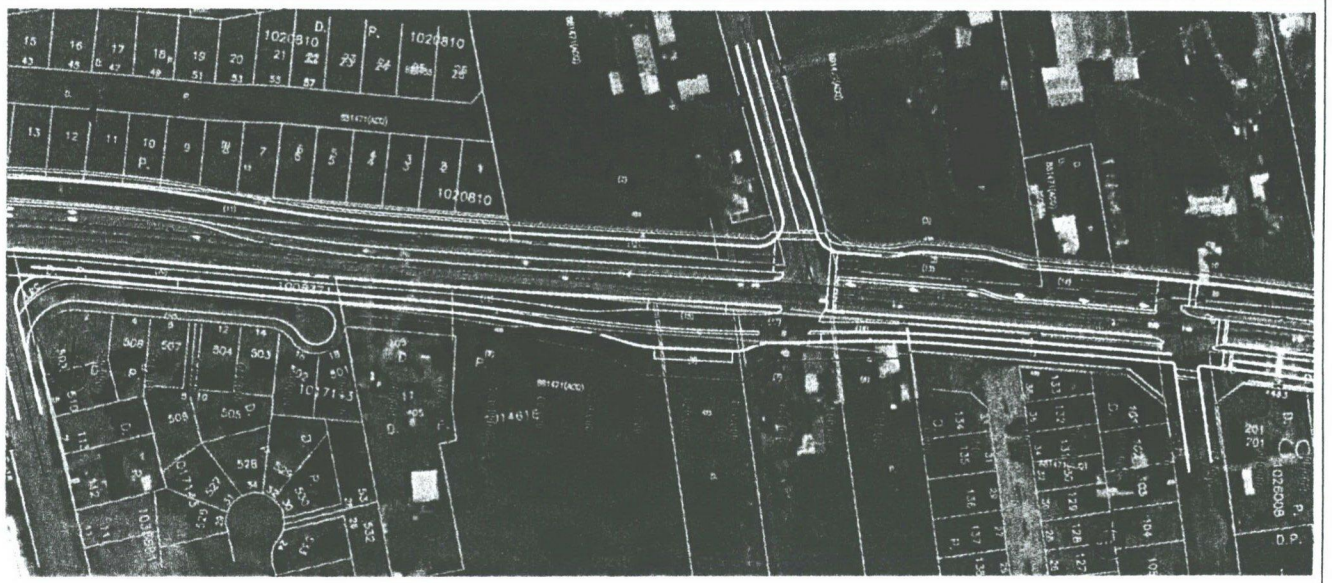

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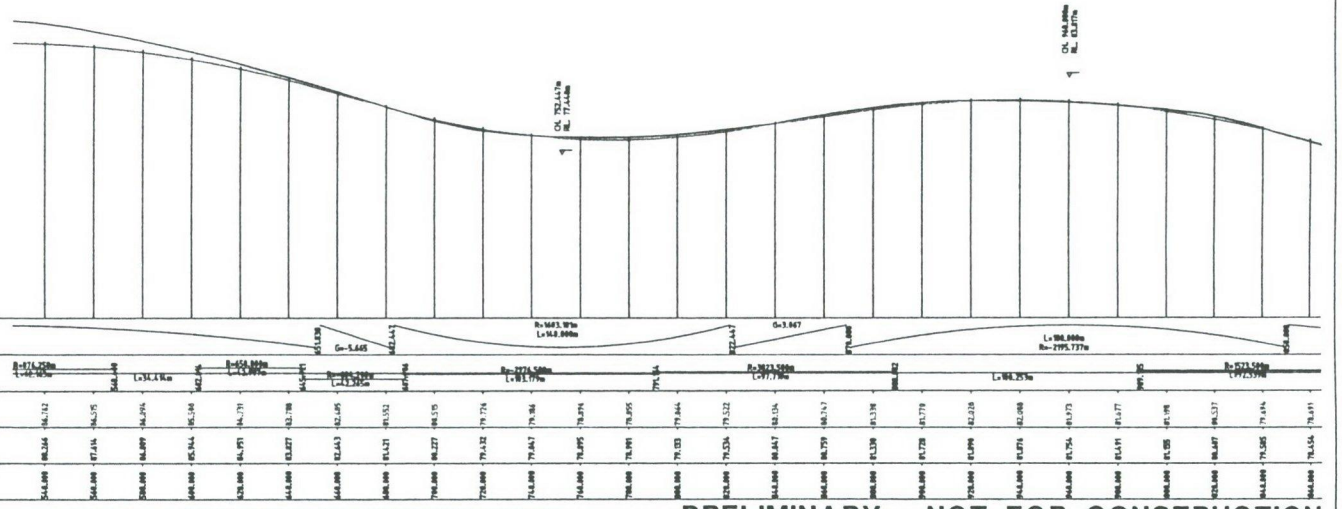

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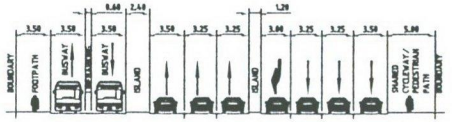

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Project	SUNNYHOLT ROAD UPGRADE JAMES COOK DRIVE TO SORRENTO DRIVE
Drawing Title	CONCEPT DESIGN ROAD GEOMETRY AND PROPERTY BOUNDARIES SHEET 2 of 3
Client	ROADS AND TRAFFIC AUTHORITY
Scales	1:2000 (plan/horiz) 1:400 (vert)
Client Project No.	061590
Architect / Project Manager	RTA, PROJECT MANAGEMENT SERVICES
Drawing No.	02S150-D03
Sheet	2 or 3
Revision	A

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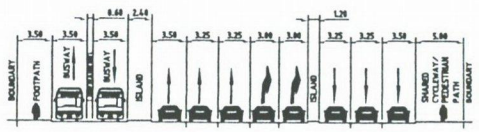

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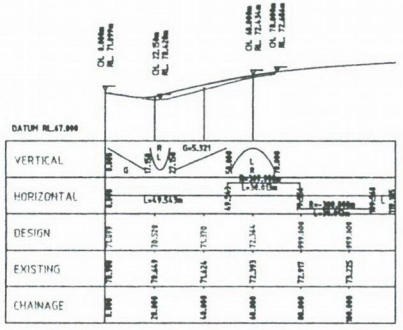

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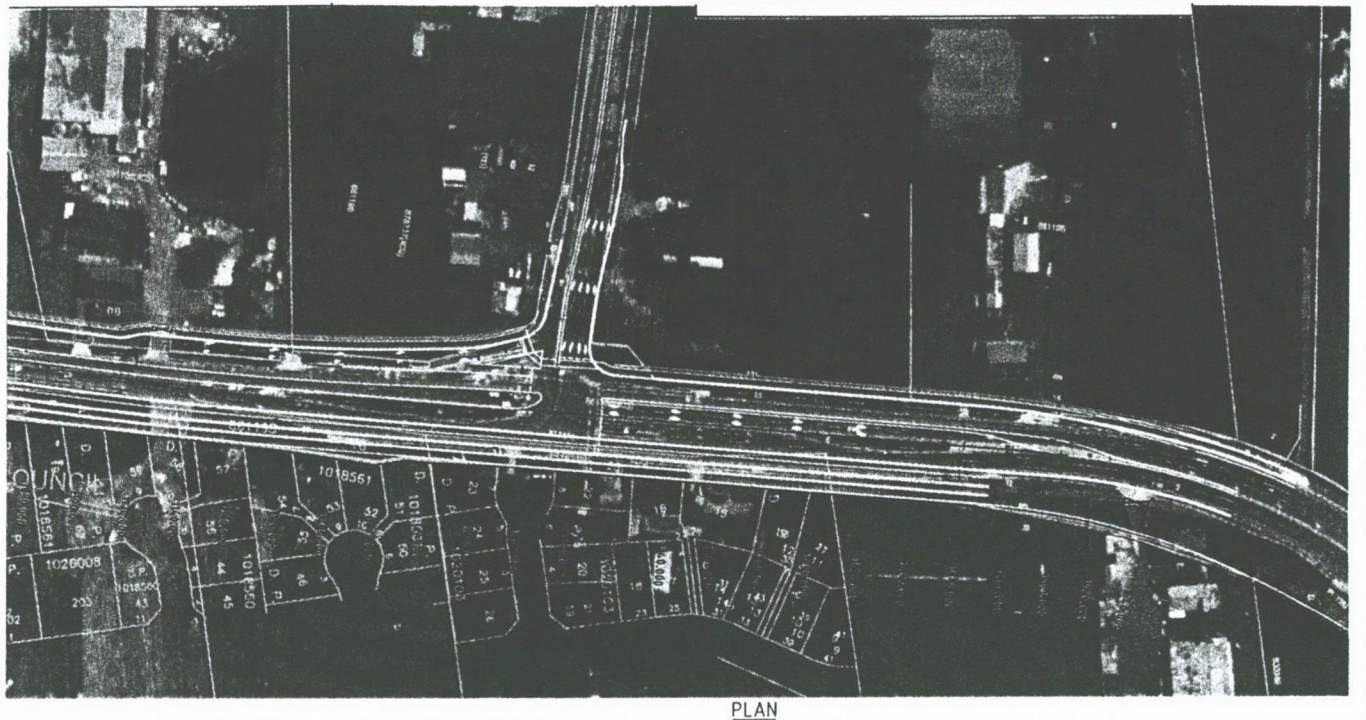

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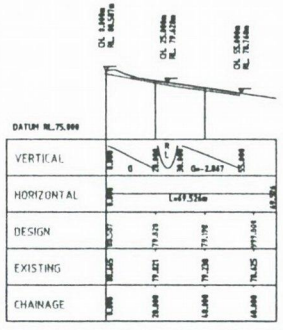

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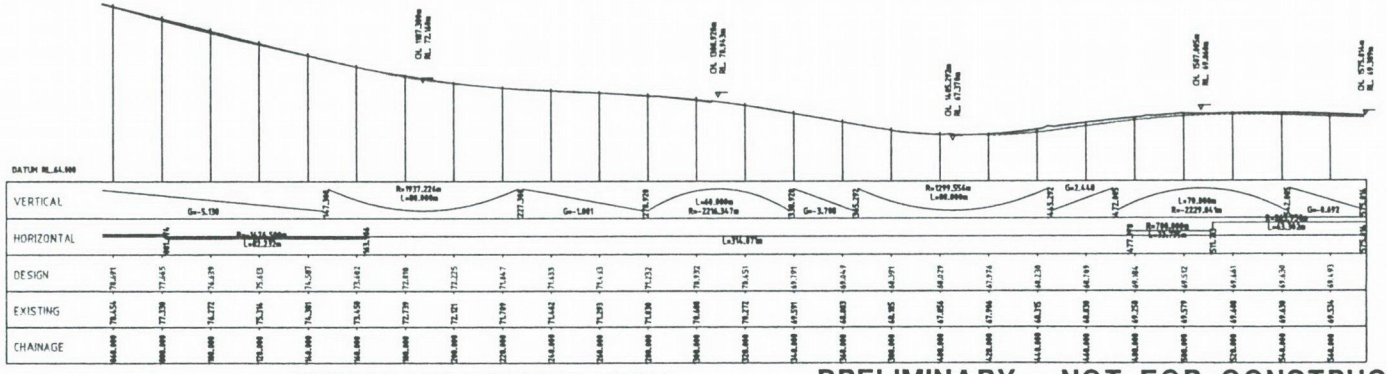

SUNNYHOLT ROAD LONGITUDINAL SECTION

PRELIMINARY - NOT FOR CONSTRUCTION

Rev.	Amendment or reason for issue	Date	Drawn	Designed	Verified	Authorised (*)
A	ISSUED FOR INFORMATION	19.11.02	RAS	VJS	X	

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Project	SUNNYHOLT ROAD UPGRADE JAMES COOK DRIVE TO SORRENTO DRIVE
Drawing Title	CONCEPT DESIGN ROAD GEOMETRY AND PROPERTY BOUNDARIES SHEET 3 of 3
Client	ROADS AND TRAFFIC AUTHORITY
Scales	1:2000 (plan/horiz) 1:400 (vert)
Client Project No.	061590
Architect / Project Manager	RTA, PROJECT MANAGEMENT SERVICES
Drawing No.	02S150-D04
Sheet	3 of 3
Revision	A

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3.4 Staging

The new northbound carriageway would be located generally to the west of the existing carriageway of Sunnyholt Road. Hence, after land acquisition and utility adjustments much of this carriageway could be built without affecting traffic on the existing road. Similarly the proposed transitway would be located to the east of the existing road and much of it could also be built without affecting traffic on the existing road. If both the ultimate northbound carriageway and the proposed transitway were built first then traffic on Sunnyholt Road could be switched onto these to enable the existing road to be reconstructed to become the ultimate southbound carriageway.

The construction staging being considered is described below. Two temporary lanes would be constructed on the eastern side of Sunnyholt Road in the area for the proposed transitway. These temporary lanes would be clear of the existing pavement lanes and would be marked for southbound traffic. The existing lanes on Sunnyholt Road would then be marked as two northbound lanes. The advantage of this staging is that four lanes would be provided within 12 to 15 months of commencement to address the existing congestion and delays along the two lane section of the road. Most of the ultimate northbound carriageway on the western side of Sunnyholt Road could then be built clear of traffic to reduce construction impacts. Two final northbound lanes could then be opened with the two temporary lanes to the east to carry southbound traffic. The existing road could then be ripped up and reconstructed to form the ultimate southbound carriageway. The two temporary lanes on the eastern side would then be closed and in the future the proposed transitway (subject to environmental assessment and planning approval) built over them.

The staging is aimed at providing four through lanes at an early date so as to relieve the existing congestion along Sunnyholt Road. Other staging options would have to be implemented if there were delays in the RTA acquiring land on which to construct the temporary pavement.

In conjunction with the staging (whatever form it takes) it is likely that access to and from side streets between James Cook Drive and Quakers Hill Parkway (that is, Meurants Lane, Wilson Road and Malvern Road) would be restricted to that proposed in the ultimate treatment. Hence there would be no access to and from Meurants Lane. Left in and left out turns only (buses excepted) would apply at Wilson Road. The right turn out of Malvern Road would be banned. These restrictions would apply to ensure safety is not compromised. The staging would not include traffic control signals at Wilson Road and Malvern Road.

In late October 2002 the RTA allowed all movements into and out of Meurants Lane at Old Windsor Road. This occurred in the conjunction with the opening of two new northbound lanes in Old Windsor Road. The opening has resulted in some complaints from residents of the Meurants Lane area about increased traffic in Meurants Lane. The proposed access restrictions at Sunnyholt Road and Meurants Lane as part of the staged improvement in conditions described above should reduce the use of Meurants Lane by traffic.

4. Specialist Studies and Community Involvement

4.1 Specialist Studies

- Traffic and civil engineering studies have been completed for the concept design of the proposal. Specialist environmental studies completed for the Review of Environmental Factors (REF) include impacts on air quality, flora and fauna, provision of a landscape concept plan, impacts on Aboriginal archaeology, noise measurements and predicted noise levels in the area of the reconstruction and widening.

- A safety audit would be completed on the detailed design before construction of the proposal. The findings of the safety audit would be incorporated in the final design. A Value Management Study and a Risk Management Study would be completed for the proposal prior to construction.

4.2 Community Involvement

A number of public organisations, utility and service providers and bus companies with a potential interest in the proposal were consulted in March 2002 and are listed below. Copies of the responses received (indicated by italics in the listing) are provided in Appendix 1.

Blacktown City Council (including RTA response)
Environment Protection Authority
Department of Land and Water Conservation
Transport NSW
AGL Gas Companies (NSW) Limited (Agility)
Telstra
Sydney Water
Cable and Wireless Optus Limited
Integral Energy
Bicycle New South Wales Inc./Camwest
Busways Group
Westbus Pty Ltd.

The relevant requirements of the public organisations, utility and service providers that have been consulted have been addressed in this REF.

In September 2002 the local Member of Parliament issued a news release on the proposal. In September 2002 the RTA also distributed a newsletter to residents in the Sunnyholt Road area and Blacktown City Council to obtain feedback on the proposal. Appendix 2 provides a summary of the 85 community comments received and RTA responses. The RTA will send everyone who made a submission on the proposal a letter summarising the outcomes of the consultation.

The outcomes/changes as a result of the community consultation include:

- At James Cook Drive the centre lane would be shared as a left turn and right turn lane, in order to relieve some of the right turn congestion.
- At Wilson Road the RTA would close off the right turn from Sunnyholt Road for general traffic; buses only could turn right into Wilson Road.
- At Quakers Hill Parkway, the four lanes to be provided into Sunnyholt Road would be two left turning and two right turning lanes. After opening, an assessment would be undertaken by the RTA to see if one of the lanes should be a shared right and left turn lane, depending on demand.

A report which details the assessment of the REF and the final proposal will be available to the public for perusal at Blacktown City Council and the RTA Parramatta and Blacktown offices.

Some of the actions raised in responses (in particular provision of infrastructure) will not be resolved until the RTA and the successful consortium completes investigations with other public authorities. The results of completing the actions will be reflected in the detailed design for the proposal.

5. Strategic Stage

5.1 General

Sunnyholt Road as Main Road 642 fulfils a role as a vital link in the metropolitan Sydney main road network as well as catering for the needs of the surrounding local communities, commuters and freight movements. As part of an on-going development programme including an extensive safety and traffic management programme and measures to improve traffic flow, main roads such as Sunnyholt Road are being upgraded by the RTA. The RTA's operational strategy for Sunnyholt Road is to:

- provide a high standard link between urban centres.
- develop and implement a safety strategy for the road.
- promote safe travel by providing continuity of standard along the road.
- adopt measures to reduce accident potential and improve traffic flow.

The result including the proposal would be improved safety, amenity and access for travellers, pedestrians and cyclists; and a higher level of service, traffic flow and capacity for future growth along Sunnyholt Road.

The RTA's strategy for upgrading Sunnyholt Road is consistent with the various strategies developed under the NSW whole of government approach as outlined below.

Cities for the 21st Century, 1995, Department of Urban Affairs and Planning.
The Department's strategy is to integrate the transport infrastructure with land use to improve access to jobs, housing, and services, thus creating more compact cities. The main principles of their strategy involve:

- minimising travel demand,
- promoting efficiency and equity,
- containing linear expansion along transport corridors, and
- relating areas of job concentration to transport infrastructure.

Integrated Transport Strategy, Department of Transport, 1995.
The Integrated Transport Strategy supports *Cities for the 21st Century* and is based on three inter-related components:

- refocussing urban management,
- concentration of residential development in established and new areas, including increased densities in highly accessible areas, and
- concentration of employment activity also in areas of high accessibility, such as along major public transport corridors.

Action for Transport 2010 - An Integrated Transport Plan for NSW, 1999, Department of Transport.
This plan provides a long-term vision for meeting the land based transport needs of NSW and contains a construction program for the expansion of the rail and bus network and major roads.

Action for Transport 2010 - An Integrated Transport Plan for Sydney, 1999, Department of Transport. This document includes a 10 point action plan for Sydney:

- Getting the best out of the Sydney system.
- Improving Sydney's air quality.
- Reducing car dependency.
- Meeting the needs of our growing suburbs.
- Getting more people on public transport.
- Safeguarding our environment.
- Making space for cyclists and walkers.
- Preventing accidents and saving lives.
- Making freight more competitive.
- Giving the community value for money.

The companion document *Action for Bikes - Bike Plan 2010* makes provision for bicycles in all new major road infrastructure projects with a strong preference for off-road cycling. Another companion document *Road Safety 2010* sets out how the road toll will be halved. The NSW Government's air quality management plan *Action for Air* links public transport options with improved air quality in the greater metropolitan region. The plan highlights transport infrastructure initiatives which will reduce growth in the total vehicle kilometres travelled in the greater metropolitan region.

5.2 Planning and Environmental Background

The RTA's February 1995 *Roadside Environment Strategic Plan* forms part of the commitment expressed in the RTA's Environmental Vision being *a roads and traffic system in harmony with the natural and social environment, while meeting community mobility needs.* In addition the Roadside Environment Policy states *in partnership with local government, other agencies and the community, the RTA will work to improve the management and enhancement of the roadside environment.*

The *Roadside Environment Strategic Plan* has a number of ecological, social and economic functions, environmental factors and environmental management components that would apply to the proposal including:

- maintain the primary economic role of the road as a transport link.
- establishment and maintenance of indigenous vegetation.
- controlling weeds in the road corridor.
- soil conservation during planning, construction and maintenance.
- to protect watercourses and their associated habitats.
- recognising scenic values in roadside corridor management and maintenance.
- consideration of safety issues and roadside corridor management.
- planning and design of roadside structures.
- development of appropriate land uses adjacent to the road corridor which complement roadside values.
- permit limited and appropriate commercial activities within the roadside corridor.
- need for community involvement.
- pollution control and management.
- to provide for public utility services.

5.3 Strategic Justification and Needs Definition

Sunnyholt Road serves local, commuter, business and freight traffic including heavy vehicles but does not meet current road capacity and safety standards. Queuing along Sunnyholt Road extends to the north of Sorrento Drive and south of James Cook Drive in peak periods mainly due to the two lane section that extends from near Malvern Road to near James Cook Drive. The Glenwood area is undergoing rapid residential development and will generate additional traffic along Sunnyholt Road. The development of the North-West sector will also increase traffic on Sunnyholt Road. When the WSO is opened in 2006 the interchange with Sunnyholt Road will also substantially increase traffic along Sunnyholt Road as traffic is drawn to the WSO from roads such as Old Windsor Road. Peak hour queuing of vehicles in Meurants Lane, Wilson Road and Malvern Road back from Sunnyholt Road is now common and drivers can only enter when vehicles on Sunnyholt Road allow them to enter. Road safety is also compromised as drivers take risks with turning movements. The two lane section of Sunnyholt Road is at capacity and inconsistent with the adjoining 4 lane sections of the road north and south of the proposal. Pedestrian and cyclist facilities are also sub-standard or non-existent.

Benefits derived from the proposal would be:

- facilitating economic growth in the area by improved traffic flow, safety and level of service for road based transport.
- reduced number of accidents.
- improved safety and amenity for pedestrians and cyclists by providing a footway and cycleway and incorporating separate facilities for their needs.
- provision of landscaping to enhance the amenity of residential areas.
- facilities to reduce pollutants in stormwater runoff from the road.
- a concept design that provides for future construction of a proposed transitway on the east side of Sunnyholt Road.

The reconstruction and widening of Sunnyholt Road would continue to play an important role in the main road network in serving the existing and future developments in the Glenwood area. The proposal is essential to meet the future transport needs of the surrounding residential areas as well as meeting the functions of a main road including an interchange with the WSO. The existing road does not meet these future local traffic needs and main road functions with the expected increases in traffic. In summary, the reconstruction and widening of Sunnyholt Road is essential to cater for future traffic volumes and road safety.

6. Concept Stage

6.1 Objectives

The objectives of the proposal are:

- improve network efficiency.
- improve inter regional transport costs by reducing delays and improving travel times.
- improve traffic flow.
- improve safety for all road users.
- improve local and through access by controlling or limiting access points.
- minimise adverse environmental impacts.
- seek community involvement during project development.
- minimise disturbances to the local community during construction.

The above objectives for the proposal are in accord with the RTA's strategy for the area and environmental policy which states *the RTA will demonstrate due diligence in the provision of its services and manage its work activities in a manner that is consistent with the principles of ecologically sustainable development.*

6.2 Options

There are a limited number of options for the arrangement and treatment of the road widening taking into account the constraints imposed by the existing alignment, adjacent improvements, the interchange with the WSO, provision for a proposed transitway in the concept design and the relatively narrow width of the existing road reserve (land acquisition is required). The proposed Blacktown to Castle Hill Transitway likely to be located on the eastern side of Sunnyholt Road has also imposed constraints. There has been recent residential development on the eastern side meaning that to avoid impacts on this development the upgraded Sunnyholt Road requires land acquisition on the relatively undeveloped western side. Initially the RTA proposed two through lanes in each direction but recent traffic modelling has indicated the need for three through lanes between Quakers Hill Parkway and James Cook Drive.

Given the need to resolve traffic delays, improve safety and cater for traffic growth expected along the road in future, the 'do nothing' or 'do minimum' option was not considered acceptable as it would not:

- provide capacity, efficiency and safety for expected increases in traffic volumes.
- be consistent with other upgraded sections of Sunnyholt Road.
- promote economic development.
- meet community expectations.

Alternative transport modes such as upgrading public transport systems considered in documents such as *Action for Transport 2010 - An Integrated Transport Plan for NSW* are beyond the scope of the REF. However, it is not practical to assume that traffic will not increase in future due to public transport improvements such as the proposed transitway along Sunnyholt Road.

6.3 Selection of the Proposal

A number of criteria were used for selection of the proposal including:

- consideration of the objectives for the area and proposal.
- minimising costs and maximising benefits.
- reducing potential environmental impacts wherever possible.
- providing route consistency (that is, a need for six lanes along Sunnyholt Road).
- where possible reducing any impact on utilities and property.
- improved operational performance by considering forecast traffic demands relevant to the reconstruction and widening arrangements within reasonable cost and services influences.

The reconstruction and widening proposal provides the most suitable and appropriate scheme for the treatment of the road. The provision of a six lane divided carriageway would be consistent with the other divided carriageway sections of Sunnyholt Road north and south of the proposal and provide for the increase in traffic associated with the WSO interchange. The proposal meets the immediate and recognised needs for the road while considering the economic and engineering constraints and can be generally constructed safely within a widened road reserve with some land acquisition.

The observed existing Level of Service[3] for travel along this section of Sunnyholt Road would improve, the Degree of Saturation[4] at intersections would reduce and average vehicle delay in seconds per vehicle would reduce with the proposal. The proposal would meet community and RTA objectives and can be justified on strategic, environmental, engineering and community grounds. In addition the proposal is in accord with some of the principles of ecologically sustainable development.

Having selected a feasible reconstruction and widening alignment and form there are also numerous alternatives available with regard to design elements such as materials, roadside furniture, finishes, noise attenuation measures and landscaping. These elements would be refined in the detailed design. The design elements to be selected would be compatible with and match materials in the surrounding roadside and urban environments.

6.4 Statutory Planning

6.4.1 Zoning and Special Provisions

[3] *In accordance with AUSTROADS 2 - Level of Service A is a condition of free flow with high speeds and low traffic volumes. Level of Service B is stable flow where drivers have reasonable freedom to select their speed. Level of Service C also has stable flow but most drivers have restricted freedom to select their speed, change lanes and overtake. Level of Service D approaches unstable flow with nearly all drivers restricted corresponding to tolerable capacity. Level of Service E is for traffic volumes at or near capacity with unstable flow and momentary stoppages. Level of Service F is forced flow operation at low speeds caused by demand exceeding capacity.*

[4] *Degree of Saturation is a measure of the operational performance of the reconstruction. For travel controlled by traffic signals both queue length and delay increase rapidly as the Degree of Saturation approaches 1 and it is usual to attempt to keep the value to less than 0.9 to prevent queues and delays.*

Sunnyholt Road and the WSO are zoned 5(b) (Special Uses - Arterial Road and Arterial Road Widening Zone) under the provisions of *Blacktown Local Environmental Plan 1988*. The objective of the 5(b) zone is to identify land required for existing or proposed arterial roads, including the widening of existing arterial roads. Roads and public utility undertakings normally require development consent from Blacktown City Council in the Special Uses 5(b) zone.

Quakers Hill Parkway is zoned 5(c) (Special Uses - Local Road and Local Road Widening Zone) under the provisions of *Blacktown Local Environmental Plan 1988*. The objective of the 5(c) zone is to identify land required for existing or proposed local roads, including the widening of existing local roads. Roads and public utility undertakings normally require development consent from Blacktown City Council in the Special Uses 5(c) zone.

The *Blacktown Local Environmental Plan 1988* also shows proposed road closures (or proposed open space) at the intersection of Sunnyholt Road with Wilson Road and Meurants Lane. However, Blacktown City Council has resolved to keep both of these roads open.

Most of the abutting areas (including the local roads of James Cook Drive, Meurants Lane, Wilson Road and Malvern Road) along both sides of Sunnyholt Road are zoned 2(a) (Residential "A") under the provisions of *Blacktown Local Environmental Plan 1988*. The objectives of the 2(a) zone include, inter alia, to make general provisions to set aside land to be used for the purpose of housing (predominantly single dwelling character) and associated facilities. Roads normally require development consent from Blacktown City Council in the 2(a) (Residential "A") zone. The retirement village located on the south-east corner of the Sunnyholt Road intersection with James Cook Drive is zoned 5(a) (Special Uses - Homes for the Aged) under the provisions of *Blacktown Local Environmental Plan 1988*.

In addition, Blacktown City Council has a Tree Preservation Order under the provisions of *Blacktown Local Environmental Plan 1988*. Section 88 of the *Roads Act, 1993* allows the RTA to remove overhanging trees from the road reserve for the purpose of carrying out road works.

6.4.2 State and Regional Environmental Planning Policies

The provisions of clause 11C of State Environmental Planning Policy No.4 *Development Without Consent and Miscellaneous Complying Development* enables the RTA (or their authority such as the successful consortium) to construct any components of the proposal that are outside the road reserve without the need for development consent (except for example, heritage items, heritage conservation areas, coastal wetlands and littoral rainforests) from Blacktown City Council. There are no other provisions of any other State or Regional Environmental Planning Policies that directly apply to the proposal.

As development consent is not required for the proposal this REF has been prepared to meet the requirements of Section 111 of the *Environmental Planning and Assessment Act, 1979.*

6.4.3 Legislation

The requirements of the following Commonwealth (*) and NSW legislation and associated regulations are relevant to the proposal and would be complied with.

Environment Protection and Biodiversity Conservation Act, 1999 *
Contaminated Land Management Act, 1997
Dangerous Goods Act, 1975
Environmental Planning and Assessment Act, 1979
Environmentally Hazardous Chemicals Act, 1985
Fire Brigades Act, 1989
Heritage Act, 1977
Land Acquisition (Just Terms Compensation Act), 1991
Local Government Act, 1993
National Parks and Wildlife Act, 1974
Native Title Act, 1993 *
Noxious Weeds Act, 1993
Protection of the Environment Operations Act, 1997
Roads Act, 1993
Soil Conservation Act, 1938
Threatened Species Conservation Act, 1995
Waste Avoidance and Resource Recovery Act, 2001
Water Management Act, 2000 (when enacted for public authorities).

7. Detailed Assessment Stage

7.1 Design Considerations

7.1.1 Existing Road

Sunnyholt Road between north of James Cook Drive and south of Quakers Hill Parkway (near Malvern Road) is generally a two lane undivided road (with shoulders in relatively poor condition) and traversing undulating topography. The southern section of this length either side of James Cook Drive is a dual carriageway (two lanes each way) road separated by a low grassed median. The northern section of this length either side of Quakers Hill Parkway is also a dual carriageway road with a low grassed and concrete median.

The road pavement is dense grade asphalt and a 60 km/hour speed limit applies to most of the length of the road until it changes to a 70 km/hour in the existing four lane sections at the northern and southern ends. The road has a good horizontal (relatively straight) alignment and adequate sight distance. There is a crest near Meurants Lane.

Traffic control devices along Sunnyholt Road include traffic signals and pedestrian crossings at the intersection with James Cook Drive and Quakers Hill Parkway. The other intersections with Meurants Lane, Wilson Road and Malvern Road are unsignalised. Overtaking is not permitted along sections of the road. *No Standing* and *No Parking* restrictions apply along most of the road. A guard fence has been provided along the east side of the road opposite Wilson Road. The road is a controlled access road with no direct access from abutting residential properties except for a few older dwellings located on large lots located in the mid-section of the road. Right turns except for buses are banned from 6 am to 10 am and 3 pm to 7 pm, Monday to Friday from Meurants Lane into Sunnyholt Road.

Bus routes operate along Sunnyholt Road and adjacent roads (Wilson Road and Quakers Hill Parkway). There are bus stops provided on both sides of the road in the mid-section and bus shelters located at the north and south ends. Pedestrian and pedal cyclist facilities are sub-standard and the roadside shoulder presently serves their needs except in the four lane north and south sections of the road where pedestrian footpaths are provided. A small dedicated cycleway lane is also provided approaching Quakers Hill Parkway. Mature vegetation generally lines both sides of the road at the south end. Recent native species landscaping has been provided around the Quakers Hill Parkway intersection. Surface drainage is into gutters and roadside drains at the north and south ends of the road for discharge to the local drainage system and waterways. However the majority of the road drains into the roadside grassed verge and low points along the road and via culverts under the road.

7.1.2 Existing and Forecast Traffic

In 1999 traffic volumes on an average annual daily basis along Sunnyholt Road (traffic in both directions) was 35,870 vehicles (at a location north of James Cook Drive). Traffic volumes along Sunnyholt Road are anticipated to have large growth, especially north of the WSO with opening of the WSO and nearby interchange, in 2006 and 2016 as shown in Table 1.

Table 1 Forecast Traffic Volumes on Sunnyholt Road in 2006 and 2016

Section of Road	Annual Average Daily Traffic (all vehicles)			Proportion Heavy Vehicles
	2006 without WSO	2006 with WSO	2016 with WSO	
Sunnyholt Road south of Quakers Hill Parkway	41,000	53,900	62,000	10%
Sunnyholt Road north of Quakers Hill Parkway	33,700	29,800	40,900	13%
Quakers Hill Parkway west of Sunnyholt Road	41,300	29,800	36,400	10%
Sunnyholt Road between James Cook Drive and Madagascar Drive	40,100	38,400	44,400	13%

A relatively high percentage of heavy vehicles are forecast along Sunnyholt Road due to freight movements between the Blacktown industrial area to the south, the WSO interchange and other main roads in the region.

Between the WSO interchange and Quakers Hill Parkway the southbound morning peak hour traffic volume in 2006 (assumed opening of the WSO) is expected to be around 2530 vehicles per hour. This traffic volume assumes the WSO is opened and would be about 300 vehicles per hour higher than the pre-opening traffic volumes. The northbound evening peak hour traffic volume is expected to be approaching 3000 vehicles per hour. Again this traffic volume assumes the WSO is opened and would be about 200 vehicles per hour higher than the pre-opening traffic volumes. At least two through lanes in each direction would be required to cater for these demands, although conditions into the future (say 10 years after opening of the WSO) need to be examined.

Between the WSO interchange and Quakers Hill Parkway the southbound morning peak hour traffic volume in 2016 is expected to approach 3100 vehicles per hour. The northbound evening peak hour traffic volume is expected to approach 3600 vehicles per hour. Three through lanes in each direction have been proposed to cater for these demands.

The Level of Service at the major intersections of Sunnyholt Road/Quakers Hill Parkway, the Sunnyholt Road/WSO interchange and Sunnyholt Road/James Cook Drive during peak hours in 2016 is expected to be acceptable although there would be some congestion (Level of Service D to E). Turn bay lengths have been determined to ensure adequate storage of vehicles.

Traffic patterns are expected to change when the WSO is built. The large number of vehicles turning left out of Quakers Hill Parkway would reduce but the right turn is

expected to increase as traffic heads towards the WSO interchange. Right turn traffic volumes out of James Cook Drive would be much higher than left turns for the same reason.

The treatment of the existing non-signalised intersections at Malvern Road, Wilson Road and Meurants Lane has been carefully considered by the RTA with regard to turning movements, traffic safety (particularly for crossing the proposed transitway) and efficiency. Buses only would be able to turn right out of Wilson Road and Malvern Road and with full access to Meurants Lane. More detail on the justification for restricting non-bus vehicle access for these roads is provided in Appendix 2.

There is some pedestrian and pedal cyclist activity along Sunnyholt Road at the north end and south end where facilities are provided. Pedestrian and pedal cyclist activity is anticipated to increase with the provision of suitable facilities with the proposal.

7.1.3 Design Parameters

The design criteria for the proposal are a design speed of 80 km/hour, a maximum grade of 5%, 3.25 metres minimum width for travel lanes, 5 metres minimum width for the shared bicycle and pedestrian path and 3.5 metres minimum width for the pedestrian footway. A speed limit of 70 km/hour would apply along the road. All RTA road design criteria would be meet for the proposal. The design criteria would ensure adequate capacity and safety for all vehicles, pedestrians and cyclists. The proposal would be designed in accordance with RTA criteria, other specifications including requirements of this document and:

- Roads and Traffic Authority Road Design Guide
- AUSTROADS Guides
- Australian Rainfall and Run-off 1987
- Roads and Traffic Authority Environment Manual
- Australian Standard 1742.3 (for traffic management).

The existing relatively narrow road reserve and the high density of utilities and services using it present constraints to the road design and construction. Other constraints include the need to tie in with the existing road while completing the upgrade generally under traffic. Some utilities including electricity, water, telecommunications and gas services and lines would need adjustment, relocation and/or being put underground. Land acquisition would be required for the proposal. The capacity of the widening works would be sufficient to meet expected traffic growth for the next 20 years including heavy vehicle loadings.

The detailed design would provide for:

- economy in construction costs.
- geometric design including horizontal and vertical alignment.
- balanced earthworks where possible with some import of selected fill.
- structural adequacy.
- pavement, pavement area, materials and wearing surface.
- line marking, sign posting, sign structures and lighting.
- adjustments to location of utilities as required.
- landscaping of exposed earthworks areas.
- implementation of safeguards specified in a Construction Environmental Management Plan[5] as required for the WSO.

7.1.4 Construction Activities

If approval were given to the proposal and following completion of detailed design construction would be undertaken between 2002 and 2007 probably in several stages as described earlier.

Any temporary construction compound(s) required for the proposal would be located within the WSO road reserve to the east and west. The compound(s) would be security fenced and include amenities sheds, portable toilets, plant and equipment storage areas, bunded areas for storage of petroleum, distillate and other chemicals to comply with Environment Protection Authority (EPA) and WorkCover Authority requirements. Any material stockpiles would be located within the WSO road reserve and be protected from possible erosion. If the successful consortium required any temporary construction compound(s) or material stockpiles to be located outside the WSO road reserve then they would be subject to a separate environmental impact assessment.

Construction hours would generally be from 7 am to 6 pm Monday to Friday and 7 am to 1 pm on Saturdays. From 7 am to 8 am on Saturdays only work inaudible at residential premises would be allowed. Work would not be permitted on Sundays and public holidays unless authorised by the RTA and EPA where required. However, night work would be necessary for a few nights for some activities such as laying asphalt to minimise inconvenience to road users at peak travel times. Any night work would follow the procedures outlined in the RTA's *Environmental Noise Management Manual* and endorsed by the EPA with regard to night-time road works noise.

[5] *A Construction Environmental Management Plan is a document prepared to ensure that all environmental requirements of a project arising from environmental impact assessments considered by the Review of Environmental Factors and RTA Decision Report, RTA policies and all relevant legislative requirements are implemented during development of the project.*

Construction equipment expected to be used on-site includes the following mobile plant and equipment as required.

- front end loaders
- excavation plant
- back hoes
- trenching machines
- chain saws
- jack hammers
- dump trucks
- bulldozers
- graders
- vibrating rollers
- concrete agitator trucks
- concrete and asphaltic paving machines
- water tankers
- road sweeper
- line marking vehicles
- trucks delivering construction materials
- low loader transporters
- light commercial and passenger vehicles.

Construction would follow normal road works procedures including the following general sequence of activities:

- acquisition of land required for the proposal.
- installation of temporary erosion, sedimentation and drainage controls.
- removal of vegetation for recycling.
- relocation and/or adjustment of all affected utilities, services and signage to suit construction programme requirements.
- drainage lines excavated by backhoe or excavator.
- topsoil stripped and stockpiled on-site by bulldozers, graders, loaders and trucks.
- surface preparation by graders.
- recycling of suitable excavated material and incorporation of unsuitable material in earthworks within the road reserve.
- import of select material for earthworks for the reconstruction.
- compaction by rollers and vibrating compactors with trimming by graders.
- batched concrete and asphalt placed on-site by pavers, autograde machines and graders and compacted by rollers.
- application of asphaltic concrete wearing surface by pavers and rollers.
- installation of noise attenuation measures as required.
- landscaping of exposed earthworks areas.
- installation of line marking, lighting, sign structures and sign posting.
- site clean up and disposal of all surplus waste materials.
- commissioning.

Construction would conform to Quality Assurance in accordance with AS/NZS ISO 9001-1994 and RTA specification Part Q *Quality System Requirements*. The safeguards in this REF would be implemented by the successful consortium throughout the sequence of activities described above.

No blasting or on-site batching of concrete or asphaltic concrete would be permitted. The construction site would be maintained in a clean and tidy state at all times. Construction equipment would be maintained to meet EPA requirements. No vehicle maintenance would be permitted outside the construction compound(s) except in emergencies. Cleaning out of batched concrete mixing plant would only be permitted in designated areas or off-site at approved facilities.

Construction would be carried out under traffic. Professional and diligent traffic management would be required to construct the proposal and avoid disruption to traffic. Two lanes on Sunnyholt Road would be generally available for traffic at all times. Traffic arrangements would be subject to RTA approval. Disruption of access to properties would be minimised and prior arrangement would be made with affected owners in the event of any short term disruption.

7.1.5 Waste Management

The RTA is committed to ensuring the responsible environmental management of waste that cannot be avoided and to providing opportunities for promoting the reuse of waste through appropriate measures. In undertaking this commitment the RTA is following the resource management hierarchy principles embodied in the *Waste Avoidance and Resource Recovery Act, 2001* which are:

- avoid unnecessary resource consumption as a priority.
- avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling and energy recovery).
- disposal is taken as a last resort. Any surplus waste material would be disposed of in a legal manner.

The proposal would generate moderate amounts of waste materials as follows:

- inert waste including virgin excavated natural material such as soil, rock, vegetation, asphalt, building and demolition waste.
- solid waste including litter and food waste.
- liquid waste including sewage and other waste water.

No waste would be buried or burnt on-site. For each type of solid and liquid waste the anticipated quantities likely to be generated would be estimated at the detailed design stage with actions for avoidance, resource recovery and disposal following the resource management hierarchy principles. For the proposal resource use would be avoided by the ordering of materials in sufficient but not excessive quantities for the road works. Suppliers of construction materials would be required to reduce unnecessary packaging or to use durable reusable packaging. Materials would be reused wherever possible including recycling of road asphalt, reuse of spoil material and topsoil generated by on-site works. Where reuse is not possible waste would be minimised through separating waste streams on-site before transport to recycling facilities. Where feasible suitable waste would be recycled in accordance with the RTA's EPA approved *Waste Reduction and Purchasing Plan*. As a last resort waste materials would be disposed of at legally operating disposal facilities.

Construction works would include minor clearing of introduced and native vegetation from the road reserve and areas of land acquisition. The number of trees to be removed

would be the minimum necessary for the safe excavation and construction operations. Any suitable vegetation would be reused either as mulch (minimising the spread of weeds) or for erosion and sediment control measures as a first priority, provided to community groups as firewood and/or disposed of at a legally operating recycling facility. The native vegetation, leaf litter and soil cleared for the construction works would be reused in the landscaping of the disturbed areas. Any exotic vegetation that cannot be mulched or noxious weeds would be disposed of at a legally operating waste disposal site.

Any excavated or excess pavement material and concrete would be incorporated in the earthworks for the reconstruction as a first priority or transported off-site for recycling. If any contaminated material was encountered it would be managed and disposed of in accordance with the guidelines developed by the EPA. The workforce would use a portable toilet facility located within the construction compound(s). The above requirements would be documented in the Construction Environmental Management Plan for the WSO as a separate component.

7.1.6 Demand Upon Resources

In addition to labour, plant, equipment and energy inputs the proposal would require concrete, steel, select fill material (crushed sandstone) and asphaltic concrete. Any prefabricated construction components, metalwork and signs required would be transported to the site. The off-site batched concrete and asphaltic concrete would be sourced from commercial outlets in or near Blacktown or facilities associated with construction of the WSO. Import of these resources would mainly involve a number of heavy vehicle loads to be transported along Sunnyholt Road and/or the WSO corridor with minimal impact. The fill would be sourced from legally operating quarries located in the western Sydney metropolitan area. Actual quantities and number of loads may vary depending on the final design. The proposal would not affect any resources in short supply. In addition, some areas of pavement within the works would be milled and re-sheeted to conserve resources rather use of new pavement.

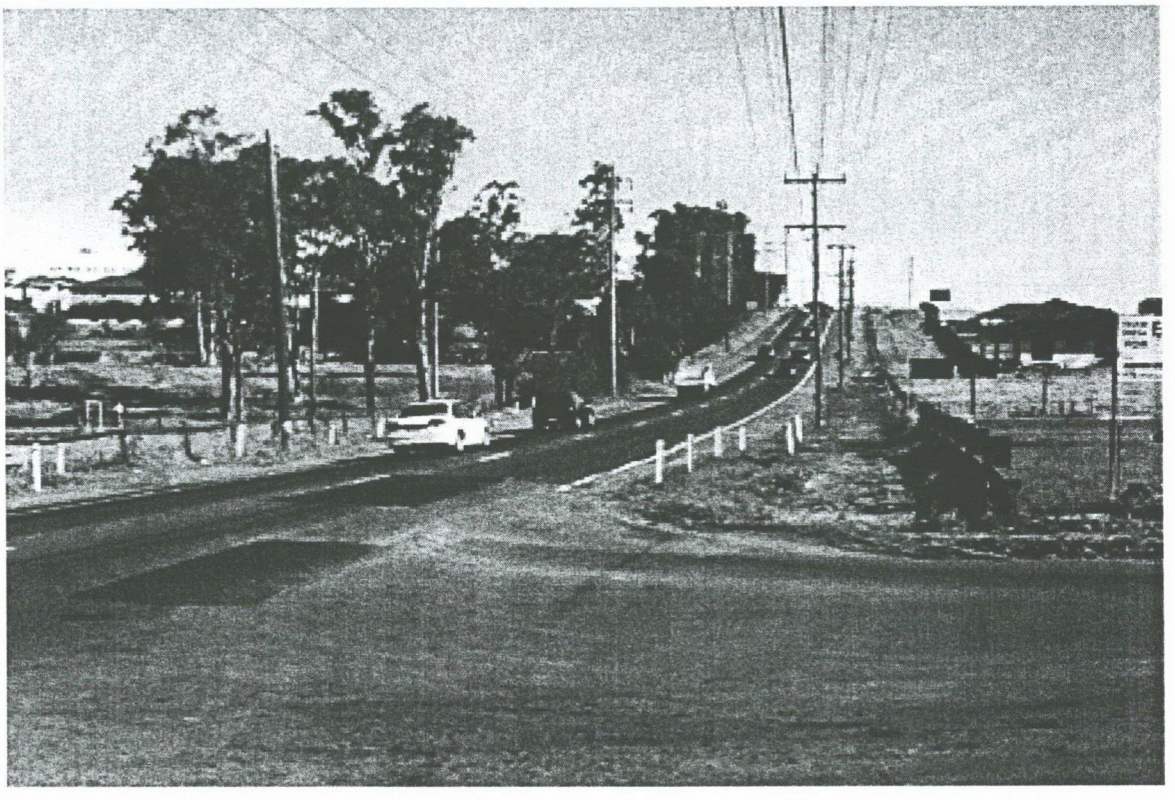
7.2 Description of Site and Surroundings

Photographs 1 to 4 show the road widening area with views north and south along Sunnyholt Road. The area around Sunnyholt Road is undergoing rapid development from rural to residential land uses. Most of the existing development along the road is low density housing comprised of single storey detached dwellings either as older style housing on larger lots or newer housing (including many dwellings under construction) on smaller lots within modern estates all interspersed with areas of vacant land. The southern end of the road south of the WSO corridor has more established housing on both sides.

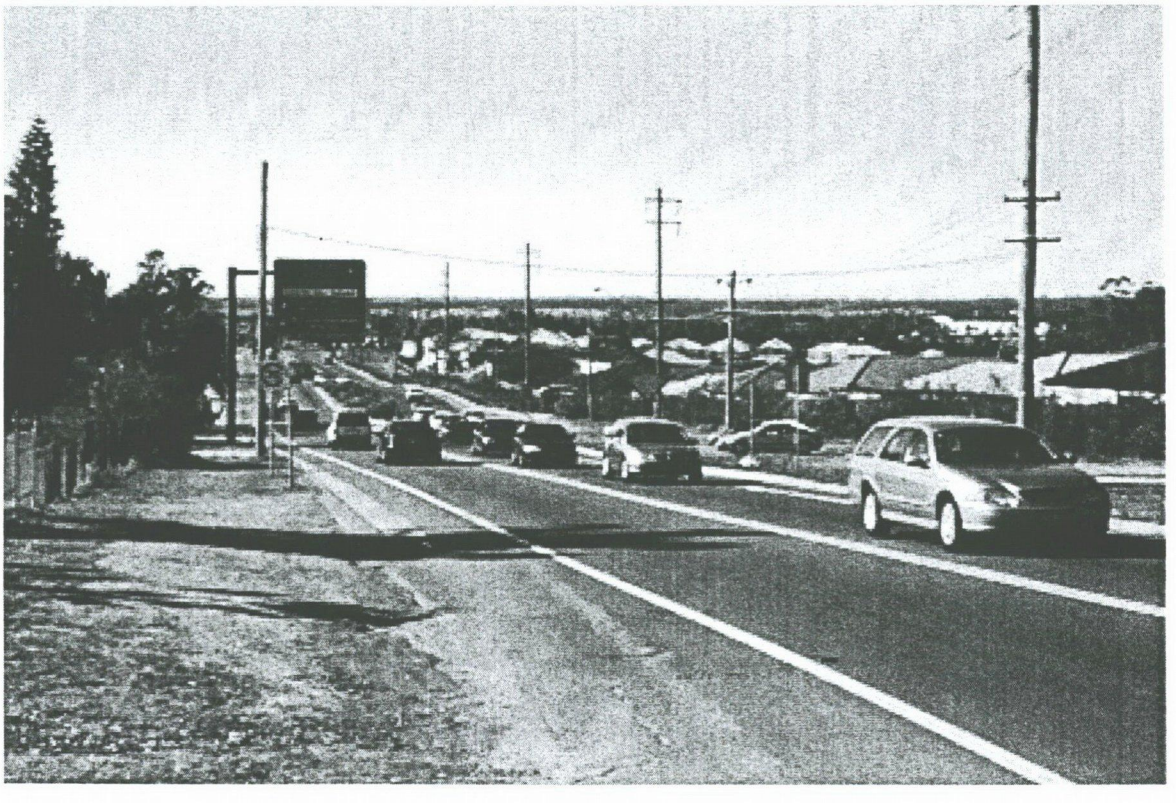
Photograph 1 Sunnyholt Road Southbound Towards James Cook Drive

Photograph 2 Sunnyholt Road Northbound from WSO Corridor

Photograph 3 Sunnyholt Road Southbound From Wilson Road Towards WSO Corridor



Photograph 4 Sunnyholt Road Northbound Towards Quakers Hill Parkway



A retirement village and nursing home with 63 dwelling units is located on the south-east corner of the Sunnyholt Road intersection with James Cook Drive. New housing estates with no access to Sunnyholt Road and protected by 1.8 metre high noise walls are being established in the mid-sections of the road. Large tracts of vacant land, appropriately zoned for residential development and ready for subdivision, occupy both sides of the mid-section of the road. The vacant and partially vegetated land of the WSO corridor occupies the main crest along the road. The dominant visual features in the area are the undulating topography and two large above ground water Marayong reservoirs located north of the WSO about 1 km west of the road. Most of the vegetation in the area is introduced grasses with isolated native trees and a strip of woodland fronting Ali Place. Minor commercial development along the road near the northern end includes an egg farm and a sand and soil supply outlet. The road area around the intersection with Quakers Hill Parkway has been landscaped in the road reserve.

The existing road reserve is variable in width but generally 20 metres wide and mainly occupied by the existing road pavement area. Some illegal activities including the display of motor vehicles for sale and portable signage take place within the road reserve. Like most major roads the road has a number of utilities in the road reserve and is partially lit with standard lighting poles on both sides. The noise environment is dominated by traffic noise from the road. There has been a high degree of physical and probably some chemical disturbance along this section of the road and adjacent road reserve. Chemical disturbance is likely to have included herbicides and pesticides from weed and pest control, hydrocarbons and heavy metals from road runoff.

7.3 Environmental Impacts

In association with the following Section 7.3 describing the environmental impacts of the proposal, the safeguards to reduce any adverse impacts and to be implemented by the RTA and successful consortium, have been listed in Section 8 of this REF.

7.3.1 Landforms

The topography of the road is relatively moderate (undulating between 68 metres and 88 metres elevation AHD) along the 1.56 km length of the proposal and encompassing a rise of approximately 20 metres between James Cook Drive and a crest at Meurants Lane. Travelling north the road then dips near Wilson Road and then rises again to a minor crest between Wilson Road and Malvern Road. Between Malvern Road and north of the Quakers Hill Parkway the road gradually dips downhill. Existing slopes along the road are generally less than 5% and these grades would be generally maintained with the proposal.

Minor changes to property frontages and levels to enable vehicular access on both sides of the road to maintain existing accesses would also be completed during construction. Where required, roadside cut and fill batters would be relatively steep with a slope of 2 horizontal to 1 vertical. Retaining walls constructed of brick and sandstone up to 1.8 metres high and 190 metres long would also be required at some roadside locations along the southern section of the proposal.

Due to the proposal following the existing relatively moderate relief and slopes there would be potential adverse environmental impacts with landform such as erosion during construction requiring appropriate safeguards to be implemented. These safeguards

include the protection of earthworks during the widening and landscaping of exposed earthworks areas to avoid erosion and consequent changes to landform.

7.3.2 Geology and Soils

The southern portion of the proposal from around James Cook Drive to just north of Meurants Lane is located within the Luddenham soil landscape grouping on Wianamatta Group shales. This soil landscape has shallow podzolic soils or massive earthy clays with high soil erosion hazard and impermeable, highly plastic and moderately reactive subsoil.

The northern portion of the proposal north of Meurants Lane is located within the Blacktown soil landscape group on Wianamatta Group shales. This soil landscape has shallow to moderately deep podzolic soils, moderately reactive highly plastic subsoil, low fertility and poor drainage.

The soil conditions within the area of the proposal would require erosion and sedimentation control safeguards during construction. There are no known acid sulphate soils, contaminated soils or commercial mineral deposits within the area of the proposal or road reserve.

7.3.3 Climate

Climatic factors would not constrain construction of the proposal except during adverse weather conditions such as heavy rain or very high winds. Heavy and prolonged rainfall in the area would not affect the widening provided appropriate safeguards to avoid erosion and sedimentation were installed around any excavated or exposed earthworks areas. The proposal would be in the same location as the existing road, the operations of which are not constrained by climatic factors. It is unlikely climatic factors would impact on operations of the proposal provided motorists and other users of the road took due care during adverse weather conditions.

7.3.4 Land Form Stability and Erosion Hazard

Components of the physical environment include a combination of relatively moderate landform and slopes, high erosion hazard soils, highly plastic and moderately reactive subsoil and possible adverse weather conditions leading to potential soil erosion during construction of the proposal. In addition, approximately 3 hectares of road reserve and property acquisition area would need clearing and grubbing. These conditions would require installation of a number of safeguards during construction including selected temporary sedimentation controls such as catch drains, diversion drains and banks, sedimentation basins, geofabric silt fences at the base of all earth works, geofabric covered hay or straw bales or sand bags secured around all storm water inlets and soil stabilisation measures along the construction areas to be documented in an Erosion and Sediment Control Plan. The controls to prevent potential soil erosion and impacts on local watercourses and waterways within Caddies Creek catchment would include the following:

- provision of silt fences and barriers to prevent sediment laden runoff from leaving the construction area;
- drainage structures to protect exposed embankment slopes during construction;
- progressive landscaping for all exposed earthworks areas not required for the proposal;

- prevention of erosion on any topsoil stockpiles;
- provision of catch drains or cut-off drains to prevent clean surface runoff entering the construction areas;
- provision of sediment traps at existing catch drains along Sunnyholt Drive for the construction period;
- the provision of scour protection measures at drain outlets.

During construction of the road works the Erosion and Sediment Control Plan would be implemented referencing the Construction Environmental Management Plan for the WSO. The sedimentation controls would need to be maintained in a functioning condition until all construction activities were completed over the construction period and the site was stabilised. Regular monitoring and maintenance of the sedimentation controls would be required to ensure they perform in a fully functioning condition at all times.

Installation of the selected sedimentation controls and landscaping of exposed earthworks areas would minimise adverse impacts both during construction and operations of the proposal. The moderate climate and lengthy growing season in the area would enhance the growth of landscaped areas over time.

7.3.5 Air Quality

An air quality impact assessment for the proposal was carried out by Holmes Air Sciences in November 2002. The results of the impact assessment are summarised below and the full report with more detail is provided in Appendix 3.

Air Quality During Construction

During the widening of Sunnyholt Road, temporary impacts on air quality may arise from:

- generation of dust by earthmoving activities, demolition and exposed areas.
- emissions (primarily diesel exhaust) from earthmoving machinery.
- emissions from construction traffic.

The phases of construction that would have an impact on air quality are:

- pre-construction activities - establishment of site compounds, clearing and preparation of work areas.
- construction of project works - this will involve cut and fill earthwork activities.

The construction contractor would be required to mitigate dust and exhaust emissions during construction. Control measures would include:

- watering of haul roads and unsealed access roads.
- watering of earthworks operations where appropriate.
- covering all loaded trucks with a tarpaulin.
- revegetating and stabilising disturbed areas immediately after the completion of earthworks.

An increase in background dust deposition levels of 2 g/m^2/month could occur before there was a perceptible degradation in air quality. Exhaust emissions from construction

equipment are not likely to be a significant issue as the equipment would be largely spread out and not operating at all hours.

Air Quality During Operations

The assessment of the impacts of motor vehicle emissions is based on the use of a computer model to determine the dispersion of emissions and to predict ground-level concentrations of the various exhaust components in the area close to the road. The primary pollutants of concern are carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter. Since the introduction of unleaded petrol, there has been a steady and unambiguous decline in lead air levels in Australian cities. The new National Standard for Fuel Quality has resulted in a ban on the supply of leaded petrol containing more the 0.005 grams/litre of lead from 1 January 2002. Lead levels in urban areas, without other local sources of lead, will therefore continue to decline. Lead has therefore not been considered in this assessment.

Table 2 over lists the EPA's air quality goals for New South Wales including the historical goals and newly adopted goals. Not all of these are major emissions from motor vehicles. Also included are goals for air toxics and odorous compounds which are minor emissions from motor vehicles. These goals are drawn from WHO, the United Kingdom and the Victorian EPA. The goals that have been applied in assessing the proposal are shown in bold print. The results of the air quality assessment undertaken for the proposal concluded that:

- Due to the present emission controls on motor vehicles and the projected traffic conditions for the years 2006 and 2016, the EPA's carbon monoxide 1-hour or 8-hour goals are not expected to be exceeded for any section of the proposed widening of Sunnyholt Road.
- The predicted changes in concentration of nitrogen dioxide indicate that the National Environment Protection Measure 1-hour goal would not be exceeded along Sunnyholt Road.
- Predicted concentrations of benzene (and other pollutants) are not at levels which, from current understanding, should pose health effects.
- The PM_{10} short-term goal of 50 $\mu g/m^3$ is not expected to be exceeded along Sunnyholt Road.

Table 2 Air Quality Goals

Pollutant	Goal	Averaging Period	Agency
Carbon monoxide	87 ppm or 108 mg/m^3 **25 ppm or 30 mg/m^3** **9 ppm or 10 mg/m^3**	15-minute maximum **1-hour maximum** **8-hour maximum**	WHO **WHO** **NHMRC, NEPM**
Nitrogen dioxide	0.16 ppm or 320 µg/m^3 0.05 ppm or 103 µg/m^3 **0.12 ppm or 246 µg/m^3** 0.03 ppm or 60 µg/m^3	1-hour maximum Annual mean **1-hour maximum** Annual Mean	NHMRC* US EPA* **NEPM** NEPM
Total suspended Particulate matter (TSP)	90 µg/m^3	Annual mean	NHMRC
Particulate matter < 10 µm (PM_{10})	150 µg/m^3 **50 µg/m^3** 50 µg/m^3 **30 µg/m^3**	24-hour maximum **24-hour maximum** Annual mean **Annual mean**	US EPA* **NEPM** US EPA* **NSW EPA**
Particulate Matter < 2.5 µm ($PM_{2.5}$)	25 µg/m^3 65 µg/m^3 25 µg/m^3	24-hour average 98th percentile averaged over three years 24-hour average	NEPM advisory reporting standard US EPA CARB proposal
	8 µg/m^3 15 µg/m^3 12 µg/m^3	Annual average Annual average Annual average	NEPM advisory reporting standard US EPA CARB
Lead	1.5 µg/m^3 0.5 µg/m^3	90-day average Annual average	NHMRC NEPM
Ozone	0.10 ppm or 200 µg/m^3 0.08 ppm or 150 µg/m^3	1-hour maximum 4-hour maximum	NHMRC, NEPM NEPM
Sulphur dioxide	0.25 ppm or 700 µg/m^3 0.20 ppm or 570 µg/m^3 0.08 ppm or 225 µg/m^3 0.02 ppm or 60 µg/m^3	10-minute maximum 1-hour maximum 1 day Annual average	NHMRC, NEPM NEPM NEPM NHMRC, NEPM
Air Toxics and Odorous Compounds: **Benzene** PAHs (as BaP) 1,3-Butadiene Acetaldehyde Formaldehyde	 **5 ppb or 16 µg/m^3** 8.7 x 10^{-5} per ng/m^3 0.45 ppm or 1 mg/m^3 0.042 ppm or 0.076 mg/m^3 0.033 ppm or 0.05 mg/m^3	 **Annual average** Unit risk factor 3-minute maximum 3-minute maximum 3-minute maximum	 **UK** WHO VEPA VEPA VEPA

**Historical goals*

ppm – parts per million.
µg/m^3 – micrograms per cubic metre.
mg/m^3 – milligrams per cubic metre.
ng/m^3 – nanograms per cubic metre.
PAH – polycyclic aromatic hydrocarbons.
BaP – benzoapyrene, the most widely studied PAH and used as an indicator compound.
Unit risk factor for benzoapyrene refers to the risk of developing cancer from a 70 year exposure to 1 ng/m^3 of benzoapyrene.

Greenhouse Issues

Australia is signatory to the *International Framework Convention on Climate Change* (Rio Convention), which commits Australia to programs of monitoring and reporting on greenhouse gas emissions. A target of the Rio Convention is that signatory countries should attempt to reduce greenhouse gas emissions to the levels that applied in 1990. At the recent Kyoto meeting the convention agreed that Australia would be allowed to reduce their emissions to 8% above the 1990 level, between 2008 and 2012.

The RTA is committed to ensuring that its environmental goals and policies are consistent with those outlined in the 1992 Intergovernmental Agreement on the Environment. This agreement addresses a number of globally important environmental issues including the greenhouse effect. This commitment is facilitated through the RTA's environmental vision which addresses greenhouse gas emissions and also energy consumption.

Approximately 14% of NSW's total carbon dioxide emissions are estimated to come from the transport sector. At a broad level, the RTA have been involved in and implemented several strategic initiatives to address the issue of road transport related greenhouse gas emissions as outlined below.

National Greenhouse Response Strategy

This strategy was adopted by the Council of Australian Governments in 1992 and aims to contribute to the national commitment to the National Strategy for Ecologically Sustainable Development. The RTA contributed to the development of this strategy and is the NSW representative on the Transport Working Group for the development of a greenhouse gas emissions inventory. With respect to transport, the response strategies include reducing fuel consumption in motorised transport; improving the technical and economic efficiency of operation of the road network and traffic management; and to encourage the use of bicycles. This proposal contributes to these initiatives.

RTA Greenhouse Reduction Plan

The RTA is implementing the State Government's Emissions Management Plan while developing its own Emissions Management Plan. Emissions of carbon dioxide from motor vehicles are directly proportional to fuel consumption. They cannot be reduced by emission control technologies except where they result in an improvement in fuel consumption. RTA programs which encourage better vehicle maintenance and hence better fuel economy will be beneficial.

The RTA also continues to engage in other strategies to encourage the tightening of vehicle emissions standards including the following.

- Enhancing the State's vehicle emissions enforcement resources.
- Continuing its role on the Motor Vehicle Environment Committee to encourage the early implementation of more stringent Australian Design Rules, including the revision of ADR 37/01 "Emission Control for Light Vehicles" and ADR70 "Exhaust Emission Control for Diesel Engined Vehicles". The new Australian Design Rules, 79/00 "Emissions Control for Light Vehicles" and 80/00 "Emissions Control for Heavy Vehicles" include for the first time, vehicles which operate on liquefied petroleum gas or natural gas. Combined with the new (1 January 2002) Fuel Standard (Petrol) Determination 2001 and the Fuel Standard (Diesel) Determination 2001 (which reduces the sulphur levels in road transport diesel fuel from the current level of 1300 parts per million to 500 parts per million by January 2003), these new Australian Design Rules will facilitate introduction of more advanced emission control technologies.
- Playing a key role in the development of the Diesel National Environment Protection Measure, which came into effect 29 June 2001. This set a framework for the management of emissions, enabled the development of regulations on diesel emissions testing standards, and facilitates the development and implementation of enforcement and alternative compliance strategies for vehicle emissions.

7.3.6 Hydrology and Water Quality

Stormwater drainage for the existing two lane mid-section of Sunnyholt Road is captured by vegetated roadside verges and culverts for eventual discharge into the tributaries of Caddies Creek. Stormwater drainage for the existing four lane sections of Sunnyholt Road at the northern and southern ends is captured by median inlets and kerb and gutters before discharge to the local waterways and tributaries within Caddies Creek catchment and eventually the Hawkesbury River.

The detailed drainage design for the widening would be calculated for a 1 in 5 year Average Recurrence Interval flood event. Flows would discharge into the kerbside gutters along the length of the proposal, median drainage inlets, sub-surface and cross road drainage to be installed under the road for continued discharge to local waterways. Following RTA and/or the successful consortium consultation with Blacktown City Council water quality devices and/or basins to reduce pollutants by trapping oil, removing litter and sediments in stormwater run-off from the road during operations would be installed before discharge to the local waterways. The final size, specifications and location of the sub-surface and cross road and drainage system would be determined during detailed design. Blacktown City Council would be responsible for maintaining the drainage system. A hazard spill containment detention basin able to accommodate 25,000 litres (for example, from a fuel tanker) would also be investigated at a location along the road to be determined during detailed design.

With the proposal there would be marginally increased stormwater flows as a result of more roadspace. The reconstructed drainage would not have any adverse impact except for a minor decrease in water quality due to increased leakages of fuel, lubricants, hydraulic fluids, coolants and particulate matter (tyre rubber, brake and clutch linings) being washed off as runoff from increased traffic flows in the future. The hydrology and water quality impacts would be similar for the existing situation and the proposal. The Erosion and Sediment Control Plan would address storm water quality controls and include the location of existing natural and constructed drainage channels in relation to the proposed work. By effectively controlling sedimentation, lead, zinc and copper as well as tyre rubber, dirt and other particles from storm water runoff, water quality in the receiving local waterways is not expected to be further affected by the proposal.

Aquatic ecosystems in local waterways are not expected to be adversely affected by the proposal. No water would be drawn from local waterways for construction purposes.

7.3.7 Flora and Fauna

A general flora and fauna habitat survey of the area around the proposal was carried out by AES Environmental Consultancy in July 2002. The results of the surveys and impact assessments are summarised below and the full report with more detail is provided in Appendix 4.

- Most of the route is either cleared of vegetation or is vegetated with pasture grasses, weeds or landscape plantings. The exception to this is on the east side of Sunnyholt Road north of Meurants Lane where there is a small remnant of Cumberland Plain Woodland.
- Cumberland Plain Woodland is listed as an endangered ecological community on both the *Threatened Species Conservation Act* and the *Environment Protection and Biodiversity Conservation Act*. Given the small amount of Cumberland Plain Woodland affected and its already modified nature, it considered that the proposed road widening would not have a significant effect on this endangered ecological community.
- No threatened flora species were recorded during the field survey. The Cumberland Plain Woodland within the route is considered to be too degraded to support any threatened flora species.
- No threatened fauna species were recorded during the field survey. Habitats within the route are considered to be too degraded to support any threatened fauna species.
- The proposed road widening is unlikely to have a significant effect on threatened species, populations or ecological communities, or their habitats. Therefore a Species Impact Statement is not required.
- The proposed development is unlikely to have a significant impact on a matter of national Environmental Significance (Cumberland Plain Woodland). Therefore, approval from the Federal Environment Minister is not required.

To mitigate against impacts on Cumberland Plain Woodland, the protection of retained trees within the road reserve and where appropriate, planting of locally occurring native plants species are recommended.

7.3.8 Visual and Landscape Considerations

Visual and landscape assessments and proposed treatment of the area around the proposal were completed by Jocelyn Ramsay and Associates Pty Ltd in October 2002. The results of the assessments and treatment are summarised below and more detail is provided in Appendix 5 including a landscape concept plan.

Visual Quality

The visual quality of the road can be classified as either low, medium or high quality as follows (these areas are also identified on the landscape assessment plan in Appendix 5). The area of highest visual quality is found on the eastern side of Sunnyholt Road within the road reserve for the WSO extending to Meurants Lane. Here there is remnant Cumberland Plain Woodland which is readily viewed by motorists passing over the crest at Meurants Lane.

There are two areas of medium visual quality being the areas generally associated with older subdivisions at the southern end and on both sides of Sunnyholt Road from Madagascar Place to the WSO road reserve corridor. This suburban area consists of

established residences in garden settings, with mature trees found intermittently on the current road verges. Underground power is provided from Madagascar Road to the last residence at the end of the Rota Place cul de sac. From here, overhead power lines are found along the remainder of the western side of Sunnyholt Road to Quakers Hill Parkway. Overhead power lines are found on the eastern side of Sunnyholt Road.

On the eastern side of Sunnyholt Road from Meurants Lane to Quakers Hill Parkway is a more recently subdivided residential area. In association with the subdivision, *Casuarinas* and *Eucalyptus* have been planted adjoining the fence line at the rear boundaries of the properties. These, in conjunction with the remnant mature Eucalypts and Cumberland Plain Woodland found in the current road verge, serve to partially screen the residential development from Sunnyholt Road and provide an attractive presentation to the streetscape for motorists although overhead power lines are present.

The areas of lowest visual quality are found on the western side of Sunnyholt Road from Quakers Hill Parkway to the WSO road reserve corridor. The general area is undergoing quite dramatic changes with rural activities adjoining extensive subdivision for new home construction. There is no remnant vegetation visible to contribute to the general presentation of the streetscape. The existing rural properties are not screened from the road and overhead power lines are present.

The high quality visual areas will be impacted by the removal of mature trees on the current road verges to allow for the construction of a possible transitway station and interchange on the eastern side of Sunnyholt Road. The construction of the WSO itself will have more impact with the removal of the existing remnant of Cumberland Plain Woodland.

The greatest impact of the proposal will be on the two medium visual quality residential areas including the southern end of Sunnyholt Road with the removal of the mature remnant Eucalypts found on the current road verges. The other area being the relatively new subdivisions on the east side of Sunnyholt Road between Meurants Lane and Quakers Hill Parkway have incorporated new plantings of *Casuarinas* and *Eucalyptus* along the boundary fence line. This will in time provide an effective visual screen between the widened Sunnyholt Road and adjoining residences. However the introduction of 3 metre high noise walls will be a noticeable element in the landscape.

In order to provide a new access road to the retirement village found at the intersection of James Cook Drive, further landscaped areas would be lost. These consist of rows of Jacarandas and mature Eucalypts which provide visual separation between the current Sunnyholt Road and the retirement village development. In addition, the widening of Sunnyholt Road will result in roadwork development in closer proximity to those residences fronting Flint Street.

Acquisition of property at Tagu Place and Rota Place on the western side of Sunnyholt Road will expose the properties behind to the visual and sound impacts of Sunnyholt Road. However, the acquired properties will provide the opportunity to establish landscape plantings to create a visual buffer to the residential development behind.

The low visual quality area along the western side of Sunnyholt Road from Quakers Hill Parkway to the WSO road reserve, will as a result of the road widening and the establishment of the new landscape plantings (also as a screen for the noise walls) be improved. However

some loss of access to the distant views will be experienced where the noise walls are installed.

Landscape Treatment

The landscape concept plan (provided in Appendix 5) nominates proposed landscape treatments associated with the roadworks and seeks to ameliorate the majority of the impacts of the proposal on those areas previously identified. Limiting factors are the presence of overhead power lines and the space available following acquisitions and the road widening which will affect the plant species selections. Opportunities exist to improve the overall presentation of the streetscape for both road users and residents on both sides of Sunnyholt Road from Quakers Hill Parkway to the WSO road reserve as shown in the landscape concept plan.

The greatest impacts of the proposal would be on the eastern side of Sunnyholt Road between the WSO road reserve and the Madagascar Drive intersection. Assuming the approval of the proposed transitway, it will be necessary to relocate the access road to the residences and retirement village. This would result in limited opportunities arising to replicate the present landscape elements and to provide a similar quality of landscape to that currently enjoyed by residents and motorists. It is recommended that owners of these properties be approached by the RTA to implement additional landscape works within the subject properties, thereby seeking to replace some of the landscape areas within the locality.

7.3.9 Socio-economic Considerations

The residents, workers and visitors to the residential and commercial areas near the proposal would be likely to experience some adverse impacts due to elevated levels of dust, noise, traffic generation and general disruption during construction. Sunnyholt Road travellers through the area and local residents would be involved in medium-term inconvenience to travel during the construction period(s) over 12 to 15 months. Some utilities would require relocation and/or adjustment during construction with possible minor inconvenience for nearby dwellings. There would be no property severance as a result of the proposal. During construction some short-term disruption to local access to dwellings with direct access to the road would be experienced by residents which would be minimised as far as possible. There would be no significant changes to existing land use apart from the conversion of some residential land to road space and road reserve. The community would be kept informed of the construction programme before and during the construction works.

Table 3 Proposed Property Acquisition

Location of Property to be Acquired	Lot and Deposited Plan Number	Ownership	Land Use	~ Area to be Acquired for Road
11 Tagu Place, Kings Park *	352/250071	Private	Residential	215
3 Rota Place, Kings Park *	400/252200	Private	Residential	140
4 Rota Place, Kings Park *	2/580740	Private	Residential	170
5 Rota Place, Kings Park *	401/252200	Private	Residential	175
6 Rota Place, Kings Park *	1/580740	Private	Residential	315
7 Rota Place, Kings Park *	402/252200	Private	Residential	190
9 Rota Place, Kings Park *	123/252086	Private	Residential	205
11 Rota Place, Kings Park *	124/252086	Private	Residential	200
13 Rota Place, Kings Park *	125/252086	Private	Residential	175
15 Rota Place, Kings Park *	126/252086	Private	Residential	80
Trevor Toms Drive, Acacia Gardens	7/1020810	Private	Residential	7
Trevor Toms Drive, Acacia Gardens	8/1020810	Private	Residential	21
Trevor Toms Drive, Acacia Gardens	9/1020810	Private	Residential	36
Trevor Toms Drive, Acacia Gardens	10/1020810	Private	Residential	47
Trevor Toms Drive, Acacia Gardens	11/1020810	Private	Residential	54
Trevor Toms Drive, Acacia Gardens	12/1020810	Private	Residential	54
Trevor Toms Drive, Acacia Gardens	13/1020810	Private	Residential	49
Trevor Toms Drive, Acacia Gardens	14/1020810	Private	Residential	34
424 Sunnyholt Road, Acacia Gardens	B/336760	Private	Farm	1220
430 Sunnyholt Road, Acacia Gardens	25/8050	Private	Residential	490
432 Sunnyholt Road, Acacia Gardens	B/350799	Private	Residential	135
438 Sunnyholt Road, Acacia Gardens	10/861198	Private	Residential	425
450 Sunnyholt Road, Acacia Gardens	23/8050	Private	Residential	1155
484 Sunnyholt Road, Acacia Gardens	14/861198	Private	Residential	495
560 Sunnyholt Road, Acacia Gardens	12/861198	Private	Residential	935
Sunnyholt Road (west side), Acacia Gardens	131/877287	Private	Residential	725
Sunnyholt Road (east side), Acacia Gardens	2/1014616	Private	Residential	~ 600
Total Area Required	**27 Properties**	**Private**	**Residential/ Farm**	**~ 8347 m^2**

**Total Acquisition* *Source: RTA*

Table 3 provides a listing of the 27 properties affected by the proposal, ownership, land use and approximate area to be acquired based on the concept design. Actual areas of acquisition may vary depending on detailed design and whether additional land is required for noise walls and stormwater treatment facilities. Land would be acquired in accordance with the RTA's Land Acquisitions Policy Statement. The RTA endeavours to purchase land by negotiation. The offer of compensation would be assessed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.

Approximately 8347 square metres of land would need to be acquired for the proposal from the 27 privately owned residential properties abutting the road. All the properties for acquisition are located on the west side of Sunnyholt Road except for Lot 2 DP 1014616 on the east side (additional land would be required from this property if the transitway was approved). All of the 10 residential properties located along Tagu Place and Rota Place, Kings Langley near the southern end of Sunnyholt Road on the west side would be totally acquired by the RTA for the proposal. The owners would be suitably compensated for the acquisition of their properties and any disruption in the form of a solatium. Any residual

land from the 10 total acquisition properties not required for the proposal would be sold off by the RTA for future residential development at a later date. Strip acquisition (maximum 3.5 metres wide) by the RTA would be required for the proposal from eight residential properties located along Trevor Toms Drive, Acacia Gardens north of the WSO on the west side of Sunnyholt Road. Additional strip acquisition (maximum 13 metres wide) by the RTA would be required for the proposal from seven residential properties and one farm property located on the west side of Sunnyholt Road between the WSO and just north of Quakers Hill Parkway.

For the strip acquisition properties the land required would represent a relatively small portion of the total property areas with no major impacts on the size or operations of the residual property. The viability of the existing residential and farm land uses should be maintained after the land acquisitions. Some property adjustments would also be required (in consultation with the land owners) such as changes in levels to accommodate vehicular access on Sunnyholt Road.

All land acquisition required on the east side of Sunnyholt Road would be as part of the proposed transitway and assessed in the environmental impact assessment for that proposal. However, the RTA can purchase the land prior to determination of the environmental impact assessment. This REF has assessed the impact on the land as it may be affected by staging of the proposed widening of Sunnyholt Road.

Local businesses (egg farm and sand and soil supply outlet) along the road could continue to trade although a median would separate the carriageways and partially restrict vehicular access. The proposal would not affect other businesses with access off Sunnyholt Road following completion of construction except for improved safety, access and capacity along the road. Economic pursuits in the area would be able to be maintained during construction and operations of the proposal. Pedestrian, cyclist and bus service access would be improved with the widened road.

As a result of the proposal the traffic along Sunnyholt Road would be closer to the occupants of around 80 existing dwelling units and possibly 70 future dwelling units with impacts of minor loss of amenity, increased noise and air pollution. The occupants of these existing and future dwellings (approximately 450 people) with views of the widening may suffer a possible minor decline in visual quality, loss of amenity and privacy, increased noise and air pollution during construction of the proposal.

Socio-economic benefits of the proposal include increased safety and capacity; improved pedestrian and pedal cyclist safety and amenity; better bus operations along the road; and improved local amenity with provision of roadside landscaping. Construction of the proposal would create both direct and indirect employment benefits for the local economy. Following completion of the proposal the residents; visitors to the area; and travellers along Sunnyholt Road would have improved access to destinations within and outside the Glenwood region.

7.3.10 Pedestrian and Cyclist Impacts

During construction the status quo would be maintained for pedestrians and pedal cyclists with a relative lack of facilities for these users provided along the road. During operation of the widening there would be improved pedestrian and pedal cyclist safety with the new pedestrian pathway and cycleway facilities. Pedestrian crossings would be maintained at the signalised intersections with James Cook Drive and Quakers Hill Parkway and new crossings provided at Wilson Road and Malvern Road. However, compared to the existing road, pedestrians and pedal cyclists would have less difficulty crossing the busier and wider road as additional crossings would be provided and the median could act as a pedestrian refuge in other sections of the road.

7.3.11 Traffic Impacts

During Construction
Construction impacts on the operation of traffic flow along the two lane section of Sunnyholt Road over the construction period would be carefully managed to minimise disruption to traffic. Section 3.4 discusses the staging of works. The control of traffic during construction may require the partial closure of a traffic lane at times, resulting in temporary traffic delays although traffic should not experience severe delays for extended periods. Where practical these partial closures would be confined to less busy periods. Night-time work may be necessary for a few nights to minimise inconvenience to road users at peak travel times. Adjacent residents would be advised of these occurrences.

Construction activities would require traffic control measures, such as signposting, cones, and traffic control personnel. During construction of the proposal the procedures for the installation and operation of traffic control devices established in the RTA's *Traffic Control at Worksites Manual* and AS 1742.3-1996 *Manual of Uniform Traffic Control Devices Part 3: Traffic Control Devices for Works on Roads* would be followed wherever possible. Only the minimum practicable length and width of the Sunnyholt Road would be affected by construction at any one time to minimise disruption and inconvenience to road users, residents and users of nearby facilities. A Traffic Management Plan would be included as part of the Construction Environmental Management Plan for the WSO and include the requirement for safe and efficient access for vehicles, buses, cyclists and pedestrians.

Operation of the Road
A summary of the works that would impact on traffic flow along Sunnyholt Road during operations includes:

- provision of six lanes with dual carriageway along the road.
- signalised intersections along the road with improved performance at James Cook Drive, Meurants Lane, Wilson Road, Malvern Road and Quakers Hill Parkway with turning lanes.
- vehicles (except buses) would not be able to turn right out of Wilson Road and Malvern Road. Motorists would need to use Quakers Hill Parkway and Sorrento Drive to turn right into Sunnyholt Road thereby increasing traffic on Pye Road and Glenwood Park Drive respectively.[6]

[6] *Traffic noise impacts along Pye Road and Glenwood Park Drive are expected to be less than 2 dB(A).*

- better heavy vehicle and bus operations along the road with improved turning movements at intersections.
- bus companies providing services along the road would continue to use the bus stops and bus shelters to be relocated along the road.

Following completion of the proposal residents; visitors to the area and travellers along Sunnyholt Road would have improved access to destinations within and outside the region.

7.3.12 Non-Indigenous Heritage

There are no items of environmental heritage listed in the *Blacktown Local Environmental Plan 1988* or State Heritage Register affected by the proposal.

The proposal would be constructed within areas already disturbed. However it is possible due to past development in the area that relics greater than 50 years old may be unearthed during construction. If this event occurred then work would cease in the immediate vicinity and the RTA's Sydney Region Environmental Adviser and the Heritage Council of NSW would be contacted for advice and/or a permit to remove or destroy the item.

7.3.13 Indigenous Heritage

An indigenous heritage assessment of the proposal was carried out by Bobbie Oakley and Associates in August 2001. The results of the assessment are summarised below and more detail is provided in Appendix 6.

- The National Parks and Wildlife Service Aboriginal Sites Register lists 132 Aboriginal archaeological sites within a 5 km radius of the centre of the study area on Sunnyholt Road. The majority of the local sites are stone artefact scatters however the general area also contains grinding groove sites, scarred trees and art sites.
- No Aboriginal archaeological sites listed with the National Parks and Wildlife Service Aboriginal Sites Register are located within, or in the vicinity of, the proposed impact areas.
- No new Aboriginal archaeological sites, or areas with the potential to contain undisturbed surface or sub-surface relics, were identified during the field survey.
- There are no constraints on archaeological grounds to the proposed road widening works along Sunnyholt Road.

If any archaeological sites or relics were found during construction then work would cease in the immediate vicinity and the NSW National Parks and Wildlife Service and the RTA's Sydney Region Environmental Adviser and Aboriginal Programs Consultant would be contacted immediately for further advice and action.

7.3.14 Noise and Vibration Effects

A noise and vibration assessment was completed by Renzo Tonin and Associates Pty Ltd in September 2002. The results of the assessments are summarised below and more detail is provided in Appendix 7.

To determine existing Leq traffic noise levels and background L90 noise levels along the road, two receiver sites were selected for long-term noise monitoring. A noise monitor was installed at each site to monitor ambient noise levels. The sound level meters used for the noise monitoring were located 1 metre from the most affected façades of the dwellings. Monitoring was conducted from 26th March to 4th April 2002 at two representative sites near the east side of the road at 36 Elsom Street, Kings Langley and 443 Sunnyholt Road, Glenwood.

EPA Criteria

The EPA criteria for traffic noise along Sunnyholt Road are Leq (15 hours) of 60 dB(A) during daytime from 7 am to 10 pm and Leq (9 hours) 55 dB(A) during night-time from 10 pm to 7 am. These criteria were exceeded as at 36 Elsom Street the Leq (15 hours) was 67 dB(A) during daytime and the Leq (9 hours) 62 dB(A) during night-time. At 443 Sunnyholt Road the Leq (15 hours) was 66 dB(A) during daytime and the Leq (9 hours) 61 dB(A) during night-time.

For sensitive land uses such as the place of worship (church) located near James Cook Drive the EPA internal criterion is Leq (1 hour) 40 dB(A) during daytime and night-time.

Background noise levels were 54 dB(A) during daytime (7 am to 6 pm) at 36 Elsom Road and 56 dB(A) during daytime at 443 Sunnyholt Road, Glenwood. Hence construction noise criteria for a 12 to 15 month construction period would be that the L10 level measured over a period of not less than 15 minutes must not exceed the background level by more than 5 dB(A) or 59 dB(A) during daytime.

Traffic Noise Impacts

Predicted traffic noise levels at selected locations in 2006 and 2016 (10 years after completion of the proposal) using the CORTN traffic noise model are summarised in Table 4 over.

Daytime and night-time traffic noise levels along the road currently exceed the EPA's criteria by up to 7 dB(A). Traffic noise levels are predicted to exceed the criteria by up to 12 dB(A) in 2006 and up to 13 dB(A) ten years after the project completion in 2016. The criterion for the church would also be exceeded.

Table 4 Existing and Predicted Traffic Noise Levels in 2006 and 2016

Location	Predicted Noise Level 2006 dB(A)		Predicted Noise Level 2016 dB(A)	
	Daytime Leq (15 hour)	**Night-time** Leq (9 hour)	**Daytime** Leq (15 hour)	**Night-time** Leq (9 hour)
2 Flint Street	68	64	68	64
9 Tagu Place	65	61	66	61
443 Sunnyholt Road	67	63	69	64
432 Sunnyholt Road	72	67	73	69
484 Sunnyholt Road	68	64	69	66
Church at 56 Elsom Street	64-68 *	Not Applicable	65-70 *	Not Applicable

* *Varies during the day*

Traffic Noise Mitigation Measures

The NSW Government's *Environmental Criteria for Road Traffic Noise* states that all feasible and reasonable measures need to be applied in seeking to reduce noise levels from existing roads to meet the noise criteria. Existing noise levels along the road are already high and they are expected to increase by at least 2 dB(A) ten years after the project completion.

A range of noise mitigation measures are available such as low noise pavement as a road surface, roadside noise barriers and architectural treatment to buildings. The selection of any noise mitigation measures would be subject to community consultation (owners' agreement for architectural treatment to buildings) and the views of Blacktown City Council.

Low Noise Pavement

A low noise pavement such as open graded asphaltic concrete could be laid along the road. This treatment could provide a 2 to 3 dB(A) noise reduction at the source compared to standard pavements, but could not achieve the criteria without being used in conjunction with other noise mitigation measures. This form of traffic noise mitigation would normally be considered useful and practical, however in this case a low noise pavement is not practical for this section of the road due to high maintenance costs caused by a relatively high percentage of heavy vehicles.

Noise Barriers

Table 5 over shows areas where noise barriers may be feasible, the height and length required to achieve the EPA traffic noise criteria.

Table 5 Approximate Noise Barrier Heights

Section of Sunnyholt Road	Side of Road	Approximate Length	Nominal Height
South of James Cook Drive to WSO	east	350 metres	3 metres
South of James Cook Drive to WSO	west	350 metres	3 metres
WSO to end of Ali Place	east	250 metres	3 metres
WSO to south of Wilson Road	west	300 metres	3 metres
Wilson Road to Malvern Road	east	130 metres	3 metres
Malvern Road to just past Quakers Hill Parkway	east	350 metres	3 metres
Total		**1730 metres**	**3 metres**

Architectural Treatment

Architectural treatment of buildings can include mechanical ventilation, sealing of wall vents and upgraded seals for windows and doors. There are ten residences and the church that may not be able to be feasibly treated by noise barriers because they are isolated or require access to Sunnyholt Road and could therefore be treated using architectural treatment. Traffic noise predictions have shown that only one residence requires more than 10 dB(A) reduction to achieve the internal noise goal. The other affected residences and the church (together with the noise wall) require less than 10 dB(A) noise reduction.

Construction Noise

Noise levels at any receptors resulting from construction would depend on the location of the receptor with respect to the area of construction, shielding from intervening topography and structures, and the type and duration of operation being undertaken. Noise levels at receivers would vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Construction Noise Management

Construction noise exceedances could occur at some nearby residences when the noisiest equipment is in operation. Noise management measures and procedures would be necessary to manage noise impacts from construction activities. Implementation of noise control measures, such as those in Australian Standard 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* are expected to reduce predicted construction noise levels. Reference to this Australian Standard suggests possible remedies such as screening, acoustic enclosures, engine silencing and substitution by alternative processes to reduce noise emission levels from typical construction equipment. In addition to physical noise controls, the following general noise management measures would be followed.

- Plant and equipment would be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.

- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work would be switched off.
- In addition to the noise mitigation measures outlined above, a management procedure would be put in place to deal with noise complaints that may arise from construction activities. Each complaint would be investigated and appropriate and practicable noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
- Good relations with people living and working in the vicinity of a construction site would be established at the beginning of a project and be maintained throughout the project. Residents and businesses would be kept informed of progress and any complaints would be addressed seriously and expeditiously. The person selected to liaise with the community would be adequately trained and experienced in such matters.

Where noise level exceedances cannot be avoided, then consideration would be given to implementing time restrictions and/or providing periods of respite for residents.

Construction Vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (for example, dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency content and number of occurrences of a vibration, all play an important role in both the annoyances caused and the strains induced in structures. As the pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific with indicative minimum 'buffer' distances used to avoid human discomfort during daytime varying for different construction plant between 5 and 25 metres.

Construction Vibration Management

The following vibration control measures would be provided to minimise vibration impact from construction activities to the nominated occupancies and to meet the EPA's human comfort vibration limits.

- A management procedure would be implemented to deal with vibration complaints. Each complaint would be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures would be put in place to mitigate future occurrences.
- Where vibration is found to be excessive, management measures would be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.
- Carry out vibration testing of actual equipment on site to determine acceptable buffer distances to commercial and residential occupancies.

- A property condition survey of all dwellings with a common boundary with Sunnyholt Road road reserve (subject to owners' agreement) would be completed by the RTA and a copy provided to every owner before construction commences.

7.4 Cumulative Environmental Impacts

The cumulative impacts of the proposal would be beneficial in the long term with enhanced accessibility to the existing and developing residential areas in the region; improved safety including better traffic flow and reduced number of accidents; and greater amenity and capacity for pedestrians, pedal cyclists, buses and other motorists along Sunnyholt Road. Since economic development in the region would progress regardless of the construction of the proposal the cumulative impact for the proposal would be relatively moderate. However, the proposal together with other road improvements such as the nearby WSO interchange would contribute towards the enhancement of the road network in the region. In addition the assessed bio-physical impact of the proposal is limited since most of the proposal is on ecologically degraded land and existing road space.

Positive cumulative impacts of the proposal include:

- enhanced accessibility within the region.
- improved traffic flow, capacity, safety and level of service along Sunnyholt Road for pedestrians, pedal cyclists, buses and motorists.
- reduced accidents, travel times and vehicle operating costs.
- improved local amenity with provision of roadside landscaping.

Adverse cumulative impacts of the proposal include:

- increased traffic noise impact near the widening.
- a decline in localised air quality over time with increased traffic.
- land acquisition areas generally converting from residential to roadspace areas.
- visual impact of the widening and loss of some vegetation until the landscaped areas mature.

Based on the concept design and provided the safeguards are implemented it is considered that the cumulative environmental impacts of the proposal are generally positive and outweigh the adverse impacts.

7.5 Ecologically Sustainable Development

Use of modern transport is an important part of the quality of life in Australia including privately owned motor cars, which provide great freedom and mobility. However, much of our current use of vehicular transport is inconsistent with the principles of ecologically sustainable development. Motor vehicles rapidly consume non-renewable resources and are a major contributor to the greenhouse effect and air pollution. To achieve ecologically sustainable development in transport it will be necessary to develop motor vehicles that are much less polluting and more energy-efficient than those used today and also decrease our use of privately owned cars.

The principles of ecologically sustainable development as detailed in the *Environmental Planning and Assessment Act* and a response in relation to the proposal follow.

(a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
There are no known threats of serious or irreversible environmental damage associated with the proposal; hence lack of full scientific certainty has not been used as a reason for postponing any of the proposed safeguard measures outlined in Section 8 to prevent environmental degradation. The proposal has followed the precautionary principle by ensuring that the environmental risks associated with the proposal have been considered and that relevant safeguards would be implemented to reduce any uncertainties and to avoid serious or irreversible damage to the environment.

(b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
The proposal has been designed for future needs and has the capacity to meet expected traffic growth for at least the next 20 years. While this does not provide for the next generation, it is highly likely that Sunnyholt Road would be maintained to provide a high level of service to cater for all road users in the foreseeable future. The health, diversity and productivity of the road reserve environment would be maintained for the benefit of future generations provided the safeguards associated with the proposal are implemented.

(c) Conservation of biological diversity and ecological integrity.
The proposal would conserve biological diversity and ecological integrity using indigenous species in landscaping of the road reserve and a weed control programme. Existing trees would be retained wherever possible in the roadside. Other safeguards would be implemented to minimise any adverse impacts on soils, water and air quality; flora and fauna; landscape and visual qualities; heritage and archaeology; the nearby residential communities; and the surrounding road network.

(d) Improved valuation and pricing of environmental resources.
The cumulative impacts of the proposal, as discussed in Section 7.4, would be beneficial in the long term. However, while prices for natural resources should be set to recover the full social and environmental costs for their use, many environmental values cannot be set in monetary terms. Nevertheless, the proposal and the community would make greater use of the road corridor reflected in the benefit cost ratio of greater than 2 (which excludes some externalities such as the cost of noise and air pollution) calculated over 30 years. The value of widening Sunnyholt Road would increase with the proposal despite the

relatively high price of construction. In addition the ultimate disposal of all waste has been considered for the proposal in an ecologically responsible manner.

In summary, the proposal is generally in accord with the principles of ecologically sustainable development. Sunnyholt Road is an integral part of the main road network and the proposal would provide a more efficient means for the transport of people and goods than at present. The widening would provide a sustainable balance between environmental and economic objectives and compliments the use of other forms of transport including provision for pedestrians, pedal cyclists and buses.

8. Proposed Safeguards

There would be some medium term, localised and adverse impacts associated with the proposal particularly during construction requiring safeguards. Any adverse impacts of constructing the proposal would be outweighed by the long term beneficial effects of the proposal.

The Construction Environmental Management Plan for the WSO would indicate the names, responsibilities and authority of site management personnel who would have primary responsibility for implementing all environmental safeguards, monitoring effectiveness, rectifying environmental deficiencies, controlling further construction activities until deficiencies were rectified and the keeping of environmental records. The Construction Environmental Management Plan would include provision for hold points where environmental damage may occur, regular reports and audits on the environmental management of the project, details of non-conformances, verification activities and emergency responses.

In summary the safeguards that would be implemented for the proposal are listed below in the pre-construction, construction, operations and maintenance phases and would be included as a separate component in the successful consortium's Construction Environmental Management Plan required for the WSO.

Pre-Construction

- ◊ Current and best available design criteria would be used to ensure the proposal is correctly constructed, maintained and operated with adequate safety and capacity to meet all reasonable traffic needs for the next 20 years.
- ◊ A safety audit of the detailed design of the proposal would be completed by the successful consortium before construction of the proposal and any findings implemented.
- ◊ All land acquisition would be by negotiation in accordance with the RTA's *Land Acquisitions Policy Statement* with compensation under the *Land Acquisition (Just Terms Compensation) Act, 1991.*
- ◊ A property condition survey of all dwellings with a common boundary with Sunnyholt Road road reserve (subject to owners' agreement) would be completed by the successful consortium and a copy provided to every owner and the RTA before construction commences.
- ◊ Any architectural treatment noise attenuation measures to be installed in the 15 noise affected dwellings located along Sunnyholt Road would be determined by the

successful consortium during detailed design and installed after consultation with the owners and the RTA.

- ◊ The RTA would advise Blacktown City Council that any further noise barriers to be located along Sunnyholt Road by developers should be at least 3 metres high.
- ◊ Water quality treatment facilities to be provided would be determined during detailed design and following liaison with Blacktown City Council. Any water quality treatment facilities to be provided would be subject to a separate environmental impact assessment prior to construction.
- ◊ A hazard spill containment detention basin able to accommodate 25,000 litres at a location near the WSO interchange would be determined during detailed design. The basin to be provided would be subject to a separate environmental impact assessment prior to construction.
- ◊ The RTA would obtain agreement with Blacktown City Council concerning on-going maintenance of landscaped areas, drainage and water quality facilities prior to construction commencing.
- ◊ All the safeguards would be included as a separate component in the successful consortium's Construction Environmental Management Plan for the WSO before construction commences to minimise adverse environmental impacts.
- ◊ The RTA would send everyone who made a submission on the proposal a letter summarising the outcomes of the community consultation.
- ◊ Nearby residents would be informed by letterbox drop of the proposal before construction commences.

Construction

Construction Areas

- ◊ Construction areas for the proposal would be maintained in a clean and tidy state at all times.
- ◊ The construction site compound(s) would be located within the WSO road reserve.
- ◊ The construction compound(s) would be security fenced and lit at night and include amenities sheds, portable toilets, plant and equipment storage areas, bunded areas for storage of petroleum, distillate and other chemicals to comply with EPA and WorkCover Authority requirements.

Hours of Work

- ◊ Construction hours would generally be from 7 am to 6 pm Monday to Friday and 7 am to 1 pm on Saturdays.
- ◊ From 7 am to 8 am on Saturdays only work that is not audible at residential premises would be allowed.
- ◊ Work would not be permitted on Sundays and public holidays or at night unless authorised by the RTA and EPA where required.

◊ Any road works outside of normal working hours would follow the procedures outlined in the RTA's *Environmental Noise Management Manual*. EPA consultation for such work would only be required if the project were subject to an Environment Protection Licence from the EPA.

Plant and Equipment

◊ Construction equipment would be maintained to meet EPA air and noise requirements.

◊ All internal combustion engines would be maintained and in proper working order to ensure air and noise emissions were minimised.

◊ No heavy vibratory rollers would be permitted to operate within 25 metres of any dwelling unless a property condition survey was completed prior to construction.

◊ No blasting would be permitted during construction.

◊ No vehicle maintenance would be permitted outside the construction compound(s) except in emergencies.

◊ Mufflers would be fitted to all construction plant and equipment to meet EPA air and noise requirements.

◊ No batching plant would be permitted on-site.

Traffic Management and Access

◊ Inconvenience to Sunnyholt Road travellers and nearby residential communities would be minimised through best construction and traffic management practices. The community would be informed of changed traffic conditions prior to implementation.

◊ A Traffic Management Plan would be included as part of the Construction Environmental Management Plan for the WSO and include the requirement for safe and efficient access for vehicles and pedestrians. Traffic arrangements in the plan would be undertaken in consultation with the RTA's Traffic Management Centre.

◊ Traffic during construction would be managed in accordance with the requirements of the RTA's *Traffic Control at Worksites Manual* and Australian Standard 1742.3 - 1996 *Manual of Uniform Traffic Control Devices Part 3: Traffic Control Devices for Works on Roads*.

◊ Two lanes on Sunnyholt Road would generally be available for traffic at all times.

◊ Traffic arrangements during construction would be subject to RTA approval.

◊ Disruption of access to properties would be minimised and prior arrangements made with affected owners in the event of any short term disruption.

◊ Any changes to the levels for private property access along Sunnyholt Road would be rectified by the successful consortium.

Waste Management

- ◊ Waste management practices for the proposal would follow the resource management hierarchy principles embodied in the *Waste Avoidance and Resource Recovery Act, 2001* and where feasible suitable waste would be recycled in accordance with the RTA's EPA approved *Waste Reduction and Purchasing Plan*.

- ◊ A Waste Management Plan would be included as part of the Construction Environmental Management Plan for the WSO and include the requirement for on-site domestic waste and sullage facilities to be provided in the construction compound(s).

- ◊ Any excavated or excess pavement material and concrete would be incorporated in the earthworks for the proposal as a first priority or transported off-site for recycling.

- ◊ No burning or burying of wastes would be permitted on-site.

- ◊ All non-recyclable waste would be disposed of at legally operating waste disposal sites.

- ◊ Cleaning out of batched concrete mixing plant would not be permitted within the construction area.

- ◊ No contaminated material would be used in any earthworks.

- ◊ Any contaminated material would be disposed of in accordance with EPA requirements.

Erosion and Sediment Control

- ◊ Sedimentation potential from construction works would require installation of selected temporary sedimentation controls (for example, catch drains, diversion drains and banks, sedimentation basins, geofabric silt fences at the base of all earth works, geofabric covered hay or straw bales secured around all storm water inlets and soil stabilisation measures) along and around the construction areas and to be documented in an Erosion and Sediment Control Plan.

- ◊ The Erosion and Sediment Control Plan would also detail surface water control, storm water drainage, landscaping and erosion and sediment control measures required during construction to minimise sedimentation impacts.

- ◊ Regular monitoring and maintenance of the sedimentation controls would be implemented to ensure they perform in a fully functioning condition at all times.

- ◊ Sediments and pollutants would be removed from temporary sedimentation basins on a regular basis and if contaminated the contents disposed of in accordance with the requirements of the EPA.

- ◊ Any material stockpiles would be located in or adjacent to the road reserve and protected from possible erosion.

- ◊ Stockpiles would be managed in accordance with the RTA's *Stockpile Site Management Procedures*.

- ◊ Exposed earthworks areas would be stabilised as quickly as possible.

Water Quality

◊ Following RTA and/or the successful consortium consultation with Blacktown City Council water quality devices and/or basins to reduce pollutants by trapping oil, removing litter and sediments in stormwater run-off from the road during operations would be installed before discharge to the local waterways. The size, specifications and location of the sub-surface and cross road and drainage system would be determined during detailed design.

Air Quality

◊ Best management practices would be implemented for minimising off-site dust impacts from the project.

◊ Regular road sweeping of Sunnyholt Road travel lanes adjacent to the road works would be carried out to ensure a clean and safe pavement.

◊ Loose materials transported in trucks travelling on public roads would be covered.

◊ Tailgates of all vehicles transporting materials on public roads would be securely fixed, sealed and loads covered.

◊ Construction work would be regularly monitored and dedicated water carts would suppress dust as required.

◊ Dust deposition levels would be limited to 2 g/m^2/month above background levels.

Noise and Vibration

◊ The contractor would use the best available techniques not entailing excessive cost to meet EPA construction noise requirements as far as practicable.

◊ Three metre high noise barriers would be erected along both sides of Sunnyholt Road for 1730 metres as per the noise impact assessment (see Appendix 7).

◊ The noise barriers to be erected along Sunnyholt Road between James Cook Drive and the WSO would be erected after any required property acquisition and before construction of the actual road widening commenced.

◊ A combination of building treatments would be used to architecturally treat the 10 residences and church adversely affected by traffic noise along Sunnyholt Road.

◊ Construction noise would be attenuated with the use of screening, acoustic enclosures, engine silencing and substitution by alternative processes to reduce noise emission levels from typical construction equipment. In addition to these physical noise controls, the following general noise management measures would be followed.

- Plant and equipment would be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.

- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work would be switched off.
- In addition to the noise mitigation measures outlined above, a management procedure would be put in place to deal with noise complaints that may arise from construction activities. Each complaint would be investigated and appropriate and practicable noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
- Good relations with people living and working in the vicinity of a construction site would be established at the beginning of a project and be maintained throughout the project. Residents and businesses would be kept informed of progress and any complaints would be addressed seriously and expeditiously. The person selected to liaise with the community would be adequately trained and experienced in such matters.

◊ The following vibration control measures would be provided to minimise vibration impact from construction activities and to meet the EPA's human comfort vibration limits.

- A management procedure would be implemented to deal with vibration complaints. Each complaint would be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures would be put in place to mitigate future occurrences.
- Where vibration is found to be excessive, management measures would be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones and if necessary, time restrictions for the most excessive vibration activities. Time restrictions would be negotiated with affected receivers.
- If required carry out vibration testing of actual equipment on site to determine acceptable site specific buffer distances to residential occupancies.

Landscape

◊ The landscape concept plan would be implemented progressively as any staging of the proposal is completed as provided in Appendix 5.

◊ Environmental resources would be maximised by retention of existing vegetation and resources where possible.

◊ The number of trees to be removed would be the minimum necessary for the safe excavation and construction operations.

◊ Site topsoil would be reused on site in landscaping works.

◊ Native vegetation removed in construction would be chipped on-site and reused as mulch in landscaping works.

◊ A weed control programme would be included in the landscaping works.

◊ Any exotic vegetation, noxious weeds, associated leaf litter and soil cleared for the construction works would not be used in the landscaping of the disturbed areas.

◊ Propagules of all noxious weeds would be removed from the construction area for disposal at a legally operating disposal site.

◊ Any suitable vegetation would be reused as mulch as a first priority, provided to community groups as firewood and/or disposed of at a legally operating recycling facility.

◊ Trees with limbs overhanging Sunnyholt Road would not be removed unless absolutely necessary for safety or construction reasons. Any overhanging limbs would be cut back where possible.

◊ The boundary of the area to be cleared and the native trees to be retained would be clearly delineated and fenced to prevent damage from workers and machinery.

◊ Parking of vehicles or storage of materials would not be permitted beneath the canopy of trees to be retained.

◊ Exposed earthworks construction areas would be progressively landscaped with native species as soon as possible following completion of sections of construction.

◊ There would be no stockpiling of materials/spoil or leaving tools, vehicles or other equipment within remnant vegetation near the roadside. Protective fencing would be erected to prevent such occurrences.

◊ Owners of the properties on the eastern side of Sunnyholt Road between the WSO road reserve and the Madagascar Drive intersection would be approached by the RTA and/or successful consortium to implement additional landscape works within the properties to replace some of the landscape areas within the locality.

Community Consultation

◊ Nearby residents would be informed by letterbox drop of progress during the construction works.

◊ Nearby residents would be informed of any night-time construction work at least three days in advance.

◊ The EPA's Hotline on 131 555 would be informed of any night construction works and the name of the project or site manager to contact in an emergency.

◊ Procedures for monitoring community comments and taking appropriate actions would be implemented.

◊ Nearby residents would be warned in advance of noisy construction periods.

Indigenous and Non-Indigenous Heritage

◊ If any Aboriginal archaeological sites or artefacts were found during construction then work would cease within 50 metres of the site and the NSW National Parks and Wildlife Service and RTA's Sydney Region Environmental Adviser and Aboriginal Programs Consultant would be contacted promptly for further advice and action.

◊ If European relics were unearthed during construction then work would cease in the immediate vicinity and the RTA's Sydney Region Environmental Adviser and the Heritage Council of NSW would be contacted for advice and/or a permit to remove or destroy the item.

Other Requirements

◊ Construction hold points would be enforced in the following circumstances:

- prior to submission of the Construction Environmental Management Plan for the WSO;
- failure to comply with environmental requirements;
- failure to secure all relevant approvals, licences and permits prior to commencement of any work relating to that approval; licence or permit;
- noise levels at adjacent properties above specified noise levels;
- receipt of Building Condition Inspection reports prior to activities that may cause damage through vibration;
- discovery of suspected or potentially contaminated ground.

◊ Utilities and infrastructure would be relocated and/or adjusted at the successful consortium's cost as required by the providers.

◊ Concrete and asphaltic concrete would be transported from legally operating established batching plants located near the proposal and required for the WSO.

◊ The requirements of all relevant legislation would be met.

◊ All approvals and licences (if any) needed to construct the proposal including any air, noise and water pollution licences from the EPA would be obtained.

Operations and Maintenance

◊ Landscaped areas would be maintained for at least twelve months with three monthly inspections following completion of construction. Weed control would be vigorously enforced in all landscaped areas during the maintenance period.

◊ At Quakers Hill Parkway, the four lanes to be provided into Sunnyholt Road would be monitored by the RTA after opening and an assessment made to see if one of the lanes should be a shared right turn and left turn lane.

◊ Traffic noise post-construction would be monitored within one year of commissioning of the proposal to determine whether the installed building treatments for the 15 dwellings along Sunnyholt Road and 3 metre high noise walls were effective.

◊ If the actual post-construction noise levels one year after opening exceed those predicted for the tenth year after opening in 2016, then further remedial measures would be undertaken subject to being cost effective and practical.

The above list of safeguards is a minimum for implementation and is not exhaustive. Further requirements may be applicable as a result of public authority requirements,

changes in legislation, community consultation and detailed design development. At this stage no approvals, licences and permits are required for the proposal until the provisions of the *Water Management Act, 2000* are enacted for public authorities.

All safeguards within this REF, any conditions imposed by government authorities and additional requirements from the RTA Decision Report would be incorporated within the Construction Environmental Management Plan for the WSO.

9. Summary of Key Issues

9.1 Major Beneficial Effects

The major beneficial effects of Sunnyholt Road widening at Glenwood would be enhanced accessibility to the main road network; improved safety, level of service and traffic flow for motorists, buses, pedestrians and pedal cyclists along the road; reduced travel times and number of accidents; improved amenity and roadside landscaping. Other benefits of the proposal include:

- provides new infrastructure at a satisfactory Level of Service for forecast traffic volumes.
- reduced vehicle operating costs.
- provides consistency of travel along Sunnyholt Road.
- reduced conflicting traffic movements through traffic segregation along the divided carriageway and signalised intersections.
- provides attenuation for traffic noise generated by vehicles along the road.

9.2 Major Adverse Effects

The major adverse effects of the proposal include possible delays to motorists along the road during construction, land acquisition and removal of native vegetation from the road reserve. Local residents would also have increased levels of noise, dusts, vibration, traffic generation and general disruption to daily activities during construction. Noise levels would increase and air quality would decline with increased traffic flows in future. However provision of noise attenuation measures would reduce any traffic noise impacts on nearby residents to within EPA criteria. There would be also a medium term loss of visual amenity for some nearby residents until landscaped areas matured. Other adverse effects of the proposal include additional road surface, noise attenuation measures, drainage controls, water quality controls, signs and markings to maintain.

9.3 Characteristics

The characteristics of the proposal would be similar to other upgraded sections of Sunnyholt Road to the north and south of the proposal with increased road safety, capacity and better landscaping. The widening would be of modern design and similar appearance to the upgraded sections of Sunnyholt Road north and south of the proposal except for the provision of noise walls at the roadside. The interactions between the proposal and the affected roadside environment would be localised except for Sunnyholt Road travellers inconvenienced during construction.

9.4 The Extent of the Impacts

The impacts during construction would be medium-term over a 12 month period, adverse and localised except for the inconvenience caused to Sunnyholt Road travellers. The main construction impacts include land acquisition, construction noise, dusts under windy conditions, loss of introduced and native vegetation, disruption to traffic and traffic generation. The extent of the positive impacts during operations would be long-term, beneficial and cumulative on a regional scale and include improved accessibility to the region, improved safety, better traffic flow and level of service along the landscaped Sunnyholt Road widening. It is considered the long-term local and regional benefits of the proposal outweigh the medium-term localised and acceptable environmental impacts, provided the safeguards are implemented.

9.5 The Nature of the Impacts

Based on construction experience of similar widening projects the level of confidence in the prediction of environmental impacts is relatively high. It is anticipated that the affected environment would have the resilience to cope with the predicted environmental impacts. With the safeguards implemented during construction it is considered the environmental impacts are manageable although not reversible in the foreseeable future.

Construction and operations of the proposal would comply with all relevant standards, plans, policies and legislation. The extent of public interest in the proposal is likely to be moderate except for higher local interest. The environmental impacts are likely to be acceptable to the public with implementation of the safeguards.

10. Consideration of Environmental Factors in Relevant Legislation

10.1 NSW *Environmental Planning and Assessment Regulation 2000* Clause 228 Factors

In assessing the impact of the proposal for the purposes of Part 5 of the *Environmental Planning and Assessment Act* the following Clause 228 factors in the *Environmental Planning and Assessment Regulation, 2000* for consideration of likely impact of an activity on the environment are summarised.

(a) any environmental impact on a community;
There would be adverse and beneficial environmental impacts on the adjacent residential communities during construction and operations of the proposal. Details of the adverse and beneficial environmental impacts are detailed in Section 7.3 of the REF.

(b) any transformation of a locality;
There would be a long term transformation of approximately three hectares of vegetated road reserve and residential land to pavement area, noise walls and roadside landscaped area, which would change the views and appearance in the locality.

(c) any environmental impact on the ecosystems of the locality;
There would be minor environmental impact on local ecosystems due to the modified nature and managed land uses in the locality.

(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality;
There would be no known reduction in the scientific or other environmental quality or value of the locality due to the proposal except for removal of a portion of Cumberland Plain Woodland. There would be a reduction in the aesthetic quality of the locality with construction of the proposal, noise walls, increased signage and traffic control measures creating a larger and more visible road presence. There would be a loss of approximately three hectares of vegetated road reserve and residential land with the proposal.

(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations;
There would be no adverse impacts on the Glenwood locality, places and buildings of local significance for present or future generations.

(f) any impact on the habitat of any protected or endangered fauna (within the meaning of the National Parks and Wildlife Act 1974);
With respect to the above Act and Section 5A of the *Environmental Planning and Assessment Act, 1979*, there would be no significant threat to any protected or endangered fauna.

(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air;
No known endangering of any species as a consequence of the proposal is anticipated.

(h) any long-term effects on the environment;
There would be long term effects on the environment including the visual impact of the widening and a decline in local noise and air quality with increasing traffic flows along Sunnyholt Road. The local noise and air effects would occur sooner without the proposal.

(i) any degradation of the quality of the environment;
The environment would experience a loss in acoustic and visual amenity for residents and visitors to the nearby residential areas due to construction and operations of the proposal. Increased traffic flows are expected in future.

(j) any risk to the safety of the environment;
There would be increased risks to the safety of the environment during construction associated with increased potential for traffic accidents along Sunnyholt Road. Appropriate construction and traffic management safeguards would be implemented to minimise these risks.

(k) any reduction in the range of beneficial uses of the environment;
There would be no change to any beneficial use of the environment apart from approximately three hectares of vegetated road reserve and residential land changing to road works area.

(l) any pollution of the environment;
Additional pollution would be generated by the proposal including increased air and noise emissions from increased traffic flows along Sunnyholt Road in future.

(m) any environmental problems associated with the disposal of waste;
All generated wastes except introduced vegetation would be recycled as a first priority, otherwise contained and removed from the construction site for safe disposal at a legally operating waste disposal site according to statutory requirements. Any contaminated material would be disposed of according to EPA requirements. No environmental problems are anticipated with the disposal of waste.

(n) any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply;
No increased demands would be made on the use of resources which are, or are likely to become in short supply.

(o) any cumulative environmental effect with other existing or likely future activities;
The cumulative environmental effects of the proposal together with the construction of other proposed road improvements along Sunnyholt Road would positively contribute towards the development of the road network in the region. Appropriate safeguards would need to be implemented to reduce the extent and nature of any adverse environmental impacts.

10.2 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* Factors

In assessing the impact of the proposal for the purposes of the Commonwealth government's *Environment Protection and Biodiversity Conservation Act, 1999* the following factors are summarised.

(a) Any environmental impact on a World heritage property?

There would be no environmental impact on any World heritage property.

(b) Any environmental impact on wetlands of international importance?

There would be no environmental impact on any wetland of international importance.

(c) Any environmental impact on Commonwealth listed threatened species and ecological communities?
There would be no significant environmental impact on any Commonwealth listed threatened species or ecological community including Cumberland Plain Woodland.

(d) Any environmental impact on Commonwealth listed migratory species?
There would be no impact on Commonwealth listed migratory species.

(e) Does any part of the proposal involve a nuclear action?

No part of the proposal involves a nuclear action.

(f) Any environmental impact on a Commonwealth marine area?
There would be no environmental impact on any Commonwealth marine area.

(g) Any impact on Commonwealth land?
There would be no environmental impact on any Commonwealth land.

The nature and magnitude of the potential impacts of the proposal have been considered above in this environmental impact assessment and are also briefly assessed below.

- all on-site, off-site, direct and indirect impacts are considered acceptable provided the environmental management safeguards listed in Section 8 are implemented.
- the proposal would be constructed with a design life and use over many decades.
- the total impact of the proposal would be relatively minor compared to other nearby existing and future developments in the region.
- the urbanised and transport orientated receiving built and natural environments around the proposal have the capacity to accept the impacts of the proposal provided the environmental management safeguards are implemented.
- the RTA and its contractors have constructed and operated many kilometres of main road around the Sydney metropolitan regions and the degree of confidence with which the environmental impacts of the action are known and understood is relatively high.

It is anticipated that the affected natural and built environments would have the resilience to cope with the predicted environmental impacts. With the safeguards implemented during construction and operations of the proposal it is considered the environmental impacts are manageable. Considering the above assessment the nature and magnitude of the potential impacts of the proposal are not considered significant under the *Environment Protection and Biodiversity Conservation Act, 1999.*

It is anticipated that the affected natural and built environments would have the resilience to cope with the predicted environmental impacts. With the safeguards implemented during construction and operations of the proposal it is considered the environmental impacts are manageable. Considering the above assessment the nature and magnitude of the potential impacts of the proposal are not considered significant under the *Environment Protection and Biodiversity Conservation Act, 1999*.

11. Declarations

This Review of Environmental Factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Signed : B.R. Adcock Date: 22nd November 2002.
Environmental Planning Pty Ltd

Signed : _____ Date: 22nd November 2002.
Motorway Development Manager (WSO),
Motorway Services Branch,
Client Services Directorate,
Roads and Traffic Authority of NSW.

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Signed : _____ Date: November 2002.
Environmental Planning Pty Ltd

Signed : _____ Date: November 2002.
Senior Project Development Manager,
Sydney Client Services,
Roads and Traffic Authority of NSW.

References

Action for Bikes - Bike Plan 2010, 1999, Department of Transport.

Action for Transport 2010 - An Integrated Transport Plan for NSW, 1999, Department of Transport.

Action for Transport 2010 - An Integrated Transport Plan for Sydney, 1999, Department of Transport.

Environmental Criteria for Road Traffic Noise, May 1999, Environment Protection Authority.

Environmental Noise Management Manual, December 2001, Roads and Traffic Authority of NSW.

Land Acquisitions Policy Statement, February 1999, Roads and Traffic Authority of NSW.

Proposed Western Sydney Orbital Environmental Impact Statement, October 2000, PPK Environment and Infrastructure and Sinclair Knight Merz.

Proposed Western Sydney Orbital Species Impact Statement, October 2000, PPK Environment and Infrastructure and Sinclair Knight Merz.

Stockpile Site Management Procedures, November 2001, Roads and Traffic Authority.

The Western Sydney Orbital Representations Report, September 2001, Roads and Traffic Authority.

The Western Sydney Orbital Preferred Activity Report, December 2001, Roads and Traffic Authority.

Waste Reduction and Purchasing Plan, 2000, Roads and Traffic Authority of NSW.

APPENDIX 2

Community Comments and RTA Responses

Issue	Summary	RTA Response
James Cook Drive	Additional right turn facilities are required out of James Cook Drive	There are currently 3 exit lanes from James Cook Drive and the lanes would be marked for right, left or shared use. One right turn lane, one left turn lane and a centre lane for shared right and left turns would be provided despite what has been shown in the Newsletter.
Meurants Lane	Right turn into Meurants Lane required, right turn out of Meurants Lane, and left turns out of Meurants Lane.	At present right turns out of Meurants Lane are prohibited in peak periods. With the upgrading, access into and out of Meurants Lane will need to be restricted further on safety and network efficiency grounds. Meurants Lane is only about 80 metres north of the WSO interchange. Left into and left out of Meurants Lane was considered but rejected based on a number of reasons. The proposed transitway would be on the eastern side of Sunnyholt Road. To enter Meurants Lane from Sunnyholt Road or exit Meurants Lane into Sunnyholt Road vehicles would need to cross the proposed transitway. Traffic signals would be required to ensure safe crossing of the proposed transitway and entry to Sunnyholt Road, and adding signals at this intersection would cause further delays along this stretch of Sunnyholt Road. A left turn lane would probably be required in Sunnyholt Road for the left turn into Meurants Lane. Further road widening and land acquisition would be required, and this additional cost would not outweigh the benefits received. Also, due to the proximity of this intersection to the WSO interchange a vehicle turning left into Meurants Lane could create confusion to subsequent vehicles and drivers might think Meurants Lane is the WSO eastbound ramp (ie, a vehicle enters the left turn lane into Meurants Lane instead of the left lane onto the WSO eastbound ramp). Southbound traffic on Sunnyholt Road would have to be stopped to allow vehicles to safely turn left out of Meurants Lane. This would create delays to southbound traffic on Sunnyholt Road. Vehicles turning left out of Meurants Lane might want to turn right into the westbound ramp to the WSO. The right turn bay would extend past Meurants Lane and unless it would be free of vehicles at Meurants Lane, vehicles from Meurants Lane might block through southbound lanes. Traffic proposing to exit from Meurants lane would only need to travel a relatively short distance to obtain safe access to Sunnyholt Road at Malvern Road (for left turns) and Sorrento Drive (for right turns).
Meurants Lane	Right turn access out of Meurants Lane at Old Windsor Road is required.	This intersection is outside of the scope of this proposal. In late October 2002 the RTA allowed all movements into and out of Meurants Lane at Old Windsor Road.
Meurants Lane	Close right turns at Meurants Lane immediately, it is unsafe.	Right turns out of Meurants Lane are currently prohibited during peak hours, except for buses. This suggestion will be forwarded to Blacktown Council for review, however should it not be closed in the interim, it would be closed when the construction of the project gets underway. In

APPENDIX 1

Responses from Public Organisations

Blacktown City Council
Growing with Pride

3 April 2002

Bruce Adcock
Director
Environmental Planning Pty. Ltd.
PO Box 6112
PYMBLE NSW 2073

Dear Sir,

Widening of Sunnyholt Road, between James Cook Drive, Kings Langley and Malvern Road, Glenwood – Review of Environmental Factors

I refer to your letter dated 13 March 2002 requesting comments with regard to the concept proposal for the abovementioned project, to be used as a basis for developing the REF. The proposal has been reviewed and the following comment made:

1. The concept proposal makes provision for the transitway along the eastern side of Sunnyholt Road prior to determination of a location for the transitway. Should the location of the transitway be on the western side would there be provision for this option under the concept?
2. The design for the left turn access to and from the east facing ramps of the Orbital appears to be an inefficient operation due to the transitway priorities.
3. There is insufficient details to assess the impact on Flint Street, however it appears there is significant property impact arising from the transitway. Further comments will be made when better plans are available to assess.
4. Previous concepts for Sunnyholt Road and in the EIS for the Western Sydney Orbital, have provided for left turn access to be retained at Meurants Lane. This proposal provides for bus access only, however will local buses be permitted to use the transitway? There was some benefits to local access in retaining left turn access.
5. The proposal for Wilson Road is consistent with Council's previous submissions and Council's recent decision to ban right turn movements at this intersection.
6. Under the previous proposals for Malvern Road the proposed access arrangements were based on advice that there will not be signals at Malvern Road. It would appear that signals have been provided to satisfy transitway requirements. Given this situation Council considers that an assessment should be made on the impact of permitting right turn movements out of

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Telephone: (02) 9839 6000 • **Facsimile:** (02) 9831-1961 • DX 8117 Blacktown
Email: council@blacktown.nsw.gov.au • **Website:** www.blacktown.nsw.gov.au
All correspondence to: The General Manager • PO Box 63 • Blacktown NSW 2148

Malvern Road and an opportunity given for further comment following modelling of this option.

7. Whilst this project may not extend to the Quakers Hill Parkway, Council considers that a left turn slip lane should be provided for left turns from the Parkway into Sunnyholt Road to improve the efficiency of this intersection.

8. The issue of noise attenuation needs to be addressed for residential properties adjacent to Sunnyholt Road where there has been no provision made previously.

This information is based on assessment by Council officers as insufficient time has been given for formal consideration by Council. Council's formal position will be made in response to the REF. Should you require further information please refer to the contact person indicated at the bottom of this letter.

Yours faithfully,
IAN REYNOLDS
GENERAL MANAGER

Per:

Your contact for this matter is: Mr. Svarc
Phone: 9839 6000 Ext. 6269
File No.: 58-786-4/9(02-14097 C)

Our Reference : 40.1810 (2)

Gordon Chivers
Infrastructure Development
Phone : 02 8814 2541
Fax : 02 8814 2036

Your Reference : 58-786-4/9 (02-14097 C)

The General Manager
Blacktown City Council
DX 8117
BLACKTOWN

Sunnyholt Road. Widening between James Cook Drive, Kings Langley and Malvern Road, Glenwood. Review of Environmental Factors (REF).

Attention : Mr R Svarc

Dear Sir

I refer to your letter of 3 April 2002 to the RTA's consultant Environmental Planning Pty Ltd who is preparing the REF.

The letter raises five issues numbered 1-4 and 6 which deal entirely with the proposed Blacktown to Castle Hill Transitway. These issues will be addressed in the Transitway EIS which is currently being prepared.

The request for a left turn slip lane from Quakers Hill Parkway into Sunnyholt Road will not be included in the proposed work. As Quakers Hill Parkway is a regional road costs of any work would be shared by RTA and Council and funded from other RTA programs.

Traffic noise issues on the western side of Sunnyholt Road will be addressed in the REF.

Traffic noise issues on the eastern side of Sunnyholt Road will be addressed in the Transitway EIS.

Should you require further information please contact Gordon Chivers on 8814 2541.

Yours faithfully

Lakshmy Mulavana
Senior Project Development Manager
Sydney Client Services
5/4/02

g:reg_dev\chiversg\sunnyholt rd\letter ccl 050402

Our Reference : SRF5983 / SR381/02
Contact : Kieran Lynch, 9995 6837

RECEIVED 9/4/02

NSW EPA

Sydney Region

Mr Bruce Adcock
Environmental Planning Pty Ltd
PO BOX 6112
PYMBLE NSW 2073

Dear Mr Adcock

UPGRADE OF SUNNYHOLT RD, GLENWOOD

Thank you for your letter to the Environment Protection Authority (EPA) requesting input into the development of a Review of Environmental Factors (REF) for the upgrade of Sunnyholt Rd at Glenwood.

The Environment Protection Authority (EPA) has considered your request and suggests the following comments for review in the development of the REF.

I trust that this information has been of assistance to you and if you have any enquiries please contact Kieran Lynch on 9995 6837.

Yours sincerely

Kieran Lynch 5/4/02

KIERAN LYNCH
A/Principal Officer, Sydney Planning

FAXED

Environment Protection Authority
PO Box 668 Parramatta NSW 2124 Australia
Level 7 79 George Street Parramatta NSW 2150
Telephone 61 2 9995 5000
Facsimile 61 2 9995 6900
ABN 43 692 285 758
www.epa.nsw.gov.au

STANDARD ENVIRONMENT PROTECTION ISSUES TO BE ADDRESSED IN THE PREPARATION OF A REVIEW OF ENVIRONMENTAL FACTORS (REF) FOR ROAD WORKS

GENERAL COMMENTS

The EPA considers that a REF should provide an overall environment protection perspective. Some issues which should be addressed are listed below:

- the impact of the proposal on the existing road system, traffic congestion, public transport and induced traffic
- the impact of the works on, and opportunities to improve, pedestrian and cycleway facilities and access to public transport
- the environmental and cost savings possible by adopting energy efficiency measures
- the possible cumulative environmental impacts and proposals to manage these cumulative impacts.
- the effects of the development of the road on land use planning in the area.

The Planning NSW's *"EIS Guideline for Roads and Related Facilities"* (September 1996) is a useful background document. In particular see section 6E: Specific requirements for an EIS – The Environmental Issues.

SPECIFIC COMMENTS

Noise and Vibration Issues

The primary objective is the maintenance of residential amenity. The assessment of impacts and discussion of mitigation measures should address both the construction and operational phases. An assessment of the impacts of maximum noise levels and the likely frequency of such events should be included.

The following guidelines may be useful in the preparation of the REF:

- EPA's *Environmental Noise Control Manual* (ENCM)
- EPA's Environmental Criteria for Road Traffic Noise
- Road and Traffic Authority's Environmental Noise Management Manual

Baseline information should be provided for all properties likely to be affected in order to allow evaluation of the projected noise and vibration impacts of the proposal. This could include one week of valid noise data. Noise descriptors of LA_{90} (background noise levels), LA_{10} and LA_{eq} (equivalent continuous noise level) should be used and collected in a manner that is not affected by rain or winds greater that 5 m/s.

The following are points taken from the ENCM relevant to the construction phase:

Guidelines for construction noise take into account the fact that these activities are transient and that noise from construction activities is often difficult to limit even with good control measures. EPA target noise levels are:

- background + 20dB(A) for periods less than 4 weeks
- background + 10dB(A) for periods between 4 and 26 weeks
- background + 5dB(A) for periods greater than 26 weeks;

A noise management plan should consider aspects including: timing of noisy activities; selection of "quiet" equipment; use of noise barriers; scheduling of noisy activities to ensure that they are

completed in a short time and do not occur at more noise sensitive times of the day; and communication strategies with residents. Such a plan should cover issues identified in Planning NSW's Guideline under Noise and Vibration (a)-(d);

Where construction hours may need to be varied details should be provided of when and why, and how work would be managed to minimise impacts. Recommended construction hours are:

- Monday to Friday, 7am to 6pm
- Saturday, 8am to 1pm.
- No work on Sundays or Public Holidays

The REF should include the following information:

- details of the potential noise and vibration impacts from construction activities, including noise from construction machinery
- identification of noise sensitive sites.
- details of any proposed noise-monitoring program to demonstrate compliance
- details of truck movements, road traffic management during the construction phase, any necessary parking facilities, etc
- the type of road surface to be used
- information on changes in noise impacts due to changed traffic flows and patterns
- options for noise mitigation

Soils & Geology

The Department of Land and Water Conservation (DLWC) *Acid Sulfate Soil Probability Maps* should be used to indicate whether the proposed excavation areas could contain Acid Sulfate Soils.

It is recommended that the proponent conduct a preliminary assessment in accordance with the 1998 New South Wales Acid Sulfate Soils Management Advisory Committee publication, *Acid Sulfate Soils – Assessment Guidelines.* This preliminary assessment should determine whether acid sulfate soils are present and if the proposed works are likely to disturb these soils.

If acid sulfate soils are likely to be disturbed by the works, an appropriate Acid Sulfate Soil Management Plan may be required. Relevant guidelines are outlined in the 1998 New South Wales Acid Sulfate Soils Management Advisory Committee publication, *Acid Sulfate Soils – Management Guidelines.*

Air Quality Issues

Air quality issues that should be considered in the REF for the construction works include:

- emissions of dust generated by activities such as earthmoving, excavation, loading and vehicle traffic (particularly from unsealed roads and surfaces);
- wind erosion from exposed surfaces and stockpiles;
- assessment of the impact of exhaust emissions from vehicles and other motorised equipment being operated on-site.

An air quality management plan should be developed for the site to describe proposed mitigation measures and safeguards to control dust generation and to minimise impact on nearby receptors.

Mitigation measures and safeguards referred to in the REF should include:

- properly maintained equipment, designed and operated to control the emission of smoke, dust, fume and other objectionable material into the atmosphere;
- spraying of earthworks, roads and other surfaces as necessary with water or other suitable liquids and the provision of dust suppression equipment;
- all working areas, access roads and disturbed areas to be stabilised as soon as practicable to minimise the generation of wind blown dust;
- staging the clearing of the site so that the exposed area and the generation of wind blown dust is minimised;
- proposals for the resolution of air complaints and details of a complaints handling and recording system.

Dust is a major issue during the construction phase. For sites that contain contaminated materials, dust management controls are even more critical. A dust management plan should be prepared for potentially dusty developments or developments that contain contaminated material. This should include: identification of sensitive receptors (eg. residences, schools, nursing homes, hospitals); prediction of dust fall-out and dust concentrations using appropriate air dispersion modelling with the assumed "worst case scenario"; proposed mitigation measures and safeguards to minimise impacts; and details of any proposed public consultation program to inform nearby residents when particularly dusty activities are proposed.

In relation to the operational phase information should be included on the projected changes in traffic volume and traffic type on the proposed road and the adjacent road network and likely changes to the existing air quality at various locations along the proposed route.

Water Issues

The REF should identify, describe and quantitatively assess the potential impacts of the development on water quality and the aquatic environment both during the construction and operational phase, and describe measures to avoid or minimise these impacts.

The location of existing water bodies such as rivers, creeks, wetlands, estuaries and the coastline should be taken into consideration. Particular care should be taken near waters supply catchments and near National Parks.

An integrated soil and water management plan should be developed to prevent an increase in pollutant loads being exported from the site both during construction and operation. The following documents will assist in the development of the plan:

- EPA (1997) Managing Urban Stormwater: Treatment Techniques;
- EPA (1997) Managing Urban Stormwater: Council Handbook (draft);
- NSW Dept of Housing: (1998) "Managing Urban Stormwater, Soils and Construction" (the blue book).

Issues that should be considered are listed below:

- the potential for water pollutants to be generated
- measures to be taken to collect, store and treat stormwater, wash down water, wheel wash water, etc
- options for water re-use on the site
- materials storage areas, ponds or beds for slurry or other materials
- management methods to ensure that earthworks do not export sediment
- separating clean water from contaminated water
- protect existing natural drainage lines and the banks of waterbodies

- measures to prevent litter entering water courses eg; trash racks, and details of permanent gross pollutant traps or other water pollution control devices proposed for the operational stage
- proposed controls for refuelling facilities during construction eg, oil separators, emergency absorbent booms or pillows
- identification of any significant effects on hydrological conditions and appropriate hydrological studies
- monitoring proposals
- consideration of the impact of the proposal on upstream and downstream flooding taking into account any existing flood plain management plans.

Hazards Issues

Consideration should be given of the need for a Hazard and Emergency Management Plan. If warranted it should be consistent with Local Emergency Management Plans and should address handling, transport and storage of hazardous materials including spill requirements and fire water management. The REF should also consider the need for management facilities for contaminated spills in the operational stage.

Waste Management

The REF should determine and classify the types of waste material generated and the different disposal strategies for each material in accordance with EPA guidelines (Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes (EPA 1999)). Waste management principles, starting with minimisation should be applied to each stage of the project's development, including the concept design and construction stages.

Where necessary to remove trees, the trees should preferably be chipped on site, and used for landscaping on adjacent areas. Alternatively, cleared timber may be sent to commercial processors or offered to the public. No trees should be bulldozed, burned in the open, or sent to landfills. Other green wastes should be sent for reprocessing, either directly to commercial composters or to transfer stations.

Suppliers of construction materials should be required to reduce unnecessary packaging or to use durable reusable packaging, pallets, crates and drums. Where packaging materials cannot be reused, recycling options should be thoroughly investigated.

Wastes should be source separated and sent to recycling outlets. Recycling facilities should be made available to site staff operating from temporary offices near the road or on the road corridor.

Spoil Management

The REF should fully investigate the cost of treatment and disposal of spoil before works commence so that adequate resources are available. Factors that need to be considered in the REF include:

- estimating the quantity of spoil material likely to be generated
- avoiding clearing additional areas of land for the storage of spoil material
- collecting, separating, storing and reusing topsoil
- maximising the reuse of spoil material on site or on developments
- proposed strategies for the handling, stockpiling reuse /recycling and disposal of spoil

- identification of the history of spoil material and whether there is any likelihood of contaminated material, and if so, measures for the management of any contaminated material
- ensuring that spoil storage areas are managed appropriately to minimise erosion and ensure that adequate sediment controls are in place.

Flora and Fauna

The REF should include a detailed assessment of the likely ecological impact of the proposal on both terrestrial and aquatic communities and individual species. Remnant and regenerated vegetative communities should be identified and assessed for their value as habitat, and wildlife corridors surveyed for rare or endangered flora and fauna species. For detailed advice, contact the National Parks and Wildlife Service, but in general the following issues should be addressed:

- maximise retention of remnant native vegetation by minimising the area of vegetation disturbance
- utilise local seedstock for planting wherever possible
- maximise linkages between areas of biodiversity value
- take special care where road corridors are adjacent to National Parks
- consider the need for fauna corridors
- rehabilitate sites when work is complete

Environmental Management Plan

The EPA strongly recommends the preparation of an environmental management plan to guide environmental performance during the project. This plan should address environmental awareness and skills training for all workers, including contractors, working on the project. In addition, the EPA suggests that the Plan should cover the issues listed above, and include the following important components:

- appropriate mitigation measures to ensure that operations do not cause unacceptable pollution, cause an unacceptable risk to public health or impact on the amenity of surrounding residents;
- clearly defined and appropriate environmental objectives, referring to relevant guidelines and standards;
- adequate environmental monitoring and reporting programs to ensure that performance is assessed against environmental objectives; and
- clear and appropriate contingency strategies.

Your Ref:
Our Ref: ERM 2002-1707

24 April 2002

RECEIVED 29/4/02

LAND & WATER CONSERVATION

Director
Environmental Planning Pty Ltd
PO Box 6112
PYMBLE NSW 2073

Attention: Bruce Adcock

Dear Sir,

Re: REF Requirements.
Proposed widening of Sunnyholt road, at Glenwood.

Thank you for your letter dated 13 March 2002, seeking this Departments comments and requirements for the above-proposed REF.

The Department of Land and Water Conservation (DLWC) is responsible for managing the soil, water and vegetation resources in New South Wales.
The vision of the Department is to facilitate *clean, healthy and productive catchments for the twenty-first century*. As part of this vision, the Department advocates the principles of ecologically sustainable development, and intra and intergenerational equity.

The Departments comments are broad in nature to cover a variety of circumstances. Some of these comments may not be fully relevant to your proposal. Overall however there would appear to be little concerns for the Department relative to the proposal.

As part of the preparation of the REF you will need to demonstrate how this proposal will meet the requirements of the various Acts and Policies within this letter.

Integrated Development

Any development proposal that requires a **3A permit under the *Rivers and Foreshores Improvement Act (1948)***, or a **water license under the *Water Act (1912)***, for either surface water or ground water extraction, will be an Integrated Development. In these instances, the Department is an Approval Body for the Consent Authority (either Council or the Minister for Planning NSW). Developments submitted after January 2003 by Public Authorities will no longer be exempt.
If the proposal falls under Pt 5 of the EPA Act (1979), then the proposal will not be an Integrated Development. However it is strongly suggested that all potential Departmental concerns for the issuing of a permit are addressed in the REF and treated similar to an Integrated Development, to avoid possible future delays and changes to the proposal.

Rivers and Foreshores Improvement Act (1948).

The Department is responsible for administering the Rivers and Foreshores Improvement (R&FI) Act (1948).
If there is any creek, drain, channel (artificial or natural), depression, etc. which conveys water, or there is a foreshore, a Part 3A Permit may be required from the Department under the Act to:

(1) **Excavate** or remove material from the bank, shore or bed of any stream, estuary or lake, or land that is not more than 40 metres from the top of the bank or shore of protected waters (measured horizontally from the top of the bank or shore). "**Protected waters**" as defined under section 22A of the Act means a river, lake into or from which a river flows, coastal lake or lagoon (including any permanent or temporary channel between a coastal lake or lagoon and the sea).

(2) **Build erosion control works** and other **structures** in a river, estuary or lake.

(3) **Place any fill material** in a river, estuary or lake.

When assessing developments that require a Part 3A permit under the R&FI Act, the Department will consider whether the proposal is consistent with State Government policy, including the NSW State Rivers and Estuaries Policy. A condition of consent to a Part 3A permit may include the establishment of a native vegetation riparian zone along a "river". The Department is unlikely to issue a Part 3A Permit for works that degrade watercourses and their environment.

It is the Departments aim that an adequate native vegetation riparian zone be kept or established on either side of any "river" or wetland area. A minimum native vegetation riparian zone of 20 meters, from the top of the bank is generally required, however a greater width may be required, depending upon the site and the surrounding area.

On-line or in-stream water quality structures such as water quality ponds, trash racks and gross pollutant traps (GPT's) are strongly discouraged, as they will affect the continuity and corridor function of streams and result in the loss of riparian vegetation and habitat.

The channelisation, piping and/or relocation of streams and the construction of on-line or in-stream structures and culverts for stream road crossings are also strongly discouraged. Developments that propose such actions must have the necessary approval of DLWC and are unlikely to receive support

Works that are undertaken by Public Authorities (not including business ventures such as state-owned corporations or commercial undertakings), or works on Crown Land, do not require a 3A permit prior to commencing works. However, all works undertaken still need to comply with Government policy, and if it is deemed that they could degrade the protected lands of the watercourse, the Department can require works to cease and issue a remedial notice to repair any damage.

Please note that the definition of a "river" in the Rivers and Foreshores Improvement Act is different to the definition in the Water Act and must be considered separately.

The proponent is advised to contact a 3A permit Resource Officer, at the Parramatta or Penrith Offices, to discuss Part 3A matters and possible inspection.

NSW State Rivers and Estuaries Policy - General.

The NSW Government has a policy to encourage sustainable development of the natural resources of the State's rivers, estuaries, wetlands and adjacent riverine plains. This is to reduce and where possible halt;

- declining water quality,
- loss of riparian vegetation,
- damage to river banks and channels,
- loss of biodiversity, and
- declining natural flood mitigation;

and to encourage projects and activities which will restore the quality of the river and estuarine systems such as;

- rehabilitating remnant habitats,
- re-establishing vegetation buffer zones adjacent to streams and wetlands,
- restoring wetland areas,
- rehabilitating of estuarine foreshores, and
- ensuring adequate streamflows to maintain aquatic and wetland habitats.

This includes ensuring the construction of any wetland or detention structure off-line, so as not to degrade the functions of that natural resource.

Floodplain Management - General

Any development on flood prone land should be considered in accordance with the NSW Government's Flood Policy (1984). These principles are further explained in the Government's Floodplain Management Manual (2001). The primary objective of the State Government's Flood Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers, and to reduce the private and public losses resulting from all levels of potential flooding. As outlined in the Manual the Policy is merits based, in which the impacts of flooding are balanced against planning, social, environmental and economic issues. The consent authority needs to check that all considerations in the Manual are adequately addressed in making decisions.

The management of flood prone land is primarily the responsibility of local government. The State Government provides technical assistance and, in association with the Federal Government, financial assistance for flood related studies, mitigation works etc.

In assessing any development proposal, consideration needs to be given, where appropriate, to the potential impacts of flooding on the proposed development; the impact of the proposed development on flood behaviour both upstream and downstream of the site; and the possible impacts of flooding on residents and other users of the floodplain. Particular attention should also be given to availability of safe access and egress from the site in times of flood. In this regard, the full range of potential flood events, up to the probable maximum flood (PMF) should be considered.

Impacts from development in isolation can be small. However, when considered in combination with other future development the impact might be significant. It is therefore prudent to assess the cumulative impacts of all likely development. A floodplain management study is an effective way of assessing these cumulative impacts.

Under the Government's Flood Policy, the determination of the acceptability of any afflux arising from proposed development should be merits based and would normally be a matter

for the relevant consent authority. However, it should be noted that in some communities an afflux as small as 10 mm has needed to be addressed by way of providing some compensatory flood mitigation.

Should you wish to discuss any Floodplain Management matters further with the Department, please do not hesitate to contact David Avery on phone number 9895 6242.

NSW Biodiversity Strategy

The NSW Government has a strategy for protecting the native biodiversity of NSW and for maintaining ecological processes and systems. The following principles will be applied in reviewing any proposal;

- Ensuring that the proposal does not decrease native biodiversity of either individual species or communities of the site or area.
- Ensuring that the proposal is not part of any threatening process to the native biodiversity of the site or area.
- Determining if the proponent has been guided by the precautionary principle to show careful evaluation to avoid, wherever possible, serious or irreversible damage to native biodiversity, through an assessment of risk-weighted consequences of various options.

The proponent will need to demonstrate how this strategy will be met.

Crown Land Matters - General

Matters the proponent needs to consider when undertaking development adjoining Crown land include;

- Overland flows, including stormwater should not be concentrated or diverted from their natural flowline.
- Roofwater shall not be discharged directly onto Crown land.
- The velocity and volume of stormwater flows to Crown land must be no greater than those before the proposed development.
- Any stormwater control structure must be designed and constructed in accordance with, *Managing urban Stormwater, Soils and Construction.* NSW Dept of Housing, 3 Ed. (1998).
- Any excavation or fill is to be contained entirely on the proponents' property and shall not jeopardise the longevity of any vegetation on Crown land. Where fill is proposed adjoining the common boundary it shall be properly drained and retained or battered back and revegetated to prevent the escape of any material onto Crown land.
- Access to any part of the proponents property is not to be over Crown Land. Should the proponent wish to construct a Crown road, permission in writing must first be obtained from the Department.
- Any fire reduction zone that is required by a development, that adjoins Crown land is to be completely within that development boundary.
- Any other matters that may adversely impact upon the Crown land.

Crown Land- Major Public Authority Projects

Where Crown lands or Crown reserves are considered to be needed, as part of a major project, the land should be acquired using the provisions of the **Land Acquisition (Just Terms Compensation) Act 1991.**
Where tunnelling or deep excavation are to be undertaken as part of the project, a close examination of all the titles of the lands affected by the proposal is required. The titles for lands in some instances are restricted in depth. The lands below this depth restriction are considered to be Crown lands and as such compensation for the acquisition of these lands are payable.

Soil Conservation Act (1938)

The Soil Conservation Act (1938) and amendments provides for the conservation of soil and farm water resources and for the mitigation of erosion within NSW. Any land use activity that disturbs a vegetative ground cover creates an erosion hazard, which requires measures to minimise environmental degradation.

In relation to soil erosion, sedimentation and land degradation in general the Department advises that the REF should address at least, but not be limited to the following issues:-

- ⇒ topography
- ⇒ landform
- ⇒ soil type
- ⇒ soil erodibility
- ⇒ site capability
- ⇒ potential for salinity problems.
- ⇒ acid sulfate and potential acid sulfate soils
- ⇒ vegetation management
- ⇒ erosion and sediment control strategy including techniques

Acid Sulfate Soils.

Deposited NSW coastal soils that are within one metre sea level (AHD) have a high potential to be affected by acid sulfate soil (PASS) materials.
If the site is within five metres AHD anywhere east of the Blue Mountains, a soil survey and soil analysis program should be conducted by the proponent to determine the potential, and extent of the problem. The REF will need to provide the Consent Authority with a management plan illustrating how they will treat the material, if this soil will be disturbed.

The Department recommends that the level of assessment and details within the acid sulfate management plan are consistent with the NSW Government guidelines regarding Assessing and Managing Acid Sulfate soils from the *Acid Sulfate Soil Manual*, Department of Urban Affairs and Planning. (1998)

Saline Soils

All developments occurring on the soils derived from the shales on the Cumberland Plain and other known areas of saline soil risk, have a high potential to be adversely impacted upon be a rising saline ground water table. Any development which clears vegetation, (particularly trees), and developments that are in the lower parts of the local landscape could cause a salinity impact, either on the site or off the site, and may not occur for several years after the development.

There are three factors to the development of salinity in an area. These are the salts that are contained within the vertical profile (whether topsoil, subsoil or bedrock); a shallow groundwater table (that will allow mobilisation of salts within the soil or bedrock) or, a shallow saline groundwater table.
In order to ascertain the presence of these factors it is recommended as a minimum:

1. Soil testing be undertaken at least every 500-1000m^2 and samples should be taken of the top 15cm, 15-30cm, 30-50cm, 50 -75cm and 75cm to 1m. If there is a salt crust anywhere on the site, a separate sample of the top 2cm should be undertaken. The location of sampling should ensure that the site is adequately represented in the results.

   Note that when electrical conductivity is tested for the soil samples, the results should ensure that conversion factors allowing for the texture of the soil have been taken into account. A raw reading for electrical conductivity with no corrections for texture will give an incorrect and misleading result.

2. Water samples should be taken from piezometers and measure for electrical conductivity. Note that the position of groundwater relative to the ground surface is very important as a shallow watertable (<3m) will affect surface conditions. This may change over time (especially during and after rainfall events) so that a data recorder may be necessary unless frequent recordings can be taken manually.

It is strongly recommended that an electromagnetic induction survey be undertaken of the entire site to determine areas at risk. Proposed development(s) can then be undertaken with reference to this information especially in terms of future drainage, stormwater retention, open space and zoning requirements.

Please note that conditions are subject to change over time whether or not development is undertaken, and that the results of the above tests do not provide any guarantee that salinity will not become a land management issue in the future.
These impacts need to be considered, and remediation strategies developed to minimise the potential impacts. If your site occurs in these soils or locations, then you are advised to seek more site specific advice from Adam Lillycrap, Salinity Officer, phone contact 4722 1188

Erosion and Sediment control Plan

An integrated site development plan needs to be prepared, incorporating an Erosion and Sediment Control Plan, for the REF. This plan shall cover the life of the proposed site extension, rehabilitation and closure, and ensure that the site land is stabilised to standards of the *Managing Urban Stormwater, Soils and Construction.* NSW Dept of Housing,, 1998, 3 Ed, and Consent Authority (which ever is the greater). The plan at the REF stage should be detailed enough to enable any reviewer to determine that the concepts for control are sound and practical. The sizes and location of control works should be according to design and the accepted policies, and the revegetation/ landscape plan will enhance the native vegetation biodiversity of the site. It is expected that the following detail will be made available upon request, if required. This same detail is what will be required before the Construction Certificate stage.

- ⇒ Soils investigation to determine erosion and sediment control design
- ⇒ Details on proposed erosion control practices
- ⇒ Details on proposed sediment and pollution control practices
- ⇒ Discharge calculations for diversionary works
- ⇒ Design specifications for banks and sediment basins

- ⇒ Detailed rehabilitation practices including selection of tree, shrub and cover crop species and implementation method
- ⇒ Maintenance and monitoring program for sediment and pollution control structures
- ⇒ Assessment of off-site impacts for surface flow from the development
- ⇒ Rehabilitation proposal for existing erosion on or adjacent to the site
- ⇒ Plans at suitable scale and with diagrams and notation clearly displayed
- ⇒ Details of development works for sequence and staging
- ⇒ Location of critical areas (water bodies, drainage lines, unstable slopes, rock outcrops, hard cover areas, flood plains and wet areas).
- ⇒ Location of all earthworks including roads, areas of cut and fill or land regrading
- ⇒ Diversion of uncontaminated up-site runoff areas to be disturbed
- ⇒ Existing and final contours
- ⇒ Revegetation program

Native Vegetation Conservation Strategy.

The Commonwealth and NSW Governments have a strategy for protecting native vegetation. The performance indicator for this strategy is the concept of no net loss.
No net loss is the enhancement of both the quality and extent of native vegetation in the long term as a result of retention and adequate offsets for losses across a specified area.
To offset an activity means to compensate for the negative impacts of that activity, by taking a separate action with equal or greater positive impacts.

The proponent will need to demonstrate how this strategy will be met.

Vegetation - Cumberland Plains areas.

All developments occurring on the soils derived from the shales on the Cumberland Plain should not remove or harm native vegetation from the site. This is before checking whether the vegetation is the Endangered Ecological Community called the Cumberland Plain Woodland, and the appropriate authority issued by the National Parks and Wildlife Service.

Vegetation other Endangered Ecological Communities

If there is any native vegetation upon the proposed development site\s, the proponent must check that there is no other Endangered Ecological Communities. There have been several recently listed, and an up to date listing, details of potential location, and description should be obtained from National Parks and Wildlife.

Vegetation - Native vegetation establishment near native vegetation areas.

The Department recommends that developments integrate an endemic native revegetation program. This is to minimise or prevent potential environmental weeds spreading into any existing nearby native vegetation areas and to minimise the fragmentation of any native vegetation by the development.

Vegetation - Native plant enhancement.

The Department recommends that developments, where applicable, integrate a bush regeneration program within the development. This is to minimise the on and off-site environmental weed invasion potential and enhance any native vegetation.

I trust the above comments will be useful in the preparation of the REF. The Department will require three full copies of the REF to be sent to Greg Brady, Environmental Review Co-ordinator, at the address supplied. Should you have any questions please contact Greg Brady on (02) 9895 7441.

Yours sincerely,

for
Marwan El-Chamy
Resource Access Manager
Sydney/South Coast Region

FAXED

Agility

? April 2002

Environmental Planning Pty Ltd
Unit 8
1051 Pacific Hwy
Pymble NSW 2073

Attention: Mr B Adcock

Dear Sir,

Re: Review of Environmental Factors for the widening of Sunnyholt Road at Glenwood

Thank you for your letter and plan of 13 March 2002 advising Agility Services of the proposal for widening of Sunnyholt Road at Glenwood.

To confirm, AGL Gas Networks has high and low pressure gas systems in the subject location as shown on the company's mains plans, copy attached. It appears from the RTA drawing no 8005.040.CD.0001, that some assets may be affected by the proposal and as such can be adjusted to suit the dynamics of the proposal.

If you require further information please do not hesitate in contacting myself on telephone number 8977 6534.

Yours Faithfully
Agility Services Pty Ltd

ames Maldon
nior Land Services Officer

Agility Services Pty Ltd ACN 009 641 187 ABN 86 009 641 187
Building A, 18 Rodborough Road, Frenchs Forest NSW 2086. PO Box 6300, Frenchs Forest Delivery Centre NSW 1640
Call 02 8977 6534 Fax 02 8977 6819 e-mail james.maldon@teamagility.com.

BLACKTOWN ID

SCALE 1:2000

50 0 50 100 150 200

THIS MAP UPDATED ON 15/8/01
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.

B1A	B1B	B2A
B1C	B1D	B2C
B4A	B4B	B5A

ADJOINING MAPS

489 / 848	845	BLACKTOWN
NETWORK AREA		MUNICIPALITY AREA

AGL

KEY

MAX ALLOWABLE OPERATING PRESSURE

—T—	TRUNK MAIN	7000 kPa
—P—	PRIMARY MAIN	3500 kPa
—S—	SECONDARY MAIN	1050 kPa
		300 kPa
		210 kPa
		7 kPa
—400—		400 kPa
—100—		100 kPa
		2 kPa
	PROPOSED MAINS	
PR 3-2 3	STEEL MAIN PROJECT NUMBER	
P	PRESSURE MONITORING STATION	
	VALVE	
	SYSTEM PRESSURE REGULATOR	
	SIPHON	
123	NETWORK NODES	
1233	ITEM DETAIL SKETCH AVAILABLE	
(814)	VALVE NUMBER (OLD NUMBERING)	
6NB	6 INCH CAST IRON MAIN	
150MM	150MM STEEL MAIN	
110MM PE/NY	110MM POLYETHYLENE/NYLON MAIN	
(6)NB 50MM NY	50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN	
1.2MBL	DISTANCE IN METRES OF MAIN FROM BUILDING LINE (TOLERANCE OF 0.4M)	
1957	YEAR LAID	
-+++-	MUNICIPALITY BOUNDARY	
	NETWORK BOUNDARY	
62	HOUSE NUMBER	

BLACKTOWN IC

SCALE 1:2000

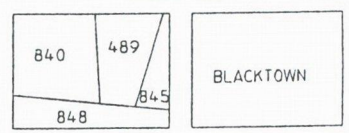
50 0 50 100 150 200

THIS MAP UPDATED ON 21/03/02
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.

DATE ALTERED:..... BY:.....

RH3B	B1A	B1B
RH3D	B1C	B1D
RH6B	B4A	B4B

ADJOINING MAPS



NETWORK AREA MUNICIPALITY AREA

AGL

KEY

MAX ALLOWABLE OPERATING PRESSURE

T	TRUNK MAIN	7000 kPa
P	PRIMARY MAIN	3500 kPa
S	SECONDARY MAIN	1050 kPa
		300 kPa
		210 kPa
		7 kPa
400		400 kPa
100		100 kPa
		2 kPa
	PROPOSED MAINS	
DR 8-2 1	STEEL MAIN PROJECT NUMBER	
P	PRESSURE MONITORING STATION	
	VALVE	
	SYSTEM PRESSURE REGULATOR	
	SIPHON	
123	NETWORK NODES	
1238	ITEM DETAIL SKETCH AVAILABLE	
66	VALVE NUMBER (OLD NUMBERING)	
6NB	6 INCH CAST IRON MAIN	
150MM	150MM STEEL MAIN	
110MM PE/NY	110MM POLYETHYLENE/NYLON MAIN	
6NB 50MM NY	50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN	
1.2MBL	DISTANCE IN METRES OF MAIN FROM BUILDING LINE (TOLERANCE OF 0.4M)	
1957	YEAR LAID	
	MUNICIPALITY BOUNDARY	
	NETWORK BOUNDARY	
62	HOUSE NUMBER	

BLACKTOWN IC


BLACKTOWN
4A
SCALE 1:2000
50 0 50 100 150 200
THIS MAP UPDATED ON 8/02/02
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.
RH3D
BIC
BID
RH6B
B4A
B4B
RH6D
B4C
B4D
ADJOINING MAPS
848
056
NETWORK AREA
BLACKTOWN
MUNICIPALITY AREA
AGL
KEY
MAX ALLOWABLE OPERATING PRESSURE
T TRUNK MAIN 7000 kPa
P PRIMARY MAIN 3500 kPa
S SECONDARY MAIN 1050 kPa
300 kPa
210 kPa
7 kPa
400 400 kPa
100 100 kPa
2 kPa
PROPOSED MAINS
PR 17-2-3 STEEL MAIN PROJECT NUMBER
PRESSURE MONITORING STATION
VALVE
SYSTEM PRESSURE REGULATOR
SIPHON
123 NETWORK NODES
1234 ITEM DETAIL SKETCH AVAILABLE
VALVE NUMBER (OLD NUMBERING)
6NB 6 INCH CAST IRON MAIN
150MM 150MM STEEL MAIN
110MM PE/NY 110MM POLYETHYLENE/NYLON MAIN
6NB 50MM NY 50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN
1.2MBL DISTANCE IN METRES OF MAIN FROM BUILDING LINE (TOLERANCE OF 0.4M)
1957 YEAR LAID
MUNICIPALITY BOUNDARY
NETWORK BOUNDARY
123 HOUSE NUMBER
BLACKTOWN 4A
EXPIRED
FALKLAND CRES
KALAN PL
CAMORTA CL
PALAWAN AVE
MADAGASCAR
MELLESLEY DR
BATAAN CRES
BARNEY
GARLING ST
TATTERSALL RD
VARDYS RD
VALEDICTION
TOBIAS PL
GILBERT CRES
CLEVELEY AVE
HAWKESWORTH PDE
LITTLEBOY ST
ELSOM
EVAN PL
SUNNY
LEBROMATEN
MELISSA PL
RONFORD RD
EGGLETON ST
ANTHONY
REDWOOD ST
RAYMOND ST
FREDERICK ST
TURNER ST
CHARLES
FORGE
BESSEMER ST
BREAKFAST CREEK
PURGE & DECOMMISSION 80MM ST & 6NB MAIN D/A/96 015039
LAY 170M x 150MM ST D/A/95 015039

Sydney
WATER

4 June 2002

Mr Bruce Adcock
Director, Environmental Planning Pty Ltd
PO Box 6112
PYMBLE NSW 2073

Dear Mr Adcock

Re: Review of Environmental Factors (REF) for the Widening of Sunnyholt Road at Glenwood

I refer to your letter of 13 March 2002 seeking information and comments from Sydney Water for consideration in the REF. Thank you for giving Sydney Water the opportunity to comment.

Sydney Water's comments regarding projects of this nature typically relate to the proper management of the following general requirements:

1.0 General Requirements

In general terms, Sydney Water would require the proponent of a development of this nature to:-

- Avoid impact on and/or adequately protect the Corporation's existing water, wastewater and stormwater related infrastructure within the proposed route/corridor (including those routes identified for construction of Sydney Water infrastructure in the future).
- Ensure adequate access is provided to Sydney Water infrastructure during both the construction and normal operation of the Transitway.
- Adequately access the liability and cost issues relating to the relocation and readjustment of affected Sydney Water assets.
- Create and/or extend water-related pipeline easements during the design and construction of Transitway infrastructure to provide adequate protection for existing and proposed Sydney Water infrastructure, in keeping with the principles currently being developed in the draft RTA/SWC agreement process.

It is essential that RTA addresses the general requirements outlined above both during the construction phase and planned operational life of the proposed works.

During the construction phase impacts on Sydney Water infrastructure will need to be adequately managed to ensure that services to the Corporation's customers are protected and are not disrupted.

Sydney Water Corporation ABN 49 776 225 038
115-123 Bathurst Street Sydney NSW 2000 Australia PO Box A53 Sydney South NSW 1232 Australia
Telephone (02) 9350 6969 Facsimile (02) 9350 6814 DX 14 Sydney Internet www.sydneywater.com.au

2.0 Specific Infrastructure

The following provides an overview of specific infrastructure likely to be affected by the widening proposal.

Existing Infrastructure
Specific existing infrastructure likely to be affected by the proposal is indicated on the attached Maps 1-3. Marayong Water Reservoir is located to the north of the Orbital intersection with Sunnyholt Road and therefore there are many water mains in the vicinity.

Planned Infrastructure
Sydney Water has planned the construction of a new 750mm water main from Marayong Water Reservoir across and down Sunnyholt Road and 2 new 900mm water mains in Meurants Lane and Sunnyholt Road. The current anticipated construction date for the 750mm and one of the 900mm pipelines is 2007. The second 900mm pipeline is scheduled for 2015 or later. The attached Map 4 indicates the approximate location of these planned works.

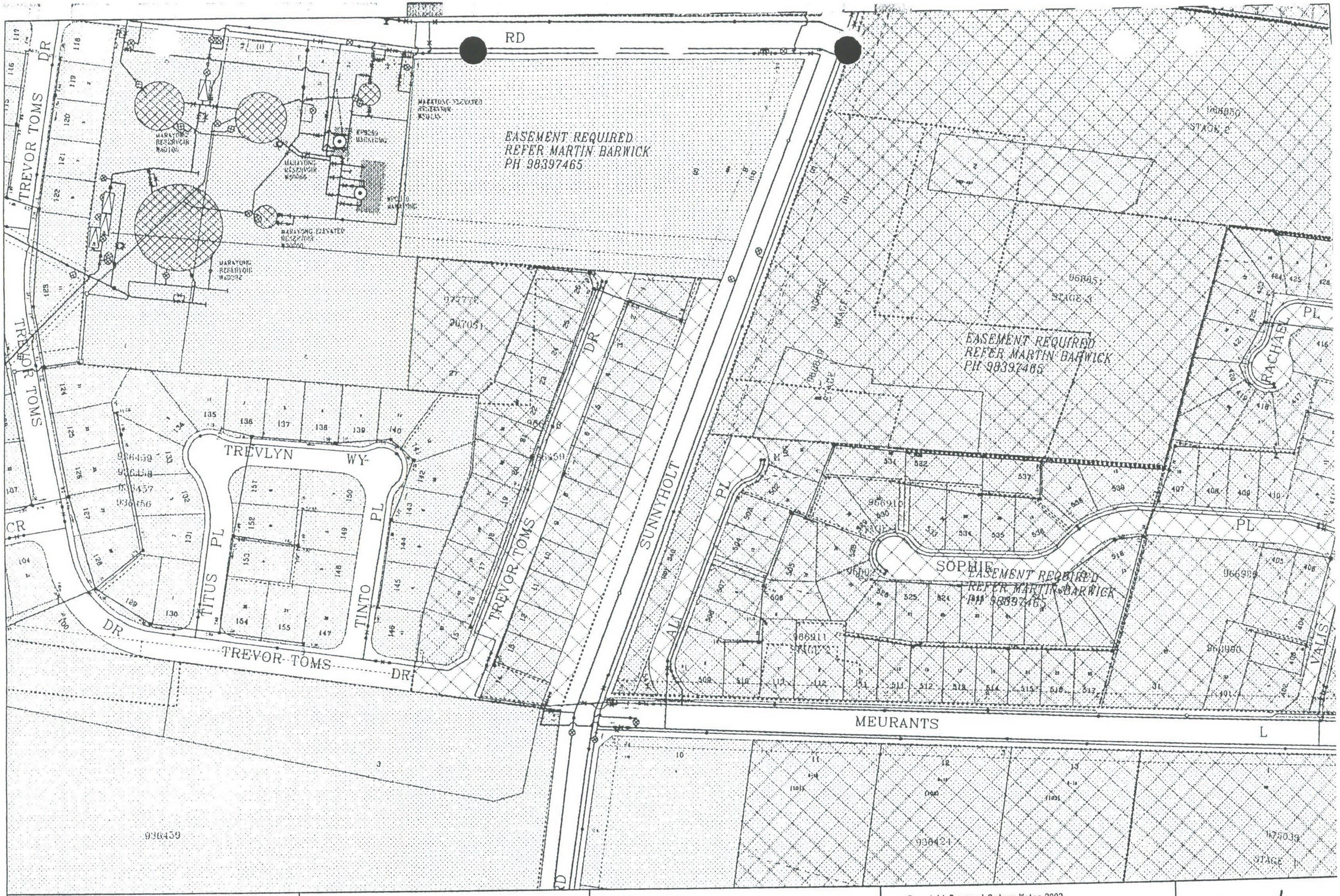
It is important that the Orbital design allow Sydney Water to place these watermains in the future and to have easy future access at all times. This will require liaison between Sydney Water, RTA and Transitway project managers at concept planning and detailed design stage.

Private Rising Main - Sunnyholt Road
There is a private rising sewermain from Parklea Caravan Park (Parklea Garden Village) that may require adjustment. One option for the asset owner to consider is to connect to the Rouse Hill sewerage system. This would be at the owner's expense however and the cost is likely to be substantial. Any adjustments / relocation or other modifications to the existing private rising sewermain in Sunnyholt Road serving Parklea Garden Village Caravan Park is the responsibility of the Caravan Park owners.

Should you require any further information and/or clarification, please contact Darren Wood on telephone 9350 5842 or e-mail darren.wood@sydneywater.com.au at the Development Coordination Branch.

Yours sincerely,

for John Stevens
Manager Development Coordination Branch



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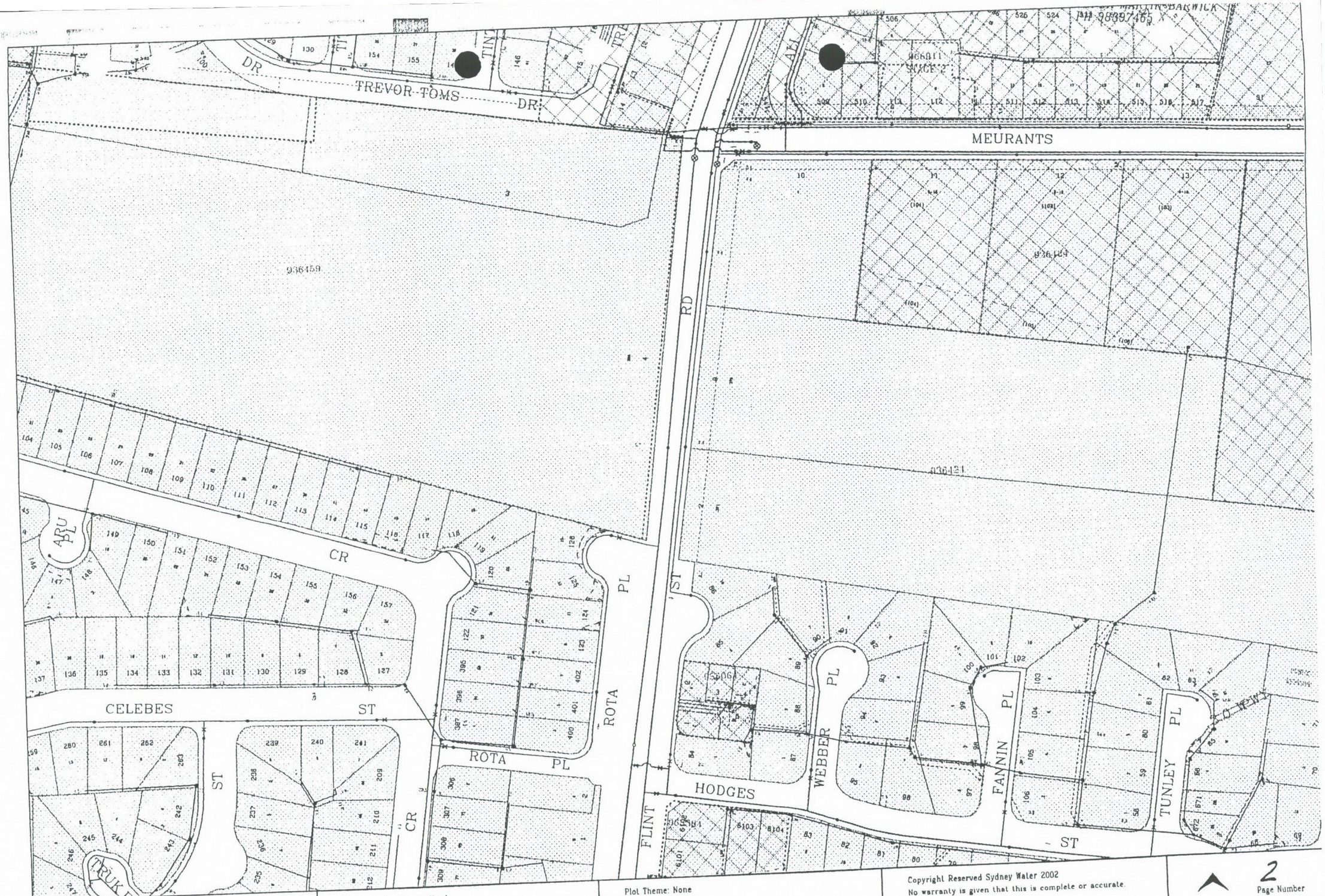

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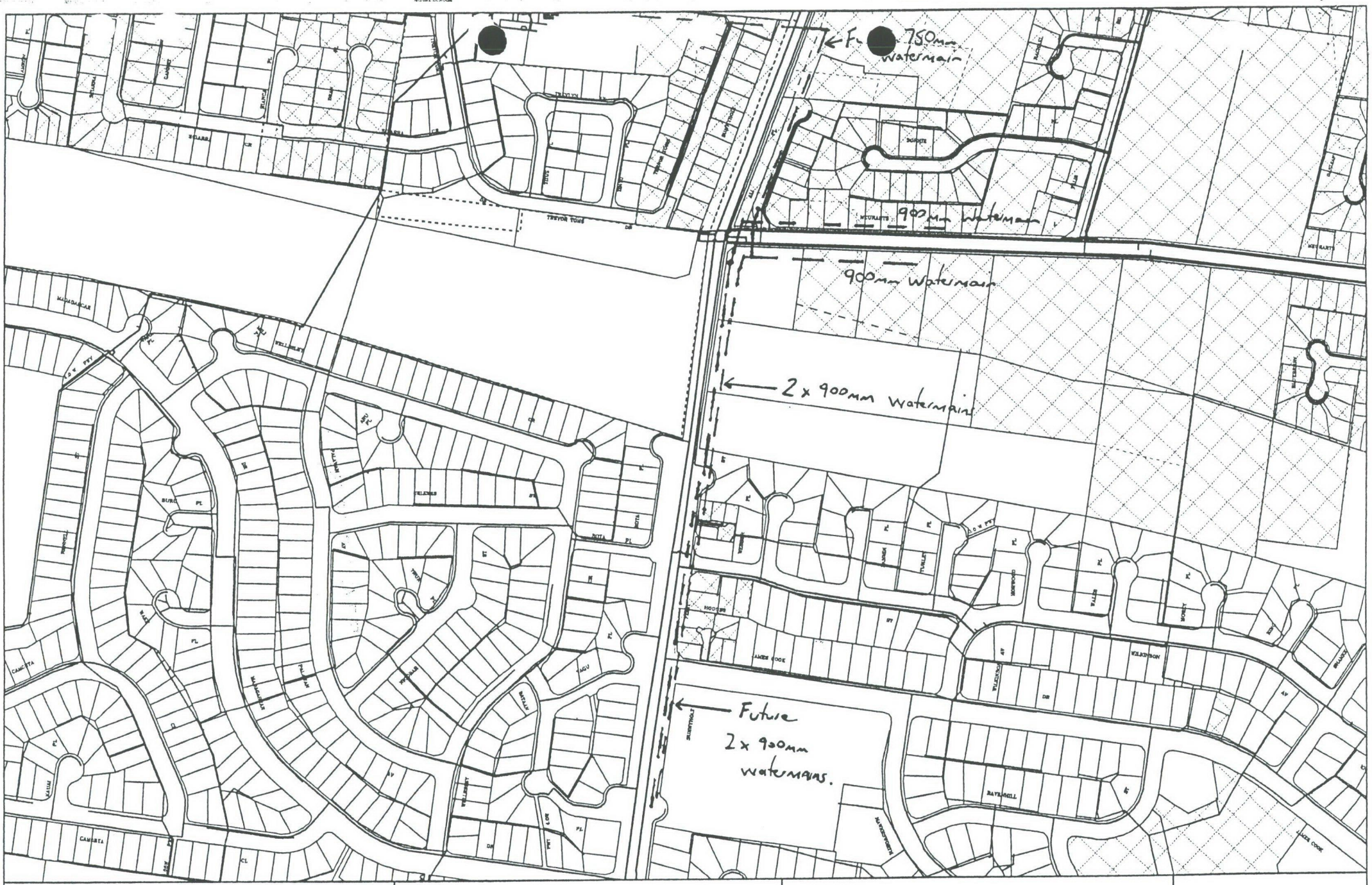

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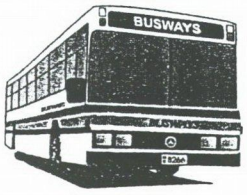
FUTURE WATERMAINS



BUSWAYS

BUSWAYS Group ABN 53 085 318 524
Level 5, 37 Ryde Road (Locked Bag 61)
PYMBLE NSW 2073
Telephone: (02) 9418 4511 Facsimile: (02) 9418 448

Registered Properties:
Busways North P/L ABN 29 084 980 263 Busways West P/L ABN 78 084 946 01
Busways South P/L ABN 80 084 946 083 Busways East P/L ABN 75 001 910 85

10 April 2002

Mr Bruce Adcock
Director
Environmental Planning Pty Ltd
PO Box 6112
PYMBLE NSW 2073

Dear Sir,

Review of Environmental Factors for the widening of Sunnyholt Road, Glenwood

Thank you for your letter of 13 March 2002 seeking Busways' comments on the REF for the widening of Sunnyholt Rd at Glenwood, and I apologise for the delay in replying.

The following points are forwarded for your consideration;

1. Busways will not require access to or from Meurants Lane, as Malvern Rd will be used for access to the Glenwood area. Therefore, it is suggested that Meurants Lane should be closed at Sunnyholt Rd after the intersection of Malvern Rd / Sunnyholt Rd is signalised.

2. The left turn from the Transitway into James Cook Drive should be made available for use by buses on the assumption that Busways will be permitted to use the Transitway between Malvern Rd and James Cook Drive.

3. The retention of existing bus stops needs to be considered if use of the Transitway stations is not permitted, or is operationally inappropriate, for local bus services.

I trust that these comments assist you in finalising the REF for the widening of Sunnyholt Rd. If I can be of any further assistance, please contact me on 9497 1878.

Yours sincerely,
Busways Group

Trevor Jennings
Planning and Infrastructure Manager

S'holtRdWidening.doc

"Providing quality public transport"

From : Integral Energy

RECEIVED 9/4/02

21 March 2002

Mr Bruce Adcock
Environmental Planning Pty Ltd
PO Box 6112
Pymble NSW 2073

Dear Sir

Review of Environmental Factors, Widening of Sunnyholt Rd, Glenwood.

Thank you for the opportunity to provide input into your deliberations regarding the above matter.

The widening of Sunnyholt Rd in the location shown will have a major impact on Integral Energy's assets supplying the area. The eastern side of Sunnyholt Rd has subtransmission assets the entire length of the proposal. There is also overhead and underground 22kV, 11kV, distribution and street light assets along the proposed route. All these assets may need to be relocated, either in their existing form or converted to underground, prior to the commencement of work.

The final proposal by the RTA will need to be closely scrutinised to determine the full impact and cost of any work required on Integral Energy's assets to facilitate construction of the proposed transit way.

Your continued contact with Integral Energy in regard to this matter will be greatly appreciated. This will allow time to conduct the necessary review and design for any work required for relocate assets in order to meet construction deadlines.

Yours faithfully

Malcolm Grebert
Project Designer
Asset Management, Seven Hills

Your contact: Malcolm Grebert ☎ Direct: Fax: (02) 9853 7608
In Reply Quote: 2002/00331/001
Huntingwood Drive, Huntingwood NSW 2148
Telephone: 131 081 Facsimile: (02) 9853 6000
Postal Address: PO Box 6366, Blacktown NSW 2148. DX 8148 Blacktown
integral@integral.com.au

Issue	Summary	RTA Response
		late October 2002 the RTA allowed all movements into and out of Meurants Lane at Old Windsor Road which has increased traffic along Meurants Lane. The proposed access restrictions at the intersection of Sunnyholt Road and Meurants Lane should reduce the future traffic along Meurants Lane.
Wilson Road	Right turn out of Wilson Road required. Close Wilson Road at Sunnyholt Road altogether, or close for traffic except buses.	Recent reviews of the area indicated that if Wilson Road was fully closed the volumes in Chase Drive would be undesirable given the presence of a primary school. Wilson Road would therefore be closed to right turning traffic in and out, except for buses. Normal right turn traffic could use Quakers Hill Parkway to access the area. This is a change from that indicated in the Newsletter, where it was shown that all traffic could turn right into Wilson Road. Instead only buses would be able to make this turn right.
Malvern Road	Concerns at Malvern Road intersection, right turn out of Malvern Road required.	The proposed arrangement would allow vehicles to turn right into Malvern Road at the same time as vehicles turn left out of Malvern Road. This would be a very efficient arrangement. Allowing the right turn out of Malvern Road would introduce another movement/phase which would conflict with the right turn into Malvern Road from Sunnyholt Road. Northbound traffic on Sunnyholt Road would need to stop to allow right turns out of Malvern Road which would introduce a further delay. Vehicles could turn right into Sunnyholt Road from Sorrento Drive which is about 700 metres north of Malvern Road. It is considered that Sorrento Drive can accommodate the increase in right turn traffic. Right turns out of Meurants Lane are prohibited in peak hours and right turn movements out of Malvern Road in peak hours are minor. The RTA is not aware of any congestion at Sorrento Drive - right turning traffic is light.
Quakers Hill Parkway	Additional left turn facilities are required at Quakers Hill Parkway or turn left anytime.	Four exit lanes are proposed to be provided in Quakers Hill Parkway. The RTA is aware of the current delays and queuing for left turn traffic. The opening of the WSO should change traffic patterns - more traffic is expected to turn right than left. Conditions will be monitored and the lanes will be marked to minimise delays. Two of the lanes would be marked as left turning lanes and two as right turning lanes. A review after opening will be conducted to establish traffic demand and if any changes are required. This is a change from what was shown in the Newsletter.
Quakers Hill Parkway	Bridge along Quakers Hill Parkway needs additional width.	The bridge at Quakers Hill Parkway is outside of the scope of this proposal.
WSO	Two left turn lanes into the eastbound ramp to the WSO are required.	The left-most through southbound lane could become a shared through/left turn lane if necessary.
General	Too many lights between James Cook Drive and Quakers Hill Parkway and Parklea.	Although an attempt has been made to limit the number of traffic signals, it is unavoidable in most cases to limit the number of signals further due to bus and pedestrian movements. In many cases right turns have been banned at intersections in order to cut down phases to improve efficiency and reduce delays.

Issue	Summary	RTA Response
General	Taken too long to upgrade.	There are many competing projects in Sydney, and funding is limited.
General	Additional capacity at Vardys Road.	Vardys Road is outside of the scope of this proposal.
General	Works at James Cook Drive will make it busier than it already is in the area.	The modelling shows that traffic along James Cook Drive is unlikely to increase significantly as a result of this proposal.
General	Lanes should be 3.5 m wide.	Standard lane widths have been adopted for this proposal as prescribed through various policies and guidelines in the RTA. These policies have been discussed with various truck/industry bodies.
General	Cyclists facilities on eastern side.	Due to space limitations, cyclist facilities can only be provided on one side. This is in accordance with standard RTA policies and other projects around Sydney.
General	Concerns about delays during construction.	Delays during construction will be minimised by carefully staging the construction. A 2-lane side track would be constructed clear of the traffic. The existing road would then be used as two lanes in the opposite direction, thereby providing 4 through lanes. The full 6 lanes would be provided for traffic at or prior to the opening of the WSO.
General	Pedestrian safety and amenity concerns.	The RTA has attempted to ensure safe pedestrian and cyclist facilities are provided.
General	When is construction starting on WSO?	Construction is expected to commence in December 2002.
General	Bus lanes should not be used, they are regarded as a waste.	The transitway is a separate proposal.
General	Maintenance of Sunnyholt Road to James Cook Drive is required.	The RTA will look at the maintenance issues raised and carry out appropriate work as required.
General	Merging concerns for 6 lanes back down to 4 lanes.	Although the traffic can be catered for with 4 lanes at the moment, modelling has shown that once the WSO is constructed, there will be 6 lanes required to cater for the traffic. Merging is likely to occur north of Quakers Hill Parkway, and where through lanes change into dedicated turn lanes (such as at James Cook Drive). The merging at these locations is not expected to be difficult.
General	Left out of Madagascar Road can't get in right lane to James Cook Drive.	Madagascar Road is outside of the scope of this proposal, however the upgrading north of James Cook Drive is expected to ease congestion and delays at Madagascar Road. This could make access to the right turn lane at James Cook Drive easier.
General	More right turn movements along Sunnyholt Road required.	Right turn movements are permitted at several intersections. These include: Sorrento Drive, Quakers Hill Parkway and James Cook Drive. Vehicles can also turn right into Malvern Road.

Issue	Summary	RTA Response
General	Noise, where are noise barriers proposed.	The proposed location and heights of noise barriers along both sides of Sunnyholt Road is shown in Table 5 and Appendix 7.
General	How will Ali Place operate?	The intersection with Ali Place, will continue to operate in a similar fashion as it currently does, with the exception that right turning traffic out of Ali Place will no longer be required, as traffic will not be able to exit out of Meurants Lane.
General	Use of Cumberland Plain native plant species in landscaping.	The RTA uses as much as possible suitable local plant species for landscaping along its roads. The use of Cumberland Plain native plant species would be incorporated as part of the landscaping (see Landscape Concept Plan in Appendix 5).
General	Will pedestrian crossing facilities be provided at the signalised intersections?	The RTA is proposing to install pedestrian crossing facilities at all signalised intersections.

APPENDIX 3

Air Quality Impact Assessment
Proposed Widening of Sunnyholt Road

November 2002, Holmes Air Sciences

AIR QUALITY IMPACT ASSESSMENT

PROPOSED WIDENING OF SUNNYHOLT ROAD

FINAL November 2002

Prepared
for
Environmental Planning

by

Holmes Air Sciences

2B 14 Glen Street
Eastwood NSW 2122
Tel: 61 2 9874 8644
Fax: 61 2 9874 8904
Email: has@holmair.com.au

CONTENTS

FIGURES

All figures at end

TABLES

Page

1 INTRODUCTION

This report has been prepared by Holmes Air Sciences for Environmental Planning Pty Ltd who are in turn acting for Roads and Traffic Authority of New South Wales (NSW RTA). Its aim is to assess the air quality impacts of the construction and operation of the proposed widening of Sunnyholt Road at Glenwood in western Sydney.

The assessment of the impacts of motor vehicle emissions is based on the use of a computer model to determine the dispersion of emissions and to predict ground-level concentrations of the various exhaust components in the area close to the road. The primary pollutants of concern are carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter. Since the introduction of unleaded petrol, there has been a steady and unambiguous decline in lead air levels in Australian cities. The new National Standard for Fuel Quality has resulted in a ban on the supply of leaded petrol containing more the 0.005 g/l of lead from January 1 2002. Lead levels in urban areas, without other local sources of lead, will therefore continue to decline. Lead has therefore not been considered in this assessment.

2 PROJECT DESCRIPTION

The RTA proposes to widen Sunnyholt Road for 1.56 km from 100 metres south of James Cook Drive to 260 metres north of Quakers Hill Road Parkway.

Sunnyholt Road serves local, commuter, business and freight traffic but would not meet road safety and capacity standards with the anticipated large growth in traffic especially after the West Sydney Orbital (WSO) opens in 2006.

The proposal would involve the reconstruction and widening of Sunnyholt Road from two to six lanes plus turning lanes with a raised median, shared cycleway and pedestrian path on the west side and a footpath on the east side. The widening would accommodate a major interchange with the WSO with space for the proposed rapid bus only transitway between Blacktown and Castle Hill. The environmental impact assessment for the rapid bus only transitway will be reported separately.

3 AIR QUALITY CRITERIA

3.1 Introduction

The New South Wales Environment Protection Authority (EPA) has historically noted air quality goals for nitrogen dioxide, carbon monoxide and particulate matter determined by the World Health Organisation (WHO), the United States Environmental Protection Agency (US EPA) and the National Health and Medical Research Council of Australia (NHMRC). Air quality goals for hydrocarbons have been used previously, but these have been discarded because they are not specific for **reactive** species which are the important elements in the formation of photochemical smog.

The National Environment Protection Council of Australia (NEPC) has determined a new set of air quality goals for adoption at a national level, which are part of the National Environment Protection Measures (NEPM). In its publication "Action for Air" (**EPA, 1998**), the NSW EPA has adopted new air quality goals for particulate matter and nitrogen dioxide. These make the NSW standards for these emissions consistent with the NEPM standards.

Table 1 lists the EPA's air quality goals for New South Wales including the historical goals and newly adopted goals. Not all of these are major emissions from motor vehicles. Also included are goals for air toxics and odorous compounds which are minor emissions from motor vehicles. These goals are drawn from WHO, the United Kingdom and the Victorian EPA (VEPA). The goals that have been applied in assessing this project are shown in bold print. The basis of these air quality goals and, where relevant, the safety margins which they provide are outlined below.

3.1.1 Carbon monoxide

Carbon monoxide can be harmful to humans because its affinity for haemoglobin is more than 200 times greater than that of oxygen. When it is inhaled approximately 80-90% of the absorbed CO binds with haemoglobin to form carboxyhemoglobin (COHb). During exposure to a fixed concentration of CO, the COHb concentration increases rapidly at the onset of exposure, starts to level off after 3 hours, and reaches a steady-state after 6-8 hours of exposure.

Symptoms of carbon monoxide intoxication are lassitude and headaches, however these are generally not reported until the concentrations of carboxyhemoglobin in the blood are in excess of 10% of saturation. This is approximately the equilibrium value achieved with an ambient atmospheric concentration of 70 mg/m^3 for a person engaged in light activity. However, there is evidence that there is a risk for individuals with cardiovascular disease when the carboxyhemoglobin concentration reaches 4% and the WHO recommends that ambient concentrations be kept to values which would protect individuals from exceeding the 4% level.

The 15-minute, 1-hour and 8-hour goals noted by the EPA provide a significant margin for safety, however this is appropriate for this type of guideline, which is designed to protect a wide range of people in the community including the very young and elderly. The 15-minute, 1 hour and 8 hour goals are 108 mg/m^3, 30 mg/m^3 and 10 mg/m^3 respectively.

3.1.2 Oxides of nitrogen

Nitrogen oxides (NO_x) emitted by motor vehicles are comprised mainly of nitric oxide (NO, approximately 95% at the point of emission) and nitrogen dioxide (NO_2, approximately 5% at the point of emission). Nitric oxide is much less harmful to humans than nitrogen dioxide and is not generally considered a pollutant with health impacts at the concentrations normally found in urban environments. Concern with nitric oxide relates to its transformation to nitrogen dioxide and its role in the formation of photochemical smog. Nitrogen dioxide has been reported to have an effect on respiratory function although the evidence concerning effects has been mixed and conflicting. The EPA has not set any air quality goals for nitric oxide, however it has set 1-hour and annual average goals for nitrogen dioxide. It has adopted the NEPM standard of 0.12 ppm or 245 $\mu g/m^3$. It has also adopted the WHO 1-hour goal of 0.11ppm or 200 $\mu g/m^3$ as a long term reporting goal.

3.1.3 Hydrocarbons

Hydrocarbons alone do not generally pose a problem at the concentrations commonly experienced. However, some hydrocarbons such as benzene are known to have an adverse effect on human health (discussed later), but these effects are thought to occur at concentrations higher than the levels of exposure found at roadsides from traffic emissions. Hydrocarbons do play a significant role in photochemical smog formation and, until recently, the air quality standards adopted by the US EPA for non-methane hydrocarbons have been applied in NSW. However it has been recognised that this goal does not distinguish the reactive species which are involved in smog formation from the total hydrocarbon concentration and this air quality goal has been abandoned by the US EPA and the NSW EPA.

There is growing concern about the amount of benzene released in motor vehicle emissions, especially in Europe where fuel has a higher benzene and aromatic content than in Australia. At present NSW has no ambient air quality goal for benzene. The Victorian EPA currently has a limit of 0.10 mg/m^3 (0.033 ppm) (3-minute average). Many in the scientific community hold the view that there is no safe limit for benzene. The WHO specifies a risk factor for developing leukaemia of $6x10^{-6}$ for a lifetime exposure to 1 μg/m^3. The United Kingdom has an annual average ambient benzene goal of 5 parts per billion (ppb) or 16 μg/m^3 to be achieved by 2005. The 5 ppb goal is based on the "No Observable Adverse Effect Level" from the findings of the UK Expert Panel on Air Quality Standards that the risk of leukaemia in workers would not be detectable when the average working lifetime exposure to benzene was less than 500 ppb. Two safety factors of 10 were then applied to derive the goal of 5 ppb.

For the purpose of this study, predicted concentrations were compared with the UK standard of 16 μg/m^3.

3.1.4 Particulate matter

The presence of particulate matter in the atmosphere can have an adverse effect on health and amenity. The health effects of particles are largely related to the extent to which they can penetrate the respiratory tract. Larger particles, that is those greater than 10 μm, generally adhere to the mucus in the nose, mouth, pharynx and larger bronchi and from there are removed by either swallowing or expectorating. Finer particles can enter bronchial and pulmonary regions of the respiratory tract, with increased deposition during mouth breathing which increases during exercise. The very fine particles can be deposited in the pulmonary region and it is these which are of particular concern.

The health effects of particulate matter are further complicated by the chemical nature of the particles and by the possibility of synergistic effects with other air pollutants such as sulphur dioxide.

Much of the recent concern over the health effects of fine particulate matter is based on investigations carried out in the US, with the view to quantifying the health risks associated with both long-term and short-term exposure to airborne particulate matter. The study is colloquially referred to as "The Six Cities Study" from the original work by **Dockery et al. (1993)**, which determined a relationship between fine particulate matter (defined as particles smaller than 2.5 μm in diameter) in the air and mortality in six US cities.

The basic findings of the Six Cities Study is that there is an increase in mortality with increasing concentrations of fine particulate matter. The conclusions appear to be robust and have been supported by subsequent studies and as far as can be determined are not confounded by other known variables.

The US EPA has not changed its PM_{10} (particles less than 10 μm in diameter) goal but has introduced new goals for very fine particles ($PM_{2.5}$) with a 24-hour limit of 65 μg/m^3 and an annual limit of 15 μg/m^3. The NSW EPA has historically noted the US EPA 24-hour air quality standard of 150 μg/m^3 and annual average standard of 50 μg/m^3 for PM_{10}. It now adopts the NEPM 24-hour standard of 50 μg/m^3, and references a new annual average of 30 μg/m^3 as a long-term reporting goal. For completeness, the US EPA goals have been included in **Table 1**, but the current proposal will be assessed using the NEPM standards, adopted by the NSW EPA.

In October 2002, NEPC released a draft variation to the NEPM for $PM_{2.5}$ and Impact Statement for public consultation (**NEPC, 2002a and 2002b**). The standards proposed are a 24-hour average of 25 μg/m^3 and an annual average of 8 μg/m^3. These standards proposed are 'advisory

reporting standards' which do not set a time line for compliance. The goal is to gather sufficient data nationally to facilitate the review of the Air Quality NEPM scheduled to commence in 2005. The draft includes a protocol setting out monitoring and reporting requirements for particles as $PM_{2.5}$. It is not appropriate to compare the predicted concentrations from the widening of Sunnyholt Road to the draft variation which is still out for consultation and sets no time line for compliance.

The NSW EPA also continues to note the NHMRC's 90 $\mu g/m^3$ annual average goal for total suspended particulate matter (TSP). This level is recommended as the maximum permissible level in urban environments.

3.1.5 Ozone

Ozone is a powerful oxidant, formed in the atmosphere in the presence of sunlight, nitrogen oxides and reactive hydrocarbons. It is not a primary emission from motor vehicles but a regional pollutant, being a major component of photochemical smog. Because of its highly reactive nature, ozone can combine with virtually all classes of biologically active molecules including enzymes, proteins and lipids. Cellular membranes are a target for ozone which has also been reported to have an irritant effect on the respiratory system. The air quality goal has been revised downwards from 257 $\mu g/m^3$ (0.12 ppm) to 200 $\mu g/m^3$ (0.10 ppm) for a 1-hour maximum. In addition the EPA now notes a 4-hour ozone goal of 0.08 ppm or 170 $\mu g/m^3$. The revision of the goal to a more stringent standard may result in additional exceedances of the goal without changes to air quality.

3.1.6 Sulphur dioxide

Sulphur dioxide is an acid gas which can have harmful effects on the respiratory system as well as on vegetation and building materials. It is, however, a minor component of motor vehicle emissions, due to the low sulphur content of Australian petrol, and has not been assessed quantitatively in this study. For example the Metropolitan Air Quality Study (MAQS) estimates that for the 1992 fleet, average SO_2 emissions under arterial travel conditions are 0.065 g/km compared to emissions of nitrogen oxides of 2.33 g/km for the same conditions. In addition transient emissions of above average levels of odorous sulphur compounds such as hydrogen sulphide and carbonyl sulphide (which may be smelt at concentrations as low as 5 ppb) have been noted from vehicles fitted with catalytic converters. While these compounds may produce a local short-term nuisance, they do not represent significant emissions under normal running conditions.

Table 1 – Air Quality Goals

Pollutant	Goal	Averaging Period	Agency
Carbon monoxide	87 ppm or 108 mg/m^3	15-minute maximum	WHO
	25 ppm or 30 mg/m^3	**1-hour maximum**	**WHO**
	9 ppm or 10 mg/m^3	**8-hour maximum**	**NHMRC, NEPM**
Nitrogen dioxide	0.16 ppm or 320 µg/m^3	1-hour maximum	NHMRC*
	0.05 ppm or 103 µg/m^3	Annual mean	US EPA*
	0.12 ppm or 246 µg/m^3	**1-hour maximum**	**NEPM**
	0.03 ppm or 60 µg/m^3	Annual Mean	NEPM
Total suspended Particulate matter (TSP)	90 µg/m^3	Annual mean	NHMRC
Particulate matter < 10 µm (PM_{10})	150 µg/m^3	24-hour maximum	US EPA*
	50 µg/m^3	**24-hour maximum**	**NEPM**
	50 µg/m^3	Annual mean	US EPA*
	30 µg/m^3	**Annual mean**	**NSW EPA**
Particulate Matter < 2.5 µm ($PM_{2.5}$)	25 µg/m^3	24-hour average	NEPM advisory reporting standard
	65 µg/m^3	98th percentile averaged over three years	US EPA
	25 µg/m^3	24-hour average	CARB proposal
	8 µg/m^3	Annual average	NEPM advisory reporting standard
	15 µg/m^3	Annual average	US EPA
	12 µg/m^3	Annual average	CARB
Lead	1.5 µg/m^3	90-day average	NHMRC
	0.5 µg/m^3	Annual average	NEPM
Ozone	0.10 ppm or 200 µg/m^3	1-hour maximum	NHMRC, NEPM
	0.08 ppm or 150 µg/m^3	4-hour maximum	NEPM
Sulphur dioxide	0.25 ppm or 700 µg/m^3	10-minute maximum	NHMRC, NEPM
	0.20 ppm or 570 µg/m^3	1-hour maximum	NEPM
	0.08 ppm or 225 µg/m^3	1 day	NEPM
	0.02 ppm or 60 µg/m^3	Annual average	NHMRC, NEPM
Air Toxics and Odorous Compounds:			
Benzene	**5 ppb or 16 µg/m^3**	**Annual average**	**UK**
PAHs (as BaP)	8.7 x 10^{-5} per ng/m^3	Unit risk factor	WHO
1,3-Butadiene	0.45 ppm or 1 mg/m^3	3-minute maximum	VEPA
Acetaldehyde	0.042 ppm or 0.076 mg/m^3	3-minute maximum	VEPA
Formaldehyde	0.033 ppm or 0.05 mg/m^3	3-minute maximum	VEPA

**Historical goals*
ppm – parts per million
µg/m^3 – micrograms per cubic metre
mg/m^3 – milligrams per cubic metre
ng/m^3 – nanograms per cubic metre
PAH – polycyclic aromatic hydrocarbons
BaP – benzo(a)pyrene, the most widely studied PAH and used as an indicator compound
Unit risk factor for BaP refers to the risk of developing cancer from a 70 year exposure to 1 ng/m^3 of BaP.
Project goals are shown in bold print

3.2 *Air quality issues*

3.2.1 *Regional air quality*

The NSW government has completed a major study of air pollution in the Sydney airshed and the Newcastle and Illawarra regions, known as the *Metropolitan Air Quality Study* (referred to as MAQS). The Metropolitan Air Quality Study upgraded and extended the Environment Protection Authority's air quality monitoring network over a wider area. It has also further refined the understanding of the present chemistry and air movements in the Sydney airshed and has updated the emissions inventories. Some aspects of this are discussed in the following sections. However, future air quality projections would need to take account of improved emissions controls or changes in population growth and employment patterns which are emerging.

On the basis of the Metropolitan Air Quality Study findings the EPA has developed a 25 year air quality management plan which is summarised in its publication "Action for Air" (**EPA, 1998**). This document sets out the EPA's priorities for maintaining and improving air quality in the greater metropolitan area.

The Action for Air plan includes the following actions:

- Adoption of new ambient air quality goals, drawing in part from those developed at a Federal level by the National Environment Protection Council (NEPC) which were discussed in **Section 3**. They have been adopted by the EPA for local use and were summarised in **Table 1**.
- Reducing emissions from motor vehicles as high priority and this will be undertaken by improved transport options including bus T-ways, new rail links, encouraging cycling and walking as well as integrating the planning of freight movement.

Heavy-duty diesel vehicles have been identified as a major source of oxides of nitrogen and particulate emissions and these will be targeted by promoting the use of cleaner fuels and alternative technologies for trucks and buses.

3.2.2 *Vehicle emissions and photochemical smog*

Motor vehicle emissions have the potential to contribute significantly to photochemical smog in an urban environment. Photochemical smog is formed by the reaction between nitrogen oxides and reactive hydrocarbons in the presence of sunlight. Models for the formation of photochemical smog envisage hydrocarbon emissions mostly from motor cars, facilities for the storage of hydrocarbons or spray painting operations and so on, mixing with nitrogen oxides from either industrial sources or from motor cars. The mixture of pollution from these sources then reacts photochemically to form photochemical smog comprising mainly ozone, but also including other oxidants. At sufficient concentrations the smog can affect the eyes and respiratory system and can adversely affect plants and materials.

In the past the State Pollution Control Commission (**SPCC, 1983**) (now EPA) has acted to control smog by reducing the amount of hydrocarbons emitted into the Sydney airshed, mainly through the use of catalytic converters on motor cars using unleaded petrol and by other controls on stationary sources. This has led to a substantial reduction in hydrocarbon emissions from individual vehicles. Total hydrocarbon emissions in the Sydney area are estimated to have declined by 20.8% from 1976 to 1992 despite an increase of about 49% in vehicle kilometres travelled (VKT) over the same period (source: data taken from **Eiser and Koo, 1984** and **Carnovale et. al, 1997**).

However, at the same time as hydrocarbon emissions have declined, emissions of nitrogen oxides from motor vehicles have substantially increased. According to the 1992 Metropolitan Air Quality Study (MAQS) estimate the increase has been 68.7% over 1976 levels. At least part of this is due to increases in diesel-powered vehicle emissions which were estimated to comprise about 40% of mobile source emissions in 1992.

The significance (to the formation of photochemical smog) of the change in hydrocarbons relative to emissions of oxides of nitrogen is as follows. The rate at which photochemical smog forms depends on the ratio of hydrocarbon to oxides of nitrogen. If the ratio favours nitrogen oxides, then the process by which ozone or smog is produced is delayed in onset until all the nitrogen oxides are consumed. The reaction then proceeds and the photochemical smog is formed. In simple terms, oxides of nitrogen determines how much ozone can form, while hydrocarbons determine the timing or how quickly it will form. The amount of ozone that is formed also depends on the temperature and the accumulated sunlight, and the concentration that occurs depends on the dilution that takes place as the reacting components are carried downwind.

Part of the aim of the MAQS was to develop an airshed model which could estimate the effect of urban development options on regional air quality, particularly with respect to photochemical smog. However the model is not sufficiently sensitive to be applied to this project where changes in emissions are of a small scale.

3.2.3 Conversion of nitric oxide to nitrogen dioxide

As discussed previously there are no ambient air quality goals for nitric oxide, the major nitrogen oxide emission from motor vehicles. Nitric oxide is however converted to nitrogen dioxide and its rate of conversion is dependent on the presence of oxidising agents. The issue here is the rate at which nitric oxide converts to the more harmful nitrogen dioxide. Analysis of the EPA's oxides of nitrogen monitoring data reveals that the percentage of nitrogen dioxide in the air is inversely proportional to the total oxides of nitrogen concentration. **Figure 1** presents a plot of the mean total oxides of nitrogen (calculated from the mean nitrogen dioxide concentration and the mean total oxides of nitrogen concentration, in ppm) against the mean nitrogen oxide concentration recorded at five sites in Sydney, namely Earlwood, Eagle Vale, Lidcombe, Kensington and Rozelle, from 1988 to 1992.

The trend in the graph shows an inverse correlation between total oxides of nitrogen concentration and percentage of nitrogen dioxide. Average percentages of nitrogen dioxide in the EPA monitoring data range from 5 to 50%, with a mean value of about 30%. These data however, are mostly collected at some distance from roads and while they demonstrate the inverse correlation between total oxides of nitrogen concentrations and nitrogen dioxide concentrations, they do not necessarily reflect the proportion of nitrogen dioxide which will be present close to roadways.

Monitoring data collected by the RTA in Sydney (**RTA, 1997**) indicate that close to the roadways, nitrogen dioxide would make up from 5 to 20% by weight of the total oxides of nitrogen. A conservative value of 15% by weight at 0 – 10 m from the roadway and 20% by weight at 20 – 50 m from the roadway has been used in the impact assessment presented in **Section 6.**

4 DISPERSION METEOROLOGY AND AIR QUALITY ISSUES

4.1 Meteorology and climate

This section describes the dispersion meteorology, general climate and air quality in the location of Sunnyholt Road. As well as information on prevailing wind patterns, historical data on temperature, humidity and rainfall are presented to give a more complete picture of the local climate.

4.1.1 Wind data for Blacktown

The closest meteorological monitoring station with data which can be considered as representative of the prevailing wind patterns along the route is at Blacktown. **Figure 2** presents seasonal and annual wind rose diagrams compiled from these data.

Wind data from Blacktown were collected by Macquarie University in 1984. Blacktown experiences winds predominantly from the north-western and south-eastern quadrants on an annual basis. This is the trend for each season except winter. During winter the winds from the southeast die down but the majority of winds still come from the northwest.

4.1.2 Rainfall, temperature and humidity

Table 2 presents the temperature, humidity and rainfall data for Parramatta North (**Bureau of Meteorology, 2002**). This was chosen as the closest meteorological site to Sunnyholt Road. Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of raindays per month.

From data recorded over 36 years, the annual average humidity at 9 am was 72%. At 3 pm the annual average humidity was 55%. Rainfall data collected show that the annual average rainfall is 983.5 mm per year, with February being the wettest month with a mean rainfall reading of 120 mm. The average number of raindays for this month was 11.8.

Table 2 – Temperature, humidity and rainfall data for Parramatta North
(Station number 066124 Latitude 33 Deg 47 Min S Longitude 151 Deg 1 Min E Elevation 55 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Relative Humidity (%) (36 years of record)													
Dry-bulb	22.4	22	20.8	18	14.6	11.7	10.8	12.5	15.6	18.5	19.6	21.7	17.3
Humidity	73	77	77	74	79	77	73	68	64	63	68	68	72
3 pm Mean Temperatures (C) and Relative Humidity (%) (36 years of record)													
Dry-bulb	26.4	26.3	24.6	22.2	19.1	16.4	16	17.5	19.6	21.7	23.3	25.5	21.5
Humidity	58	59	60	57	60	60	54	48	49	51	55	54	55
Daily Maximum Temperature (C) (36 Years of record)													
Mean	28.1	27.8	26.3	23.8	20.4	17.6	17.2	18.8	21.3	23.7	25.1	27.3	23
Daily Minimum Temperature (C) (36 Years of record)													
Mean	17.4	17.5	15.8	12.8	10.2	7.4	6.2	7.1	9.2	11.9	13.9	16.1	12.1
Rainfall (mm) (36 Years of record)													
Mean	113.6	120	116.2	92	72.7	83	46.6	60.7	53.8	69.5	85.5	70	983.5
Raindays (Number) (36 Years of record)													
Mean	11.9	11.8	12.3	8.8	10.3	10.3	7.7	7.8	8	10.3	11.2	9.7	120.1

Source: Bureau of Meteorology (2002)

4.2 *Existing air quality*

There has been no monitoring undertaken specifically for this project, but there are data available from the EPA monitoring network. The station that is most representative of the location is at Blacktown. The most recent year of data published by the EPA is 2001 (**EPA, 2001**). The monthly average data are summarised in **Table 3**, with monitoring results for carbon monoxide, nitrogen dioxide and particulate matter.

The maximum level of NO_2 measured at Blacktown was 119 $\mu g/m^3$ which is below the NEPM goal of 245 $\mu g/m^3$. The maximum level of carbon monoxide recorded was 6.0 mg/m^3. This is also below the NSW EPA 1-hour goal of 30 mg/m^3.

High volume sampling data (HVAS) at Blacktown provides 24-hour average PM_{10} measurements. The highest of these readings is 44 $\mu g/m^3$ in November 2001. This is below all the 24-hour goals listed in **Table 1**, including the NSW EPA goal of 50 $\mu g/m^3$. The Tapered Element Oscillating Microbalance (TEOM) measurements are continuous recordings of PM_{10} and the 24-hour averages are not presented in the EPA reports (the short-term goal for particulate matter refers to a 24-hour averaging period). The long-term average of 21 $\mu g/m^3$ (TEOM) is below the NSW EPA long-term reporting goal of 30 $\mu g/m^3$ as is the 24-hour annual average of 20 $\mu g/m^3$ at Blacktown for HVAS.

There were three days in 2001 when the 24-hour PM_{10} was exceeded according to TEOM measurements. These were all during bushfire episodes.

These data indicate that air quality in the area is typical of Sydney suburban sites and in 2001 was in compliance with goals noted by the NSW EPA (except during the bushfire episodes). No data are available on dust deposition rates, but concentrations of PM_{10} indicate that levels are likely to be typical of residential areas, that is 1 – 2 g/m^2/month. [As a rule of thumb, annual TSP concentrations of 90 $\mu g/m^3$, which are also equivalent to about 40 – 50 $\mu g/m^3$ of PM_{10}, correspond to dust deposition rates of 4 g/m^2/month. Therefore an annual average of 20 $\mu g/m^3$ (at Blacktown) for PM_{10} would be approximately equal to 1.6 g/m^2 /month ((20/50) x 4)].

Table 3 – EPA monitoring data for Blacktown (2001)

	Blacktown Monthly average (Monthly maximum)						
	CO		NO_2		PM_{10} (TEOM)[a], [b]		PM_{10} (HVAS)[c]
NSW Goal	*31 mg/m³*		*245 µg/m³*		*30 µg/m³*		*50 µg/m³*
Month	mg/m³	No of days above goal	µg/m³	No of days above goal	µg/m³	No of days above goal	µg/m³
January	0.1 (2.1)	0	23 (72)	0	20 (221)	0	20 (26)
February	0.3 (2.0)	0	25 (94)	0	20 (89)	0	16 (22)
March	0.3 (3.0)	0	25 (94)	0	20 (221)	0	20 (35)
April	0.3 (2.6)	0	33 (119)	0	21 (144)	0	19 (36)
May	0.5 (3.9)	0	31 (96)	0	18 (153)	0	17 (26)
June	0.8 (4.5)	0	33 (96)	0	24 (196)	0	24 (41)
July	0.6 (3.9)	0	31 (76)	0	16 (74)	0	14 (23)
August	0.4 (4.4)	0	27 (76)	0	17 (111)	0	15 (23)
September	0.3 (3.8)	0	29 (74)	0	22 (156)	0	18 (39)
October	0.1 (1.8)	0	27 (76)	0	15 (73)	0	16 (26)
November	0.1 (1.8)	0	25 (72)	0	22 (144)	0	28 (44)
December	0.3 (6.0)	0	23 (76)	0	33 (859)	3	27 (40)
Annual average	**0.3**		**27**		**21**		**20**
Annual Maximum	**6.0**		**119**		**859**		**44**

[a] TEOM 1-hour average.

[b] Noted in the EPA data - construction work in the vicinity of the Blacktown monitoring site may have had an effect on PM_{10} concentrations. There were also severe bushfires in the region during December.

[c] High Volume Air Sampling 24-hour average on a 6-day cycle.

5 APPROACH TO ASSESSMENT

The Caline4 dispersion model has been used to estimate the concentration of oxides of nitrogen, carbon monoxide, hydrocarbons and particulate matter that are likely to be produced in the vicinity of the route.

This model is an upgrade of Caline3, the most recent US EPA approved model, and is a steady state Gaussian model which can determine concentrations at receptor locations downwind of "at grade", "fill", "bridges" and "cut section" highways located in relatively uncomplicated terrain. The model is applicable for any wind direction, highway orientation and receptor location.

Although it is technically possible to assess air quality impacts at every sensitive receptor along the route, taking account of local terrain, road grade and distance of the receptor from the road, it is neither feasible within the scope of a Review of Environmental Factors nor indeed necessary to do so for a proposal such as the upgrade of Sunnyholt Road. The very detailed approach is warranted when model validations are being carried out, where actual traffic counts and identification of vehicle types can be matched with contemporaneous monitoring data. Such a study which validated the Caline4 model used in this report has been undertaken in Sydney by **Williams et al. (1994)** for the RTA. Other studies are being carried out currently by the RTA in a range of typical situations which frequently arise in road impact assessments.

The approach taken for this project has been to carry out an assessment at fixed receptors using the emission rates resulting from the Metropolitan Air Quality Study (MAQS). These are described in more detail in **Section 5.1**.

5.1 Emission estimates

This section provides a brief description of the methods used to calculate the major emissions from vehicles, namely carbon monoxide, nitrogen oxides, hydrocarbons and particulate matter. This information is required as input to the dispersion models used to predict ground-level concentrations of the various pollutants.

5.1.1 MAQS data

A comprehensive emissions inventory which relates vehicle emissions to different travel conditions in NSW was prepared for the Sydney Metropolitan Air Quality Study (**Carnovale et. al, 1997**). These data are continually being developed and updated by the NSW EPA Motor Vehicle Emission Projection System (MVEPS) and the most recent emission estimates were used for this study (**EPA, 2002**).

MVEPS takes into account vehicle fleet age structures, fleet turnover, implementation of new emission standards and major changes in relevant fuel characteristics. The emission rates presented in **Table 4** show that all these factors result in emission rates per vehicle decreasing between 2002, 2006 and 2016.

These emission rates have been combined with traffic flow data and used in a computer dispersion model to determine current air quality in the vicinity of the road in 2006 and 2016.

Appendix A provides a detailed description of the calculation of vehicle emissions for all years.

5.1.1.1 Carbon monoxide

The way in which vehicle emissions vary with speed is fundamental to the understanding of the analysis presented in this report. The relationship between speed and carbon monoxide

emission is shown in **Figure 3** where the estimated carbon monoxide emission rates in the years 1988 and 2006 are presented for light duty petrol vehicles (hot start). It is assumed that approximately 30% and 96% of cars are fitted with catalytic converters in 1988 and 2006 respectively. At present about 70% of the fleet are fitted with catalytic converters and so the year 2000 assumption of 96% would be an overestimate. For cars without catalytic converters, there is a marked decrease of emissions with speed. Fitting cars with catalytic converters reduces the overall emissions and again the same pattern of decreasing emission rate with speed is observed.

The emissions of carbon monoxide from vehicles were determined for previous studies from these relationships (**Nigel Holmes & Associates, 1992, 1994**). The emissions inventory prepared for MAQS takes a different approach. Although similar principles apply in terms of the relationship between speed and emissions, the roads are divided into different categories and emissions from the mix of traffic on that type of road is determined. The different categories are:

- Freeway / Highway
- Arterial
- Commercial – Arterial
- Commercial – Highway
- Residential / Minor

For this assessment it has been assumed that travel on Sunnyholt Road in 2006 and after equates to free-flowing arterial travel conditions.

5.1.1.2 Oxides of nitrogen

Oxides of nitrogen emissions show a different trend with speed from carbon monoxide and this is illustrated in **Figure 4**. As in the case of carbon monoxide, catalytic converters reduce the overall oxides of nitrogen emission rate, however the trend with increasing speed is reversed, that is oxides of nitrogen increases with increasing speed, although the effect is more gradual.

As for carbon monoxide, while the same trend remains, these emission factors have been replaced by those determined for MAQS (see **Appendix A**).

5.1.1.3 Hydrocarbons

Hydrocarbon emissions vary with speed in a similar way to carbon monoxide and have been determined for MAQS in the same way (see **Appendix A**).

5.1.1.4 Particulate matter

Particulate matter emission rates for the different vehicle types are presented in **Appendix A**. These comprise exhaust emissions as well as emissions from tyre and brake wear. Diesel vehicles are the main contributors to particulate emissions and so improved diesel technology is very important in this regard.

Emission rates during peak hour are estimated from the total traffic volume and emission rate per vehicle. The peak hour flows for 2006 and 2016 are summarised in **Table 5**. The estimated peak hour emission rates in kg/km/h are summarised in **Table 6** for 2006 and **Table 7** for 2016.

Table 4 - Vehicle emission rates (g/veh-km)

Pollutant	Vehicle Type: Passenger Petrol Vehicles			Heavy Duty Diesel Vehicles			Heavy Duty Petrol Vehicles			Buses Diesel			All
	Year												
	2002	2006	2016	2002	2006	2016	2002	2006	2016	2002	2006	2016	All
	Emission Rates - Arterial Flow (g/veh-km)												
CO	11.908	8.135	3.725	4.567	3.564	2.109	66.535	51.099	33.000	6.397	4.136	1.673	-
NOx	1.167	1.055	0.882	12.146	10.517	6.598	3.995	3.276	2.075	13.955	10.237	5.096	-
HC	0.885	0.62	0.282	1.076	0.830	0.581	5.908	4.422	2.074	1.504	1.259	0.826	-
PM10	0.031	0.024	0.017	0.461	0.248	0.091	0.132	0.103	0.059	0.705	0.374	0.085	-
PM10 (Brake & Tyre Wear)	-	-	-	-	-	-	-	-	-	-	-	-	0.009

Source: NSW EPA (2002)

Table 5 - Peak hour traffic flows (veh/h)

Section of Sunnyholt Road	Direction of Flow	2006		2016	
		AM Peak	PM Peak	AM Peak	PM Peak
Sorrento Drive - Quakers Hill Pky	Northbound	858	1561	1538	1983
	Southbound	1064	1137	1233	1268
Quakers Hill Pky - Wilson Road	Northbound	1148	3168	1866	3904
	Southbound	2531	1510	2986	1596
Wilson Road - Meurants Lane	Northbound	1148	3168	1866	3904
	Southbound	2531	1510	2986	1596
Meurants Lane - James Cook Drive	Northbound	1146	2504	1571	3133
	Southbound	1960	1401	2131	1568

Source: Masson, Wilson, Twiney (November, 2002)

Table 6 - Estimated peak hour emission rates 2006 (kg/km/h)									
		2006							
		AM Peak				PM Peak			
Section of Sunnyholt Road	Direction of Flow	CO	NO_x	HC	PM_{10}	CO	NO_x	HC	PM_{10}
Sorrento Drive - Quakers Hill Pky	Northbound	5.14	0.72	0.40	0.023	2.23	0.31	0.17	0.010
	Southbound	3.29	0.46	0.26	0.014	2.76	0.38	0.22	0.012
Quakers Hill Pky - Wilson Road	Northbound	10.23	1.40	0.79	0.044	3.01	0.41	0.23	0.013
	Southbound	4.18	0.57	0.32	0.018	6.64	0.91	0.51	0.029
Wilson Road - Meurants Lane	Northbound	10.23	1.40	0.79	0.044	3.01	0.41	0.23	0.013
	Southbound	4.18	0.57	0.32	0.018	6.64	0.91	0.51	0.029
Meurants Lane - James Cook Drive	Northbound	8.21	1.12	0.64	0.035	3.00	0.41	0.23	0.013
	Southbound	4.11	0.56	0.32	0.018	5.14	0.70	0.40	0.022

Table 7 - Estimated peak hour emission rates 2016 (kg/km/h)									
		2016							
		AM Peak				PM Peak			
Section of Sunnyholt Road	Direction of Flow	CO	NO_x	HC	PM_{10}	CO	NO_x	HC	PM_{10}
Sorrento Drive - Quakers Hill Pky	Northbound	1.89	0.45	0.14	0.013	2.44	0.58	0.18	0.017
	Southbound	1.52	0.36	0.11	0.011	1.56	0.37	0.12	0.011
Quakers Hill Pky - Wilson Road	Northbound	2.30	0.54	0.17	0.016	4.82	1.14	0.36	0.033
	Southbound	3.68	0.87	0.28	0.026	1.97	0.46	0.15	0.014
Wilson Road - Meurants Lane	Northbound	2.30	0.54	0.17	0.016	4.82	1.14	0.36	0.033
	Southbound	3.68	0.87	0.28	0.026	1.97	0.46	0.15	0.014
Meurants Lane - James Cook Drive	Northbound	1.94	0.46	0.15	0.013	3.87	0.91	0.29	0.027
	Southbound	2.63	0.62	0.20	0.018	1.93	0.46	0.15	0.013

6 ASSESSMENT OF IMPACTS

This section assesses the air quality impacts of the project by comparing the predicted ground-level concentrations of roadway emissions with air quality goals or other air quality criteria where specified goals are not available. Predictions have been made for 2006 and 2016.

The maximum predicted concentrations have been calculated using the MAQS emissions data and do not include background levels. The model has been set to find the worst-case wind angle assuming a wind speed of 1.0 m/s. It has also been assumed that F-class stability[1] conditions occur.

Table 8 presents the maximum predicted 1-hour average ground-level concentrations of carbon monoxide, hydrocarbons, nitrogen oxides, nitrogen dioxide and particulate matter at various distances from the kerb for 2006 and 2016.

For each of the years the concentrations are predicted for 0 m, 10 m, 30 m and 50 m from the kerb at the outside edge of the proposed layout of the road.

Noise barriers are to be located on both sides of Sunnyholt Road. The barriers may result in a slight increase in pollutant concentrations on the road itself, however, RTA studies show that the effect on the outside of the barrier is minimal (**Holmes et al., 1998**). This study has not included the barriers in the assessment and the effect will not be much different than a road through a built up shopping area where buildings create a continuous barrier.

6.1.1 Carbon Monoxide

It can be seen from **Table 8** that the highest predicted 1-hour carbon monoxide concentration is 9.8 mg/m^3. This occurs during the AM peak hour in 2006 at the kerbside of the northbound carriageway between Wilson Road and Meurants Lane. In 2016, the concentration at this location decreases to 3.4 mg/m^3. The maximum predicted concentration in 2016 is 4.6 mg/m^3 during the PM peak at the kerbside of the northbound carriageway between Wilson Road and Meurants Lane. The maximum predicted concentrations decrease rapidly with distance from the road.

All predicted concentrations are well below the NSW EPA's 1-hour goal of 30 mg/m^3. Even when added to 6.0 mg/m^3, the maximum of the hourly average levels in **Table 3**, the 1-hour goal is unlikely to be exceeded.

6.1.2 Nitrogen Dioxide

Estimating nitrogen dioxide concentrations is more complicated than estimating carbon monoxide concentrations. As discussed in **Section 3.2.3**, nitrogen oxides are initially emitted as a mixture of nitric oxide and other oxides of nitrogen, which are oxidised to nitrogen dioxide. At the point of emission the mixture is generally about 5% nitrogen dioxide by mass. However, while the maximum concentrations of total oxides of nitrogen generally occur during peak hour, this is not necessarily the case for nitrogen dioxide. An extensive monitoring program undertaken by the RTA (**RTA, 1997**) indicates that during peak hour the percentage of nitrogen dioxide at 10 m from the roadway edge is likely to be about 5%. The conversion rate from nitric oxide to nitrogen dioxide at other times of the day may be significantly higher than this although the total oxides of nitrogen

[1] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances.

levels may be significantly lower than peak hour levels. It is necessary therefore to assume some intermediate value for a worst-case assessment.

Data from the RTA program indicates that at 10 m from the roadway a conversion rate of 15% by weight is still conservative (i.e. an overestimate), but more realistic than the 20% assumed in previous EIS studies. At distances of 30 – 60 m from the kerbside the 20% conversion rate appears to be appropriate. There are no monitoring data for the kerbside location in the present study, but it is considered that a 15% conversion rate at 10 m is likely to still be conservative. Conversion rates of 10% and 15% have been used at 0 m and 10 m respectively, while a rate of 20% has been assumed for the remaining distances of 30 m and 50 m.

Taking this into consideration, it can be seen from **Table 8** that the highest predicted 1-hour nitrogen dioxide concentration in 2006 is 133.9 $\mu g/m^3$. This occurs during the AM peak hour at the kerbside of the northbound carriageway between Wilson Road and Meurants Lane. In 2016, the concentration during the AM peak at this location decreases to 79.6 $\mu g/m^3$. The maximum predicted concentration in 2016 is 108.6 $\mu g/m^3$ during the PM peak at the kerbside of the northbound carriageway between Wilson Road and Meurants Lane. The maximum predicted concentrations decrease rapidly with distance from the road.

All of the predicted values are below the goal of 245 $\mu g/m^3$. When added to the maximum measured 1-hour average nitrogen dioxide concentration of 119 $\mu g/m^3$ (see **Table 3**), levels would be slightly above the goal at the kerbside but would not be exceeded ay any location 10 m and greater from the road. Also, it is unlikely that the maximum background level recorded at the monitoring station would coincide with the maximum predicted levels. Further, the "background" data recorded at the EPA monitoring location on Flushcombe Road would have contributions from roadway traffic and as such would not represent a true measurement of background pollution levels. It is likely that use of these data would overestimate the background pollution levels along Sunnyholt Road that would be present in the absence of traffic. Use of "background" data that has contributions from traffic results in some double counting of emissions.

It should also be noted that predictions do not take into account fully the benefits of three-way catalytic converters which are fitted to all new (fuel-injected) petrol-fuelled passenger vehicles in Australia and which substantially reduce oxides of nitrogen emissions. Nor (more significantly) do they take account of controls on diesel vehicles which are being implemented through the new design rule ADR-70.

The NEPM standard for nitrogen dioxide adopted by the NSW EPA, would currently be difficult to achieve in many areas of Australia, most notably in the vicinity of busy roads carrying a high percentage of heavy diesel vehicles. The approach developed by NEPC is that compliance with the standard will be achieved over a 10-year time frame through a raft of measures including source control. These controls are to be left to individual jurisdictions to determine and implement. This approach is reflected in the NSW EPA Air Quality Management Plan (**EPA, 1998**), which targets diesel emissions and heavy industry.

It is therefore reasonable to assume that by 2016, the fleet emissions per vehicle will be substantially lower than those assumed in the modelling presented in this report.

6.1.3 Hydrocarbons

Hydrocarbon concentrations are not specified in the NSW EPA's air quality goals. This is largely due to the fact that a simple hydrocarbon concentration goal is now recognised as not being useful for the purposes of assessing health impacts or identifying the need for air quality management

requirements. More detailed information on specific hydrocarbons is required. As noted in **Section 3.1.3** hydrocarbons, in particular those associated with motor vehicles, are a common contaminant of urban atmospheres and have been for many years. Emission controls on Australian cars and equivalents since 1978 have resulted in a considerable reduction in both evaporative and exhaust emissions of hydrocarbons.

One of the components of hydrocarbons that has become a concern in the community is benzene, which is a known carcinogen (**WHO, 1987**). **Appendix B** (data from **Nelson and Quigley, 1982**) shows an analysis of the hydrocarbon content of fuel and exhaust. It can be seen that benzene is a component of petrol comprising approximately 2.6%. It can also be seen that the percentage benzene (by mass) in vehicle exhausts was approximately 5% (note these data relate to leaded petrol, but there has not been any substantial change in the benzene content with the introduction of unleaded petrol). More recent data also supports this assumption (**Ye et al., 1996**).

It should be noted that the assessment of hydrocarbon concentrations has been undertaken using the Caline4 model. These predicted levels are for 1-hour averaging periods while the air quality goal refers to an annual period. Comparing these is therefore a conservative approach (that is an over-prediction) as the maximum predicted 1-hour average would always be higher than the predicted annual average. The relationship between the predicted 1-hour maximum and the annual average will obviously vary with meteorology and daily traffic flow.

Assuming a 5% benzene composition in the exhaust, the maximum predicted 1-hour average benzene concentration would be approximately 35 $\mu g/m^3$ in 2006 and 16 $\mu g/m^3$ in 2016, under unfavourable dispersion and with peak traffic flows. As discussed above, it should be emphasised that these are worst-case 1-hour average predictions and so although the maximum predicted concentration in 2006 exceeds the UK annual average goal of 16 $\mu g/m^3$, the long-term concentrations would be substantially less than the short-term peaks as they are averaged over conditions which include much lower traffic flows and much better atmospheric dispersion. Concentrations would be substantially lower at the locations of residences. It is nevertheless recognised that there may be no safe limit for benzene, but the risk to a particular individual over a lifetime is small, and on a population and individual basis would be offset by lower risks through safer roads, although to an undetermined extent.

6.1.4 Particulate Matter

The assessment of PM_{10} concentrations has been undertaken using the Caline4 model. These predicted levels however, are for 1-hour averaging periods while the air quality goal refers to a 24-hour period. Comparing these is therefore a conservative approach (that is an over-prediction) as the maximum predicted 1-hour average would always be higher than the predicted 24-hour average. The relationship between the predicted 1-hour maximum and the 24-hour average will obviously vary with meteorology and daily traffic flow. Work done on the air quality assessment for the Western Sydney Orbital suggests a time correction factor of approximately 0.47 to convert 1-hour predictions to 24-hour averages (**Holmes Air Sciences, 1999**). This figure is based on the local meteorology and the hourly traffic variation, and is likely to be similar for this study area.

Additionally, in dispersion modelling it is often difficult to account for background concentrations in a rigorous way. Ideally, model predictions made with real meteorological data are added to concurrent background concentrations, but this level of detailed information is rarely available. An alternative approach is to add the maximum predicted level to the maximum background level. This approach is very conservative, but if it results in no exceedances of the air quality goals, no further consideration needs to be given to this issue. Alternatively, an average background can be added to

the maximum model predictions. This provides an estimate of how the project will add to existing levels on average but may not account for the worst-case.

In the case of particulate matter, there will be exceedances of the 24-hour air quality goal from time to time throughout Sydney, therefore background levels on occasions are already close to or in exceedance of the goal. If the logic that there should be no exceedances of air quality goals is followed, no project could be approved on the basis of particulate emissions given that the goals are already exceeded. In these circumstances it is useful to consider the degree to which the project on its own consumes the air quality goal.

The approach adopted in this report has been to consider first the extreme worst-case of adding maximum predicted to maximum background. If this approach shows exceedances, the predicted maximum levels are then added to an average background concentration to provide an estimate of the degree to which the project could increase levels on average. Finally, the degree to which the predicted concentrations of pollutants consume the relevant air quality goal is noted.

Based on current traffic flows, the highest 1-hour concentration is predicted to be 38.6 $\mu g/m^3$ in 2006 and 29.3 $\mu g/m^3$ in 2016. Using the correction factor of 0.47, the 24-hour concentrations are likely to be of the order of 18 $\mu g/m^3$ (2006) and 14 $\mu g/m^3$ (2016). When added to the maximum 24-hour value in **Table 3** of 44 $\mu g/m^3$ these estimates will increase to 62 $\mu g/m^3$ (2006) and 58 $\mu g/m^3$ (2006). These levels are slightly above the 24-hour NSW EPA goal of 50 $\mu g/m^3$. However, when added to the annual average of 20 $\mu g/m^3$ the estimates of 38 $\mu g/m^3$ in 2006 and 34 $\mu g/m^3$ in 2016 are below the EPA goal. The maximum predicted concentration of 18 $\mu g/m^3$ represents 36 % of the EPA goal.

It should be noted that the maximum predicted concentrations discussed above are at the kerbside of the road and the concentrations decrease significantly with distance from the road.

It must also be remembered that the background level includes emissions from traffic already in the area, and there is therefore an element of double counting when adding these to predicted concentrations. Further, the EPA PM_{10} goal is a regional target and will not be met everywhere in Sydney, particularly next to busy roads.

Table 8 - Maximum predicted 1-hour average concentrations

Section of Sunnyholt Road	Direction of Flow	AQ goal	CO mg/m³				NO2 µg/m³				Benzene µg/m³				PM10 µg/m³			
			31				245				16				50			
		Distance from kerb	2006		2016		2006		2016		2006		2016		2006		2016	
			AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Sorrento Drive - Quakers Hill Pky	Northbound	0	6.2	3.8	2.5	2.9	85.4	52.9	60.0	69.0	22.0	13.6	8.7	10.0	24.6	15.2	16.2	18.6
		10	3.5	2.5	1.6	1.7	73.3	52.5	55.1	59.3	12.6	9.1	5.4	5.8	14.1	10.1	9.9	10.7
		30	2.6	2.0	1.2	1.2	72.0	54.8	56.0	58.3	9.3	7.1	4.1	4.3	10.4	7.9	7.5	7.9
		50	2.2	1.7	1.0	1.0	60.3	46.3	46.8	49.0	7.8	6.0	3.4	3.6	8.7	6.7	6.3	6.6
	Southbound	0	3.6	2.7	1.6	1.7	48.9	37.3	36.9	39.6	12.6	9.6	5.4	5.8	14.1	10.7	9.9	10.7
		10	3.1	2.4	1.4	1.5	63.4	49.1	48.6	51.4	10.9	8.5	4.7	5.0	12.2	9.4	8.7	9.2
		30	2.6	2.1	1.2	1.2	71.3	56.8	56.3	57.8	9.2	7.3	4.1	4.2	10.3	8.2	7.6	7.8
		50	2.3	1.8	1.1	1.1	62.3	50.0	49.8	50.5	8.1	6.5	3.6	3.7	9.0	7.2	6.7	6.8
Quakers Hill Pky - Wilson Road	Northbound	0	8.8	5.0	3.1	4.2	121.3	67.9	73.6	98.3	31.4	17.6	10.7	14.3	34.9	19.6	19.9	26.5
		10	4.1	2.9	1.7	1.9	83.8	59.3	60.2	68.1	14.5	10.2	5.8	6.6	16.1	11.4	10.8	12.2
		30	2.5	2.0	1.2	1.2	69.0	55.3	54.3	56.0	8.9	7.2	4.0	4.1	9.9	8.0	7.3	7.5
		50	2.1	1.7	1.0	1.0	58.3	47.3	46.3	47.3	7.6	6.1	3.4	3.5	8.4	6.8	6.2	6.4
	Southbound	0	4.5	4.0	2.3	2.1	61.9	54.6	53.8	50.3	16.0	14.2	7.8	7.3	17.8	15.7	14.5	13.5
		10	3.6	3.1	1.8	1.7	74.1	63.6	62.3	60.0	12.8	11.0	6.1	5.8	14.2	12.2	11.2	10.8
		30	2.7	2.3	1.3	1.2	72.8	62.0	60.5	59.0	9.4	8.0	4.4	4.3	10.5	8.9	8.2	8.0
		50	2.1	1.8	1.0	1.0	57.5	49.3	48.0	46.8	7.5	6.4	3.5	3.4	8.3	7.1	6.5	6.3
Wilson Road - Meurants Lane	Northbound	0	9.8	5.3	3.4	4.6	133.9	73.0	79.6	108.6	34.7	18.9	11.6	15.8	38.6	21.0	21.5	29.3
		10	5.0	3.3	2.0	2.3	101.8	68.6	71.4	82.7	17.6	11.8	6.9	8.0	19.5	13.2	12.8	14.8
		30	3.0	2.1	1.3	1.4	82.0	58.8	60.5	66.5	10.6	7.6	4.4	4.9	11.8	8.5	8.2	9.0
		50	2.2	1.6	1.0	1.0	60.0	44.0	45.0	48.8	7.8	5.7	3.3	3.5	8.6	6.3	6.1	6.6
	Southbound	0	3.1	2.8	1.5	1.4	42.1	38.9	36.4	34.1	10.9	10.1	5.3	5.0	12.1	11.2	9.8	9.2
		10	2.6	2.3	1.2	1.2	52.5	47.1	44.1	42.6	9.1	8.1	4.3	4.1	10.1	9.0	7.9	7.7
		30	2.1	1.7	1.0	1.0	58.8	46.8	47.3	47.8	7.6	6.1	3.5	3.5	8.5	6.7	6.4	6.4
		50	1.9	1.5	0.9	0.9	50.8	40.0	40.8	41.3	6.6	5.2	3.0	3.0	7.3	5.8	5.5	5.6
Meurants Lane - James Cook Drive	Northbound	0	5.9	4.2	2.3	2.8	81.3	57.3	55.0	65.9	21.0	14.8	8.0	9.6	23.4	16.5	14.8	17.8
		10	4.1	3.1	1.7	1.9	84.9	62.8	61.1	69.0	14.7	10.9	5.9	6.7	16.3	12.1	11.0	12.4
		30	2.9	2.3	1.3	1.4	80.8	61.8	60.5	65.5	10.5	8.0	4.4	4.8	11.6	8.9	8.2	8.8
		50	2.3	1.8	1.0	1.1	63.8	49.5	49.3	51.8	8.2	6.4	3.6	3.8	9.2	7.1	6.6	7.0
	Southbound	0	2.8	2.4	1.4	1.3	38.8	33.4	32.1	31.5	10.1	8.7	4.7	4.6	11.2	9.6	8.7	8.5
		10	2.5	2.1	1.2	1.2	52.5	44.1	42.9	42.6	9.1	7.6	4.2	4.1	10.1	8.5	7.7	7.6
		30	2.2	1.9	1.1	1.1	61.5	52.8	51.5	50.0	8.0	6.8	3.8	3.6	8.9	7.6	6.9	6.7
		50	2.0	1.7	1.0	0.9	55.0	47.3	46.3	44.8	7.1	6.1	3.4	3.3	7.9	6.8	6.2	6.0

7 CONSTRUCTION IMPACTS

During the widening of Sunnyholt Road, temporary impacts on air quality may arise from:

- Generation of dust by earthmoving activities, demolition and exposed areas
- Emissions (primarily diesel exhaust) from earthmoving machinery
- Emissions from construction traffic.

The phases of construction that would have an impact on air quality are:

- Pre-construction activities - establishment of site compounds, clearing and preparation of work areas.
- Construction of project works - this will involve cut and fill earthwork activities. Equipment to be used in the project includes backhoes, excavators, dozers, graders, rock breakers, compactors, and concrete trucks.

The construction contractor will be required to mitigate dust and exhaust emissions during construction. An environmental management plan (EMP) will include a dust management sub-plan which will involve a monitoring program and control measures. Control measures would include:

- Watering of haul roads and unsealed access roads;
- Watering of earthworks operations where appropriate;
- Covering all loaded trucks with a tarpaulin; and
- Revegetating and stabilising disturbed areas immediately after the completion of earthworks.

The EMP would include detailed requirements for air quality control and methods of monitoring the construction impact on surrounding air quality.

In addition to the goals for ambient dust concentrations discussed in **Section 3.1**, it is appropriate to consider goals for dust deposition during the construction period. The EPA consider that residential areas begin to experience dust related nuisance impacts when annual average dust (insoluble solids) deposition levels exceed 4 g/m^2/month, and that dust impacts would be at unacceptable levels when they reached 10 g/m^2/month (**SPCC 1983**). In the early 1990s the EPA (**Dean et al., 1990**) refined these criteria. They are now expressed in terms of an acceptable increase in dust deposition over the existing background. For example, in residential areas with annual average deposition levels of between 0 and 2 g/m^2/month, an increase of up to 2 g/m^2/month would be permitted before it is considered that a significant degradation of air quality has occurred. **Table 9** shows the maximum acceptable increase in dust deposition over the existing dust levels.

Dust levels in the area are likely to be of the order of 1-2 g/m^2/month. Therefore an increase of 2 g/m^2/month could occur before there was a perceptible degradation in air quality.

Table 9 – EPA assessment criteria for deposited dust

Maximum increase in deposited dust level	Maximum total deposited dust levels
(g/m^2/month)	
2	4

Exhaust emissions from construction equipment are not likely to be a significant issue as the equipment will be largely spread out and not operating at all hours.

3 GREENHOUSE ISSUES

The temperature of the earth's atmosphere is determined by the balance between incoming solar radiation and the loss of heat energy by radiation from the earth and atmosphere to outer space. This balance is in turn affected by a complex set of processes, acting on a global scale, which control the way in which heat is transported around the earth by winds and ocean currents, and by the quantities of energy that are reflected and absorbed by the earth's surface. While the broad principles of the way in which these processes work to control the temperature of the earth's atmosphere are understood, the details, which may well be very important in determining the final temperature that is achieved at the earth's surface, are still the subject of scientific research.

One of the important factors in determining the amount of radiant energy absorbed in the atmosphere is the concentration of carbon dioxide. Changes in this concentration are likely to cause changes in the temperature of the earth's atmosphere near the earth's surface. Increases in carbon dioxide concentration are expected to cause increases in temperature.

Australia is signatory to the "International Framework Convention on Climate Change" (Rio Convention), which commits Australia to programs of monitoring and reporting on greenhouse gas emissions. A target of the Rio Convention is that signatory countries should attempt to reduce greenhouse gas emissions to the levels that applied in 1990. At the recent Kyoto meeting the convention agreed that Australia would be allowed to reduce their emissions to 8% above the 1990 level, between 2008 and 2012.

Transport NSW and RTA are committed to ensuring that its environmental goals and policies are consistent with those outlined in the 1992 Intergovernmental Agreement on the Environment. This agreement addresses a number of globally important environmental issues including the greenhouse effect. This commitment is facilitated through Transport NSW and RTA's environmental vision which addresses greenhouse gas emissions and also energy consumption.

Approximately 14% of NSW's total carbon dioxide emissions are estimated to come from the transport sector (**EPA, 1995**). At a broad level, Transport NSW and RTA have been involved in and implemented several strategic initiatives to address the issue of road transport related greenhouse gas emissions. These are:

- National Greenhouse Response Strategy

  This strategy was adopted by the Council of Australian Governments in 1992 and aims to contribute to the national commitment to the National Strategy for Ecologically Sustainable Development. The RTA contributed to the development of this strategy and is the NSW representative on the Transport Working Group for the development of a greenhouse gas emissions inventory. With respect to transport, the response strategies include reducing fuel consumption in motorised transport; improving the technical and economic efficiency of operation of the road network and traffic management; and to encourage the use of bicycles. This proposal contributes to these initiatives.

- RTA Greenhouse Reduction Plan

  The RTA is implementing the State Government's Emissions Management Plan (EMP) while developing its own EMP.

- Transport NSW has a number of aims and initiatives, all of which will contribute to a reduction in greenhouse gases from transport. These are detailed in the document *Action for Transport* (**Transport NSW, 1998**) include:

  - halting the growth in per capita vehicle kilometres travelled (vkt) by 2011
  - halting the growth in total vkt by 2021
  - reduce current growth in car use
  - increase usage of public transport

Emissions of carbon dioxide from motor vehicles are directly proportional to fuel consumption. They cannot be reduced by emission control technologies except where they result in an improvement in fuel consumption. RTA programs which encourage better vehicle maintenance and hence better fuel economy will be beneficial.

The RTA also continues to engage in other strategies to encourage the tightening of vehicle emissions standards. These include;

- Enhancing the State's vehicle emissions enforcement resources;
- Continuing its role on MVEC (Motor Vehicle Environment Committee) to encourage the early implementation of more stringent Australian Design Rules, including the revision of ADR 37/01 "Emission Control for Light Vehicles" and ADR70 "Exhaust Emission Control for Diesel Engined Vehicles". The new ADRs, 79/00 "Emissions Control for Light Vehicles" and 80/00 "Emissions Control for Heavy Vehicles" include for the first time, vehicles which operate on liquefied petroleum gas or natural gas. Combined with the new (1 January 2002) Fuel Standard (Petrol) Determination 2001 and the Fuel Standard (Diesel) Determination 2001 (which reduces the sulphur levels in road transport diesel fuel from the current level of 1300 parts per million (ppm) to 500 ppm by January 2003), these new ADRs will facilitate introduction of more advanced emission control technologies; and
- Playing a key role in the development of the Diesel National Environment Protection Measure (NEPM), which came into effect 29 June 2001. This set a framework for the management of emissions, enabled the development of regulations on diesel emissions testing standards, and facilitates the development and implementation of enforcement and alternative compliance strategies for vehicle emissions.

9 CONCLUSIONS

The results of the air quality assessment undertaken for this project conclude that:

1. Due to the present emission controls on motor vehicles and the projected traffic conditions for the years 2006 and 2016, the EPA's carbon monoxide 1-hour or 8-hour goals are not expected to be exceeded for any section of the proposed widening of Sunnyholt Road.
2. The predicted changes in concentration of nitrogen dioxide indicate that the NEPM 1-hour goal would not be exceeded along Sunnyholt Road.
3. Predicted concentrations of benzene (and other pollutants) are not at levels which, from current understanding, should pose health effects.
4. The PM_{10} short-term goal of 50 $\mu g/m^3$ is not expected to be exceeded along Sunnyholt Road.

10 REFERENCES

Bureau of Meteorology (2002)
Climatic Averages on Bureau of Meteorology Internet Site, www.bom.gov.au

Carnovale F, Tilly K, Stuart A, Carvalho C, Summers M and Eriksen P (1997)
"Metropolitan Air Quality Study – Air Emissions Inventory" prepared by the Environment Protection Authority of Victoria, 1997

Dean M., Holmes N. and Mitchell P. (1990)
"Air Pollution from Surface Coal Mining Community Perception, Measurement and Modelling", Proceedings of the International Clean Air Conference 1990, Auckland, New Zealand, March 25-30, p 215-222.

Dockery D W, Pope C A, Xu X, Spengler J D, Ware J H, Fay M E, Ferris B G and Speizer F E (1993)
"An association between air pollution and mortality in six US cities" The New England Journal of Medicine, **329**, 1753-1759.

Eiser C R and Koo F(1984)
"Emission Trends for Hydrocarbons and Nitrogen Oxides from Stationary Sources in Sydney" Proceedings of the Eighth International Clean Air Conference, Melbourne, 8-11 May.

EPA (1995)
"NSW Greenhouse Gas Inventory Report - Estimate for 1990 and 2000" prepared by the NSW EPA ISBN 0 7310 3770 7.

EPA (1998)
"Action for Air", the NSW Government's 25-Year Air Quality Management Plan

EPA (2001)
"Quarterly Air Monitoring Report 2001" prepared by NSW EPA

EPA (2002)
Personal communication Charles Xu 8/7/2002

Holmes K T, Holmes N E and Jones R (1998)
"Generic monitoring studies to provide a database for assessing roadway impacts", Clean Air and Environment Conference 18 - 22 October1998, Mebourne, Australia.

Holmes Air Sciences (1999)
"Air Quality Assessment, Proposed Western Sydney Orbital Elizabeth Drive to Baulkham Hills", prepared for Sinclair Knight Merz

Nelson P F and Quigley S M (1982)
"Atmospheric Hydrocarbons in Sydney: Compositions of the Sources" In "The Urban Atmosphere Sydney a Case Study" Edited by Carras J.N. and Johnson G.M., Proceedings of a Conference organised by CSIRO.

NEPC (2002a)
"Variation to the National Environment Protection (Ambient Air Quality) Measure". National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.

NEPC (2002b)
"Impact Statement for $PM_{2.5}$ Variation. Setting a $PM_{2.5}$ Standard in Australia". National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.

Nigel Holmes & Associates (1992)
"Air Quality Assessment, M5 Casula Link" working paper prepared for Stephenson & Associates, 1992

Nigel Holmes & Associates (1994)
"Air Quality Assessment, Proposed Motorway Billinudgel to Chinderah" working paper prepared for Sinclair Knight, 1994

Pengilley M (1989)
"Motor Vehicle Emission Factors for 1988 and 2000" State Pollution Control Commission, Noise and Transport Branch, GPO Box 4036, Sydney.

RTA (1997)
"RTA Air Quality Monitoring Program" prepared for the RTA by Holmes Air Sciences, January 1997.

SPCC (1983)
"Pollution Control in NSW: A Progress Report", Supplement of 1982, 1983 Annual Report.

Stephenson (1991)
"Air Quality Study, North West Transport Links, Environmental Impact Statement" Stephenson & Associates, August 1991.

Transport NSW (1998)
"Action for Transport 2010"
Available from http://www.transport.nsw.gov.au/pubs_legal/act2010.html\

US EPA (1981)
"Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources", US EPA, Office of Research and Development, Cincinnati, Ohio.

US EPA (1985)
"Compilation of Air Pollutant Emission Factors", AP-42, Forth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

WHO (1987)
"Air Quality Guidelines for Europe". World Health Regional Office for Europe, WHO Regional Publication European Series: No. 23, ISBN 92-890-1114-9.

Williams D J, Carras J N, Shenouda D, Drummond M S and Lange A L (1994)
"Traffic generated pollution near roads and highways: models and measurements" prepared by CSIRO Division of Coal and Energy Technology for the RTA, March 1994 Investigation Report CET/IR238.

Ye Y, Weeks I A, Galblly I E, Duffy B L, Nelson P F (1996)
"Emissions of Air Toxics from a Representative Portion of the Australian Car Fleet" 2000 Then What? 13 International Clean Air and Environment Conference Adelaide, 22-25 September.

APPENDIX A
EMISSION CALCULATIONS

MAQS VEHICLE EMISSIONS FACTORS

The emissions from vehicles on NSW roads were assumed to all fit into three classes:

1. Passenger petrol vehicles (PPV)
2. Heavy duty petrol vehicles (HDPV)
3. Heavy duty diesel vehicles (HDDV)

These classes of vehicles account for more than 99% of all vehicle kilometres travelled on Sydney's roads (**Pengilley, 1989**). Of the heavy vehicles category, 90% are considered to be HDDV and 10% are considered to be HDPV.

The emissions of CO, oxides of nitrogen, HC and particulate matter were taken from estimates in the Sydney Metropolitan Air Quality Study (MAQS) (**Carnovale et. al, 1997**) and updated emission rates provided by NSW EPA (**EPA, 2002**) It was assumed that traffic on Sunnyholt Road was in free-flowing arterial travel mode.

The emission of particulate matter from vehicles is made up of lead salts, organic and sulphate components. The total emissions comprise exhaust emission plus airborne brake wear particulate emission and airborne tyre wear particulate emissions.

Calculation of vehicle emission rates

Details of emission calculations for Sunnyholt Road at peak hour for 2006 and 2016 are presented in the following tables.

Emission rates for CO, oxides of nitrogen (NO_x), hydrocarbons (HC) and particulate matter (PM) are expressed as g/km/vehicle and presented for each class of vehicle in Table A1.

The total emissions for a given section of road during the peak AM and PM periods have been calculated by multiplying the emission rate by the total number of vehicles estimated to be using the road in the one-hour peak period. These values are expressed as gg/km/h. Finally these values have been converted to g/vehicle-mile for use as input to the model.
Tables A2 – A5 present the emission rates for each year.

Table A1: Vehicle Emission Rates (g/veh-km)													
	Vehicle Type												
	Passenger Petrol Vehicles			Heavy Duty Diesel Vehicles			Heavy Duty Petrol Vehicles			Buses Diesel			All
	Year												
	2002	2006	2016	2002	2006	2016	2002	2006	2016	2002	2006	2016	All
Pollutant	Emission Rates - Arterial Flow (g/veh-km)												
CO	11.908	8.135	3.725	4.567	3.564	2.109	66.535	51.099	33.000	6.397	4.136	1.673	
NOx	1.167	1.055	0.882	12.146	10.517	6.598	3.995	3.276	2.075	13.955	10.237	5.096	
HC	0.885	0.62	0.282	1.076	0.830	0.581	5.908	4.422	2.074	1.504	1.259	0.826	
PM10	0.031	0.024	0.017	0.461	0.248	0.091	0.132	0.103	0.059	0.705	0.374	0.085	
PM10 (Brake & Tyre Wear)													0.009

Source: NSW EPA (2002

Table A2 - 2006 AM Peak Emission Rates

Section of Sunnyholt Road	CALINE4 ID	Description	Direction of Flow	% HDV's	2006 AM Peak flow					CO g/km				CO g/veh-mile	NOx g/km				NOx g/veh-mile	HC g/km				HC g/veh-mile	PM10 g/km					PM10 g/veh-mile
					Flow per lane	LDV	HDV	HDPV	HDDV	LDV	HDPV	HDDV	Total	Total	LDV	HDPV	HDDV	Total	Total	LDV	HDPV	HDDV	Total	Total	LDV	HDPV	HDDV	Brake & Tyre	Total	Total
Sorrento Drive - Quakes Hill Pky	SectionA1	Bus	SB	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA3	Other	SB		423	368	55	5	5	2991	281	18	3290	12.53	388	18	52	458	1.74	228	24	4	256	0.98	9	1	1	4	14	0.05
	SectionA4	Other	SB		423	368	55	5	5	2991	281	18	3290	12.53	388	18	52	458	1.74	228	24	4	256	0.98	9	1	1	4	14	0.05
	SectionA5	Other	SB		423	368	55	5	5	2991	281	18	3290	12.53	388	18	52	458	1.74	228	24	4	256	0.98	9	1	1	4	14	0.05
	SectionA6	Right turn	SB		141	122	18	2	2	994	93	6	1094	12.53	129	6	17	152	1.74	76	8	1	85	0.98	3	0	0	1	5	0.05
	SectionA7	Right turn	SB		141	122	18	2	2	994	93	6	1094	12.53	129	6	17	152	1.74	76	8	1	85	0.98	3	0	0	1	5	0.05
	SectionA8	Other	NB		661	575	86	9	8	4678	439	28	5145	12.53	607	28	81	716	1.74	357	38	6	401	0.98	14	1	2	6	23	0.05
	SectionA9	Other	NB		661	575	86	9	8	4678	439	28	5145	12.53	607	28	81	716	1.74	357	38	6	401	0.98	14	1	2	6	23	0.05
	SectionA10	Other	NB		661	575	86	9	8	4678	439	28	5145	12.53	607	28	81	716	1.74	357	38	6	401	0.98	14	1	2	6	23	0.05
Quakes Hill Pky - Wilson Road	SectionB1	Bus	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB3	Other	SB		532	479	53	5	5	3895	272	17	4184	12.66	505	17	50	573	1.73	297	24	4	324	0.98	11	1	1	5	18	0.05
	SectionB4	Other	SB		532	479	53	5	5	3895	272	17	4184	12.66	505	17	50	573	1.73	297	24	4	324	0.98	11	1	1	5	18	0.05
	SectionB5	Other	SB		532	479	53	5	5	3895	272	17	4184	12.66	505	17	50	573	1.73	297	24	4	324	0.98	11	1	1	5	18	0.05
	SectionB6	Right turn	NB		938	844	94	9	8	6868	479	30	7377	12.66	891	31	89	1010	1.73	523	41	7	572	0.98	20	1	2	8	32	0.05
	SectionB7	Other	NB		1301	1171	130	13	12	9528	665	42	10234	12.66	1236	43	123	1401	1.73	726	58	10	793	0.98	28	1	3	12	44	0.05
	SectionB8	Other	NB		1301	1171	130	13	12	9528	665	42	10234	12.66	1236	43	123	1401	1.73	726	58	10	793	0.98	28	1	3	12	44	0.05
	SectionB9	Other	NB		1301	1171	130	13	12	9528	665	42	10234	12.66	1236	43	123	1401	1.73	726	58	10	793	0.98	28	1	3	12	44	0.05
Wilson Road - Meurants Lane	SectionC1	Other	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC2	Other	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC3	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC4	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC5	Left turn	SB		148	133	15	1	1	1084	76	5	1164	12.66	141	5	14	159	1.73	83	7	1	90	0.98	3	0	0	1	5	0.05
	SectionC6	Other	SB		532	479	53	5	5	3895	272	17	4184	12.66	505	17	50	573	1.73	297	24	4	324	0.98	11	1	1	5	18	0.05
	SectionC7	Other	SB		532	479	53	5	5	3895	272	17	4184	12.66	505	17	50	573	1.73	297	24	4	324	0.98	11	1	1	5	18	0.05
	SectionC8	Other	SB		532	479	53	5	5	3895	272	17	4184	12.66	505	17	50	573	1.73	297	24	4	324	0.98	11	1	1	5	18	0.05
	SectionC9	Right turn	SB		469	422	47	5	4	3434	240	15	3688	12.66	445	15	44	505	1.73	262	21	4	286	0.98	10	0	1	4	16	0.05
	SectionC10	Right turn	SB		469	422	47	5	4	3434	240	15	3688	12.66	445	15	44	505	1.73	262	21	4	286	0.98	10	0	1	4	16	0.05
	SectionC11	Other	NB		1301	1171	130	13	12	9528	665	42	10234	12.66	1236	43	123	1401	1.73	726	58	10	793	0.98	28	1	3	12	44	0.05
	SectionC12	Other	NB		1301	1171	130	13	12	9528	665	42	10234	12.66	1236	43	123	1401	1.73	726	58	10	793	0.98	28	1	3	12	44	0.05
	SectionC13	Other	NB		1301	1171	130	13	12	9528	665	42	10234	12.66	1236	43	123	1401	1.73	726	58	10	793	0.98	28	1	3	12	44	0.05
Meurants Lane - James Cook Drive	SectionD1	Bus stop lane		10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD2	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD3	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD4	Bus stop lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD5	Other	SB		523	470	52	5	5	3827	267	17	4111	12.66	496	17	49	563	1.73	292	23	4	319	0.98	11	1	1	5	18	0.05
	SectionD6	Other	SB		523	470	52	5	5	3827	267	17	4111	12.66	496	17	49	563	1.73	292	23	4	319	0.98	11	1	1	5	18	0.05
	SectionD7	Other	SB		523	470	52	5	5	3827	267	17	4111	12.66	496	17	49	563	1.73	292	23	4	319	0.98	11	1	1	5	18	0.05
	SectionD8	Right turn	NB		133	119	13	1	1	970	68	4	1042	12.66	126	4	13	143	1.73	74	6	1	81	0.98	3	0	0	1	4	0.05
	SectionD9	Right turn	NB		133	119	13	1	1	970	68	4	1042	12.66	126	4	13	143	1.73	74	6	1	81	0.98	3	0	0	1	4	0.05
	SectionD10	Other	NB		1044	940	104	10	9	7646	534	33	8213	12.66	992	34	99	1125	1.73	583	46	8	637	0.98	23	1	2	9	35	0.05
	SectionD11	Other	NB		1044	940	104	10	9	7646	534	33	8213	12.66	992	34	99	1125	1.73	583	46	8	637	0.98	23	1	2	9	35	0.05
	SectionD12	Other	NB		1044	940	104	10	9	7646	534	33	8213	12.66	992	34	99	1125	1.73	583	46	8	637	0.98	23	1	2	9	35	0.05
	SectionD13	Left turn	NB		479	431	48	5	4	3507	245	15	3767	12.66	455	16	45	516	1.73	267	21	4	292	0.98	10	0	1	4	16	0.05

Table A3 - 2006 PM Peak Emission Rates

Section of Sunnyholt Road	CALINE4 ID	Description	Direction of Flow	% HDV's	2006 PM Peak flow: Flow per Lane	CO g/km: LDV	CO g/km: HDPV	CO g/km: HDDV	CO g/km: Total	CO g/veh-mile: Total	NOx g/km: LDV	NOx g/km: HDPV	NOx g/km: HDDV	NOx g/km: Total	NOx g/veh-mile: Total	HC g/km: LDV	HC g/km: HDPV	HC g/km: HDDV	HC g/km: Total	HC g/veh-mile: Total	PM10 g/km: LDV	PM10 g/km: HDPV	PM10 g/km: HDDV	PM10 g/km: Brake & Tyre	PM10 g/km: Total	PM10 g/veh-mile: Total
Sorrento Drive - Quakes Hill Pky	SectionA1	Bus	SB	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA3	Other	SB		355	355	0	0	2885	13.09	374	0	0	374	1.70	220	0	0	220	1.00	9	0	0	3	12	0.05
	SectionA4	Other	SB		355	355	0	0	2885	236	0	3121	14.16	374	15	0	389	1.77	220	20	0	240	1.09	9	0	0	3	12	0.06
	SectionA5	Other	SB		355	355	0	0	2885	236	0	3121	14.16	374	15	0	389	1.77	220	20	0	240	1.09	9	0	0	3	12	0.06
	SectionA6	Right turn	SB		52	52	0	0	419	236	0	655	20.45	54	15	0	69	2.17	32	20	0	52	1.63	1	0	0	0	2	0.07
	SectionA7	Right turn	SB		52	52	0	0	419	34	0	453	14.16	54	2	0	57	1.77	32	3	0	35	1.09	1	0	0	0	2	0.06
	SectionA8	Other	NB		286	286	0	0	2327	34	0	2361	13.28	302	2	0	304	1.71	177	3	0	180	1.01	7	0	0	3	10	0.05
	SectionA9	Other	NB		286	286	0	0	2327	190	0	2517	14.16	302	12	0	314	1.77	177	16	0	194	1.09	7	0	0	3	10	0.06
	SectionA10	Other	NB		286	286	0	0	2327	190	0	2517	14.16	302	12	0	314	1.77	177	16	0	194	1.09	7	0	0	3	10	0.06
Quakes Hill Pky - Wilson Road	SectionB1	Bus	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB3	Other	SB		844	844	0	0	6863	0	0	6863	13.09	890	0	0	890	1.70	523	0	0	523	1.00	20	0	0	8	28	0.05
	SectionB4	Other	SB		844	844	0	0	6863	431	0	7294	13.91	890	28	0	918	1.75	523	37	0	560	1.07	20	1	0	8	29	0.05
	SectionB5	Other	SB		844	844	0	0	6863	431	0	7294	13.91	890	28	0	918	1.75	523	37	0	560	1.07	20	1	0	8	29	0.05
	SectionB6	Right turn	NB		1034	1034	0	0	8412	431	0	8843	13.76	1091	28	0	1119	1.74	641	37	0	678	1.06	25	1	0	9	35	0.05
	SectionB7	Other	NB		383	383	0	0	3113	528	0	3641	15.31	404	34	0	438	1.84	237	46	0	283	1.19	9	1	0	3	14	0.06
	SectionB8	Other	NB		383	383	0	0	3113	196	0	3309	13.91	404	13	0	416	1.75	237	17	0	254	1.07	9	0	0	3	13	0.05
	SectionB9	Other	NB		383	383	0	0	3113	196	0	3309	13.91	404	13	0	416	1.75	237	17	0	254	1.07	9	0	0	3	13	0.05
Wilson Road - Meurants Lane	SectionC1	Other	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC2	Other	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC3	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC4	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC5	Left turn	SB		608	608	0	0	4946	0	0	4946	13.09	641	0	0	641	1.70	377	0	0	377	1.00	15	0	0	5	20	0.05
	SectionC6	Other	SB		844	844	0	0	6863	311	0	7174	13.68	890	20	0	910	1.74	523	27	0	550	1.05	20	1	0	8	28	0.05
	SectionC7	Other	SB		844	844	0	0	6863	431	0	7294	13.91	890	28	0	918	1.75	523	37	0	560	1.07	20	1	0	8	29	0.05
	SectionC8	Other	SB		844	844	0	0	6863	431	0	7294	13.91	890	28	0	918	1.75	523	37	0	560	1.07	20	1	0	8	29	0.05
	SectionC9	Right turn	SB		517	517	0	0	4206	431	0	4637	14.43	545	28	0	573	1.78	321	37	0	358	1.11	12	1	0	5	18	0.06
	SectionC10	Right turn	SB		517	517	0	0	4206	264	0	4470	13.91	545	17	0	562	1.75	321	23	0	343	1.07	12	1	0	5	18	0.05
	SectionC11	Other	NB		383	383	0	0	3113	264	0	3377	14.20	404	17	0	421	1.77	237	23	0	260	1.09	9	1	0	3	13	0.06
	SectionC12	Other	NB		383	383	0	0	3113	196	0	3309	13.91	404	13	0	416	1.75	237	17	0	254	1.07	9	0	0	3	13	0.05
	SectionC13	Other	NB		383	383	0	0	3113	196	0	3309	13.91	404	13	0	416	1.75	237	17	0	254	1.07	9	0	0	3	13	0.05
Meurants Lane - James Cook Drive	SectionD1	Bus stop lane		10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD2	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD3	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD4	Bus stop lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD5	Other	SB		653	653	0	0	5315	0	0	5315	13.09	689	0	0	689	1.70	405	0	0	405	1.00	16	0	0	6	22	0.05
	SectionD6	Other	SB		653	653	0	0	5315	334	0	5649	13.91	689	21	0	711	1.75	405	29	0	434	1.07	16	1	0	6	22	0.05
	SectionD7	Other	SB		653	653	0	0	5315	334	0	5649	13.91	689	21	0	711	1.75	405	29	0	434	1.07	16	1	0	6	22	0.05
	SectionD8	Right turn	NB		123	123	0	0	1001	334	0	1334	17.46	130	21	0	151	1.98	76	29	0	105	1.38	3	1	0	1	5	0.06
	SectionD9	Right turn	NB		123	123	0	0	1001	63	0	1063	13.91	130	4	0	134	1.75	76	5	0	82	1.07	3	0	0	1	4	0.05
	SectionD10	Other	NB		382	382	0	0	3108	63	0	3170	13.36	403	4	0	407	1.71	237	5	0	242	1.02	9	0	0	3	13	0.05
	SectionD11	Other	NB		382	382	0	0	3108	195	0	3303	13.91	403	13	0	416	1.75	237	17	0	254	1.07	9	0	0	3	13	0.05
	SectionD12	Other	NB		382	382	0	0	3108	195	0	3303	13.91	403	13	0	416	1.75	237	17	0	254	1.07	9	0	0	3	13	0.05
	SectionD13	Left turn	NB		330	330	0	0	2605	195	0	2880	14.04	348	13	0	361	1.76	205	17	0	221	1.08	8	0	0	3	11	0.06

Table A4-2016 AM Peak Emission Rates

Section of Sunnyholt Road	CALINE4 ID	Description	Direction of Flow	% HDV's	2016 AM Peak flow					CO g/km				CO g/veh-mile	NOx g/km				NOx g/veh-mile	HC g/km				HC g/veh-mile	PM 10 g/km				PM 10 g/veh-mile
					Flow per lane	LDV	HDV	HDPV	HDDV	LDV	HDPV	HDDV	Total	Total	LDV	HDPV	HDDV	Total	Total	LDV	HDPV	HDDV	Total	Total	LDV	HDPV	HDDV	Brake & Tyre	Total	Total
Sorrento Drive - Quakes Hill Pky	SectionA1	Bus	SB	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA3	Other	SB		411	411	0	0	0	1531	0	0	1531	5.99	363	0	0	363	1.42	116	0	0	116	0.45	7	0	0	4	11	0.04
	SectionA4	Other	SB		411	411	0	0	0	1531	176	0	1707	6.68	363	11	0	374	1.46	116	3	0	119	0.47	7	0	0	4	11	0.04
	SectionA5	Other	SB		411	411	0	0	0	1531	176	0	1707	6.68	363	11	0	374	1.46	116	3	0	119	0.47	7	0	0	4	11	0.04
	SectionA6	Right turn	SB		67	67	0	0	0	248	176	0	424	10.26	59	11	0	70	1.69	19	3	0	22	0.53	1	0	0	1	2	0.05
	SectionA7	Right turn	SB		67	67	0	0	0	248	29	0	276	6.68	59	2	0	60	1.46	19	1	0	19	0.47	1	0	0	1	2	0.04
	SectionA8	Other	NB		513	513	0	0	0	1910	29	0	1938	6.08	452	2	0	454	1.43	145	1	0	145	0.46	9	0	0	5	13	0.04
	SectionA9	Other	NB		513	513	0	0	0	1910	220	0	2130	6.68	452	14	0	466	1.46	145	4	0	148	0.47	9	0	0	5	14	0.04
	SectionA10	Other	NB		513	513	0	0	0	1910	220	0	2130	6.68	452	14	0	466	1.46	145	4	0	148	0.47	9	0	0	5	14	0.04
Quakes Hill Pky - Wilson Road	SectionB1	Bus	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB3	Other	SB		995	995	0	0	0	3708	0	0	3708	5.99	878	0	0	878	1.42	281	0	0	281	0.45	17	0	0	9	26	0.04
	SectionB4	Other	SB		995	995	0	0	0	3708	328	0	4036	6.53	878	21	0	899	1.45	281	6	0	286	0.46	17	1	0	9	26	0.04
	SectionB5	Other	SB		995	995	0	0	0	3708	328	0	4036	6.53	878	21	0	899	1.45	281	6	0	286	0.46	17	1	0	9	26	0.04
	SectionB6	Right turn	NB		1302	1302	0	0	0	4850	328	0	5178	6.40	1148	21	0	1169	1.44	367	6	0	373	0.46	22	1	0	12	34	0.04
	SectionB7	Other	NB		622	622	0	0	0	2317	430	0	2747	7.11	549	27	0	576	1.49	175	8	0	183	0.47	11	1	0	6	17	0.04
	SectionB8	Other	NB		622	622	0	0	0	2317	205	0	2522	6.53	549	13	0	562	1.45	175	4	0	179	0.46	11	0	0	6	17	0.04
	SectionB9	Other	NB		622	622	0	0	0	2317	205	0	2522	6.53	549	13	0	562	1.45	175	4	0	179	0.46	11	0	0	6	17	0.04
Wilson Road - Meurants Lane	SectionC1	Other	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC2	Other	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC3	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC4	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC5	Left turn	SB		481	481	0	0	0	1792	0	0	1792	5.99	424	0	0	424	1.42	136	0	0	136	0.45	8	0	0	4	13	0.04
	SectionC6	Other	SB		995	995	0	0	0	3708	159	0	3866	6.25	878	10	0	888	1.44	281	3	0	283	0.46	17	0	0	9	26	0.04
	SectionC7	Other	SB		995	995	0	0	0	3708	328	0	4036	6.53	878	21	0	899	1.45	281	6	0	286	0.46	17	1	0	9	26	0.04
	SectionC8	Other	SB		995	995	0	0	0	3708	328	0	4036	6.53	878	21	0	899	1.45	281	6	0	286	0.46	17	1	0	9	26	0.04
	SectionC9	Right turn	SB		651	651	0	0	0	2425	328	0	2753	6.81	574	21	0	595	1.47	184	6	0	189	0.47	11	1	0	6	18	0.04
	SectionC10	Right turn	SB		651	651	0	0	0	2425	215	0	2640	6.53	574	14	0	588	1.45	184	4	0	187	0.46	11	0	0	6	17	0.04
	SectionC11	Other	NB		622	622	0	0	0	2317	215	0	2532	6.55	549	14	0	562	1.45	175	4	0	179	0.46	11	0	0	6	17	0.04
	SectionC12	Other	NB		622	622	0	0	0	2317	205	0	2522	6.53	549	13	0	562	1.45	175	4	0	179	0.46	11	0	0	6	17	0.04
	SectionC13	Other	NB		622	622	0	0	0	2317	205	0	2522	6.53	549	13	0	562	1.45	175	4	0	179	0.46	11	0	0	6	17	0.04
Meurants Lane - James Cook Drive	SectionD1	Bus stop lane		10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD2	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD3	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD4	Bus stop lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD5	Other	SB		710	710	0	0	0	2646	0	0	2646	5.99	627	0	0	627	1.42	200	0	0	200	0.45	12	0	0	6	18	0.04
	SectionD6	Other	SB		710	710	0	0	0	2646	234	0	2880	6.53	627	15	0	641	1.45	200	4	0	204	0.46	12	0	0	6	19	0.04
	SectionD7	Other	SB		710	710	0	0	0	2646	234	0	2880	6.53	627	15	0	641	1.45	200	4	0	204	0.46	12	0	0	6	19	0.04
	SectionD8	Right turn	NB		125	125	0	0	0	464	234	0	698	9.02	110	15	0	125	1.61	35	4	0	39	0.51	2	0	0	1	4	0.05
	SectionD9	Right turn	NB		125	125	0	0	0	464	41	0	505	6.53	110	3	0	112	1.45	35	1	0	36	0.46	2	0	0	1	3	0.04
	SectionD10	Other	NB		524	524	0	0	0	1951	41	0	1992	6.12	462	3	0	464	1.43	148	1	0	148	0.46	9	0	0	5	14	0.04
	SectionD11	Other	NB		524	524	0	0	0	1951	173	0	2123	6.53	462	11	0	473	1.45	148	3	0	151	0.46	9	0	0	5	14	0.04
	SectionD12	Other	NB		524	524	0	0	0	1951	173	0	2123	6.53	462	11	0	473	1.45	148	3	0	151	0.46	9	0	0	5	14	0.04
	SectionD13	Left turn	NB		358	358	0	0	0	1334	173	0	1506	6.77	316	11	0	327	1.47	101	3	0	104	0.47	6	0	0	3	10	0.04

Table A5 - 2016 PM Peak Emission Rates

Section of Sunnyholt Road	CALINE4 ID	Description	Direction of Flow	% HDV's	2016 PM Peak flow	CO g/km				CO g/veh-mile	NOx g/km				NOx g/veh-mile	HC g/km				HC g/veh-mile	PM10 g/km				PM10 g/veh-mile
					Flow per lane	LDV	HDV	HDPV	HDDV	Total	LDV	HDPV	HDDV	Total	LDV	HDPV	HDDV	Total	LDV	HDPV	HDDV	Total	LDV	HDPV	HDDV	Brake & Tyre	Total
Sorrento Drive - Quakes Hill Pky	SectionA1	Bus	SB	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionA3	Other	SB		423	423	0	0	0	1574	0	0	1574	5.99	373	0	0	373	1.42	119	0	0	119	0.45	7	0	0	4	11	0.04
	SectionA4	Other	SB		423	423	0	0	0	1574	181	0	1756	6.68	373	11	0	384	1.46	119	3	0	122	0.47	7	0	0	4	11	0.04
	SectionA5	Other	SB		423	423	0	0	0	1574	181	0	1756	6.68	373	11	0	384	1.46	119	3	0	122	0.47	7	0	0	4	11	0.04
	SectionA6	Right turn	SB		141	141	0	0	0	523	181	0	705	8.07	124	11	0	135	1.55	40	3	0	43	0.49	2	0	0	1	4	0.05
	SectionA7	Right turn	SB		141	141	0	0	0	523	60	0	584	6.68	124	4	0	128	1.46	40	1	0	41	0.47	2	0	0	1	4	0.04
	SectionA8	Other	NB		661	661	0	0	0	2462	60	0	2522	6.14	583	4	0	587	1.43	186	1	0	187	0.46	11	0	0	6	17	0.04
	SectionA9	Other	NB		661	661	0	0	0	2462	284	0	2746	6.68	583	18	0	601	1.46	186	5	0	191	0.47	11	1	0	6	18	0.04
	SectionA10	Other	NB		661	661	0	0	0	2462	284	0	2746	6.68	583	18	0	601	1.46	186	5	0	191	0.47	11	1	0	6	18	0.04
Quakes Hill Pky - Wilson Road	SectionB1	Bus	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB2	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionB3	Other	SB		532	532	0	0	0	1982	0	0	1982	5.99	469	0	0	469	1.42	150	0	0	150	0.45	9	0	0	5	14	0.04
	SectionB4	Other	SB		532	532	0	0	0	1982	176	0	2157	6.53	469	11	0	480	1.45	150	3	0	153	0.46	9	0	0	5	14	0.04
	SectionB5	Other	SB		532	532	0	0	0	1982	176	0	2157	6.53	469	11	0	480	1.45	150	3	0	153	0.46	9	0	0	5	14	0.04
	SectionB6	Right turn	NB		938	938	0	0	0	3494	176	0	3670	6.30	827	11	0	838	1.44	265	3	0	268	0.46	16	0	0	8	25	0.04
	SectionB7	Other	NB		1301	1301	0	0	0	4847	310	0	5157	6.38	1148	19	0	1167	1.44	367	5	0	372	0.46	22	1	0	12	34	0.04
	SectionB8	Other	NB		1301	1301	0	0	0	4847	429	0	5277	6.53	1148	27	0	1175	1.45	367	8	0	375	0.46	22	1	0	12	35	0.04
	SectionB1	Other	NB		1301	1301	0	0	0	4847	429	0	5277	6.53	1148	27	0	1175	1.45	367	8	0	375	0.46	22	1	0	12	35	0.04
Wilson Road - Meurants Lane	SectionC1	Other	SB	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC2	Other	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC3	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC4	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionC5	Left turn	SB		148	148	0	0	0	551	0	0	551	5.99	131	0	0	131	1.42	42	0	0	42	0.45	3	0	0	1	4	0.04
	SectionC6	Other	SB		532	532	0	0	0	1982	49	0	2031	6.14	469	3	0	472	1.43	150	1	0	151	0.46	9	0	0	5	14	0.04
	SectionC7	Other	SB		532	532	0	0	0	1982	176	0	2157	6.53	469	11	0	480	1.45	150	3	0	153	0.46	9	0	0	5	14	0.04
	SectionC8	Other	SB		532	532	0	0	0	1982	176	0	2157	6.53	469	11	0	480	1.45	150	3	0	153	0.46	9	0	0	5	14	0.04
	SectionC9	Right turn	SB		469	469	0	0	0	1747	176	0	1923	6.60	414	11	0	425	1.46	132	3	0	135	0.46	8	0	0	4	13	0.04
	SectionC10	Right turn	SB		469	469	0	0	0	1747	155	0	1902	6.53	414	10	0	423	1.45	132	3	0	135	0.46	8	0	0	4	12	0.04
	SectionC11	Other	NB		1301	1301	0	0	0	4847	155	0	5002	6.19	1148	10	0	1158	1.43	367	3	0	370	0.46	22	0	0	12	34	0.04
	SectionC12	Other	NB		1301	1301	0	0	0	4847	429	0	5277	6.53	1148	27	0	1175	1.45	367	8	0	375	0.46	22	1	0	12	35	0.04
	SectionC13	Other	NB		1301	1301	0	0	0	4847	429	0	5277	6.53	1148	27	0	1175	1.45	367	8	0	375	0.46	22	1	0	12	35	0.04
Meurants Lane - James Cook Drive	SectionD1	Bus stop lane		10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD2	Bus	SB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD3	Bus	NB		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD4	Bus stop lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SectionD5	Other	SB		523	523	0	0	0	1947	0	0	1947	5.99	461	0	0	461	1.42	147	0	0	147	0.45	9	0	0	5	14	0.04
	SectionD6	Other	SB		523	523	0	0	0	1947	172	0	2119	6.53	461	11	0	472	1.45	147	3	0	150	0.46	9	0	0	5	14	0.04
	SectionD7	Other	SB		523	523	0	0	0	1947	172	0	2119	6.53	461	11	0	472	1.45	147	3	0	150	0.46	9	0	0	5	14	0.04
	SectionD8	Right turn	NB		133	133	0	0	0	494	172	0	666	8.09	117	11	0	128	1.55	37	3	0	40	0.49	2	0	0	1	4	0.05
	SectionD9	Right turn	NB		133	133	0	0	0	494	44	0	537	6.53	117	3	0	120	1.45	37	1	0	38	0.46	2	0	0	1	4	0.04
	SectionD10	Other	NB		1044	1044	0	0	0	3890	44	0	3934	6.06	921	3	0	924	1.42	295	1	0	295	0.46	18	0	0	9	27	0.04
	SectionD11	Other	NB		1044	1044	0	0	0	3890	345	0	4235	6.53	921	22	0	943	1.45	295	6	0	301	0.46	18	1	0	9	28	0.04
	SectionD12	Other	NB		1044	1044	0	0	0	3890	345	0	4235	6.53	921	22	0	943	1.45	295	6	0	301	0.46	18	1	0	9	28	0.04
	SectionD13	Left turn	NB		479	479	0	0	0	1784	345	0	2129	7.15	422	22	0	444	1.49	135	6	0	141	0.47	8	1	0	4	13	0.04

APPENDIX B
HYDROCARBON ANALYSIS OF VEHICLE EXHAUST, PETROL AND PETROL VAPOUR

HYDROCARBON COMPOSITION OF VEHICLE EXHAUST, PETROL AND PETROL VAPOUR

Hydrocarbon	Exhaust Average	Standard Deviation	Petrol Average	Standard Deviation	Petrol Vapour
ethane	1.4	0.5	ND		ND
ethylene	11.2	3.2	ND		ND
acetylene	8.7	2.7	ND		ND
propane	0.1	0.1	0.1	0.1	1.5
propylene	5.0	1.6	ND		ND
methylacetylene	0.4	0.3	ND		ND
n-butane	2.1	0.6	2.9	0.4	18.7
i-butane	1.0	0.3	1.2	0.3	11.1
1-butene	0.9	0.3	0.2	0.1	1.6
i-butene	1.4	0.6	ND		ND
trans-2-butene	0.6	0.4	0.6	0.1	3.7
cis-2-butene	0.5	0.2	0.5	0.1	2.9
n-pentane	3.0	0.7	6.0	0.6	10.7
i-pentane	4.8	0.9	10.6	0.5	25.4
cyclopentane	0.4	0.1	0.5	0.1	0.6
1-pentene	0.2	0.1	0.3	0.1	0.7
trans-2-pentene	0.3	0.2	0.8	0.1	1.5
cis-2-pentene	0.3	0.2	0.5	0.1	0.9
2-methyl-1-butene	0.3	0.2	0.6	0.1	1.3
2-methyl-2-butene	0.5	0.2	1.6	0.2	2.6
n-hexane	1.9	0.4	3.5	0.3	1.9
2-methylpentane	2.3	0.4	4.9	0.2	3.5
3-methylpentane	1.6	0.3	3.2	0.1	2.2
2,2-dimethylbutane	0.3	0.2	0.5	0.1	0.6
2,3-dimethylbutane	0.6	0.1	1.3	0.1	1.1
methylcyclopentane	1.0	0.2	1.9	0.1	0.9
cyclohexane	0.6	0.2	0.8	0.1	0.3
1-hexene	0.3	0.2	0.4	0.1	0.3
other C_6 olefins	0.7	0.2	1.6	0.1	1.0
benzene	5.0	0.7	2.6	0.2	0.9
n-heptane	0.8	0.2	1.6	0.1	0.3
2-methylhexane	1.5	0.3	2.9	0.1	0.7
3-methylhexane	1.2	0.3	2.3	0.1	0.5
2,4-dimethylpentane	0.3	0.1	0.7	0.1	0.2
methylcyclohexane	0.6	0.2	1.1	0.2	0.2
other C_7 cycloalkanes	0.3	0.2	0.6	0.1	0.1
toluene	10.2	0.9	9.6	0.6	1.0
n-octane	0.4	0.1	0.7	0.1	ND
2,2,4-trimethylpentane	1.0	0.4	2.1	0.5	0.4
other C_8 alkanes	3.2	0.7	7.1	0.6	0.6
ethylbenzene	1.9	0.2	1.6	0.1	0.1
m, p-xylenes	6.5	0.9	6.5	0.4	0.2
o-xylene	2.5	0.4	2.3	0.2	0.1
n-nonane	0.2	0.1	0.3	0.1	ND
other C_9 alkanes	1.7	0.4	2.1	0.3	ND
n-propylbenzene	0.4	0.1	0.4	0.1	ND
i-propylbenzene	0.2	0.1	0.2	0.1	ND
1,2,4-trimethylbenzene	1.9	0.3	1.8	0.2	ND
1,3,5-trimethylbenzene	0.7	0.1	0.7	0.1	ND
m, p-ethyltoluenes	2.0	0.3	1.8	0.2	ND
o-ethyltoluene	0.6	0.2	0.5	O.1	ND
n-decane	0.4	0.1	0.4	0.1	ND
other C_{10} alkanes & aromatics	0.9	0.4	1.2	0.3	ND
C_{11} and C_{12} alkanes & aromatics	3.6	1.1	4.2	0.7	ND
Total[a]	100.40		99.80		100.30

(a) Total does not equal 100 due to rounding.

Source: **Nelson & Quigley (1982)**

Figures

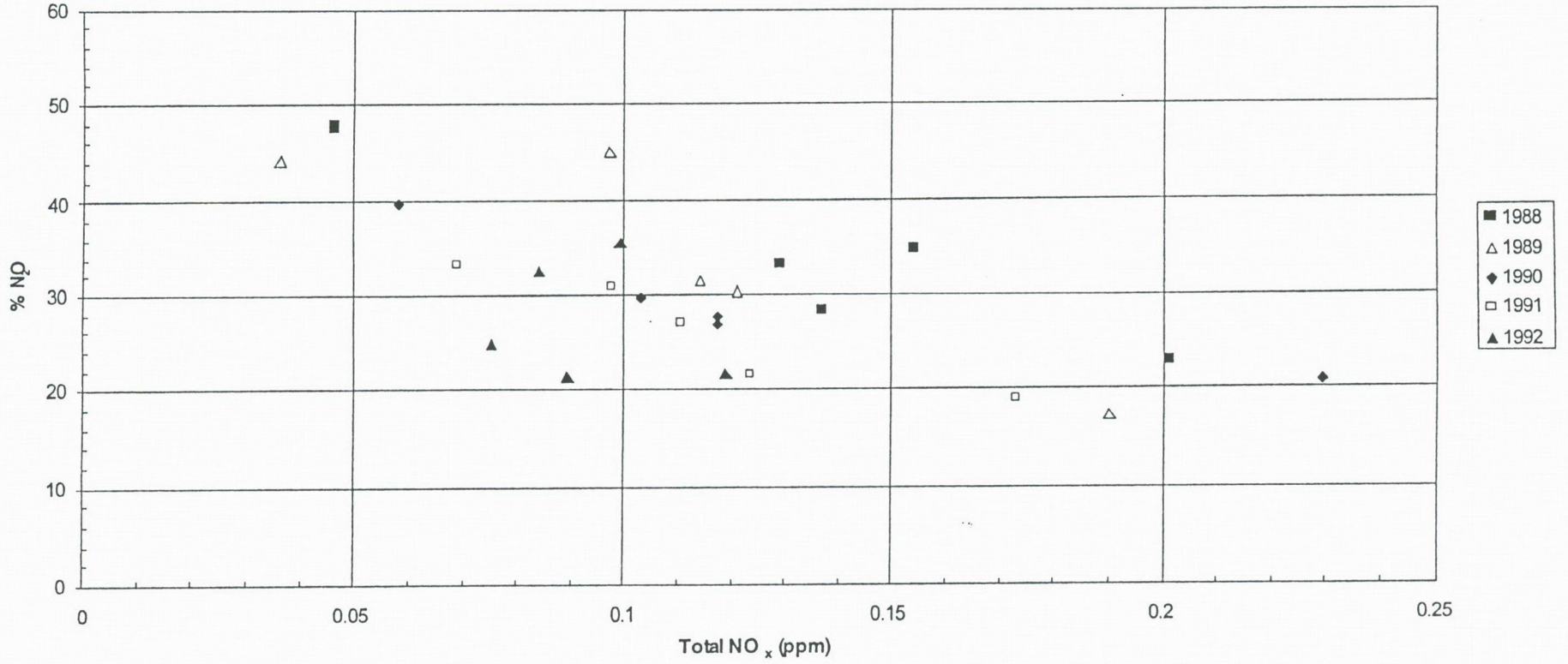


Figure 1 - Correlation between percentage NO_2 and total NO_x - EPA monitoring data

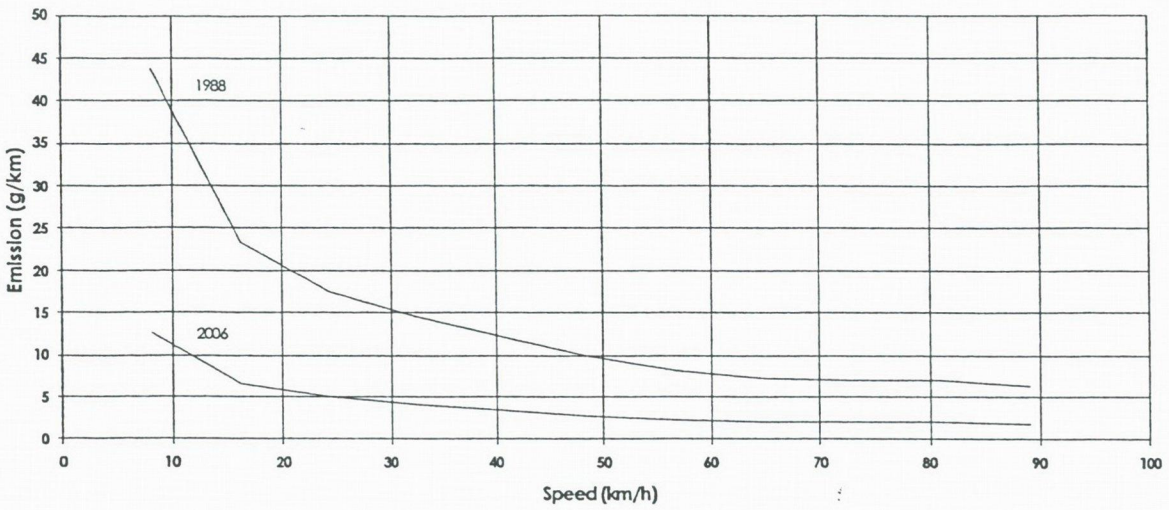


Figure 2 - Emission rate of CO vs speed for light duty petrol vehicles years 1988 and 2006

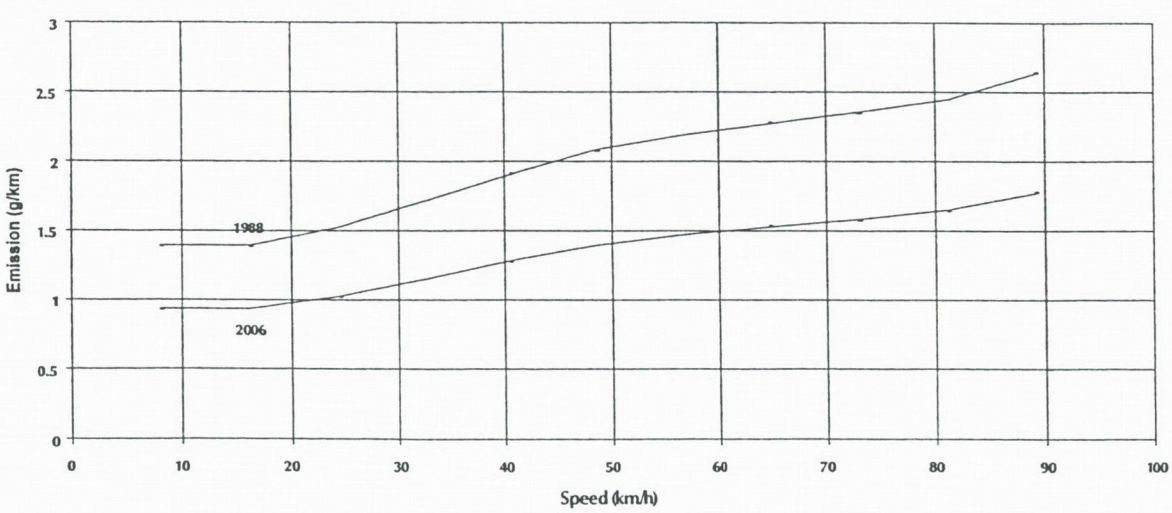


Figure 3 - Emission rate of NO_x vs speed for light duty petrol vehicles years 1988 and 2006

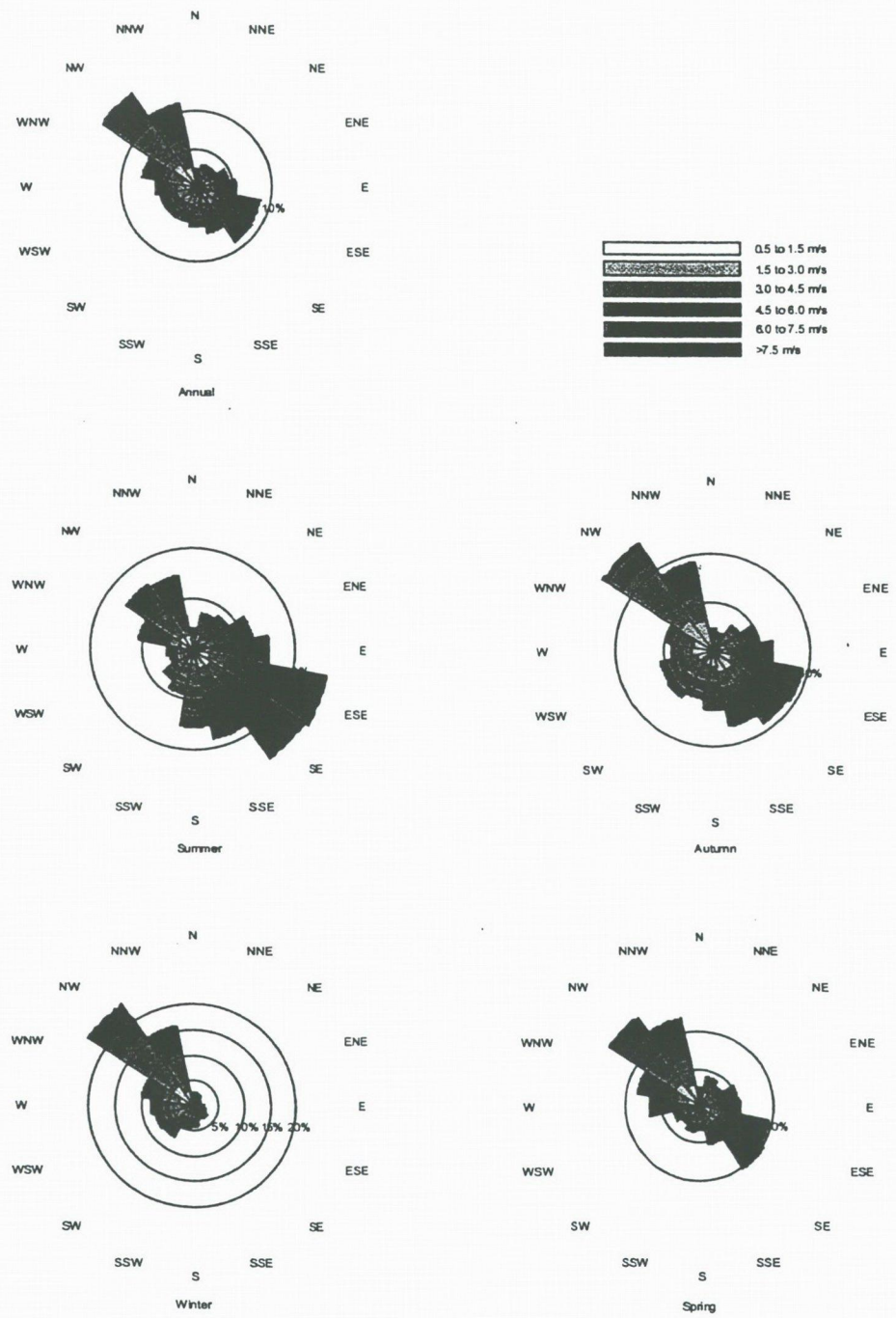


Figure 4 - Annual and seasonal windroses for Blacktown

APPENDIX 4

Flora and Fauna Assessment
Proposed Widening of Sunnyholt Road, Glenwood.

July 2002, AES Environmental Consultancy

Flora and Fauna Assessment, Proposed Widening of Sunnyholt Road, Glenwood.

July 2002

AES

Environmental Consultancy

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1. Introduction and Recommendations

The Roads and Traffic Authority proposes to widen Sunnyholt Road between south of James Cook Drive and south of Sorrento Drive, Glenwood. The proposal would involve widening of the main road from two to six lanes with an associated cycleway and footway. AES was contracted to undertake a fauna and flora assessment of the proposed road-widening route. The aims of this assessment are to determine:

- whether the proposal is likely to cause a "significant effect on threatened species, populations or ecological communities or their habitats", based on the eight factors listed in Section 5A of the *Environmental Planning and Assessment Act, 1979* as amended by the *Threatened Species Conservation Act, 1995*, and
- impacts in relation to the *Commonwealth Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

The main findings of the assessment are as follows:

- Most of the route is either cleared of vegetation or is vegetated with pasture grasses, weeds or landscape plantings. The exception to this is on the east side of Sunnyholt Road north of Meurants Lane where there is a small remnant of Cumberland Plain Woodland.
- Cumberland Plain Woodland is listed as an endangered ecological community on both the *Threatened Species Conservation Act* and the *Environment Protection and Biodiversity Conservation Act*. Given the small amount of Cumberland Plain Woodland affected and its already modified nature, it considered that the proposed road widening would not have a significant effect on this endangered ecological community.
- No threatened flora species were recorded during the field survey. The Cumberland Plain Woodland within the route is considered to be too degraded to support any threatened flora species.
- No threatened fauna species were recorded during the field survey. Habitats within the route are considered to be too degraded to support any threatened fauna species.
- The proposed road widening is unlikely to have a significant effect on threatened species, populations or ecological communities, or their habitats. Therefore a Species Impact Statement is not required.
- The proposed development is unlikely to have a significant impact on a matter of national Environmental Significance (Cumberland Plain Woodland). Therefore, approval from the Federal Environment Minister is not required.

2. Methodology

Fieldwork was undertaken on 10th April and 5th July 2002 using the following methods.

2.1 Vegetation

The vegetation of the route is described based on the dominant tree species and the height and cover of the tree layer following Specht (1970). Plants not readily identified in the field were collected for identification using standard texts. Checks were made against the Schedules 1

and 2 of the *Threatened Species Conservation Act*, Briggs & Leigh (1995) and James *et al* (1999) for species of conservation significance.

2.2 Fauna

The vegetation community descriptions were used to describe the different fauna habitats that occur along the route. The habitat surrounding the site was also investigated to gain an appreciation of the relative importance of the habitat that occurs on the site.

Notes were made of specific sources of native fauna food and shelter, such as dense shrubs, flowering trees, tree hollows and rock outcrops. The presence, or lack, of particular fauna habitat requirements was noted to enable predictions of species that would be likely to utilise the site.

A search was made for indirect evidence of mammal presence such as droppings, burrows, tracks, diggings and bones. Habitat types and the degree of disturbance were assessed to enable predictions of mammal species presence. Due to the absence of hollow-bearing trees within the area affected, it was considered superfluous to undertake spotlighting and insectivorous bat surveys.

A reptile search was undertaken throughout the site. This involved looking under rocks, bark, fallen timber and leaf litter, with particular attention given to rock outcrop areas. Debris found near moist habitats was checked for the presence of frogs and the type of moist habitats present were noted to allow predictions of frog species likely to occur.

A search was undertaken for the threatened Large Land Snail (*Meridolum corneovirens*) by looking under debris and around the bases of trees.

3. Flora

3.1 Vegetation Description

The entire length of the route on the west side of Sunnyholt Road has been previously cleared. Apart from a few remnant Grey Box (*Eucalyptus moluccana*), it is either denuded of vegetation or is the edge of pasture dominated by introduced grass species.

On the eastern side of Sunnyholt Road there is a landscaped strip from the southern end of the route to Flint Street. North of Flint Street to Meurants Lane are remnant Grey Box and Forest Red Gum (*Eucalyptus tereticornis*) trees above Kikuyu (*Penniseteum clandestinum*) and other weeds such as African Olive (*Olea europaea ssp Africana*), Cobbler's Pegs (*Bidens pilosa*) and Thistle (*Cyrsium vulgare*).

A more intact stand of remnant vegetation occurs adjacent to the proposed edge of the road widening north of Meurants Lane for a distance of approximately 125 metres. Here there are Forest Red Gum, Grey Box, Broad-leaved Ironbark (*Eucalyptus fibrosa*) and Narrow-leaved Ironbark (*E.crebra*). There is a wide variety of native grasses and herbs including Kangaroo

Grass (*Themeda australis*), Weeping Meadow Grass (*Microlaena stipoides*), Wallaby Grass (*Austrodanthonia tenuior*), Three-awn Spear Grass (*Aristida vagans*), Plume Grass (*Dichelachne rara*), Austral Trumpet (*Brunoniella australis*) and *Glycine tabacina*. Weed cover is about 50-60% and dominated by Mother-of-millions (*Bryophyllum delagoense*), Cobblers Pegs and African Love Grass (*Eragrostis curvula*). This narrow strip was until recently part of a larger remnant of woodland, which has been cleared for residential development to the east of Sunnyholt Road.

From here to the northern end of the route is weedy vegetation with a few remnant eucalypts.

3.2 Conservation Significance of the Vegetation

The NSW National Parks and Wildlife Service undertook mapping of remnant native vegetation in western Sydney in 1998 and 1999 (NPWS, 2000). This was mainly based on aerial photograph interpretation with limited field checking.

The woodland north of Meurants Lane conforms to and is mapped as Shale Plains Woodland "B" by NPWS (2000). Shale Plains Woodland is a sub-unit of Cumberland Plain Woodland, which is listed as an endangered ecological community on both the *Threatened Species Conservation Act* and the *Environment Protection and Biodiversity Conservation Act*. "B" signifies that there is less than 10% crown cover and that the remnant is larger than 5 hectares. Due to clearing for Ali Place and the adjacent subdivision, the remnant is now only about 1000 m^2.

Other areas of vegetation along the route are considered to not have any conservation significance due to high levels of modification and dominance of introduced species.

3.3 Threatened Flora Species

No threatened flora species were found along the route. The following threatened flora species have been detected within a five-kilometre radius of the site (Source: NPWS Wildlife Atlas).

Species	Status		Habitat
	EPBC	TSC	
Grevillea juniperina ssp juniperina	-	V	Shale-gravel Transition Forest
Pimelea spicata	V	V	Cumberland Plain Woodland

The route may previously have been habitat for *Pimelea spicata*. However, its soils (including those within the Cumberland Plain Woodland north of Meurants Lane) are now unlikely to support a seedbank of the species due to past clearing and weed invasion.

3.4 Noxious Weeds

No plant species declared as noxious weeds under the *Noxious Weeds Act, 1993* were found along the proposed road-widening route.

4. Fauna

No threatened fauna species were detected along the route. The following threatened fauna species listed on the TSC Act have been detected within a five-kilometre radius of the site (Source: NPWS Wildlife Atlas).

Scientific Name	Common Name	Habitat
Lathamus discolor	Swift Parrot	Winter visitor to flowering eucalypts; unlikely.
Neophema pulchella	Turquoise Parrot	Woodlands and margins; unlikely.
Xanthomyza phrygia	Regent Honeyeater	Winter visitor to flowering eucalypts; unlikely.
Mormopterus norfolkensis	East Coast Freetail Bat	Roosts in tree hollows; forages in open forest and woodland; unlikely.
Miniopterus schreibersii	Common Bent-wing Bat	Roosts in caves, mines, tunnels etc; forages over forest, woodland and occasionally urban areas.
Chalinolobus dwyeri	Large-eared Pied Bat	Roosts in caves, mines, tunnels etc; forages over forest, woodland and occasionally urban areas.
Meridolum corneovirens	Cumberland Land Snail	Intact remnants of Cumberland Plain Woodland unlikely.

Given the highly disturbed and modified nature of the habitats along the route, none of these threatened fauna species are considered likely to occur.

5. Impacts of the Proposed Development

5.1 *Threatened Species Conservation Act*

Of the endangered ecological communities, endangered populations and threatened species listed on the schedules to this Act, Cumberland Plain Woodland is the only relevant biota occurring along the route.

The eight factors set out in S5A of the *Environmental Planning and Assessment Act* (as amended by the *Threatened Species Conservation Act*) are considered below.

5.1.1 Cumberland Plain Woodland

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be significantly compromised,

Not relevant.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

Not relevant.

(c) in relation to the regional distribution of the habitat of an ecological community, whether a significant area of known habitat is to be modified or removed,

The proposed road widening and associated transitway would affect an area of Cumberland Plain Woodland north of Meurants Lane. This remnant covered an area of about 1.2 hectares prior to the clearing of most of it for residential development. What is left now between Sunnyholt Road and Ali Place is about 1000 m^2 in area. The proposed development will remove this small remnant, which is already being impacted upon by weed invasion and rubbish dumping. These processes are likely to result in degradation of this Cumberland Plain Woodland remnant in the long term regardless of the construction of the road. Given this and the small size of the Cumberland Plain Woodland remnant affected, it is considered that the proposal would not remove or modify a significant area of known habitat of Cumberland Plain Woodland.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate area of habitat for an ecological community,

The Cumberland Plain Woodland remnant within the route is already isolated from other occurrences of the community.

(e) whether critical habitat will be affected,

Critical habitat is yet to be defined.

(f) whether an ecological community, or its habitat, is adequately represented in conservation reserves (or other similar protected area) in the region,

Cumberland Plain Woodland occurs entirely within the Sydney Basin Biogeographic Region. There is only about 9% of the original (pre-European) distribution of Cumberland Plain Woodland left (NPWS, 2000). The JANIS criteria (JANIS, 1997) for adequate reservation for those communities that are not naturally rare, is that 15% of the original distribution should be protected. By this criterion Cumberland Plain Woodland must be considered inadequately represented in regional conservation reserves.

(g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

"Clearing of native vegetation" has been listed as a Key Threatening Process on Schedule 3 of the *Threatened Species Conservation Act*. Cumberland Plain Woodland is listed in the

appendix to the Scientific Committee's Final Determination as an endangered ecological community adversely affected by this threatening process.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution,

On the basis of mapping by NPWS (2000) Cumberland Plain Woodland is distributed between Landsdowne in the east to Glossodia/Mulgoa in the west; and from Freemans Reach/East Kurrajong in the north to Douglas Park and just south of Picton in the south. Therefore, Cumberland Plain Woodland is not at the limit of its distribution at Glenwood.

Conclusion
The proposed development is unlikely to have a significant effect on Cumberland Plain Woodland, or its habitat.

5.2 *Environment Protection and Biodiversity Conservation Act*

Cumberland Plain Woodland is listed as an endangered ecological community on the *Environment Protection and Biodiversity Conservation Act*. The following factors are used as guidelines to determine whether the proposed road widening would have a significant impact on this matter of National Environmental Significance.

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered ecological community if it does, will, or is likely to:

- *lead to a long-term adverse effect on an ecological community*
  The amount of Cumberland Plain Woodland likely to be affected by the proposed road widening and transitway is about 1000 m^2. This future of this remnant is already compromised by existing weed invasion and other ongoing edge effects such as rubbish dumping and weakening of trees by wind shear. Therefore the loss of this remnant is unlikely to lead to a long-term adverse effect on Cumberland Plain Woodland.

- *or reduce the extent of the community*
  The proposed road widening and transitway will reduce to a small amount the extent of Cumberland Plain Woodland.

- *or fragment an occurrence of the community,*
  Surrounding development already fragments the subject remnant.

- *or adversely affect habitat critical to the survival of an ecological community,*
  It is unlikely that the subject remnant of Cumberland Plain Woodland is critical to the survival of the community.

- *or modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival,*
  As well as direct removal of Cumberland Plain Woodland, works associated with the proposed road widening and transitway are likely to modify soil and nutrient levels.

However, as previously stated, the subject remnant is already compromised by existing surrounding development.

- *or result in invasive species that are harmful to the critically endangered or endangered ecological community becoming established in an occurrence of the community,*
  Invasive species are already well established in the subject remnant of Cumberland Plain Woodland.

- *or interfere with the recovery of an ecological community.*
  The reserve's remnant of Cumberland Plain Woodland is unlikely to be important to the recovery of the community.

Conclusion
Given the factors considered above, the proposal would not have a significant impact on this matter of National Environmental Significance. Referral to Environment Australia is not required.

6. Environmental Management Measures and Safeguards

To mitigate against impacts on Cumberland Plain Woodland, the following measures are recommended:

- Protection of retained trees within the road reserve;
- Where appropriate, planting of locally occurring native plants species.

References

Briggs, J.D., & Leigh, J.H., (1995), *Rare or Threatened Australian Plants.* CSIRO Publishing, Collingwood.

James, T., McDougall, L. & Benson, D.H. (1999), *Rare Bushland Plants of Western Sydney.* Royal Botanic Gardens, Sydney.

NPWS (2000), *Interpretation Guidelines for the Native Vegetation of the Cumberland Plain, Western Sydney.* NSW National Parks and Wildlife Service, Hurstville.

APPENDIX 5

Landscape Assessment
Proposed Widening of Sunnyholt Road, Glenwood

October 2002, Jocelyn Ramsay & Associates Pty Ltd

LANDSCAPE ASSESSMENT

PROPOSED WIDENING OF SUNNYHOLT ROAD, GLENWOOD

October 2002

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Table of Contents

1.0 INTRODUCTION.

The Roads and Traffic Authority proposes to widen Sunnyholt Road at Glenwood. The proposal involves widening of the main road from two to generally six lanes with associated cycleway, proposed busway and footway. Note the proposed bus transitway is subject to a separate environmental assessment and planning approval study.

The aims of this assessment are to identify the landscape/visual quality of the existing site conditions, review the project proposal, identify impacts of the proposal on the existing site conditions and recommend landscape treatments which can provide opportunities to address issues raised and contribute to enhancing and improving the overall visual quality of the locality.

2.0 VISUAL QUALITY.

The section of Sunnyholt Road in question can be visually assessed as either being of High, Medium or Low Visual Quality. The areas of each are identified on the accompanying Landscape Assessment Plan.

High

The area of highest visual quality is found on the eastern side of Sunnyholt Road, within the road reserve for the Western Sydney Orbital extending to Meurants Lane. Here, there is remnant Cumberland Plain Woodland which is readily viewed by motorists passing over the crest at Meurants Lane.

Medium

There are two areas of Medium Visual Quality - these being identified on the accompanying Landscape Assessment Plan.

The medium visual quality areas are generally associated with older subdivisions at the southern end of the study area, on both sides of Sunnyholt Road from Madagascar Place to the proposed Western Sydney Orbital road reserve. This suburban area consists of established residences in garden settings, with mature trees – part of the remnant Cumberland Plain Woodland - found intermittently on the current road verges. Underground power is provided from Madagascar Road to the last residence at the end of the Rota Place cul de sac. From here, overhead power lines are found along the remainder of the western side of Sunnyholt Road to Quakers Hill Parkway. Overhead power lines are found on the eastern side of Sunnyholt Road.

On the eastern side of Sunnyholt Road from Meurants Lane to Quakers Hill Parkway is a more recently subdivided residential area. In association with the subdivision, *Casuarinas* and *Eucalyptus* have been planted adjoining the fence line at the rear boundaries of the properties. These, in conjunction with the remnant mature Eucalypts- remnant Cumberland Plain Woodland - found in the current road verge, serve to partially screen the residential development from Sunnyholt Road and provide an attractive presentation to the streetscape for motorists. Overhead power lines are present.

Low

The areas of lowest visual quality are found on the western side of Sunnyholt Road from Quakers Hill Parkway to the Western Sydney Orbital road reserve corridor. The general area is undergoing quite dramatic changes with rural activities adjoining extensive subdivision for new home construction. There is no remnant vegetation visible to contribute to the general presentation of the streetscape. The existing rural properties are not screened from the road. Overhead power lines are present.

3.0 ASSESSMENT OF THE IMPACT OF THE PROPOSAL ON VISUAL QUALITY

The proposed roadworks involve the construction of additional lanes, a cycleway, busways and footway. Land will be acquired on both sides of the current Sunnyholt Road. The greatest impact of the proposal will be on the Medium Visual Quality residential areas found at the southern end of Sunnyholt Road.

High Quality Visual areas will be impacted by the removal of mature trees on the current road verges to allow for the construction of the Orbital Station and Interchange on the eastern side of Sunnyholt Road. The construction of the Western Sydney Orbital itself will have more impact with the removal of the current remnant Cumberland Plain Woodland.

Medium Quality Areas.
The Medium Quality residential area on the eastern side of Sunnyholt Road, north of Meurants Lane will be affected primarily by the removal of the mature remnant Eucalypts found on the current road verges. The relatively new subdivisions in this locality have incorporated new plantings of *Casuarinas* and *Eucalyptus* along the boundary fence line. This will in time provide an effective visual screen between the widened Sunnyholt Road and adjoining residences.

Proposed three metre high noise walls are to be introduced from Wilson Road to Malvern Road on the east side for 130 metres and from Malvern Road to just east of Quakers Hill Parkway east side for 350 metres. The introduction of these walls will be a noticeable element in the landscape.

The greatest impact of the proposal is on both sides of Sunnyholt Road south of the Western Sydney Orbital road reserve. The proposal will involve the removal of remnant Eucalyptus on the current road verges and other cultural plantings associated with the residential development. Proposed three metre high noise walls will be introduced in selected locations from James Cook Drive to the Western Sydney Orbital which will be a visually intrusive element in the streetscape. In order to provide a new access road to the retirement village found at the intersection of James Cook Drive, further landscaped areas would be lost. These consist of rows of Jacarandas and mature Eucalypts which provide visual separation between the current Sunnyholt Road and the residential / retirement village development. In addition, the widening of Sunnyholt Road will result in roadwork development in closer proximity to those residences fronting Flint Street.

Acquisitions of property, namely 11 Tagu Place, and Nos 6, 4, 3, 5, 7, 9, 11, 13 and 15 Rota Place on the western side of Sunnyholt Road will expose the properties behind to the visual and sound impacts of Sunnyholt Road. However, the acquired properties will provide the opportunity to establish landscape plantings to create a visual buffer to the residential development behind.

Low Quality Areas

The low visual quality area along the Western side of Sunnyholt Road from Quakers Hill Parkway to the Western Sydney Orbital road reserve, is undergoing rapid change from rural to residential land use. The new boundary line for the subdivision, it is assumed, has taken into account the proposed road widening. It is also assumed that as part of the subdivision requirements, a plantation strip has been nominated with similar landscape screening treatment to that of the eastern side of Sunnyholt Road. A three metre high noise wall is proposed from the proposed Western Sydney Orbital to Malvern Road for a distance of 300 metres. The introduction of the noise wall will prevent views into the new suburban area and the areas beyond.

However, as a result of the road widening and the establishment of the new landscape plantings (these will also provide screening for the noise walls) the overall quality of the streetscape for residents and motorists for this portion of Sunnyholt Road will be improved. Some loss of access to the distant views will be experienced where the noise walls are installed.

4.0 LANDSCAPE TREATMENT.

The attached Landscape Concept Plan nominates proposed landscape treatments associated with the roadworks and seeks to ameliorate the majority of the impacts of the project on those areas previously identified.

In general, improvements to the low quality areas are associated with the new subdivisions adjoining Sunnyholt Road and the opportunity to repeat landscape treatments evident adjoining the new residential subdivisions found on the eastern side of Sunnyholt Road. In addition, plant species selection provides the opportunity to use Cumberland Plain Woodland Species. Limiting factors are the presence of overhead power lines which will affect the plant species selections.

Suggested Planting.
Acacia parramattensis
Melaleuca decora
Eucalyptus crebra
Eucalyptus moluccana
Eucalyptus maculata
Eucalyptus tereticornis
Callistemon citrinus
Dianella longifolia
Dianella revoluta
Lomandra filiformis
Lomandra multiflora.

Improvements to the Medium Quality areas are limited by the space available following acquisitions and the road widening. From Bataan Place to Tagu Place, sufficient space is available to supplement the existing vegetation to provide visual separation between the residences and the proposed roadworks. Acquisitions of property in Tagu Place and Rota Place similarly provide opportunities to establish landscape areas to create a visual buffer and screen noise walls between the widened Sunnyholt Road and adjoining residences.

Suggested Planting.
Acacia parramattensis
Eucalyptus crebra
Eucalyptus moluccana
Eucalyptus maculata
Eucalyptus tereticornis
Callistemon citrinus
Melaleuca decora
Dianella longifolia
Dianella revoluta
Lomandra filiformis
Lomandra multiflora.

The major impact of the proposed road widening will be on those residences facing Flint Street, the Retirement Village and the residences immediately to the south of the Retirement Village opposite Bataan Place. The widening of the road will provide limited opportunity to screen Flint Street residences. However, these residences are currently highly exposed to Sunnyholt Road, with the landscape strip separating Flint Street and Sunnyholt Road currently being generally grassed. The retirement village and those residences immediately to the south will be impacted by the relocation of the current access road to the east to provide for the proposed transitway lanes. This will involve the removal of remnant mature *Eucalypts* and other cultural plantings. As a result of the road widening and relocation of the access road there will be limited width of landscaped area to enable the establish additional screening vegetation.

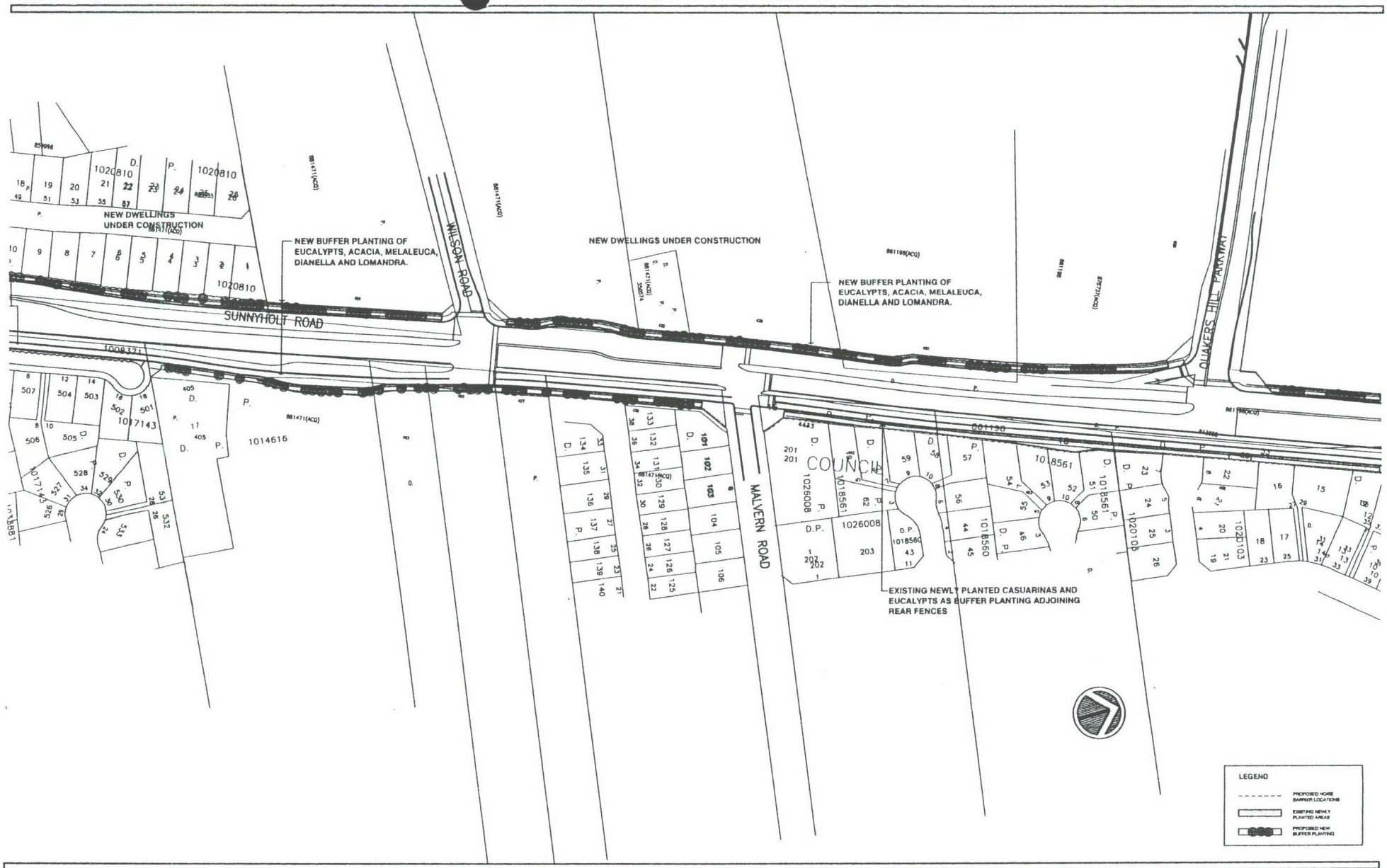
The High Quality landscape area affected by the proposed road widening can be ameliorated with the inclusion of landscape planting associated with the Orbital Station and Interchange.

5.0 CONCLUSION.

The proposed widening of Sunnyholt Road from Quakers Hill Parkway to Madagascar Drive will result in a general change to the existing landscape of the road. This change must also be taken in context with the daily changes associated with subdivision of rural lands for residential land use.

Opportunities exist to improve the overall presentation of the streetscape for both road users and residents on both sides of Sunnyholt Road from Quakers Hill Parkway to the Western Sydney Orbital road reserve. Refer to the attached Landscape Concept Plan. The current landscape quality of some parts of the current Sunnyholt Road as previously identified is quite low. The introduction of landscaped areas in the low quality areas will be a considerable improvement on the landscape quality currently experienced in those localities.

The greatest impacts of the project are found on the eastern side of Sunnyholt Road between the Western Sydney Orbital road reserve and the Madagascar Drive intersection. Assuming the approval of the Transitway, it will be necessary to relocate the access road to the residences and Retirement Village. This will result in limited opportunities arising to replicate the present landscape elements, to provide a similar quality of landscape to that currently enjoyed by residents and motorists. It is recommended that owners of these properties be approached by the RTA to implement additional landscape works within the subject properties, thereby seeking to replace some of the landscape areas within the locality.



ISSUE	DATE	REASON
A	18 09 02	APPROVAL
B	29 10 02	PLANT SPECIES ALTERED

JOCELYN RAMSAY AND ASSOCIATES PTY. LTD.

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PROJECT
PROPOSED WIDENING OF SUNNYHOLT ROAD, GLENWOOD

LANDSCAPE CONCEPT PLAN

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JOB#	DWG#	ISSUE
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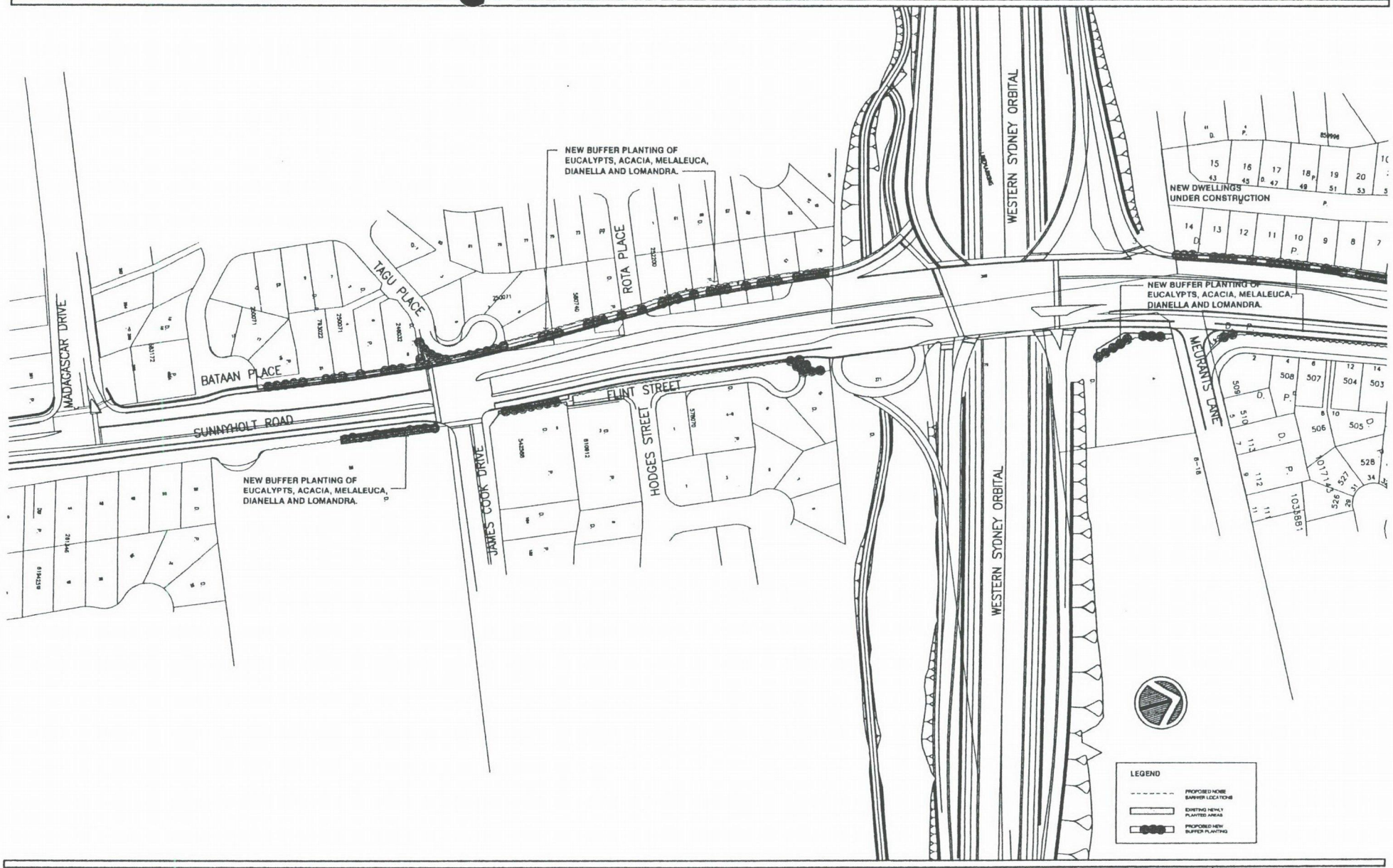

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PROJECT
PROPOSED WIDENING OF SUNNYHOLT ROAD, GLENWOOD

LANDSCAPE CONCEPT PLAN

DATE	SCALE	DRAWN	CHECKED
SEP 2002	1:2000 @ A3	HAD	JR

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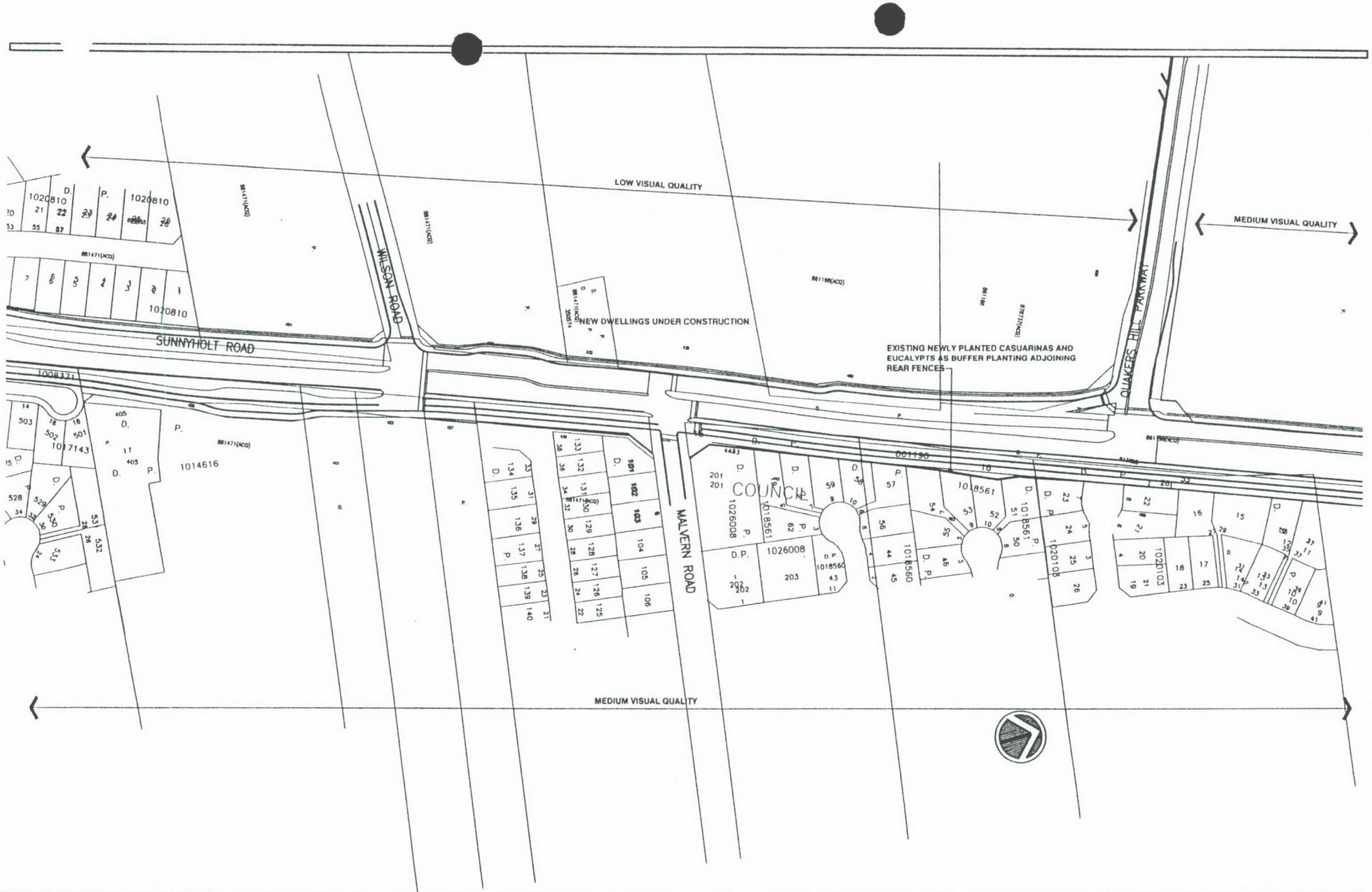

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PROJECT
PROPOSED WIDENING OF SUNNYHOLT ROAD, GLENWOOD

LANDSCAPE ASSESSMENT PLAN

DATE	SCALE	DRAWN	CHECKED
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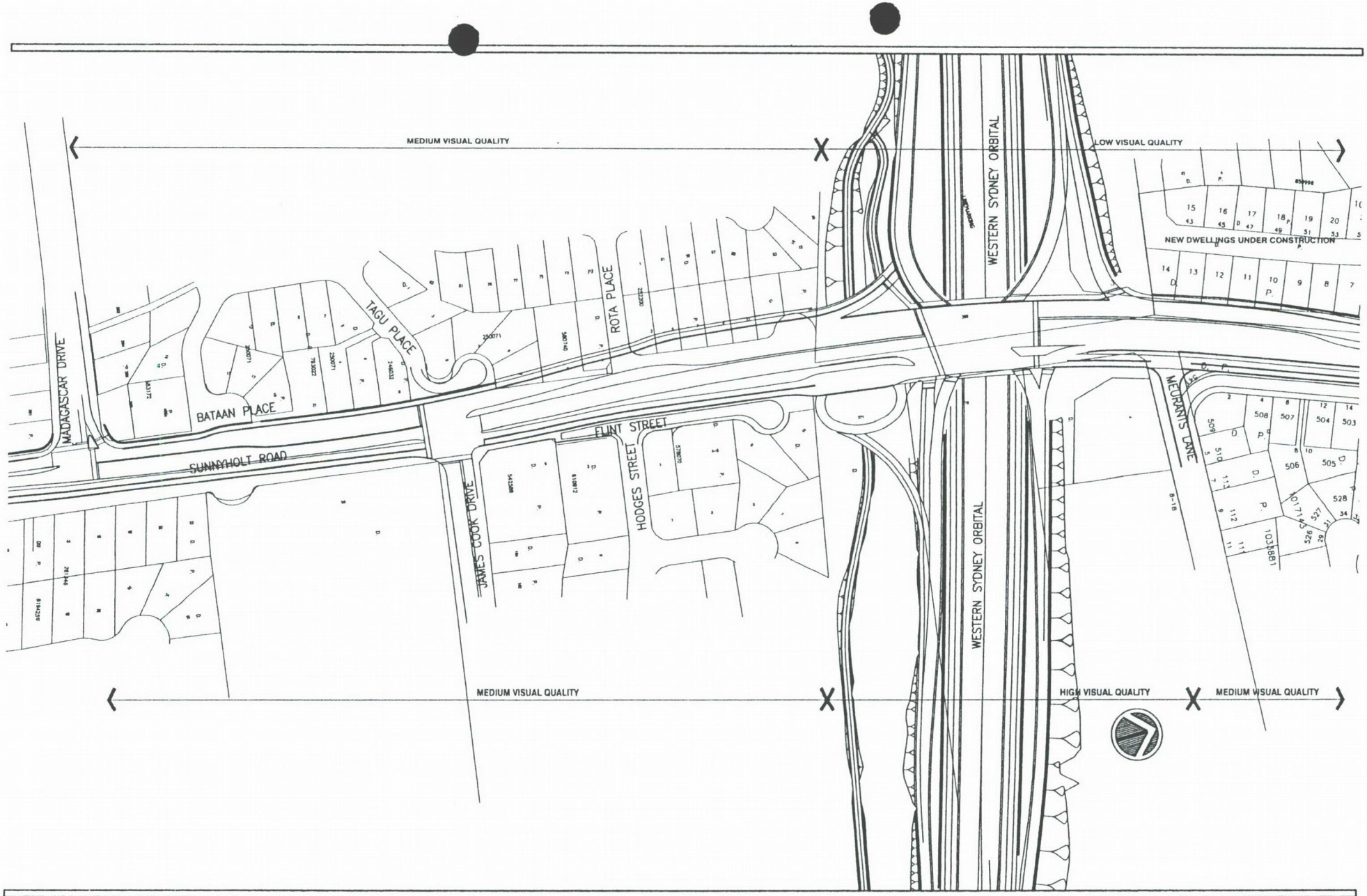

ISSUE	DATE	REVISION
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PROJECT
PROPOSED WIDENING OF SUNNYHOLT ROAD, GLENWOOD

LANDSCAPE ASSESSMENT PLAN

DATE	SCALE	DRAWN	CHECKED
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JOB #	DWG #	ISSUE
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APPENDIX 6

Indigenous Heritage Assessment
Widening of Sunnyholt Road at Glenwood NSW

August 2002, Bobbie Oakley & Associates Heritage Consultants

Indigenous Heritage Assessment
Widening of Sunnyholt Road
at Glenwood
NSW

Report to
Environmental Planning Pty Ltd

August 2002

Bobbie Oakley

Bobbie Oakley & Associates Heritage Consultants
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phone & fax 02.64957614 email bobbie.oakley@bigpond.com.au ABN 17476991681

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Photographic Record

Indigenous Heritage Assessment Widening of Sunnyholt Road at Glenwood NSW

1. Introduction

This report presents the findings of a survey for Aboriginal archaeological sites along Sunnyholt Road between Madagascar Drive and about 200 metres north of Quakers Hill Parkway, a distance of approximately 1.7km (***Figures 1 & 2***). The width of the proposed impact is variable and will occur on both sides Sunnyholt Road (***Figure 3***).

The archaeological assessment will form part of a Review of Environmental Factors [REF] being prepared by Environmental Planning Pty Ltd, PO Box 6112 Pymble 2073. The NSW Roads and Traffic Authority [RTA] commissioned the REF.

1.1 Proposed Works

The RTA proposes to widen Sunnyholt Road at Glenwood, which will involve widening the main road from 2 to 8 lanes and will include the provision of a cycleway and footway. The road widening will be located on both sides of the existing road (see ***Figure 3***).

1.2 The Consultancy Brief

The consultant was required to assess whether the proposed widening of Sunnyholt Road would affect any Aboriginal archaeological sites or relics. As part of this process the consultant was required to:

- liaise with the RTA's Aboriginal Community Liaison Officer;
- liaise with the Deerubbin Local Aboriginal Land Council [DLALC], the Darug Custodian Aboriginal Corporation [DCAC], and the Darug Tribal Aboriginal Corporation [DTAC];
- conduct research at the NSW National Parks and Wildlife Service (NPWS);
- conduct an archaeological survey accompanied by a members of the Aboriginal organisations to assess the scale and nature of likely impacts of the proposal on indigenous heritage;
- make recommendations on measures to both minimize and reduce any adverse impact on indigenous heritage; and
- prepare a report in accordance with the NPWS report-writing guidelines.

1.3 Summary of Results

- No Aboriginal archaeological sites listed with the NPWS ASR are located within, or in the vicinity of, the proposed impact areas.

- No new Aboriginal archaeological sites, or areas with the potential to contain undisturbed surface or sub-surface relics, were identified during the field survey.

1.4 Summary of Recommendations

There are no constraints on archaeological grounds to the proposed road widening works along Sunnyholt Road.

2. Aboriginal Participation

There are three Aboriginal stakeholder organisations in the area:

Deerubbin Local Aboriginal Land Council (DLALC)
Darug Tribal Aboriginal Corporation (DTAC)
Darug Custodian Aboriginal Corporation (DCAC)

Each group was contacted regarding the proposed development, and representatives were invited to participate in the field survey.

Mr John Gallard represented the DCAC during the survey, and Mr Gordon Morton represented the DTAC.

In addition Nigel Robinson, the RTA's Aboriginal Liaison Officer, has been consulted regarding the proposed works, and the findings of the study as outlined in this report.

The three Aboriginal groups and Nigel Robinson have been sent a copy of the draft report for comment. A final copy of the report will be forwarded on completion of the study.

3. Methodology

3.1 Research

Research was carried out at the NPWS Aboriginal Sites Register [ASR]. Research included obtaining a printout of all sites within a 5km radius of AMG E.307000.N6265000 and plotting each site within 1km of the study area on to the Riverstone 1:25k topographic map sheet (***Figure 2***). All relevant archaeological reports were consulted.

3.2 The Survey

The survey was conducted on 9 April and 1 August 2002.

3.3 Survey Strategy

The survey of the proposed impact area between Madagascar Drive and about two hundred metres north of Quakers Hill Parkway was conducted on foot, and all exposures and mature trees were inspected. In addition, given that the archaeological visibility for surface sites (artefact scatters) was low due to dense grass cover, the potential for the study area to contain sites (surface and sub-surface) was also assessed.

4. Environmental Context

4.1 Location, Geology and Topography

The study area is located on the gently undulating Northern Cumberland Plain. It is approximately 3 kilometres north of Blacktown, 2.5 kilometres west of Old Windsor Road, approximately 1.2 kilometres west of Caddies Creek, approximately 500 metres west of a tributary of Caddies Creek, approximately 1 kilometre southeast of the upper reaches of Chain of Ponds Creek, and 5 kilometres east of Eastern Creek (***see Figure 2***).

The underlying bedrock is Ashfield Shale, a subgroup of the Wianamatta Shale Group, and the shale soils are a buff silty loam overlying a yellow/red basal clay. Exposures in the study area revealed eroding shallow soils, which in places revealed the underlying clay.

The study area is located on the crest and upper slopes of a low, gently undulating ridgeline, which divides the catchments of Second Ponds Creek in the northwest and Caddies Creek in the east. These creeks run roughly north-south.

4.2 Vegetation

The area has been cleared of native vegetation and only contains one remnant stand of regrowth vegetation with mature and immature Grey Box (*Eucalyptus moluccana*), and an occasional isolated grey box..

Before European settlement the area would have supported Cumberland Plain Woodland dominated by an Ironbark-Grey Box (*E.crebra -E.moluccana*) community.

4.3 Landuse and Disturbance

The ground surface within the entire study area been extensively modified by vegetation clearing, road construction, gas pipeline installation, drain and culvert excavation, residential and commercial development, access driveways, grading within the road reserve, grazing, intensive market gardening, and heavy vehicle impact along the unsealed road margins (***Photographs 1,2,3 and 4***).

Exposures revealed that deposit overlying the shale bedrock was extremely shallow, and in most of the exposures erosion had removed the topsoil, exposing the eroding shale bedrock and red/yellow clay.

5. Archaeological Context

5.1 Regional Context – The Cumberland Plain

Archaeological investigations on the Cumberland Plain have recorded more than 650 Aboriginal archaeological sites, and demonstrated that an open campsite at Jamisons Creek was occupied almost continuously from 7000 years ago until well after European settlement (Kohen 1985). However, as Pleistocene dates have been obtained from rock shelter sites in the nearby Blue Mountains, it can be assumed that occupation of the Plain dates to that period.

A relatively recent analysis of 666 sites listed with the NPWS ASR (Jo McDonald CHM Pty Ltd 1998a) showed that open campsites were the most commonly recorded site type (89%). Scarred trees accounted for 2.1%, shelter sites and grinding grooves accounted for 3.6%, and isolated finds and a combination of open/other site types (eg scarred trees) accounted for 3.5% of the recorded sites.

The analysis also found that:

> Open sites were located in all landscapes on the Plain except the shale-sandstone interface areas, and the very high proportion of sites recorded on creekbanks or creekbank combinations was assessed to be more indicative of surface visibility and taphanomic factors, than human distribution of artefacts across the landscape.
>
> Sites located in catchments closer to the Hawkesbury/Nepean contained greater proportions of chert/indurated mudstone than those located further to the east and south.

In addition, investigations by Baker (1996) and by Barton (1996) have demonstrated that many silcrete pieces found on the Cumberland Plain were the result of natural fracturing rather than Aboriginal tool making; and an analysis of silcrete pieces excavated from a site a Plumpton, found that the majority of the artefacts had been 'made' by plough blades (Oakley 1993).

5.2 Local Context

The NPWS ASR lists 132 Aboriginal archaeological sites within a 5 kilometre radius of the centre of the study area on Sunnyholt Road. The majority of sites are stone artefact scatters however the general area also contains grinding groove sites, scarred trees and art sites.

None of the sites are located within or the vicinity of the study area. However, a large number of archaeological investigations (surveys and test excavation programmes) have been conducted in the surrounding area, the most extensive (and intensive) of which were conducted for the Rouse Hill Infrastructure Project Stage 1 (McDonald 1993a,b; McDonald and Rich 1993a,b) and Stage 2 (JoMcDonald CHM P/L 1998b). These investigations included sample surveying and subsequent excavations of recorded sites and PADs within a 40sq km area, primarily to the east, north and southeast of the current study. According to JoMcDonald CRM P/L (1999), the results of the surveys and excavations provide "a generally consistent picture of pre-contact Aboriginal occupation within the local area. The archaeological evidence of generally sparse, low density stone artefact scatters –'background scatter'- punctuated by the occasional high density activity area, suggests that Aboriginal people occupied the area on a more occasional basis for specific activities, such as microblade production, rather than using the area as a more permanent camping location." (1999:23)

Other investigations in the local area include studies by Kohen (1984), Dallas (1982, 1994), Corkill (1992), Byrne (1993a, b and 1994) , Mills (1996a,b and 1998, 1999), Jo McDonald CHM P/L (1999).

Dallas 1982 found seven stone artefact scatters and four isolated stone artefacts during

surveys conduced at Riverstone, Schofields and Quakers Hill for the Land Commission of NSW. The sites fell into two groups: open campsites associated with the small eastern tributaries of Eastern Creek; and stone tool manufacturing and campsites above and alongside Eastern Creek where there was abundant stone and permanent water. The majority of the artefacts were made of silcrete.

Corkill 1992 conducted a survey along Windsor Road and Old Windsor Road in Western Sydney to the east and northeast of the current study. The survey found eight stone artefact scatters (OWR 1-8) , two isolated stone artefacts, and one possible Aboriginal scarred tree. All the sites were found within 200 metres of a watercourse, and the majority of the stone artefacts were made of red silcrete. It was recommended that application be made for consent to destroy sites OWR 1-6 and the isolated artefacts, and that sites OWR 7 and 8 be subjected to sub-surface testing in order to determine the extent and nature of the sites. Further investigation of the authenticity of the possible Aboriginal scarred tree by an expert was also recommended. The subsequent investigation of sites OWR 7 and 8 were conducted by the Rouse Hill Stage 1 project (McDonald and Rich 1993a). No sub-surface artefacts were located and it was concluded that the areas had been heavily disturbed. In addition, following a request by the Deerubbin LALC, OWR 2 and OWR 3 were also test excavated and it was revealed that they represented preliminary stone cobble reduction areas which had rarely been documented in excavations of open sites. However as no undisturbed deposits were found it was recommended that application be made for consent to destroy the sites (Everett 1999).

Dallas 1994 found one stone artefact scatter, one isolated quartz artefact, and artefacts within the historic Post Office site (RH/46) during a survey of the Rouse Hill Public Golf Course. The artefact scatter comprised 14 pink silcrete artefacts on an exposure 15m north of the #1 Green. It was recommended that an application be made for consent to destroy the artefact scatter and the isolated artefact, and that the historic site be further investigated.

Byrne 1993a conducted a survey of Lot 1899 DP25310 approximately 2km southeast of the current study area. The survey found two open camp sites (NPWS Sites 45-5-0935 and 45-5-936) and one isolated stone artefact. The open campsites were small low-density scatters of flaked stone located on the lower slopes of low spurs. A programme of sub-surface testing was recommended to test whether the artefacts were part of a light background artefact scatter that extended to known sites in the Bella Vista area.

Byrne 1993b conducted a sub-surface testing programmed at the Lot 1899 DP253810, which retrieved very few artefacts, and Byrne concluded that the low retrieval rate of artefacts indicated "the presence over much of the study area of a very low-density background scatter".

Byrne 1994 identified one scarred tree and two areas with PAD (Potential Archaeological Deposit) during a survey of No. 100 Windsor Road, Kellyville several kilometres east of the current study. The report recommended that the tree be retained undisturbed and that a programme of sub-surface testing enable archaeological assessment of the PADs.

Mills 1996a found no Aboriginal archaeological sites during a survey for the RTA along Abbott Road between Old Windsor Road and Seven Hills Road southeast of the current study, however it was recommended that two sensitive areas be monitored during the

construction stage of the development.

Mills 1996b conducted the survey for the Sydney Orbital Road that passes through the centre of the current study area. Mills found one isolated artefact, one felled scarred tree (SO-ST-6), and one artefact scatter and PAD (SO-OS-13) several kilometres southeast of the current study.

Mills 1998 conducted a survey for a proposed residential development at Meurnats Lane/Old Windsor Road, Parklea, approximately 2 kilometres east of the current study. Nine areas of indigenous heritage were identified in the survey: six open campsites, and three PADs. Five of the sites were assessed as having low scientific/archaeological significance, and one of the sites and two PADs were assessed to have moderate to high significance. The report recommended that the developer apply for consent to destroy the five sites with low significance, and that site OWR-OS-1 and associated PAD be conserved within an open space area. It was also recommended that two of the PADs (PADs 2 and 3) be subjected to a sub-surface testing programme. Mills concluded that "the survey results conform with previously observed site distribution patterns for the region in that the sites located were open camp sites, all of which were located either on raised ground adjacent to permanent creeklines or on ridge crests" (Mills 1998:19). Subsequent sub-surface testing of PAD 3, which was located on a hill slope below the main ridge line which extends to Bella Vista, revealed no artefacts from 28 test pits. However, PAD 2, a raised, level terrace above a permanent spring fed creekline, revealed more than 900 artefacts within a 3 metre square pit! A low-density background scatter surrounded the high-density area. According to Mills, " the location of the small, high density artefact site adjacent to a spring fed creek, supports the general site distribution model for the Cumberland Plain...." "...which identifies major creeklines and confleuences of creeklines as the most likely location for large, more permanent occupation sites." (Mills 1999:6)

JoMcDonald CRM P/L 1999 conducted a survey of 9ha of land adjacent to Old Windsor Road at Kellyville, several kilometres northeast of the current study. The survey relocated one previously recorded stone artefact scatter (NPWS site 45-5-2027) and one isolated stone artefact was identified during the survey. Site 45-5-2027 comprised eight stone artefacts (silcrete and indurated mudstone) on the eroded creek bank of a tributary of Caddies Creek. It was recommended that the developer apply for consent to destroy the site and the isolated artefact.

5.3 Predictions

On the basis the previous studies conducted within the Cumberland Plain region and in the local area, and given the shale bedrock, it is predicted that the study area may contain low-density background scatters of stone artefacts.

Scarred trees may also be present if the area has not been subjected to clearing.

However it must be noted that as the study area is located within and adjacent to the road easement of a major arterial road within a developed rural residential/commercial area, there is only a low probability that *in situ* relics will be found.

6. Results and Discussion

6.1 Results

No Aboriginal archaeological sites listed with the NPWS ASR are located within the study area and the survey found no new sites. It is also assessed that there is no potential for the subject land to contain in-situ relics (surface or sub-surface) as the ground surface within the entire area has been severely modified by a long period of intensive land-use.

6.2 Discussion

That no sites or sensitive areas were found was predicted. The ground surface within the study area has been severely modified, and although low density background scatters, as described by Byrne (1993), may once have occurred along the ridgeline, particularly on the gentle slopes within 400m of a tributary of Caddies Creek, intensive long-term land use would have destroyed their integrity.

7. Recommendations

The following recommendations are based on:

The requirements of the **National Parks & Wildlife Act (NSW) 1974** (as amended) whereby it is illegal to damage, deface or destroy an Aboriginal relic without first obtaining the written permission of the Director General of the NSW NPWS; and

The findings of the study as documented in this report.

It is recommended that:

There are no constraints on archaeological grounds to the proposed road widening along Sunnyholt Road.

It is also recommended that:

- Should the location of the proposed impact change an archaeologist and representatives of the Aboriginal stakeholders must be commissioned to survey the new area.
- Should archaeological relics be found during the proposed works, work must cease and the NPWS contacted to inspect the finds.
- Three copies of this report are sent to the Archaeologist, Metropolitan Aboriginal Heritage Unit, NPWS Head Office, PO Box 1967, Hurstville, 2220.
- One copy of this report is sent to:
    - Mr Frank Vincent, Chairperson, Deerubbin Local Aboriginal Land Council, PO Box V184, Mt Druitt Village, NSW.
    - Mr Colin Gale, Darug Tribal Aboriginal Corporation, PO Box 441, Blacktown. NSW.
    - Mr John Gallard, Darug Custodian Aboriginal Corporation, PO Box 36, Kellyville, NSW 2153. NSW.2153.

References

Baker N.1996. Archaeological test excavation for the Quakers Hill Bypass, Quakers Hill, NSW.

Barton H.1996. Archaeological Survey at 65 Burfitt Road, Riverstone, NSW.

Byrne D. 1993a. Survey for Aboriginal archaeological sites on Lot 1899DP253810, Old Windsor Road, Parklea. Report to Asher McNeil Niall Pty Ltd.

Byrne D. 1993b. Program of archaeological sub-surface testing at Lot 1899 DP253810, Old Windsor Road, Parklea, NSW. Report to A.V.Jennings Pty Ltd.

Byrne D. 1994. Archaeological Survey of No. 100 Windsor road, Kellyville, NSW. Report to A V Jennings Ltd.

Corkill T. 1992. Survey for Aboriginal Archaeological Sites Along Windsor Road and Old Windsor Road, Sydney, NSW. Report to Mitchell McCotter & Assoc. Pty Ltd.

Dallas M. 1982. An Archaeological Survey at Riverstone, Schofields and Quakers Hill, NSW.

Dallas M. 1994. Archaeological Survey for Aboriginal Sites at the Rouse Hill Public Golf Course, Windsor Road, Rouse Hill. Report to Travis McEwen Group.

Everett C. 1999. Archaeological Survey of a Proposed Road Upgrade, Intersection of Schofields Road & Old Windsor Road, Rouse Hill. Report for RTA Sydney Technical Services.

Jo McDonald CHM Pty Ltd. 1998a. Archaeological Survey of two land parcels known as Bona Vista and Fernadell at Pitt Town, NSW. Report to Don Fox Planning on behalf of Bona Vista and Fernadell Pty Ltd.

Jo McDonald CHM Pty Ltd. 1998b. Survey for archaeological sties: Proposed Rouse Hill Stage 2 Infrastructure works at Rouse Hill, Parklea and Kellyville, NSW.

Jo McDonald CHM Pty Ltd. 1999. Archaeological Survey of Proposed Landcom Project 50112, Old Windsor road, Kellyville. Report prepared for John G. Nelson Pty Ltd on behalf of Landcom.

Kohen J. 1984. Preliminary Report on an Aboriginal site Complex at Second Ponds Creek. Quakers Hill. PhD research Macquarie University.

Kohen J. 1985. An Archaeological Survey of Industrial Land in the City of Blacktown. Report to Blacktown city Council.

Mc Donald J. 1993a. Archaeological Survey of the Rouse Hill Infrastructure Project (Stage 1) Works along Caddies, Smalls and Second Ponds Creeks, Rouse Hill, NSW. Report for the Rouse Hill Joint Venture.

Mc Donald J. 1993b. Additional archaeological survey of the Rouse Hill Infrastructure Project (Stage 1) Works along Caddies and Second Ponds Creeks, Rouse Hill, NSW. Report for Rouse Hill Pty Ltd.

McDonald J. & Rich E. 1993a Archaeological investigation of sites OWR-7, OWR-8 and Bella Vista at Parklea, NSW. Test Excavation Report on behalf of Rouse Hill Pty Ltd.

McDonald J. & Rich E. 1993b. Archaeological investigations for the Rouse Hill Infrastructure Project (Stage 1) Rouse Hill and Parklea, NSW. Final report on test excavation programme on behalf of Rouse Hill Pty Ltd.

Oakley B. 1993. Test Excavations at Plumpton Park II (PPII) on a Tributary #3 Bells Creek Plumpton Park NSW. Report to Blacktown City Council.

Mills R. 1996a. Archaeological Survey of Proposed RTA Reconstruction of Abbott Road between Old Windsor Road and Seven Hills Road. Commissioned for RTA by Sinclair Knight Merz.

Mills R. 1996b.Archaeolgical Survey of the proposed Western Sydney Orbital from West Baulkham Hills to Cecil Park. Report to NPWS.

Mills R. 1998. An Aboriginal Heritage Study of a proposed residential development at Old Windsor Road and Meurants Lane, Parklea. Report to Conacher Travers

Mills R. 1999. Re-assessment of Indigenous Heritage sites on the route of the proposed upgrade of the Schofields/Windsor Road intersection at Rouse Hill. Report to the RTA Blacktown.

Smith L.1989. Archaeological Site Survey and Analyses of Sites on the Northern Cumberland Plain. Vol 1. Report to NSW NPWS.

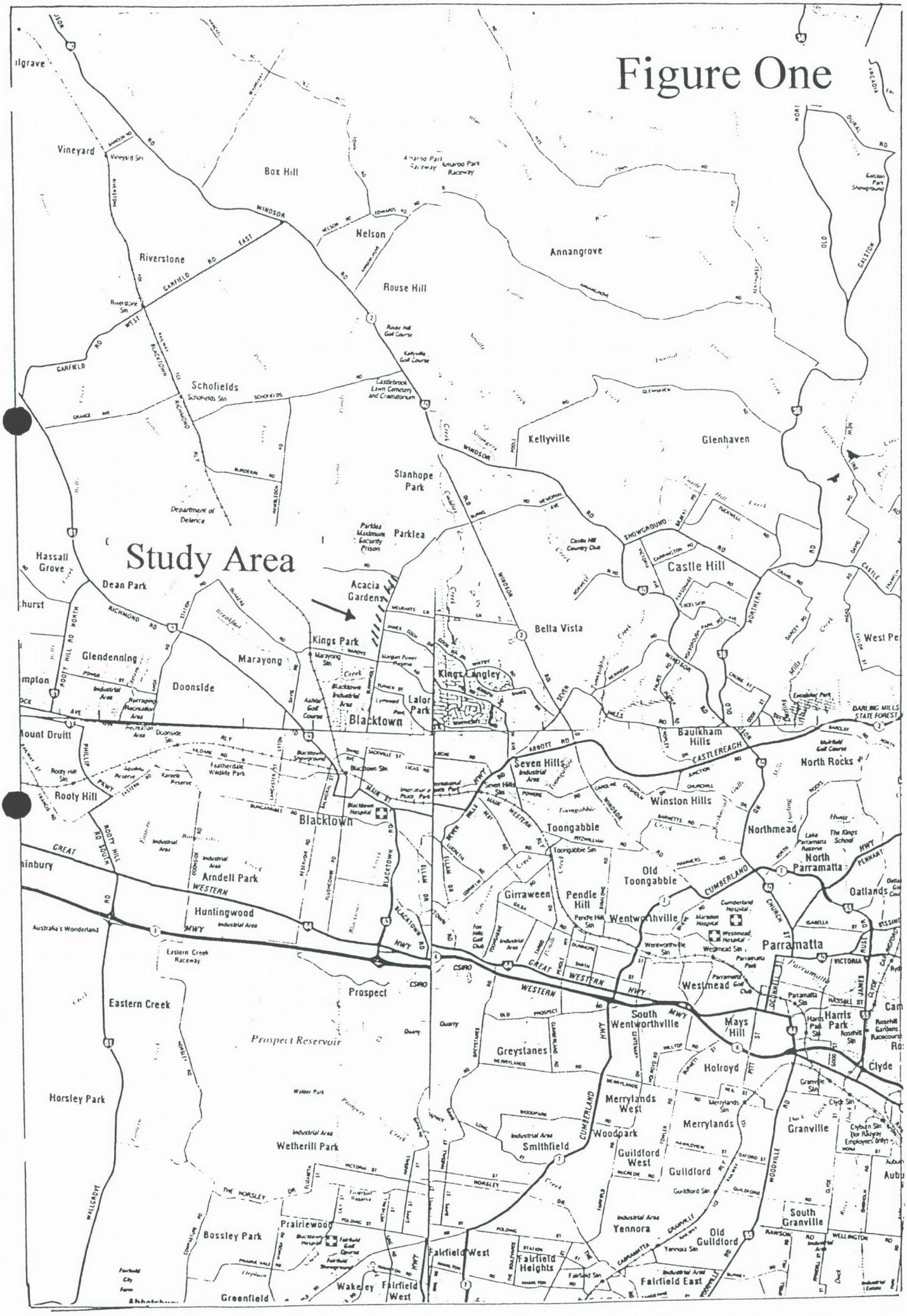


Figure One
Study Area
N
Vineyard
Box Hill
Nelson
Riverstone
Rouse Hill
Annangrove
Schofields
Kellyville
Glenhaven
Stanhope Park
Parklea
Hassall Grove
Dean Park
Acacia Gardens
Castle Hill
Bella Vista
Glendenning
Marayong
Kings Park
Kings Langley
Doonside
Lalor Park
Blacktown
Baulkham Hills
Seven Hills
North Rocks
Winston Hills
Northmead
Toongabbie
North Parramatta
Old Toongabbie
Girraween
Pendle Hill
Wentworthville
Oatlands
Parramatta
Rooty Hill
Arndell Park
Huntingwood
Prospect
Eastern Creek
Prospect Reservoir
Westmead
South Wentworthville
Mays Hill
Harris Park
Greystanes
Holroyd
Clyde
Horsley Park
Merrylands West
Merrylands
Granville
Wetherill Park
Woodpark
Smithfield
Guildford West
Guildford
South Granville
Prairiewood
Bossley Park
Yennora
Old Guildford
Fairfield West
Fairfield Heights
Fairfield East
Greenfield
Wakeley

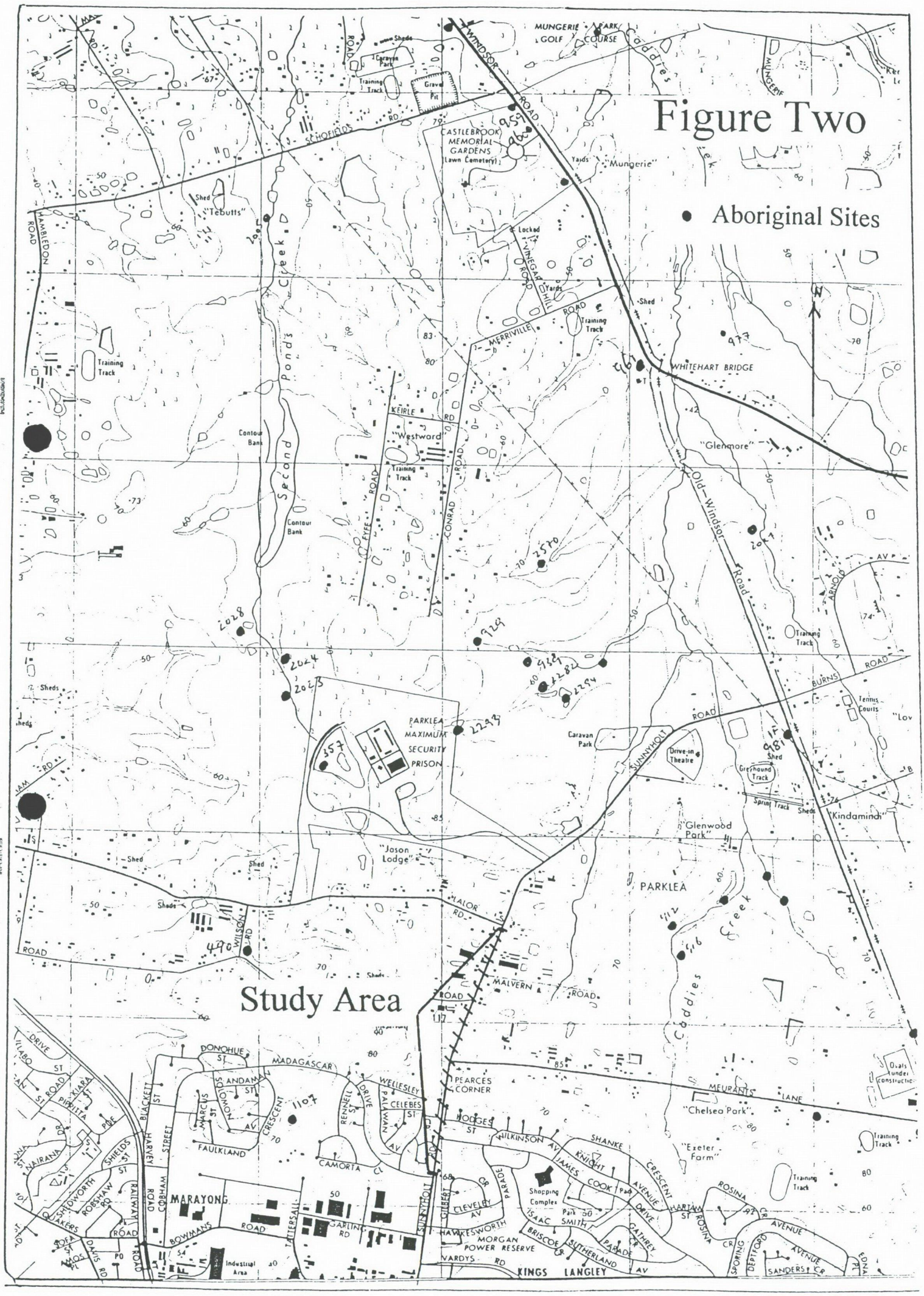


Figure Two
Aboriginal Sites
Study Area
MUNGERIE PARK GOLF COURSE
WINDSOR ROAD
CASTLEBROOK MEMORIAL GARDENS (Lawn Cemetery)
"Mungerie"
"Tebutts"
HAMBLEDON ROAD
Second Ponds Creek
SCHOFIELDS RD
VINEGAR HILL ROAD
MERRIVILLE ROAD
WHITEHART BRIDGE
KEIRLE RD
"Westward"
"Glenmore"
Old Windsor Road
CONRAD ROAD
EYRE ROAD
Contour Bank
Training Track
Caravan Park
Gravel Pit
Shed
Yards
Locked
PARKLEA MAXIMUM SECURITY PRISON
"Jason Lodge"
"Glenwood Park"
PARKLEA
Caddies Creek
BURNS ROAD
SUNNYHOLT ROAD
Drive-in Theatre
Greyhound Track
Sprint Track
Tennis Courts
"Kindaminda"
ARNOLD AV
MALOR RD
WILSON RD
MALVERN ROAD
PEARCES CORNER
MEURANTS LANE
"Chelsea Park"
"Exeter Farm"
MARAYONG
Industrial Area
BOWMANS ROAD
GARLING RD
TATTERSALL
SUNNYHOLT
HAWKESWORTH
MORGAN POWER RESERVE
VARDYS RD
KINGS LANGLEY
Shopping Complex
Park
ISAAC SMITH
JAMES COOK DRIVE
SHANKE AVENUE
KNIGHT CRESCENT
HARTAN ST
ROSINA
GATHREY PARADE
BRISCOE CR
SUTHERLAND AV
CLEVELEY AV
PARADE
WILKINSON AV
HODGES ST
WELLESLEY DRIVE
PALAWAN AV
RENNELL ST
CELEBES ST
CAMORTA CL
FAULKLAND
MARCUS ST
SOLOMON ST
ANDAMAN ST
CRESCENT
DONOHUE ST
MADAGASCAR
BLACKETT ST
HARVEY STREET
COBHAM ROAD
RAILWAY
SHIELDS ST
ROBSHAW RD
SHIDWORTH
QUAKERS ROAD
DAVIS RD
PO
NAIRANA DR
PIPIRITA ST
KIARA ST
DRIVE
ROAD
SPONING
DEPTFORD AVENUE
SANDERS CR
EDWARD
Ovals under construction

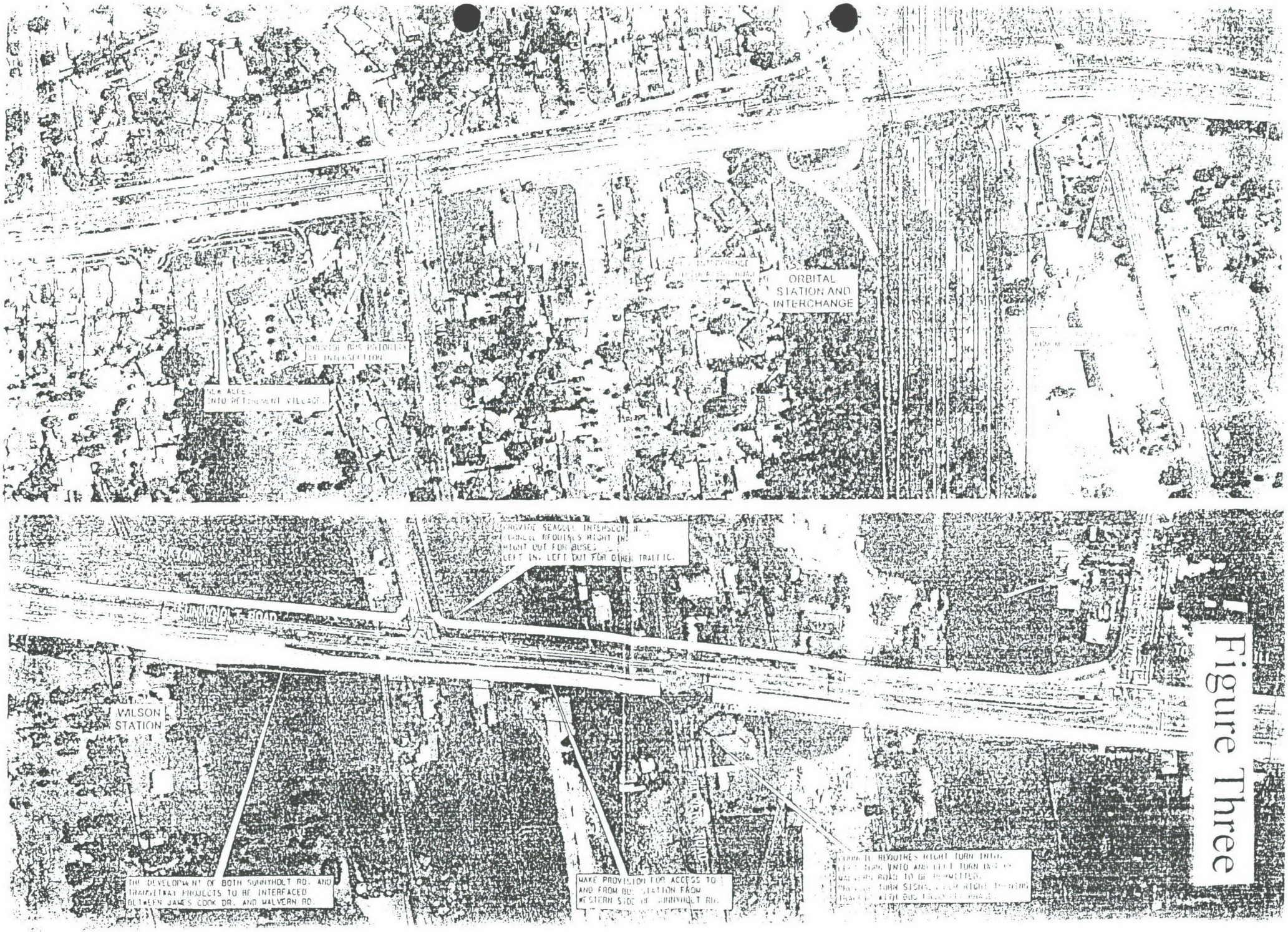


Figure Three

DARUG TRIBAL ABORIGINAL CORPORATION
[Incorporating Darug Link Associating Inc.]
P.O BOX 441
BLACKTOWN
2148
ABN -GST no. 77 184 151 969

20/8/02.

Bobbie Oakley & Associates
" Millpost "
Greenlands Rd
Nimmitabel 2631

Re: Aboriginal Cultural survey — additional works RTA Transitway --- Sunnyholt Rd.

Gordon Morton attended this survey on 1-8-02 with yourself and reports that the area under survey very badly disturbed with no possible intact Aboriginal Heritage issues to deal with. DTAC has no further intcrest in this section of road relating to this project.

Yours Faithfully
Colin Gale
Chairman

P.O. Box 36.
KELLYVILLE 2153
N.S.W.

8-6-2002.

DARUG CUSTODIAN ABORIGINAL CORPORATION

To: Bruce Adcock,
Environmental Planning Pty Ltd,
P.O. Box 6112,
Pymble, 2073.
N.S.W.

Dear Sir,

Subject: Roadwidening of Sunnyhalt Road from Madagascar Drive through to Quakers Hill Parkway on Western side. Inspection for Aboriginal Cultural Heritage with Bobbie Oakley Archaeological Consultant and John Gallard, Sites Officer for D.C.A.C.

On Tuesday 9th April 2002 I met with Bobbie Oakely at Madagascar Drive. We walked and examined the Western side of Sunnyhalt Road covering the area of the proposed road-widening between Madagascar Drive and Quakers Hill Parkway.

This strip of land has been subject to considerable disturbance., ie; a gas pipeline runs through the strip paralleling the road, numerous driveways have been constructed to the various adjoining properties, a dam exists in one section and there are signs of market gardening in the past.

The driveway re-entrants and driveways were basically the only bare ground areas, and these were examined in detail, but no signs of Cultural Heritage material was

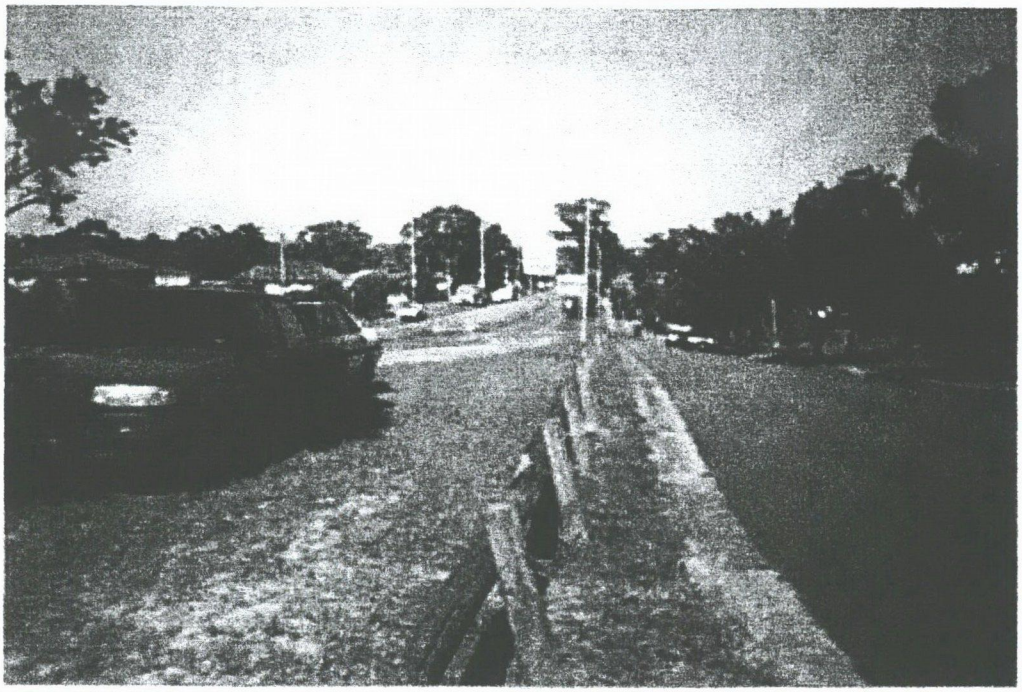
Seen. The rest of the area was thickly covered with grass and the visibility almost nil.

I believe that it is highly unlikely that this very disturbed strip of land contains any material of Archaeological - Cultural Heritage significance and Darug Custodian Aboriginal Corporation has no objection to or concerns about the proposed road widening.

Respectfully Yours

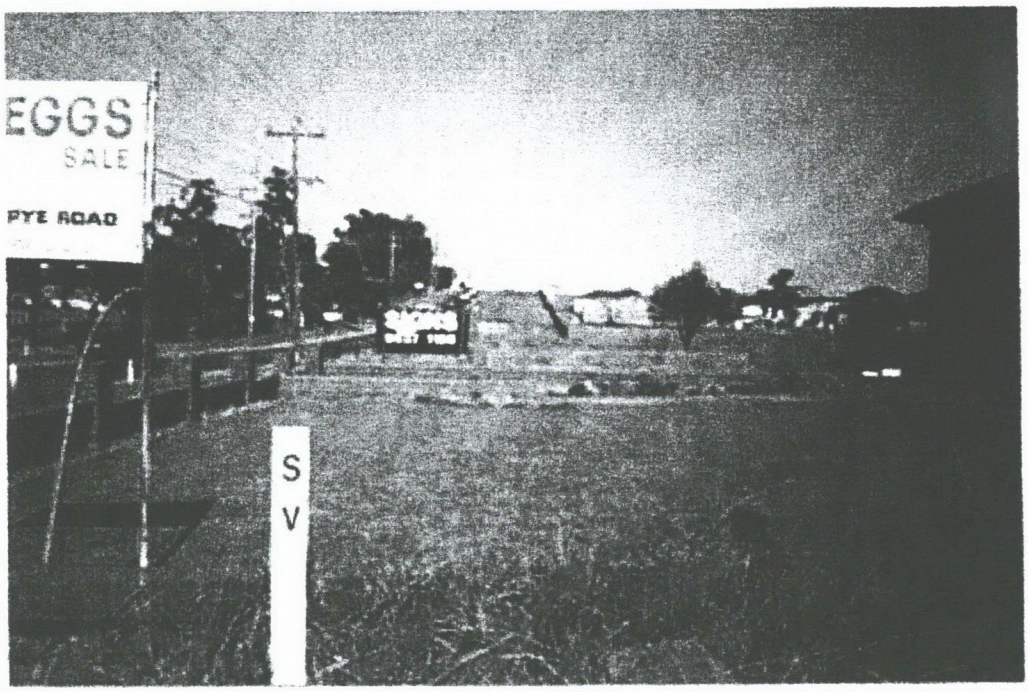
N Wallace

Sites & Research Officer D.C.A.C.



Photograph 1

Photograph 2



Photograph 3

Photograph 4

APPENDIX 7

Widening of Sunnyholt Road at Glenwood
Noise and Vibration Impact Assessment,

September 2002, Renzo Tonin & Associates Pty Ltd.

RENZO TONIN
& ASSOCIATES PTY LTD
ABN 65 002 225 078
Consultants in Acoustics, Vibration and Structural Dynamics

Level 1, 418A Elizabeth Street
Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0500 Fax: (02) 8218 0501
Email: acoustics@rtagroup.com.au
Website: www.rtagroup.com.au

technical report

WIDENING OF SUNNYHOLT ROAD AT GLENWOOD

NOISE AND VIBRATION IMPACT ASSESSMENT

APPENDIX 7

September, 2002

Prepared for:

Environmental Planning Pty Ltd
Unit 8, 1051 Pacific Hwy
Pymble NSW 2073

Facsimile: 9983 1400

Attention: Bruce Adcock

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1 INTRODUCTION – PROJECT DESCRIPTION AND PURPOSE

1.1 BACKGROUND & PURPOSE OF PROJECT

Renzo Tonin & Associates were engaged to carry out a noise survey and assessment of the environmental noise and vibration effects from the proposed widening of Sunnyholt Road at Glenwood.

This study identifies sensitive locations and assesses potential noise and vibration impacts against noise and vibration criteria set by the NSW Environment Protection Authority (EPA). The issues addressed in this study include:

- noise and vibration emissions during construction of the project,
- noise emissions from traffic travelling along Sunnyholt Road after its widening and upgrade,
- noise emission contributions from buses travelling along the proposed Transitway.

To assist in addressing these issues, the existing ambient noise environment was quantified and characterised by conducting unattended long-term noise monitoring at two residential premises along the route.

This study assesses noise impact to receivers affected by traffic noise generated by Sunnyholt Road and considers noise contributions from the Transitway. However, the Transitway will not be constructed as part of the Sunnyholt Road proposal. A separate environmental impact assessment (in progress) and planning approval are required for the proposed Blacktown to Castle Hill Transitway and stations, which do not form part of this proposal to widen Sunnyholt Road at Glenwood. The preferred location for the Transitway is on the eastern side of Sunnyholt Road and provision has been made in the concept design as shown in this Review of Environmental Factors for a two lane proposed Transitway in this location. If required, the proposed Transitway space could be used as a temporary southbound carriageway for Sunnyholt Road. Therefore, noise impact contributions from the proposed Transitway are included here as a "worst case" scenario.

Any noise impact resulting from upgrades or changes to traffic conditions on surrounding local streets is also not assessed in this report.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

1.2 PROJECT DESCRIPTION

The section of the Sunnyholt Road where widening is proposed extends from just south of James Cook Drive to just north of Quakers Hill Parkway and is approximately 1.56km in length. The project will involve widening of the road from two lanes to six lanes. The possible construction of a two lane bus Transitway, alongside the road to the east being the preferred location, is part of a separate assessment and approvals process. Residences are located on both sides of the roadway with the facades of the nearest dwellings approximately 15m from the kerbside.

Residential developments are currently under construction in the project area. New residential dwellings have recently been constructed on the east side of Sunnyholt Road between Quakers Hill Parkway and Malvern Road. Other recently constructed residences are located on the west side of Sunnyholt Road, between Wilson Road and the proposed WSO. For both developments,

the dwellings are approximately 20m from Sunnyholt Road and are fronted by a 1.8 metre high light-weight (aerated) concrete fence.

1.3 PROPOSED CHANGES TO TRAFFIC CONDITIONS

The construction of the WSO and its intersection with Sunnyholt Road will increase traffic volumes and therefore traffic noise levels in the area.

Traffic noise levels at residences fronting Sunnyholt Road could also potentially increase where widening of the road reduces the distance between vehicles on the road and the affected receptor locations. The proposed construction of the Transitway could also potentially increase noise levels at receptors, particularly those located on the east side of Sunnyholt Road, where the Transitway is being proposed, although noise contributions from the Transitway would be small in comparison to the overall road traffic noise.

Construction noise could also potentially impact residences that are near to the project construction area.

1.4 ROAD CLASSIFICATION

Sunnyholt Road is classed as an 'arterial' road as it is a road that handles through traffic bound for another locality and has characteristically heavy and continuous traffic flows. This project is essentially an expansion of an existing arterial road corridor to increase its traffic carrying capacity.

2 TRAFFIC FLOW AND COMPOSITION SUMMARY

Estimates of future traffic volumes on Sunnyholt Road with the Western Sydney Orbital built were generated by Masson Wilson Twiney traffic and transport consultants. The estimated compositions in terms of daytime (15hr) and night-time (9hr) data are shown below for the year of completion, being 2006, and ten years after completion (2016). The RTA supplied the Transitway data. All traffic noise predictions in this assessment are therefore based on the following traffic data.

Table 1 – Future Traffic Volumes on Sunnyholt Road, Year 2006

Road Section	AADT	7am to 10pm (15hr)		10pm to 7am (9hr)	
		Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
North of Quakers Hill Parkway	29800	22817	3446	3111	426
North of WSO	54050	42918	4698	5853	581
South of WSO	44500	33408	5817	4556	719
Transitway	-	0	214	0	54

Table 2 – Future Traffic Volumes on Sunnyholt Road, Year 2016

Road Section	AADT	7am to 10pm (15hr)		10pm to 7am (9hr)	
		Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
North of Quakers Hill Parkway	39900	30632	4531	4177	560
North of WSO	71400	56853	6047	7753	747
South of WSO	54100	41243	6437	5624	796
Transitway	-	0	240	0	60

3 EXISTING NOISE ENVIRONMENT

3.1 STUDY AREA AND NOISE MONITORING LOCATIONS

To determine current L_{eq} traffic noise levels and background L_{90} noise levels along Sunnyholt Road, long-term noise monitoring was conducted at two representative receiver sites. The selected monitoring sites were:

- **Location 1** – residence at 36 Elsom Street, Kings Langley. Residence located on east side of Sunnyholt Road, south of the proposed WSO, approximately 20m from kerbside.
- **Location 2** – residence at 443 Sunnyholt Road, Glenwood. Residence located on east side of Sunnyholt Road, north of the proposed WSO, approximately 25m from kerbside.

Monitoring locations on the east side of Sunnyholt Road were selected because the proposed Transitway is planned to be on the east side and so the worst-case impact and highest total traffic noise is expected here. Furthermore, properties on the west side in Rota Place or Tagu Place are to be totally acquired by the RTA for the widening of Sunnyholt Road. Those property numbers are 3, 4, 5, 6, 7, 9, 11, 13 and 15 Rota Place, and 11 Tagu Place. Properties on the east side at 423 and 427 Sunnyholt Road, opposite Wilson Road, are also to be acquired for the Transitway.

Figure 1 is a locality map showing the noise monitoring locations.

3.2 NOISE MONITORING PROCEDURES AND INSTRUMENTATION

Monitoring was conducted from Tuesday 26th March to Thursday 4th April, 2002 which included the Easter period. Traffic patterns are considered to be abnormal over this period so noise data from Friday 29th March to Monday 1st April has not been included in the analysis. Weather information was obtained from the Bureau of Meteorology for the area over this period and any data adversely affected by rain, wind or extraneous noise was also discarded.

RTA Technology noise monitors were installed approximately one metre from the facades of the aforementioned dwellings and facing the road. The noise monitoring equipment used comply with Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and are designated as Type 2 instruments suitable for field use.

A noise monitor consists of a sound level meter and a computer housed in a weather resistant enclosure. Ambient noise levels were recorded at a rate of 10 samples per second. Every 15 minutes, the data is processed statistically and stored in memory. The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 calibrator. No significant drift in calibration was observed.

The graphical recorded outputs of each noise monitor are presented in **Appendix B**.

3.3 AMBIENT L_{EQ} NOISE LEVELS

The measured L_{eq} traffic noise levels at each monitoring location are shown in the tables below. The descriptors relevant to traffic noise studies, according to the EPA's current policy for traffic noise, are the $L_{Aeq(15hr)}$ daytime and $L_{Aeq(9hr)}$ night time descriptors. Daytime represents the period 7am to 10pm and night represents the period 10pm to 7am.

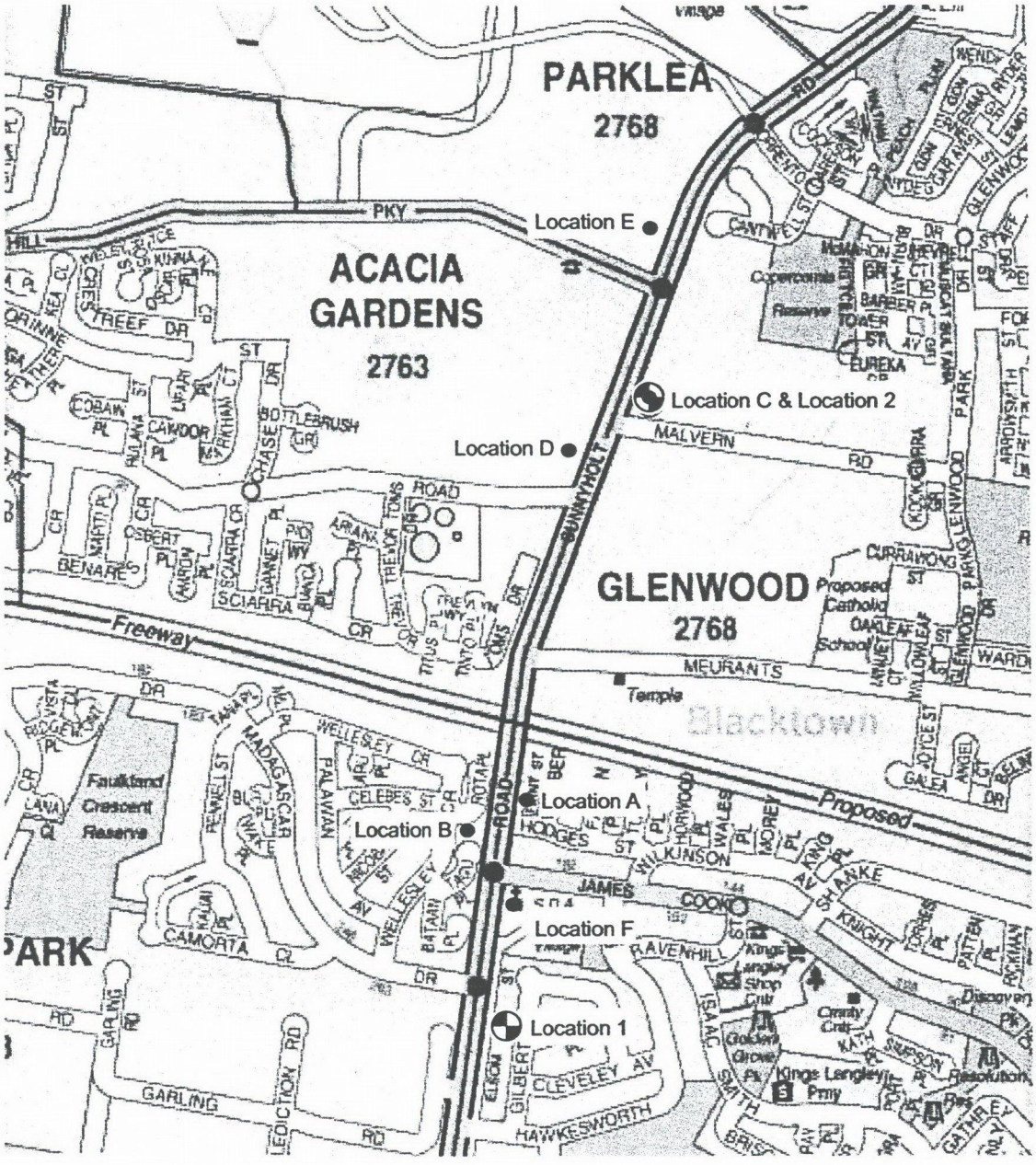


Figure 1: Noise Monitoring & Assessment Locations

Ref: TA 741-02P01(rev2).cdr

Member of the Association of Australian Acoustical Consultants

Table 3 – Results of Traffic Noise Monitoring at Location 1 - 36 Elsom Street, Kings Langley

Day	L_{Aeq} Noise Levels	
	15 hours, Day (7am - 10pm)	9 hours, Night (10pm - 7am)
Tuesday 26th March 2002	65	61
Wednesday 27th March 2002	66	63
Thursday 28th March 2002	67	60
Friday 29th March 2002	-	-
Saturday 30th March 2002	-	-
Sunday 31st March 2002	-	-
Monday 1st April 2002	-	56
Tuesday 2nd April 2002	66	58
Wednesday 3rd April 2002	65	58
Thursday 4th April 2002	66	63
Representative Weekday	**67**	**62**

Table 4 – Results of Traffic Noise Monitoring at Location 2 - 443 Sunnyholt Road, Glenwood,

Day	L_{Aeq} Noise Levels	
	15 hours, Day (7am - 10pm)	9 hours, Night (10pm - 7am)
Tuesday 26th March 2002	64	60
Wednesday 27th March 2002	63	61
Thursday 28th March 2002	65	61
Friday 29th March 2002	-	-
Saturday 30th March 2002	-	-
Sunday 31st March 2002	-	-
Monday 1st April 2002	-	55
Tuesday 2nd April 2002	63	58
Wednesday 3rd April 2002	64	57
Thursday 4th April 2002	64	62
Representative Weekday	**66**	**61**

3.4 BACKGROUND L_{90} NOISE LEVELS

The measured L_{90} background noise levels at the two monitoring locations are shown in Table 5 and Table 6 below. Day represents the period 7am to 6pm, evening 6pm to 10pm and night 10pm to 7am.

Table 5 – Results of Background Noise Monitoring at Location 1 - 36 Elsom Street, Kings Langley

Day	L_{A90} Background Noise Levels		
	Day	Evening	Night
Tuesday 26th March 2002	53	54	43
Wednesday 27th March 2002	54	50	49
Thursday 28th March 2002	57	53	46
Friday 29th March 2002	-	-	-
Saturday 30th March 2002	-	-	-
Sunday 31st March 2002	-	-	-
Monday 1st April 2002	-	-	42
Tuesday 2nd April 2002	55	52	41
Wednesday 3rd April 2002	53	53	44
Thursday 4th April 2002	53	54	49
Representative Level	**54**	**53**	**44**

Table 6 – Results of Background Noise Monitoring at Location 2 - 443 Sunnyholt Road, Glenwood

Day	L_{A90} Background Noise Levels		
	Day	Evening	Night
Tuesday 26th March 2002	57	56	37
Wednesday 27th March 2002	56	50	43
Thursday 28th March 2002	57	56	45
Friday 29th March 2002	-	-	-
Saturday 30th March 2002	-	-	-
Sunday 31st March 2002	-	-	-
Monday 1st April 2002	-	-	36
Tuesday 2nd April 2002	55	52	37
Wednesday 3rd April 2002	56	52	39
Thursday 4th April 2002	55	52	48
Representative Level	**56**	**52**	**39**

4 ACOUSTIC CRITERIA

4.1 TRAFFIC NOISE

Road traffic noise impact is assessed in this report in accordance with the EPA's Environmental Criteria for Road Traffic Noise (ECRTN) and the RTA's Environmental Noise Management Manual (ENMM). Sunnyholt Road is classed as an arterial road because it is a road that handles through traffic bound for another locality and has characteristically heavy and continuous traffic flows. This project involves widening this existing arterial road and constructing a Transitway.

According to the ENMM, this project does not constitute a 'new road traffic noise source' because the road is not a new road and does not produce noise to receptors from a different direction. This project is essentially an expansion of an existing road corridor to increase traffic carrying capacity and there is already an existing road traffic noise exposure greater than 55dB(A) $L_{eq(15hr)}$ and 50dB(A) $L_{eq(9hr)}$. Therefore, the "redeveloped road" criteria does apply. The noise criteria for redevelopment of an existing arterial road are set out in the EPA's ECRTN as follows.

Table 7- EPA's Policy – Environmental Criteria for Road Traffic Noise

Type of Development	Criteria		
	Day, dB(A)	Night, dB(A)	Where Criteria are Already Exceeded
3. Redevelopment of existing freeway/arterial road	$L_{Aeq(15hr)}$60	$L_{Aeq(9hr)}$55	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulations of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

Sensitive Land Use Developments

The EPA's traffic noise policy also sets guidelines for the assessment of traffic noise on sensitive land uses such as schools, hospitals, places of worship and recreation areas. There is a church building located within the retirement village on the south east corner of James Cook Drive. The ECRTN noise criteria for places of worship are shown below.

Table 8- EPA'S Road Traffic Noise Criteria for Sensitive Land Use Developments

Type of Development	Criteria		
	$L_{eq(1hr)}$, dB(A)		Noise Mitigation Measures
	Day	Night	
Places of worship	40 (internal)	40 (internal)	To achieve internal noise criteria in the short-term, the most practicable mitigation measures are often related to building or facade treatments. In the medium to longer term, strategies such as regulation of exhaust noise from in-service vehicles, limitations on exhaust brake use, and restricting access for sensitive areas or during sensitive to low noise vehicles can be applied to mitigate noise impacts across the road system. Other measures include improved planning, design and construction of sensitive land use developments; reduced new vehicle emission standards; greater use of public transport; and alternative methods of freight haulage. These medium- to long-term strategies apply equally to mitigating internal and external noise levels. Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal or external criteria (as appropriate) cannot be achieved, the proposed road or land use development should be designed so as not to increase existing road traffic noise levels by more than 0.5dB(A) for new roads and 2dB(A) for redeveloped roads or land use development with potential to create additional traffic.

4.2 CONSTRUCTION NOISE

The EPA's Environmental Noise Control Manual (ENCM) is used to assess noise generated during the construction phase. Chapter 171 of the EPA's ENCM states the following:

Level Restrictions

i) *Construction period of 4 weeks and under.*
The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by **more than 20 dB(A)**.

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

iii) *Construction period greater than 26 weeks.*
The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by **more than 5 dB(A)**.

The construction noise criteria are summarised below.

Table 9 – Summary of Construction Noise Criteria

Length of Construction Period	Construction Noise Criteria, dB(A)	
	Location 1	Location 2
4 weeks and under	54 + 20 = **74**	56 + 20 = **76**
Greater than 4 weeks and not exceeding 26 weeks	54 + 10 = **64**	56 + 10 = **66**
Greater than 26 weeks	54 + 5 = **59**	56 + 5 = **61**

Time Restrictions

- Monday to Friday, 7am to 6pm.
- Saturday, 7am to 1pm if audible on residential premises, otherwise: 8am to 1pm.
- No construction work to take place on Sundays or Public Holidays.

4.3 CONSTRUCTION VIBRATION

The effects of ground vibration on buildings near construction sites may be broadly defined by the following three categories:

1. Disturbance to building occupants - Vibration in which the occupants or users of the building are inconvenienced or possibly disturbed,
2. Effects on building contents - Vibration where the building contents may be affected, and,
3. Effects on building structures - Vibration in which the integrity of the building or structure itself may be prejudiced.

In general, vibration criteria for human disturbance (1) are more stringent than vibration criteria for effects on building contents (2) and building structural damage (3). Hence, compliance with the more stringent limits dictated by Category 1, would ensure that compliance is also achieved for the other two categories.

Category 1 – Human Comfort

Chapter 174 of the EPA's ENCM presents vibration level limits based on Australian Standard AS 2670.2-1990 "Evaluation of human exposure to whole body vibration – Continuous and shock induced vibration in buildings". It states that for human comfort, vibration from activities such as construction work shall not exceed a prescribed curve of vibration limits expressed in terms of velocity units over a range of frequencies. The set levels aim to protect human comfort (ie Category 1).

The EPA advocates that general vibration in buildings be assessed in terms of "continuous" or "intermittent / impulsive" vibration criteria, while vibration generated from construction sites is to comply with the "intermittent / impulsive" vibration limits set out in the ENCM.

Continuous vibration is vibration that is present at a reasonably steady level for long periods of time, for example vibration from vibratory rollers and compactors. Intermittent or impulsive vibration results from sources such as rock breaking, piling or blasting. Continuous vibration limits are generally more stringent than intermittent / impulsive vibration limits, mainly due to duration differences and subsequently differences in degrees of annoyance.

The EPA guidelines also require restricting vibration generating activities to within normal construction hours if vibration levels exceed the "continuous" vibration limits. That is, if vibration is not perceivable or within "continuous" vibration limits, then no time restriction should apply.

Based on Chapter 174-2 of the EPA's ENCM, the following table presents 'root-mean-squared' (rms) vibration limits presented in terms of velocity levels at one-third octave band frequencies applicable between 8Hz and 80Hz (which is the frequency range of interest for construction) determined for normal construction activities to protect human comfort.

Table 10 – EPA Vibration Limits to Protect Human Comfort (rms)

Place	Time	Continuous	Intermittent or Impulsive
Residential	Daytime	0.2mm/s	6.0mm/s
	Night time	0.14mm/s	2.0mm/s
Office	Daytime	0.4mm/s	12.7mm/s
	Night time	0.4mm/s	12.7mm/s
Workshops	Daytime	0.8mm/s	12.7mm/s
	Night time	0.8mm/s	12.7mm/s

All of the human comfort limits described above are based on minimising annoyance. These vibration levels are well below the levels required for the prevention of structural damage to buildings and are therefore considered suitable for use in this assessment.

5 NOISE AND VIBRATION PREDICTION MODELLING

5.1 TRAFFIC SOURCES

The source noise levels used in this project to model traffic noise levels of the redeveloped road are contained within the calculation algorithms of the CORTN noise model.

The traffic noise prediction model used in this project is based on a method developed by the United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)" known as the CORTN (1988) method. This method has been adapted to Australian conditions and extensively tested by the Australian Road Research Board. The model predicts noise levels for free flowing traffic and a modified method has been developed which enables an accurate prediction of noise from high truck exhausts to be taken into account. The method predicts the $L_{10(1hour)}$ noise levels, and a correction of -3dB(A) is applied to obtain the $L_{eq(1\ hour)}$ noise levels for every hour in a 24 hour day.

The $L_{eq(1\ hour)}$ noise levels for the time period 7.00am to 10.00pm are then collated and logarithmically averaged to derive the daily $L_{eq(15\ hour)}$ noise level. Similarly, the $L_{eq(1\ hour)}$ noise levels for the time period 10.00pm to 7.00am are collated and logarithmically averaged to derive the night time $L_{eq(9\ hour)}$ noise level.

The noise prediction model takes into account:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- road gradient;
- location of the noise sources on the carriageways;
- the differing source heights of cars and trucks;
- relative levels and angles of view of the road from the receiver's position;
- reflections from barriers, cuttings, roadside structures etc;
- attenuation from barriers (natural and purpose built) and cuttings;

The model was verified and calibrated using the long-term noise monitoring results obtained for this project.

5.2 CONSTRUCTION NOISE

The following table lists construction plant and equipment likely to be used by the contractor to carry out the necessary construction work for this project. No piling or blasting is expected to be required for widening of Sunnyholt Road.

Table 11 - Typical Construction Equipment & Sound Power Levels

Plant Item	Plant Description	L_{A10} Sound Power Levels	
		Range	Typical (Mid-Point)
1	Concrete Saw	118 – 118	118
2	Concrete Leveller	115 – 115	115

Plant Item	Plant Description	L_{A10} Sound Power Levels	
		Range	Typical (Mid-Point)
3	Pneumatic Jack Hammer	110 – 115	113
4	Mobile Crane	110 – 115	113
5	Scraper	110 – 115	113
6	Front End Loader	110 – 115	113
7	Pneumatic Hand Tools (general)	110 – 115	113
8	Compactor	110 – 115	113
9	Pavement Laying Machine	110 – 114	112
10	Bulldozer	105 – 118	112
11	Tracked Excavator	105 – 115	110
12	Grader	105 – 115	110
13	Vibratory Roller	108 – 110	109
14	Concrete Truck	108 – 110	109
15	Dump Trucks	102 – 113	108
16	Water Cart	106 – 108	107
17	Rollers	100 – 113	107
18	Asphalt Truck	106 – 106	106
19	Truck (>20tonne)	103 – 108	106
20	Concrete Pump	100 – 109	105
21	Backhoe	100 – 108	104
22	Power Generator	100 – 106	103
23	Concrete Vibrator	101 – 105	103
24	Silenced Air Compressor	90 – 105	98

Note: The sound power data within the column marked "Typical (Mid-Point)" has been used in this study to calculate typical noise levels at the nominated assessment locations.

The sound power levels for the majority of activities presented in the above table are based on maximum levels given in Table D2 of Australian Standard 2436 - 1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites", information from past projects and information held in our library files.

5.3 CONSTRUCTION VIBRATION

Construction plant most likely to cause significant vibration are jackhammers, bulldozers, vibratory rollers and trucks. Typical vibration levels from these items are summarised below. The information was sourced from a variety of reference materials available in the Renzo Tonin & Associates library.

Jackhammers

Typical ground vibration levels from jackhammers range from 1 mm/s to 2 mm/s at distances of approximately 5 m. At distances greater than 20 m, vibration levels are usually below 0.2 mm/s.

Bulldozers

Typical ground vibration levels from bulldozers are similar to those from jackhammers. They range from 1 mm/s to 2 mm/s at distances of approximately 5 m and at distances greater than 20m, vibration levels are usually below 0.2 mm/s.

Vibratory rollers

Levels of ground vibration caused by vibratory rollers can range up to 1.5 mm/s at distances of 25 m. The highest levels of vibration usually occur as the roller is brought to rest and the frequency of the centrifugal forces passes through resonance with the natural frequency of the roller/ground/structure. Machinery should therefore not be brought to rest when in the vicinity of susceptible buildings, especially dwellings.

Truck traffic

Typical vibration levels from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels in the range of 0.01-0.2 mm/s at the footings of buildings located 10-20 m from a roadway. Very large surface irregularities can cause levels up to five to ten times higher.

In general, ground vibration from trucks is usually imperceptible in nearby buildings. The rattling of windows and other loose fittings that is sometimes reported is more likely to be caused by airborne acoustic excitation from very low frequency (infrasonic) noise radiated by truck exhausts and truck bodies. While this may cause concern to the occupants, the phenomenon is no different from the rattling caused by wind or people walking or jumping on the floor and fears of structural damage or even accelerated ageing are usually unfounded.

6 PREDICTED NOISE & VIBRATION

6.1 ROAD TRAFFIC NOISE ASSESSMENT

Future traffic noise levels at completion of the project, and 10 years after completion, have been predicted using the CORTN88 traffic noise model. Future traffic volumes along both Sunnyholt Road and the proposed Transitway have been obtained from traffic studies conducted for the RTA and are shown in Section 2 of this report.

The increase in traffic on Sunnyholt Road due to the Western Sydney Orbital (WSO) being built has been included in these traffic volume predictions. However, the effect of traffic noise directly from vehicles travelling along the WSO is not included in the overall traffic noise predictions as a separate EIS for the WSO has been completed and traffic noise mitigation measures have already been developed to control traffic noise emissions from the WSO.

Distances between vehicles and critical receivers were obtained from site measurements and from drawings supplied by the RTA. Other factors such as relative heights of road and receivers, gradient of the road and angles of view are not expected to change significantly due to the proposed road widening and Transitway proposal.

There are new housing estates in the study area of this project and some new dwellings are situated alongside Sunnyholt Road. New estates are bounded by solid light-weight (aerated) concrete fences which reduce noise impact from traffic on Sunnyholt Road. These new residences are set further back from the road than those existing residences identified above. In this report, potentially worst affected receivers are considered to be existing dwellings that have clear line-of-sight to Sunnyholt Road.

The receivers determined to be potentially most affected by the project are:

- Existing residences in Flint Street on the east side of Sunnyholt Road and south of the WSO,
- Existing residences in Tagu Place on the west side of Sunnyholt Road and south of the WSO that are not going to be acquired by the RTA,
- Existing residences on the east side of Sunnyholt Road and north of the WSO,
- Existing residences on the west side of Sunnnyholt Road and north of the WSO,
- Existing residences on west side of Sunnyholt Road and north of Quakers Hill Parkway,
- The church on the east side of Sunnyholt Road just south of James Cook Drive,
- vacant land abutting Sunnyholt Road that may potentially be developed for residential use before the Sunnyholt Road REF is approved.

The potentially worst affected dwellings are listed below as the selected assessment locations. The maximum changes in road-to-receiver distance are also shown and were measured directly from the drawings. The distances shown in Table 12 are from the centre of the nearside carriageway to the facades of dwellings.

Table 12 – Change in Road to Receiver Distance

Assessment Locations	Distance, m			
	Sunnyholt Rd		Transitway	
	Existing	Proposed	Existing	Proposed
Location A – 2 Flint Street	20	25	-	18
Location B – 9 Tagu Place	30	24	-	50
Location C – 443 Sunnyholt Rd	28	28	-	20
Location D – 432 Sunnyholt Rd	20	10	-	36
Location E – 484 Sunnyholt Rd	18	15	-	45
Location F – Church, 56 Elsom Street	23	23		14

6.1.1 Residential Receivers

Table 13 presents future daytime $L_{Aeq(15hr)}$ traffic noise levels at the five assessed residential locations after the proposed works are complete. Table 14 presents future $L_{Aeq(9hr)}$ night time traffic noise levels for these locations.

The future-existing traffic noise level (the noise level from existing sources of road traffic noise predicted for the time of opening) has been determined from modeling, using the noise monitoring results presented in Section 3 of this report for validation purposes.

Table 13 – Daytime Traffic Noise Levels at Residences

Location	Future-Existing $L_{Aeq(15hr)}$ Noise Level Yr2006	Future $L_{Aeq(15hr)}$ Noise Level Yr2006			Future $L_{Aeq(15hr)}$ Noise Level Yr2016		
		Sunnyholt Rd	Transitway	Total	Sunnyholt Rd	Transitway	Total
Location A	68	68	53	68	68	53	68
Location B	63	65	45	65	66	46	66
Location C	66	67	52	67	69	53	69
Location D	68	72	50	72	73	50	73
Location E	68	68	48	68	69	49	69

Table 14 – Night-Time Traffic Noise Levels at Residences

Location	Future-Existing $L_{Aeq(9hr)}$ Noise Level Yr2006	Future $L_{Aeq(9hr)}$ Noise Level Yr2006			Future $L_{Aeq(9hr)}$ Noise Level Yr2016		
		Sunnyholt Rd	Transitway	Total	Sunnyholt Rd	Transitway	Total
Location A	63	64	49	64	64	49	64
Location B	58	61	41	61	61	42	61
Location C	61	63	48	63	64	49	64

Location	Future-Existing $L_{Aeq(9hr)}$ Noise Level Yr2006	Future $L_{Aeq(9hr)}$ Noise Level Yr2006			Future $L_{Aeq(9hr)}$ Noise Level Yr2016		
		Sunnyholt Rd	Transitway	Total	Sunnyholt Rd	Transitway	Total
Location D	63	67	46	67	69	46	69
Location E	63	64	45	64	66	45	66

The results of unattended noise monitoring have shown that daytime and night-time traffic noise levels along the Sunnyholt Road currently exceed the EPA's redeveloped road criteria during both the day and the night. The predicted noise levels for ten years after the project's opening are generally more than 2dB(A) above the future existing noise levels with the exception of Location A. Location D is most affected and noise levels are predicted to increase by up to 6dB(A) as a result of the proposal. The increase in traffic noise levels at Location D is due to both the increase in traffic volumes in the future and the decrease in distance between the residence and the widened road.

Due to the relatively low number of buses on the Transitway in comparison to the number of vehicles using Sunnyholt Road over the 15 hour day or 9 hour night periods, noise from the Transitway does not significantly contribute to the total noise level.

Since total traffic noise levels are not within the 2dB(A) allowance above the future-existing noise levels at four of the five assessed locations, and since the total noise levels exceed 65dB(A) $L_{Aeq(15hr)}$ and 60dB(A) $L_{Aeq(9hr)}$ and are therefore considered to be acute, the RTA's ENMM states that noise control options such as noise barriers, quieter pavements and architectural treatments must be investigated. The goal is to reduce noise levels to the ECRTN noise goals of 60dB(A) $L_{Aeq(15hr)}$ and 55dB(A) $L_{Aeq(9hr)}$ for redeveloped roads, where reasonable and feasible. See Section 8 of this report for possible noise mitigation options.

It should be noted that this study assesses impacts to residential land uses that are existing or under construction. However, the following areas have parcels of vacant land with residential zoning and may be developed in the future.

- WSO to Wilson Road (east side)
- Wilson Road to Quakers Hill Parkway (west side)
- North of Quakers Hill Parkway (both sides)

If development applications for these areas are made before the Sunnyholt Road widening project is approved, noise mitigation will probably be required here also, depending on the distances from the road to the nearest facades. If residences are located a similar distance from the road as existing dwellings, then treatment similar to that recommended in Section 8.1 will be required. Where applications are not submitted before approval of this project, developers are responsible for treatment to comply with the ECRTN or local council's noise limits.

6.1.2 Church

The weekly uses of the church at 56 Elsom Street generally occur on Saturday mornings from 9.30am, Friday evenings between 6.00pm and 7.00pm, and Wednesday mornings from 10am. Existing noise levels measured at Location 1 during these times have been distance corrected to determine the likely existing noise levels at the church. The maximum number of buses on the Transitway in one hour during the day has is estimated to be fifteen in 2006, and sixteen in 2016. The table below presents future external daytime $L_{Aeq(1hr)}$ traffic noise levels at the church.

The church has openable windows. It is generally accepted that most buildings facades provide a noise reduction of at least 10dB(A) when windows are left 20% open (EPA ECRTN p14). If the $L_{Aeq(1hr)}$ internal noise goal for the day and the night is 40dB(A), then this equates to an external criteria of $L_{Aeq(1hr)}$ 50dB(A).

Table 15 – External Daytime Traffic Noise Levels at Church, Location F

Time	Future-Existing $L_{Aeq(1hr)}$ Noise Level Yr2006	Future $L_{Aeq(1hr)}$ Noise Level Yr2006			Future $L_{Aeq(1hr)}$ Noise Level Yr2016		
		Sunnyholt Rd	Transitway	Total	Sunnyholt Rd	Transitway	Total
Sat 10am – 11am	67	68	54	68	70	54	70
Fri 6pm – 7pm	62	63	54	64	65	54	65
Wed 10am – 11am	66	67	54	67	69	54	69

Assuming a 10dB(A) noise reduction through an open window in the church, internal noise levels are predicted to reach 60dB(A) in 2016 which exceeds the ECRTN internal $L_{Aeq(1hr)}$ criteria of 40dB(A) for places of worship by up to 20dB(A).

6.2 CONSTRUCTION NOISE

Noise levels at any receptors resulting from construction would depend on the location of the receptor with respect to the area of construction, shielding from intervening topography and structures, and the type and duration of operation being undertaken. Furthermore, noise levels at receivers will vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Table 16 presents predicted external construction noise levels at the five selected assessment locations.

Table 16 – Predicted L_{A10} Construction Noise Levels

Plant Item	Plant Description	Location A	Location B	Location C	Location D	Location E
1	Concrete Saw	90	83	87	90	87
2	Concrete Leveller	87	80	84	87	84
3	Pneumatic Jack Hammer	85	78	82	85	82
4	Mobile Crane	85	78	82	85	82
5	Scraper	85	78	82	85	82
6	Front End Loader	85	78	82	85	82
7	Pneumatic Hand Tools (general)	85	78	82	85	82
8	Compactor	85	78	82	85	82
9	Pavement Laying Machine	84	77	81	84	81
10	Bulldozer	84	77	81	84	81
11	Tracked Excavator	82	75	79	82	79

Plant Item	Plant Description	Location A	Location B	Location C	Location D	Location E
12	Grader	82	75	79	82	79
13	Vibratory Roller	81	74	78	81	78
14	Concrete Truck	81	74	78	81	78
15	Dump Trucks	80	73	77	80	77
16	Water Cart	79	72	76	79	76
17	Rollers	79	72	76	79	76
18	Asphalt Truck	78	71	75	78	75
19	Truck (>20tonne)	78	71	75	78	75
20	Concrete Pump	77	70	74	77	74
21	Backhoe	76	69	73	76	73
22	Power Generator	75	68	72	75	72
23	Concrete Vibrator	75	68	72	75	72
24	Silenced Air Compressor	70	63	67	70	67
25	Spreader	67	60	64	67	64

The construction noise criteria established for Location 1 in Section 4.2 can be assumed to be the criteria for Location A and Location B. Similarly, the construction noise criteria established for Location 2 can be assumed to be the criteria for Location C, Location D and Location E.

Based on the construction noise levels predicted above, even the EPA's least stringent construction noise criteria will be exceeded at all assessment locations by the noisiest plant. Noise management measures will be required to achieve compliance. It should also be noted that noise levels could exceed those shown if two or more items of plant are operating concurrently in close proximity.

6.3 CONSTRUCTION VIBRATION

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (eg dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency content and number of occurrences of a vibration, all play an important role in both the annoyances caused and the strains induced in structures.

As the pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific, below are some indicative minimum 'buffer' distances based on some recent projects used to avoid human discomfort during daytime.

Table 17 – Recommended Minimum Buffer Distances for Construction Plant

Plant Item	Recommended Minimum Buffer Distance, m
Jackhammers	5
Bulldozers	5
Vibratory rollers - light	5
Vibratory rollers - medium	12
Vibratory rollers - heavy	25
Truck movements	10

Based on the above table and a separation distance as small as 10m from the proposed road works to one of the selected assessment locations, vibration from medium and heavy vibratory rollers could exceed the set limits at the nearest residences. A buffer distance in the order of 25m is required if heavy vibratory rollers are to be used. Project specific buffer distances should be determined once vibration emission levels are measured from each plant item prior to the commencement of operation on site.

7 MAXIMUM NOISE LEVEL ASSESSMENT

The EPA's policy on traffic noise does not specify a night-time L_{max} noise limit or noise goal. This is primarily because research conducted to date in this field has not been definitive and the relationship between maximum noise levels, sleep disturbance and subsequent health effects is not currently well defined. According to the policy however, the likely maximum or peak noise levels are to be broadly assessed and reported for the night-time period, which is considered by the EPA as being 10pm to 7am.

The results presented in Table 18 below show the predicted L_{A1} noise levels generated by heavy vehicle traffic along the widened route at night time at the five selected assessment locations. The L_{A1} noise level for a truck and a bus travelling at 70km/h was modelled in ENM Windows noise prediction software to the facade of each residence based on truck and bus noise data available from our past projects and library databases, with the appropriate distance corrections.

The background noise level measured at Location 1 is assumed to be the background noise level at Location A and Location B. The background noise level measured at Location 2 is assumed to be the background noise level at Location C, Location D and Location E.

Table 18 – Maximum night time noise levels – Road Traffic Noise

Location	Noise Levels at Receiver Location		
	Modelled L_{A1}		Existing Night-Time L_{A90} noise levels (10pm-7am)
	Trucks	Buses	
Location A	74	69	44
Location B	74	61	44
Location C	73	69	39
Location D	82	63	39
Location E	79	61	39

The predicted maximum noise levels range from 61 to 82dB(A) and are up to 43dB(A) above the ambient background noise level. However, the existing L_{A1} noise levels measured during the noise monitoring period at Location C commonly ranged from 70 to 77dB(A). Therefore the results presented in Table 18 above show that instantaneous noise generated by trucks and buses travelling along the widened road are mostly expected to be within the range of existing L_{A1} noise levels generated by existing traffic.

Given that heavy vehicles are the cause of most of the maximum noise emissions, the frequency of occurrence of maximum noise events is expected to increase roughly proportionally to the increase in heavy vehicle volumes.

8 NOISE AND VIBRATION MITIGATION OPTIONS

8.1 TRAFFIC NOISE MITIGATION

The ECRTN states that where feasible and reasonable, noise levels from existing roads should be reduced to meet the set noise criteria. Further, as discussed in Section 6 of this report, the RTA's ENMM also requests the investigation of noise control options such as noise barriers or mounds, quieter pavements and architectural treatments for this project.

The following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. This information is presented for the purpose of the approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant. Assistance of an acoustic consultant must be sought at the detailed design phase of these works to provide the necessary design details and specifications prior to construction.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

8.1.1 Noise Barriers

Noise barriers are most feasible where residences are closely grouped, where the barriers do not cause access difficulties to properties, and where they are visually acceptable.

There are a mixture of property types in this study area. The older existing residences are generally located on large parcels of land, are not closely grouped and require driveway access to Sunnyholt Road. Constructing noise barriers in front of these residences is probably not feasible. See Section 8.1.2 for alternative noise mitigation for these residences.

The new housing estates recently completed or currently under construction along Sunnyholt Road do not generally have direct access to Sunnyholt Road and are already fronted by light-weight (aerated) concrete fences which act as a noise barrier. These barriers are nominally 1.8 metres high and will probably not mitigate noise enough to achieve the ECRTN noise goals of 60dB(A) $L_{eq(15hr)}$ and 55dB(A) $L_{eq(9hr)}$ for the redeveloped road. The table below shows areas where noise barriers may be feasible, the height and length to achieve the set noise goals.

Noise barrier predictions were performed using the CORTN88 traffic noise model. The model assumes that:

- The noise barrier is to be located approximately 3.5m (one lane width) from the edge of the outer most lane on the roadway
- The base of the barrier has the same relative level as the road
- Some wrap-around of barriers where Sunnyholt Road adjoins the WSO or other local streets may be required to form an effective noise barrier.

Aerated concrete or timber are generally the least expensive barrier construction materials. Metal or polycarbonate tends to be more expensive. Using transparent panels, absorptive facing or patterned aesthetic finishes also increases costs. Prices vary but $300 per square metre has been used as a reasonable estimate of cost for the purpose of this exercise for supply, delivery and erection of concrete barriers.

Table 19 – Noise Barrier Locations and Nominal Heights

Location	Side	Approx. Length	Nominal Height	Cost
Just south of James Cook Dr to WSO	east	350m	3m	$315,000
Just south of James Cook Dr to WSO	west	350m	3m	$315,000
WSO to end of Ali Pl	east	250m	3m	$225,000
WSO to just south of Wilson Rd	west	300m	3m	$270,000
Wilson Rd to Malvern Rd	east	130m	3m	$117,000
Malvern Rd to just past Quakers Hill Pky	east	350m	3m	$315,000
	TOTAL	**1730m**	**Avg. 3m**	**$1,557,000**

Although many of the new residences that have recently been constructed alongside Sunnyholt Road are single storey, there are also some double-storey residences. The noise barrier heights recommended above are designed to mitigate noise to the ground level only. The ECRTN (p12) states that;

> *"In the case of multi level residential buildings, the external point of reference for measurement for the criteria is the two floors of the building that are most exposed to traffic noise (generally the ground and first floors)."*

To mitigate noise to acceptable levels for double-storey residences using noise barriers, the barrier height would need to increase to approximately 4.5 metres, depending on the location of the barrier in relation to the road and the dwelling. However, where there are only a few double-storey residences that are not grouped together, it may be more cost effective to architecturally treat the first floor rather than build higher barriers. Final barrier heights can be determined at the detail design phase of the project.

These barriers are designed to achieve the noise goal for residential receivers. However, future traffic noise levels at the church on Elsom Street are predicted to excced the 50dB(A) external noise criteria by up to 20dB(A). The 3m high noise barriers as recommended above will not achieve this so architectural treatment may need to be used in conjunction with noise barriers to achieve the 40dB(A) internal noise criterion.

8.1.2 Architectural Treatment

Building treatment should only be considered for dwellings where the ECRTN criteria is exceeded and other noise mitigation measures are either exhausted or are not feasible or cost effective.

The ECRTN's target noise levels are external noise goals but building treatment only reduces noise levels inside a dwelling. Therefore, any building treatment should be designed to achieve the internal noise levels that would have been achieved had noise from Sunnyholt Road complied with the ECRTN criteria externally.

It is generally accepted that most buildings provide a noise reduction of at least 10dB(A) when windows are left 20% open, without providing additional treatment (EPA ECRTN p14). This equates to an ECRTN internal criteria $L_{Aeq(15hr)}$ 50dB(A) and $L_{Aeq(9hr)}$ 45dB(A) for a redeveloped road. Therefore, the goal of architecturally treating residences is to reduce future traffic noise levels to 50dB(A) $L_{Aeq(15hr)}$ and 45dB(A) $L_{Aeq(9hr)}$ inside.

For this project, there are ten habitable residences in the study area that may not be able to be feasibly treated by noise barriers because they are isolated or require access to Sunnyholt Road, and could therefore be treated using architectural treatment. This number was estimated from site visits and aerial photos and includes;

- Seven existing residences on the west side of Sunnyholt Road, from just south of Wilson Road to just past Quakers Hill Parkway,
- Two existing residences on the east side of Sunnyholt Road opposite Wilson Road,
- The existing residence on the east side of Sunnyholt Road, just north of Ali Place.

Traffic noise predictions have shown that only one residence (Location D) requires more than 10dB(A) reduction to achieve the internal noise goal. Other affected residences require less than 10dB(A) noise reduction.

Option 1 - Mechanical ventilation and sealing of wall vents

For the residences where less than 10dB(A) reduction is required, the internal criteria may be achieved with windows closed. If the internal noise criteria can only be achieved with windows closed, then mechanical ventilation or air conditioning must be provided to ensure fresh airflow inside the dwelling so to meet the requirements of the Building Code of Australia.

It is important to ensure that mechanical ventilation does not provide a new noise leakage path into the dwelling and does not create a noise nuisance to neighbouring residential premises.

The estimated cost for providing the above treatment is in the order of $5,000 - $15,000 per dwelling (RTA's ENMM p.111 sets a limit of $15,000 per residence).

Option 2 - Upgraded seals for windows and doors

For residences where slightly greater than 10dB(A) reduction is required then additional to installing mechanical ventilation systems (Option 1), special acoustic grade seals should be installed on windows and perimeter doors exposed to road traffic noise to enable the internal noise criteria to be achieved with windows and doors shut.

The estimated cost for providing the combined treatment of both Options 1 and 2 is in the order of $10,000 - $20,000 per dwelling (RTA's ENMM p.111 sets a limit of $20,000 per residence).

The table below shows cost estimates for architectural treatment for this project.

Table 20 – Cost Estimates for Architectural Treatment

Reduction Required	Estimated number of dwellings	Estimated cost of treatment per dwelling	Total Cost
< 10dB(A)	9 + church	$10,000	$90,000 + church
>10dB(A)	1	$15,000	$15,000
		TOTAL	**$105,000 + church**

8.1.3 Low Noise Pavement

A low noise pavement such as Open Graded Asphaltic Concrete (OGAC) could be laid along the Sunnyholt Road and the Transitway. This treatment can provide a 2 - 3 dB(A) noise reduction at the source compared to standard pavements, but could not achieve the criteria without being used in conjunction with other noise mitigation measures.

8.2 CONSTRUCTION NOISE

Noise impacts from likely construction activities have been calculated. The results show that noise exceedances could occur at some nearby residences when the noisiest equipment are in operation. Noise management measures and procedures will be necessary, as outlined below, to manage noise impacts from construction activities.

Implementation of noise control measures, such as those suggested in Australian Standard 2436-1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-1981, Appendix E, Table E1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table E2 in Appendix E presents typical examples of noise reductions achievable after treatment of various noise sources. Table E3 in Appendix E presents the relative effectiveness of various forms of noise control treatment.

Table 21 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 21– Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	7 to 10	**5 to 10**	15	**15**
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 30	**10 to 20**	50	**30**
Engine Silencing	Residential class mufflers	5 to 10	**5 to 10**	20	**20**
Substitution by alternative process	Use electric motors in preference to diesel or petrol	15 to 25	**15 to 25**	60	**40**

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436, for this assessment.

Table 22 below identifies possible noise control measures, which are applicable on some of the construction plant likely to be used on site.

Table 22 – Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Mobile Crane	✔	✔	✔	x

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Pneumatic Hand Tools (general)	✔	✔	✔	✔
Dump Trucks	✔	x	✔	x
Concrete Truck	✔	x	✔	x
Concrete Pump	✔	✔	✔	✔
Water Cart	✔	x	✔	x
Truck (> 20 tonne)	✔	x	✔	x
Power Generator	✔	✔	✔	x
Concrete Vibrator	✔	x	x	x
Silenced Air Compressor	✔	✔	✔	✔
Jack hammers	✔	x	✔	x
Excavator (30 tonne)	✔	x	✔	x
Bulldozer	✔	x	✔	x
25 tonne truck	✔	x	✔	x
Concrete Truck	✔	x	✔	x
Excavator (25 tonne)	✔	x	✔	x

To ensure efficient noise attenuation performance is achieved using any of the methods listed above, it is recommended acoustic engineers work closely with the construction contractors and carry out preliminary testing prior to commencement of works.

In addition to physical noise controls, the following general noise management measures should be followed:

- Plant and equipment should be properly maintained
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel
- Avoid any unnecessary noise when carrying out manual operations and when operating plant
- Any equipment not in use for extended periods during construction work should be switched off
- In addition to the noise mitigation measures outlined above, a management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community should be adequately trained and experienced in such matters.

Where possible, the recommended roadside noise barriers should be constructed before the road widening begins so that construction noise impacts to residences are minimised. Where noise level exceedances cannot be avoided, then consideration should be given to implementing time restrictions and/or providing periods of repose for residents.

8.3 CONSTRUCTION VIBRATION

The following in-principle vibration control measures are provided to minimise vibration impact from construction activities to the nominated occupancies and to meet the EPA's human comfort vibration limits:

1. A management procedure should be implemented to deal with vibration complaints. Each complaint should be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones as mentioned in Section 6 of this report, and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

3. Carry out vibration testing of actual equipment on site to determine acceptable buffer distances to commercial and residential occupancies.

9 CONCLUSION

An assessment of traffic noise and construction noise emissions from the proposed widening of a section of Sunnyholt Road at Glenwood has been undertaken. The assessment has been conducted at potentially affected residential dwellings.

Overall noise impact from the proposed widening of the road has been determined and traffic noise levels are expected to increase by up to 6dB(A) at the worst affected residential locations. This increase, and the fact that road widening is proposed where current traffic noise levels are already acute, has determined that noise mitigation will be required as part of this project. Noise mitigation options have been provided for further consideration in terms of their reasonability and feasibility.

As per the RTA's ENMM, several methods of noise mitigation were considered. A combination of noise barriers and architectural treatment has been described and preliminary costs for the work have been estimated. The RTA should therefore adopt the proposed options to reduce traffic noise levels at the identified noise-sensitive receptors, subject to further evaluation of issues relating to feasibility and reasonableness, and taking account of any design changes that may emerge during the detailed design phase.

It was also found that construction noise is likely to impact residences located close to the road. Although unlikely, it is also possible that vibration levels during typical road construction works would exceed human comfort limits. In-principle noise and vibration mitigation measures are provided to reduce construction noise and vibration impacts to acceptable levels.

APPENDIX A – GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe traffic noise to assist in understanding the technical issues presented in this document.

Air-borne noise	This refers to noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise and receiver.
Ambient Noise	The general environmental noise at any specific location, being a composite of sounds from many sources, both near and far.
Assessment Period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
A-weighting	An adjustment made to sound level measurement, by means of an electronic filter, to approximate the response of the human ear.
Barrier - noise	Any natural or artificial physical barrier to the propogation of noise (from a roadway), but generally referring to acoustically reflective or absorbent fences, walls or mounds (or combinations thereof) constructed beside a roadway.
Buffer	An area of land between a roadway and a noise-sensitive land use, used as open space or for some other noise-tolerant land use.
Decibels [dB]	10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound. The following are examples of the decibel readings of every day sounds: 0 dB the faintest sound we can hear 30 dB a quiet library or in a quiet location in the country 45 dB typical office space; ambience in the city at night 60 dB Martin Place at lunch time 70 dB the sound of a car passing on the street 80 dB loud music played at home 90 dB the sound of a truck passing on the street 100 dB the sound of a rock band 115 dB limit of sound permitted in industry 120 dB deafening.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels.
Diffraction	The distortion around solid obstacles of waves travelling past.
Fluctuating Noise	Noise that varies continuously and to an appreciable extent over the period of observation.

Frequency	Of a periodic quantity: the time rate of repetition or the reciprocal of the period. It is also synonymous with *pitch* and is often used to describe the character of a sound. Frequency is measured in Hertz (Hz).
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
$L_{10(1hr)}$	The L_{10} level measured over a 1 hour period.
$L_{10(18hr)}$	The arithmetic average of the $L_{10(1hr)}$ levels for the 18 hour period between 6am and 12 midnight on a normal working day.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{Aeq}	Equivalent sound pressure level – the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{Aeq(1hr)}$	The L_{eq} noise level for a one-hour period. In the context of the EPA's Traffic Noise Policy it represents the highest tenth percentile hourly A-weighted Leq during the period 7am to 10pm, or 10pm to 7am (whichever is relevant).
$L_{eq(8hr)}$	The continuous noise level during any one hour period between 10pm and 6am.
$L_{eq(9hr)}$	The L_{eq} noise level for the period 10pm to 7am.
$L_{eq(15hr)}$	The L_{eq} noise level for the period 7am to 10pm.
$L_{eq\ (24hr)}$	The equivalent continuous noise level during a 24 hour period, usually from midnight to midnight.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
Noise	Sound which a listener does not wish to hear.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path

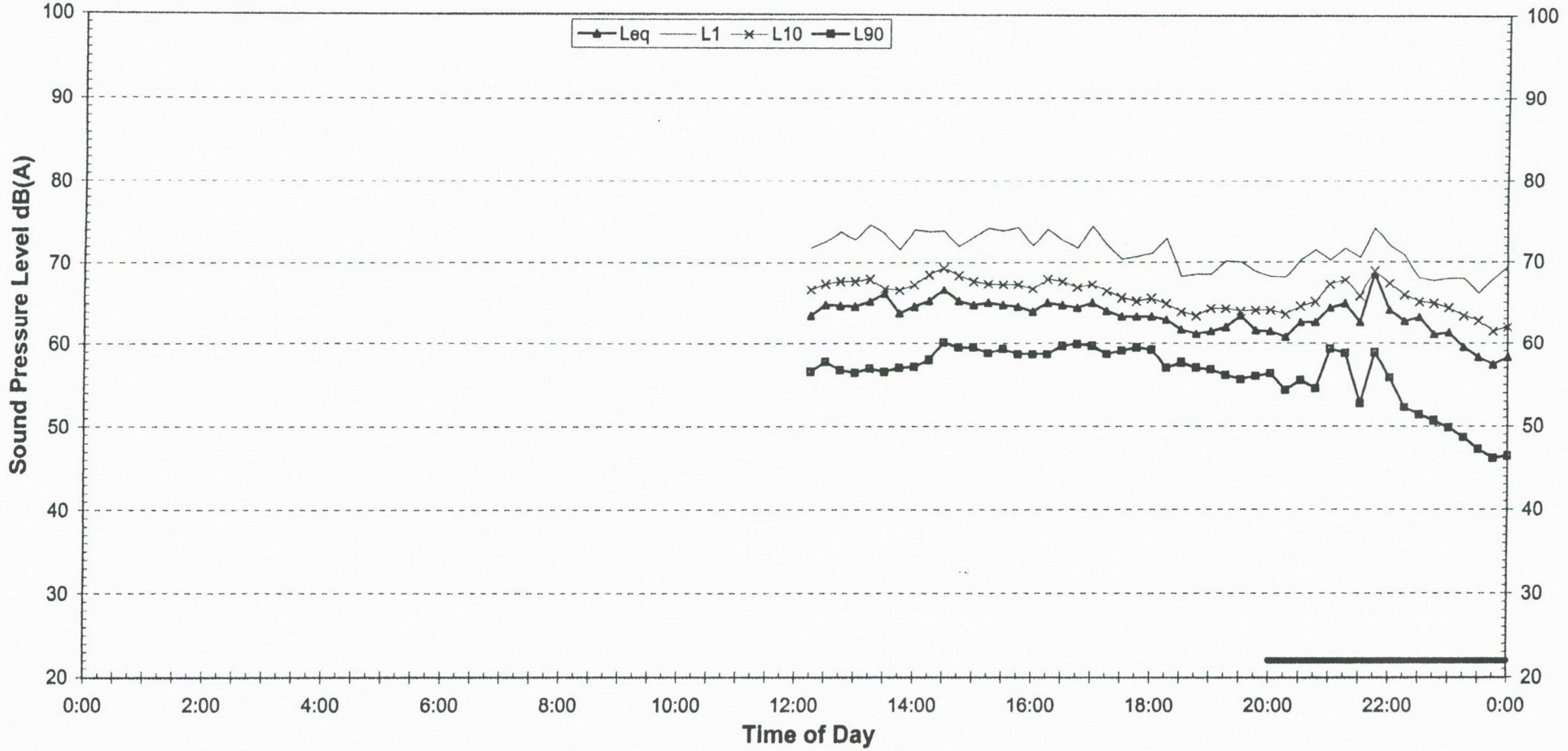
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	An alteration in pressure, stress, particle displacement, or particle velocity which is propagated in an elastic material or the superposition of such propagated alterations.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.

APPENDIX B – LONG TERM NOISE MONITORING RESULTS

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Tuesday, 26 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	56.8	55.7	36.5
Leq (see note 3)	62.1	59.6	57.5

NOTES:
1. Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured 1m from facade; tabulated results free-field corrected

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	64.2	60.0
Leq 1hr upper 10 percentile	65.5	64.7
Leq 1hr lower 10 percentile	61.9	49.8

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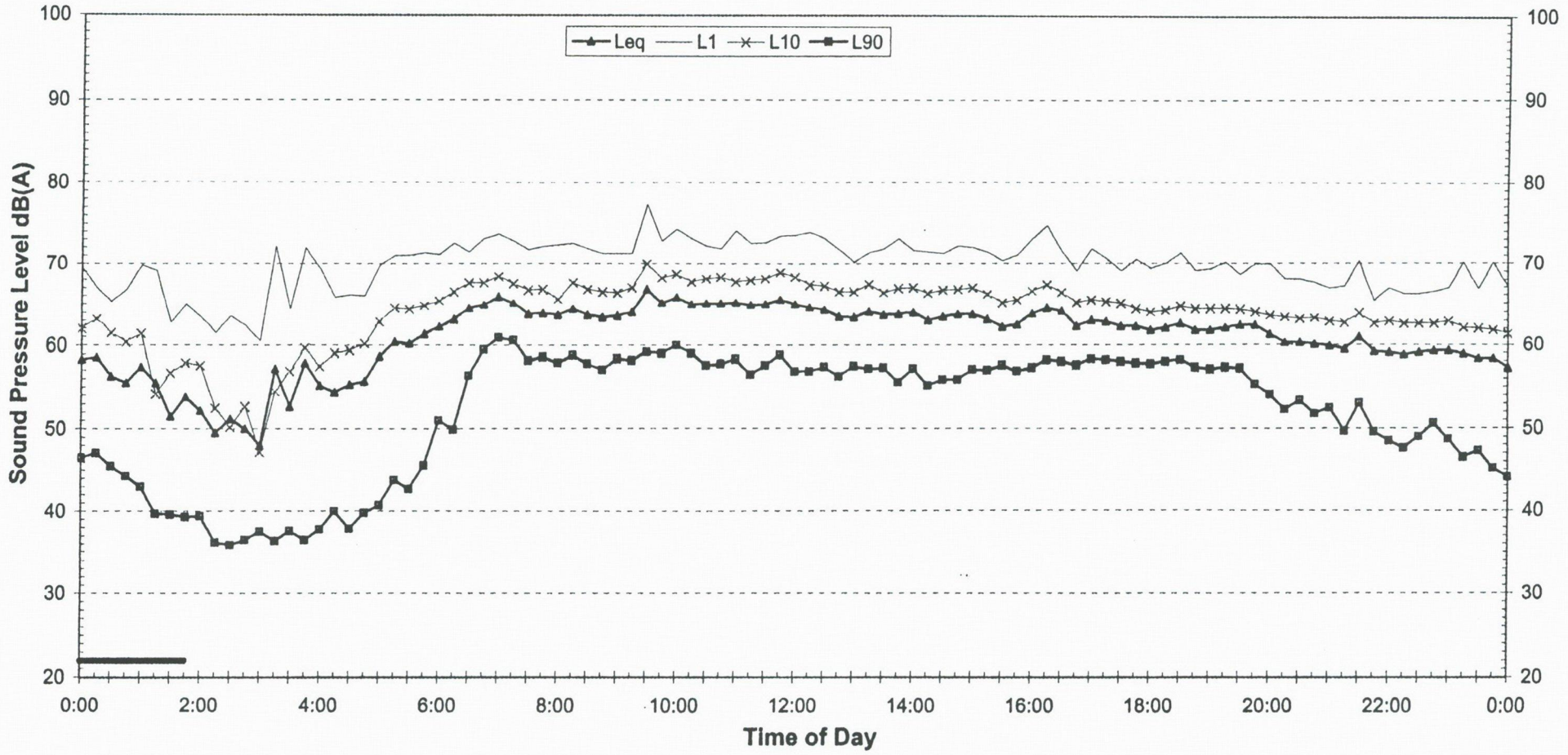
TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Wednesday, 27 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	56.3	49.6	42.9
Leq (see note 3)	61.5	58.7	58.7

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	63.4	61.2
Leq 1hr upper 10 percentile	65.3	64.4
Leq 1hr lower 10 percentile	60.0	55.1

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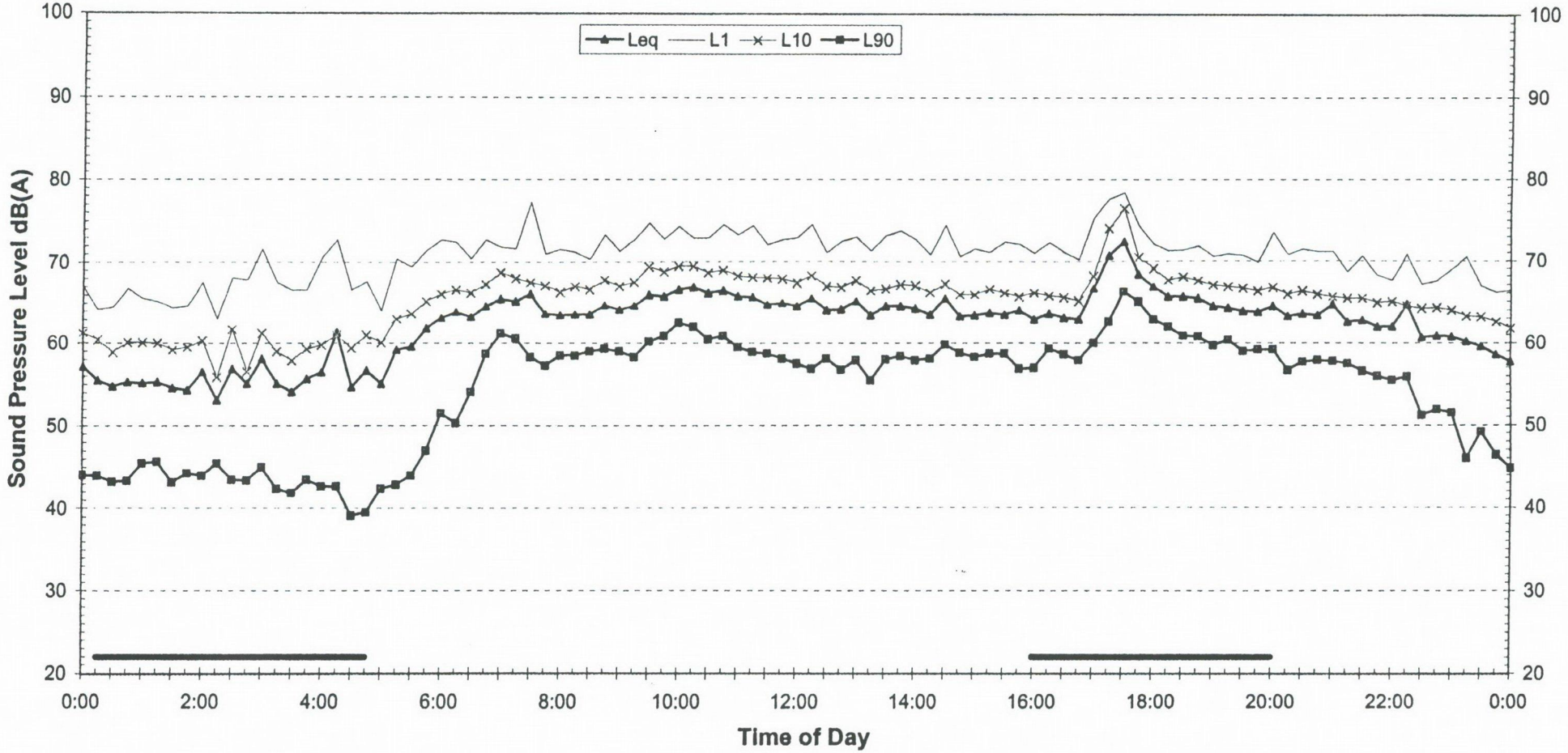
TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Thursday, 28 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	56.9	55.5	44.8
Leq (see note 3)	62.3	60.6	58.4

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	64.6	60.9
Leq 1hr upper 10 percentile	66.3	62.1
Leq 1hr lower 10 percentile	62.5	59.1

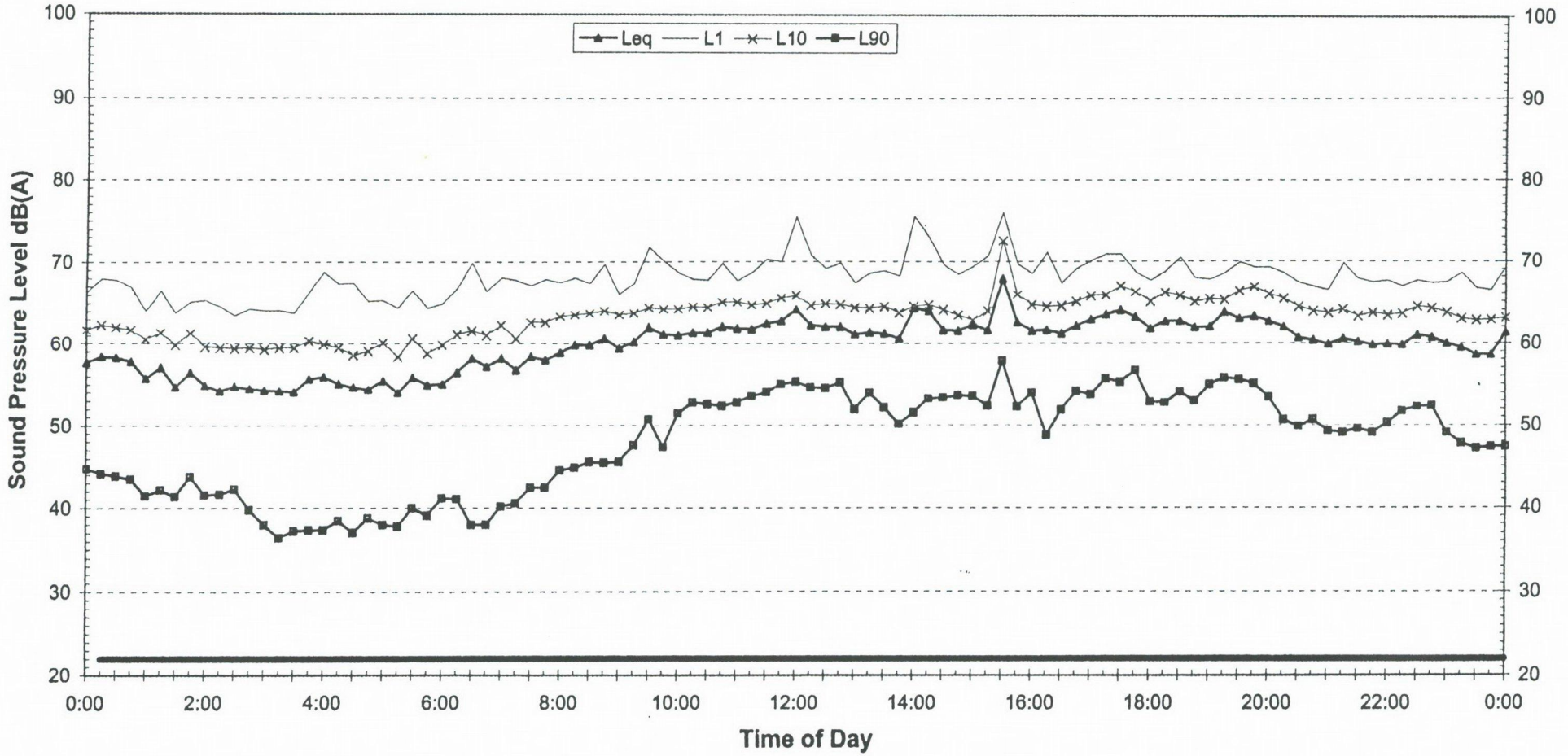
Rev 9 Data File 007mg.dat

TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Friday, 29 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	-
Leq 1hr upper 10 percentile	-	-
Leq 1hr lower 10 percentile	-	-

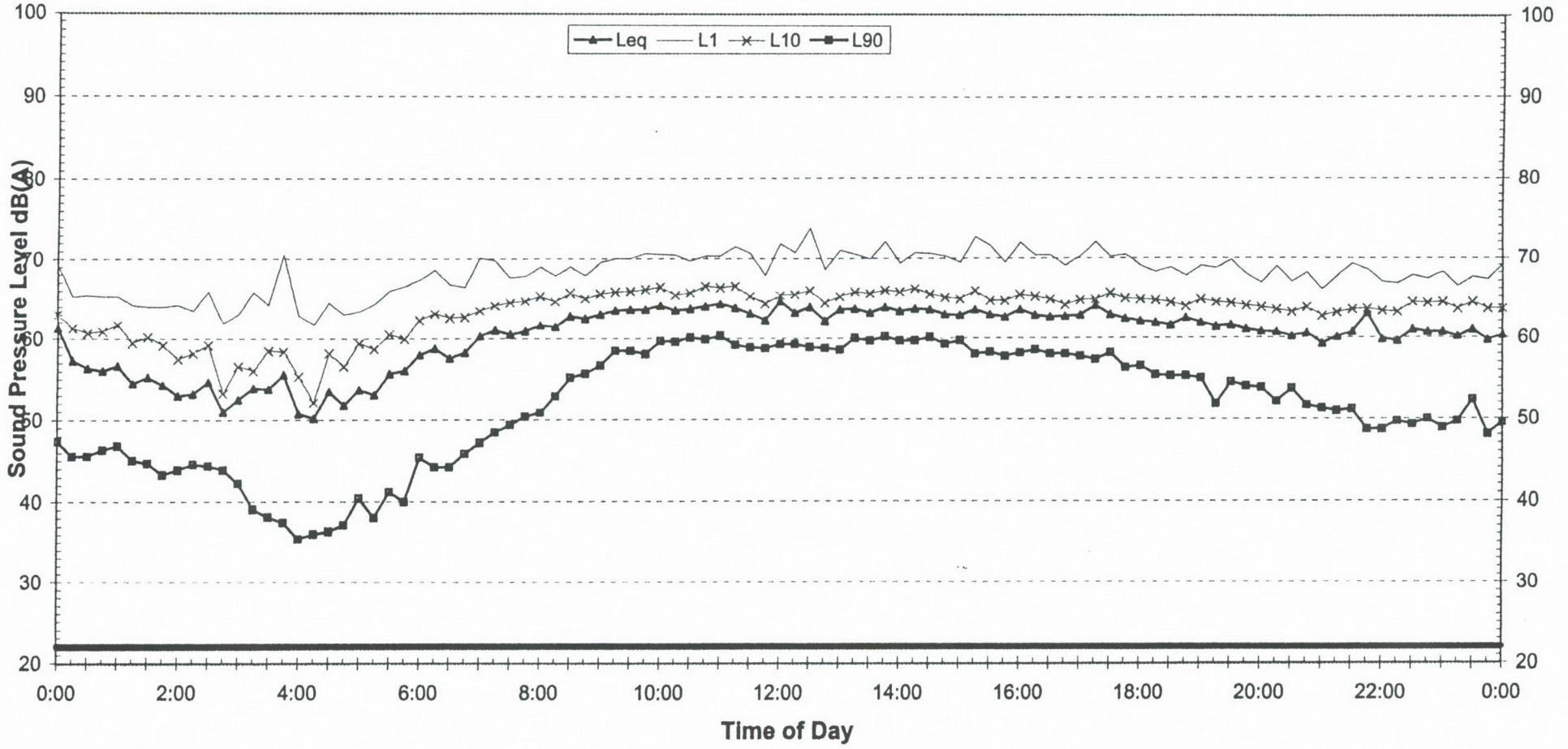
Rev 9 Data File 007mg.dat

TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Saturday, 30 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	-
Leq (see note 3)	-	-	-

NOTES:
1. Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured 1m from facade; tabulated results free-field corrected

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	-
Leq 1hr upper 10 percentile	-	-
Leq 1hr lower 10 percentile	-	-

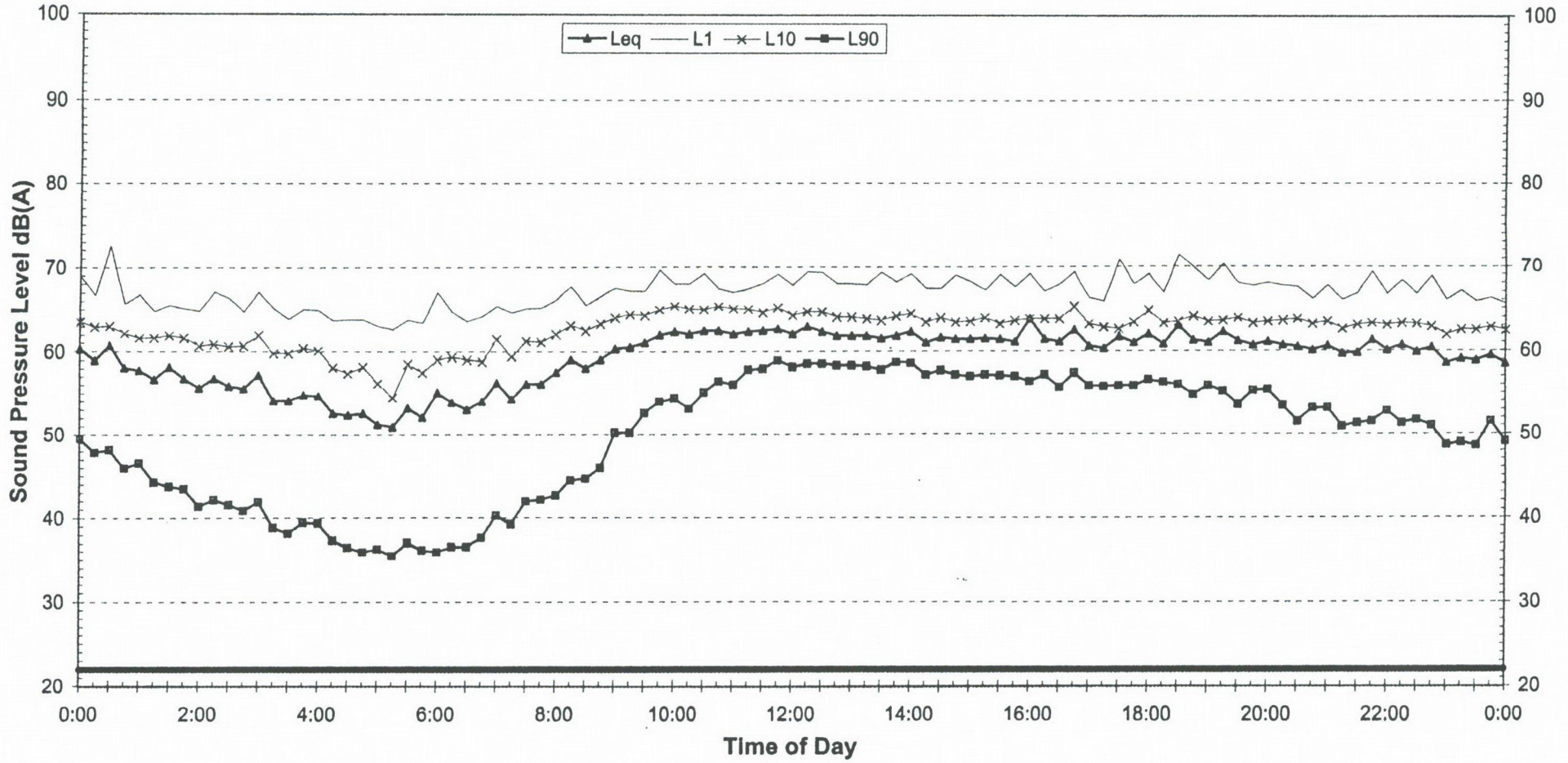
Rev 9 Data File 007mg.dat

TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Sunday, 31 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	-
Leq 1hr upper 10 percentile	-	-
Leq 1hr lower 10 percentile	-	-

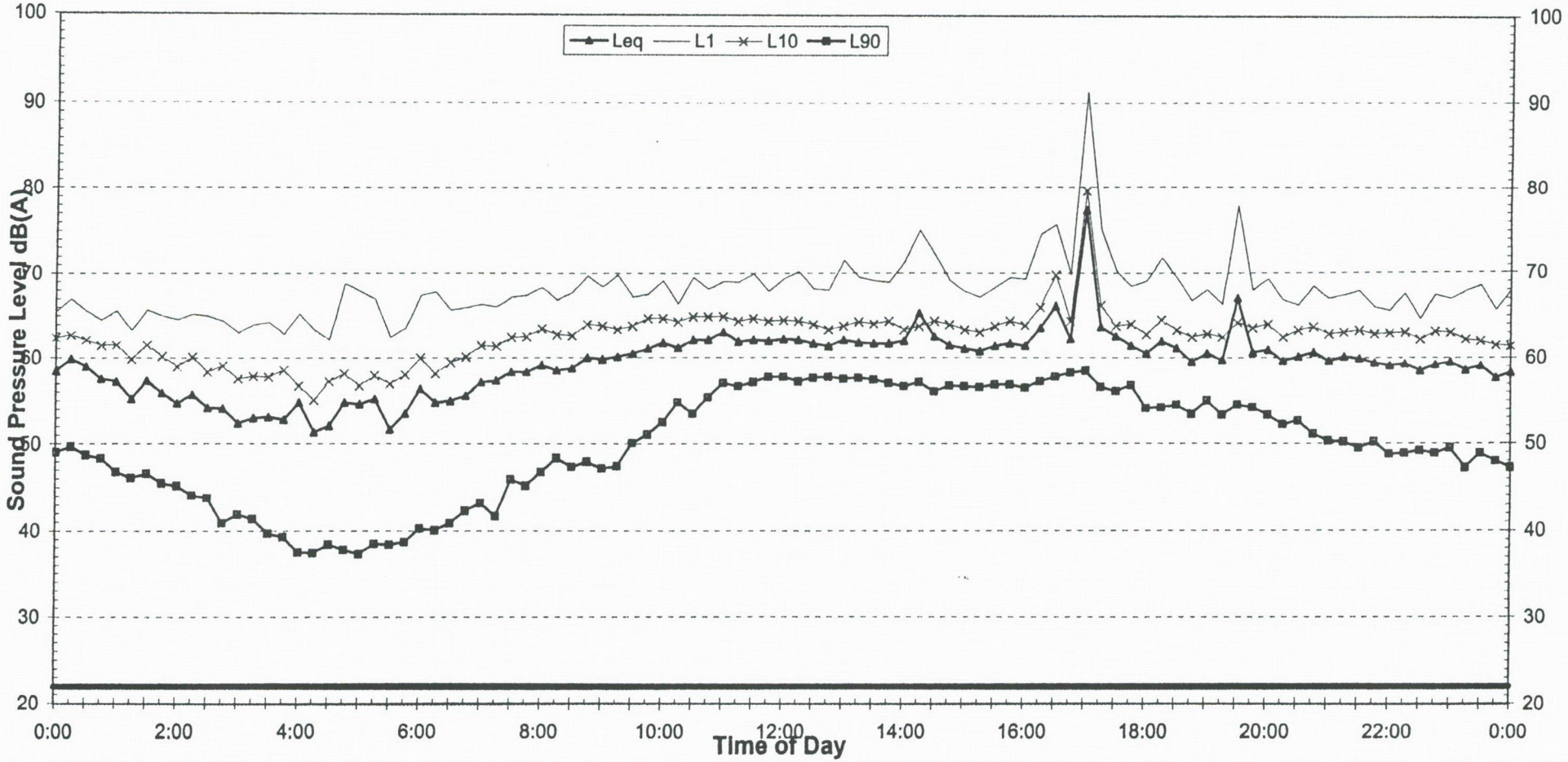
Rev 9 Data File 007mg.dat

TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Monday, 1 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	35.7
Leq (see note 3)	-	-	52.9

NOTES:

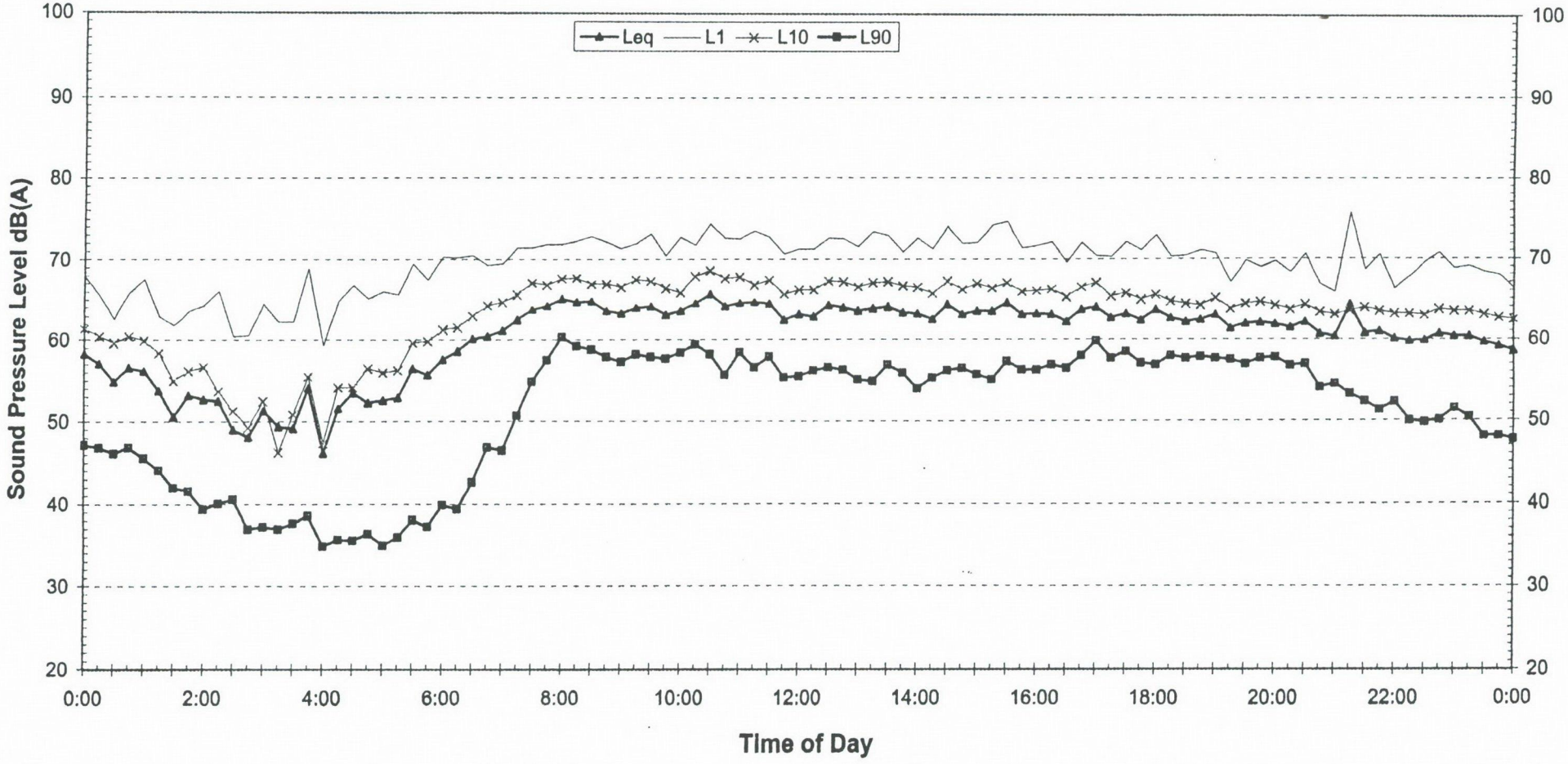
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	55.4
Leq 1hr upper 10 percentile	-	60.1
Leq 1hr lower 10 percentile	-	50.6

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Tuesday, 2 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	55.1	52.3	37.1
Leq (see note 3)	61.2	59.4	55.2

NOTES:

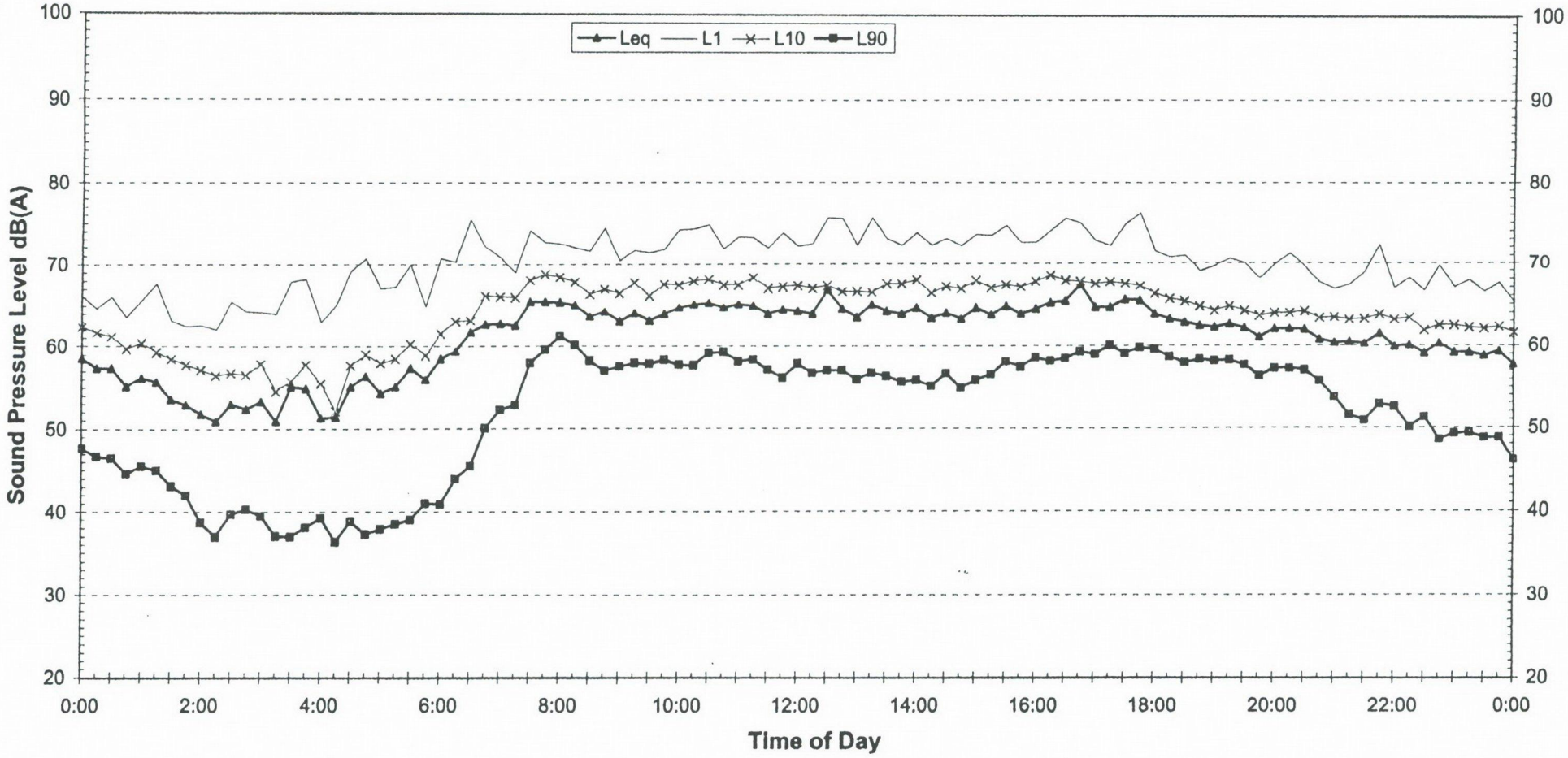
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	63.3	57.7
Leq 1hr upper 10 percentile	64.4	61.8
Leq 1hr lower 10 percentile	61.6	52.5

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Wednesday, 3 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	55.9	51.6	38.8
Leq (see note 3)	62.1	59.3	54.8

NOTES:

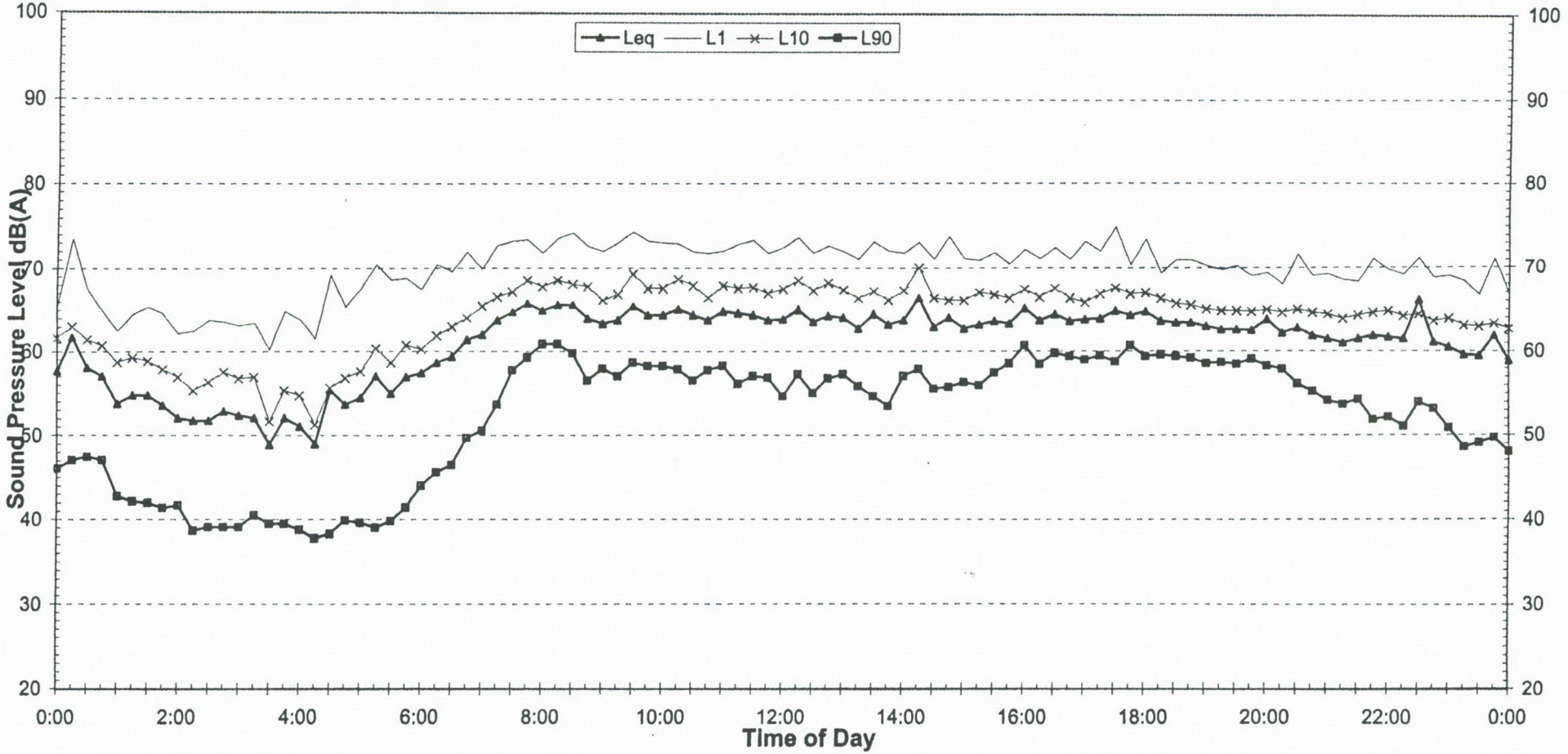
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	64.0	57.3
Leq 1hr upper 10 percentile	65.4	60.6
Leq 1hr lower 10 percentile	61.0	51.2

EXISTING AMBIENT NOISE LEVELS

443 Sunnyholt Road, Glenwood - Front verandah

Thursday, 4 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	55.1	52.2	48.0
Leq (see note 3)	61.8	60.0	59.3

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	63.9	61.8
Leq 1hr upper 10 percentile	64.8	63.0
Leq 1hr lower 10 percentile	61.8	60.1

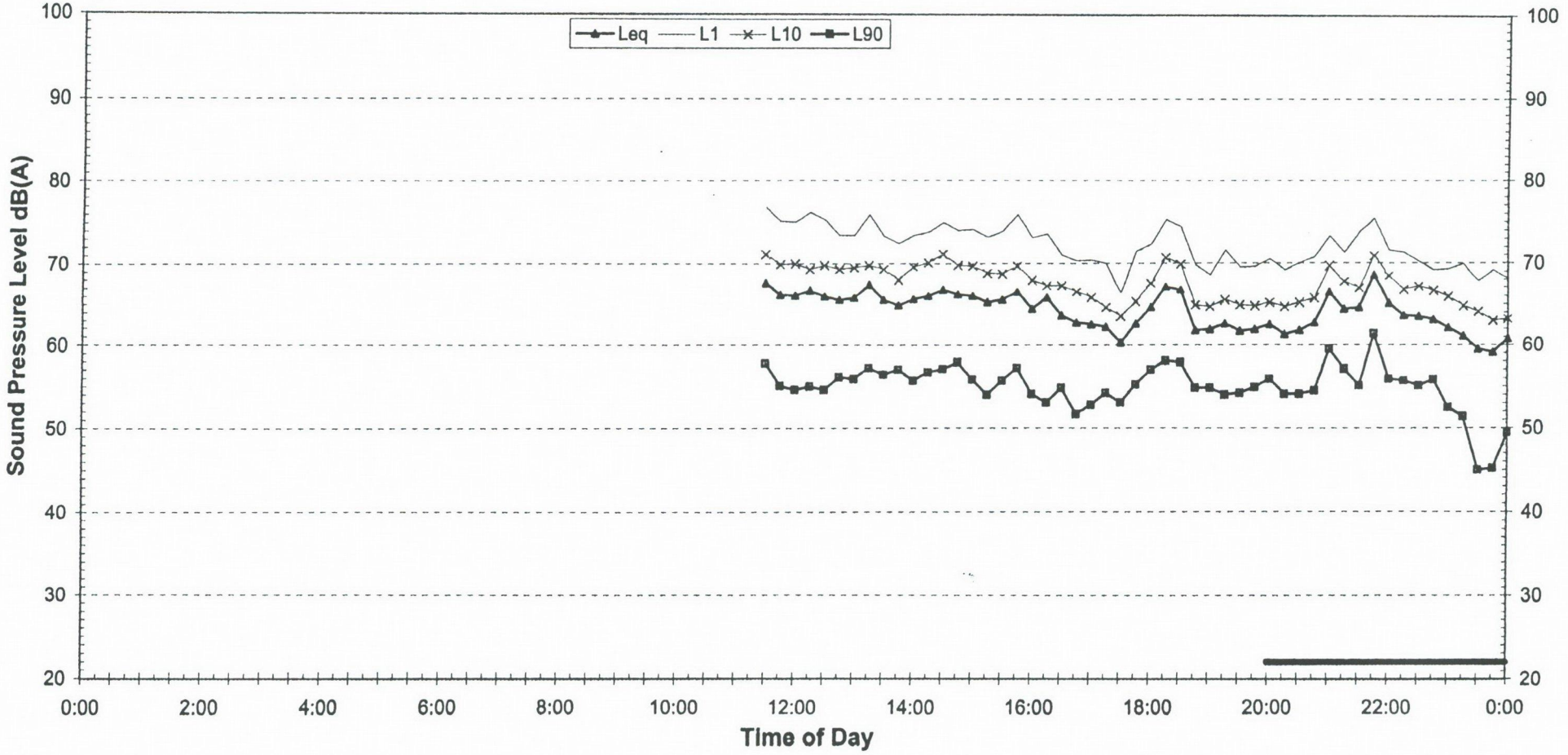
Rev 9 Data File 007mg.dat

TA741-01S01(rev0)

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Tuesday, 26 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	53.1	54.0	43.1
Leq (see note 3)	62.9	61.5	58.6

NOTES:
1. Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured 1m from facade; tabulated results free-field corrected

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	65.2	61.1
Leq 1hr upper 10 percentile	66.7	65.7
Leq 1hr lower 10 percentile	62.1	53.3

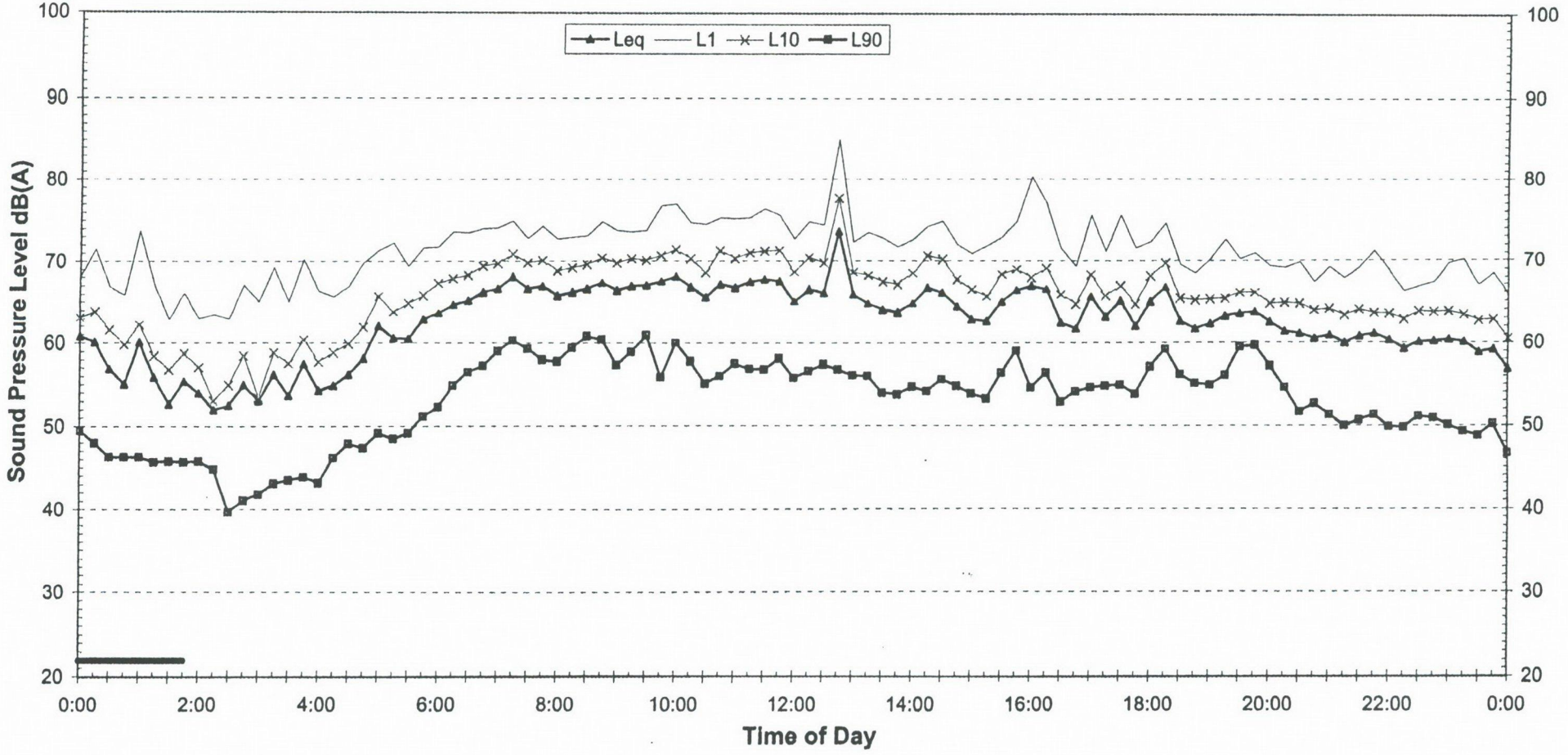
Rev 9 Data File 017.dat

TA741-01S02(rev0)

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Wednesday, 27 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	53.9	50.0	48.8
Leq (see note 3)	63.9	59.9	60.0

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	65.7	62.5
Leq 1hr upper 10 percentile	68.6	65.9
Leq 1hr lower 10 percentile	60.8	58.5

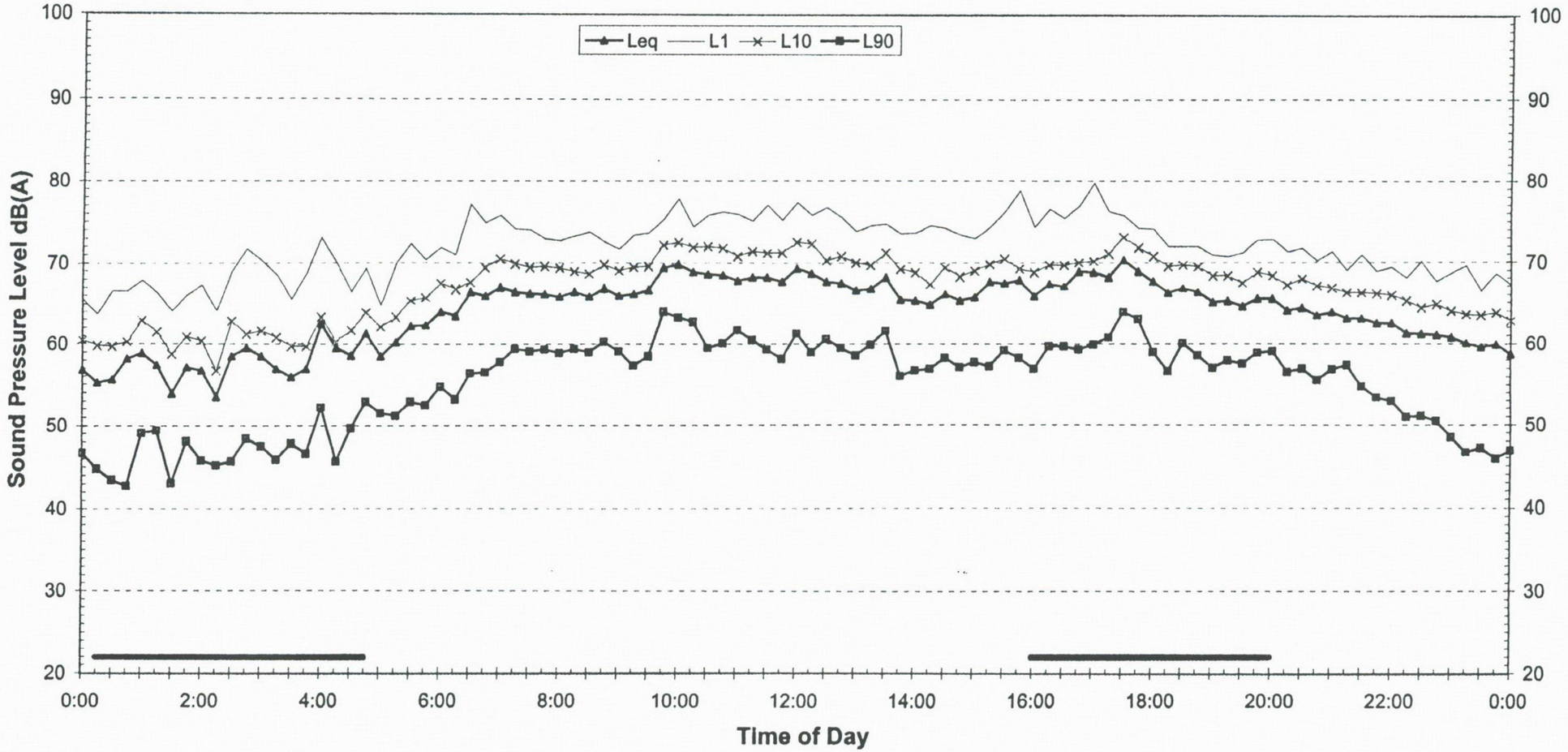
Rev 9 Data File 017.dat

TA741-01S02(rev0)

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Thursday, 28 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	57.2	52.9	45.9
Leq (see note 3)	64.9	60.9	57.9

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	66.8	60.4
Leq 1hr upper 10 percentile	68.5	61.1
Leq 1hr lower 10 percentile	62.9	59.6

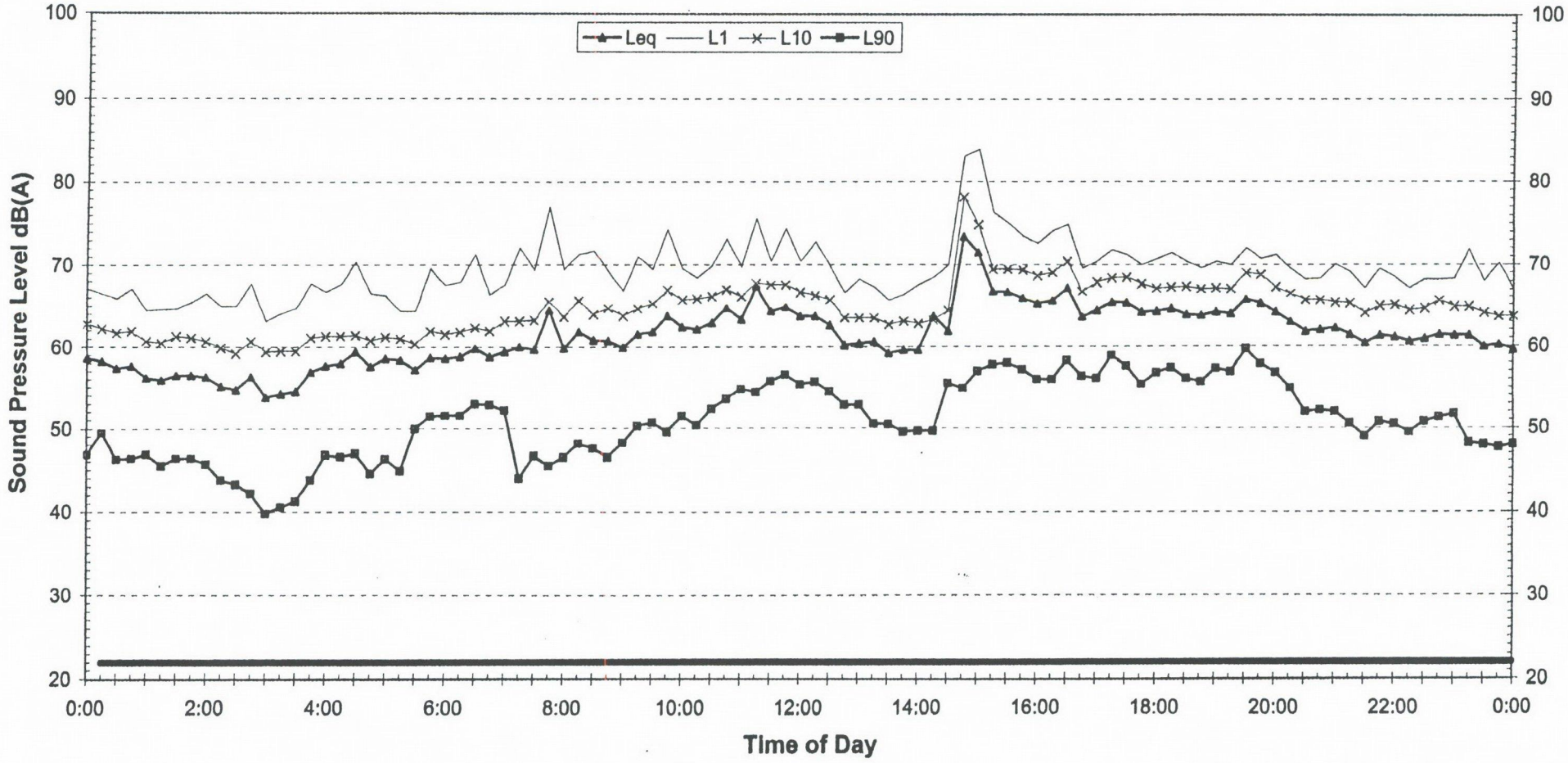
Rev 9 Data File 017.dat

TA741-01S02(rev0)

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Friday, 29 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	-
Leq (see note 3)	-	-	-

NOTES:

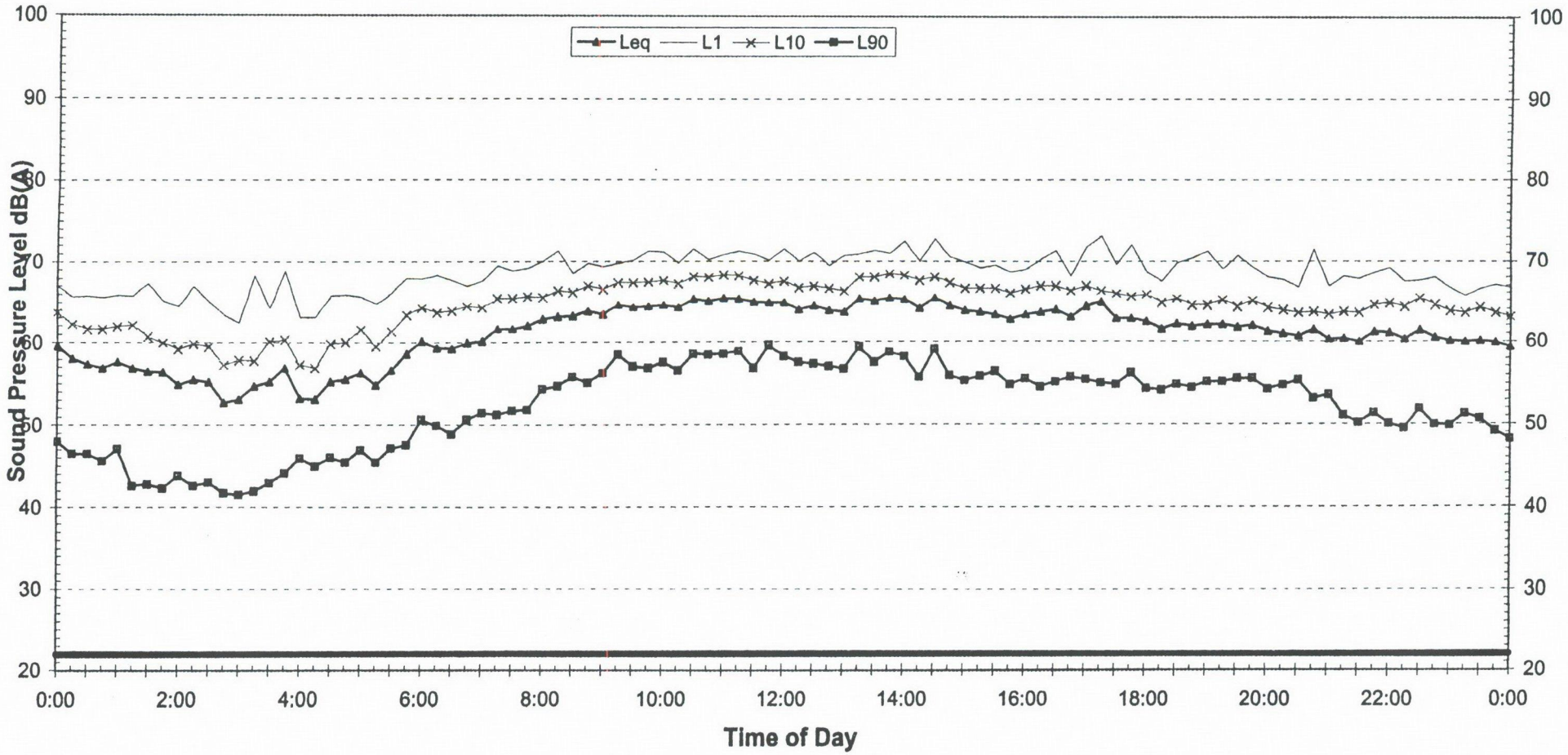
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	-
Leq 1hr upper 10 percentile	-	-
Leq 1hr lower 10 percentile	-	-

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Saturday, 30 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	-
Leq (see note 3)	-	-	-

NOTES:
1. Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured 1m from facade; tabulated results free-field corrected

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	-
Leq 1hr upper 10 percentile	-	-
Leq 1hr lower 10 percentile	-	-

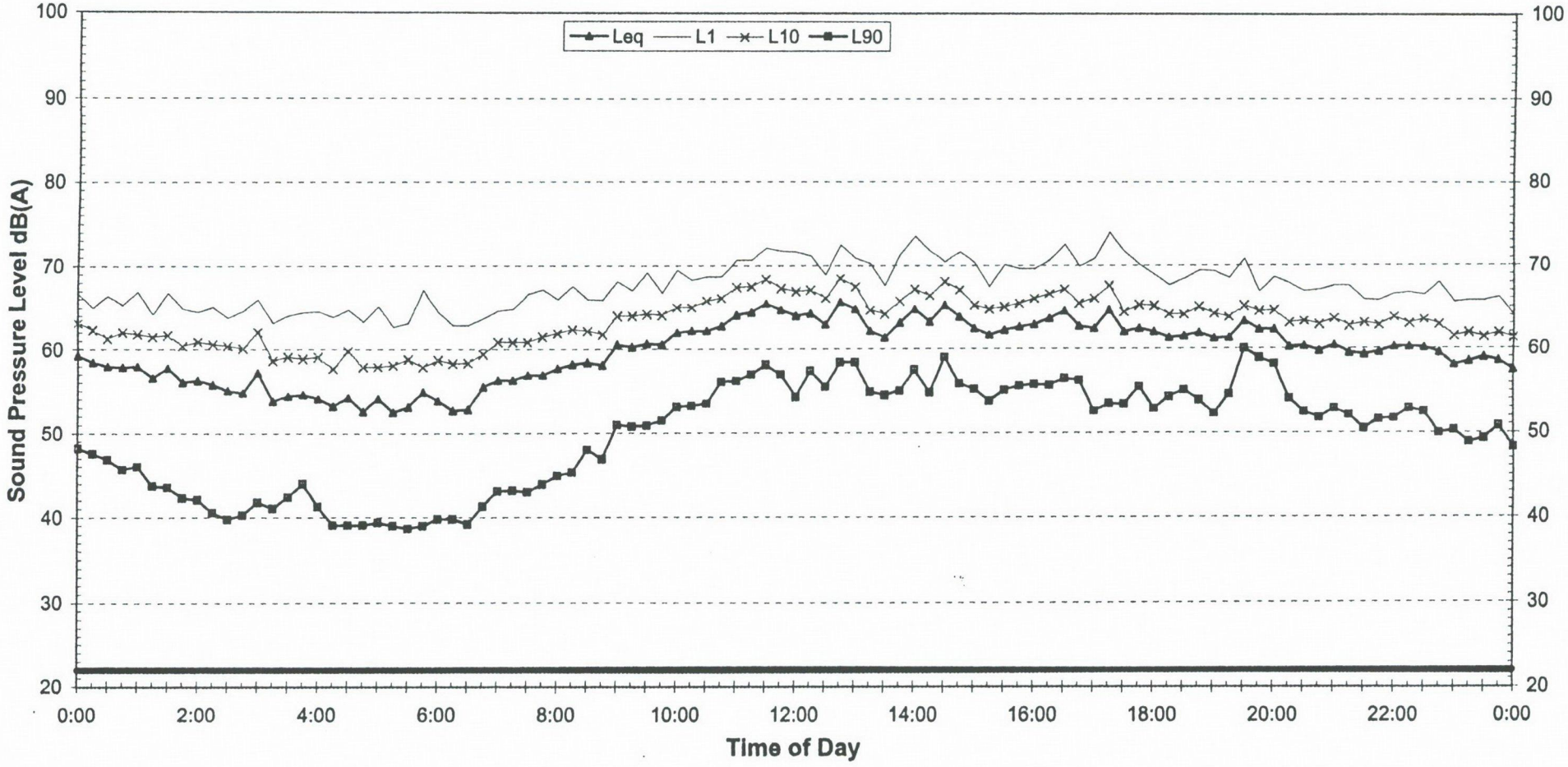
Rev 9 Data File 017.dat

TA741-01S02(rev0)

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Sunday, 31 March 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	-
Leq (see note 3)	-	-	-

NOTES:

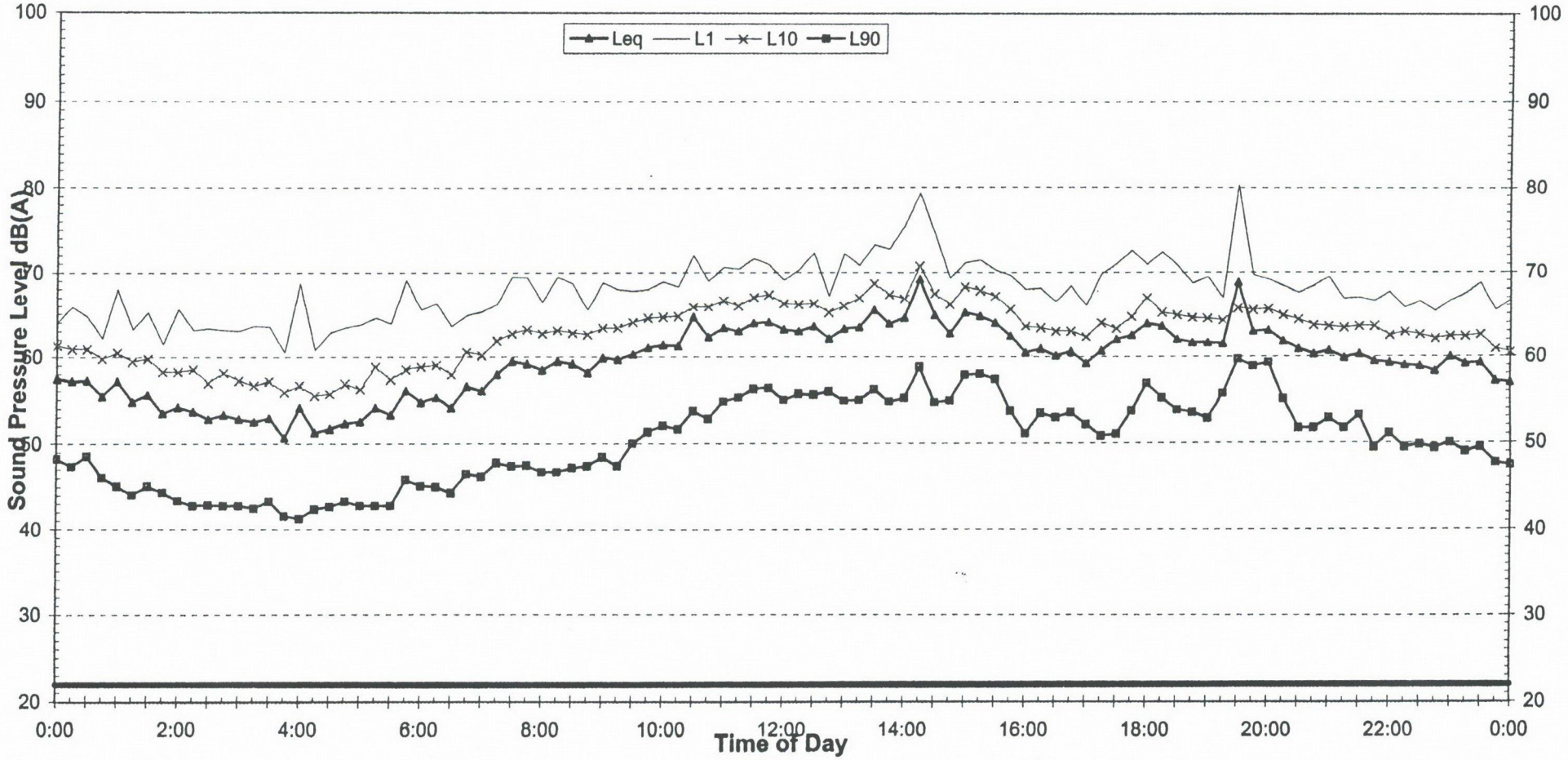
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	-
Leq 1hr upper 10 percentile	-	-
Leq 1hr lower 10 percentile	-	-

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Monday, 1 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	-	-	41.7
Leq (see note 3)	-	-	53.0

NOTES:

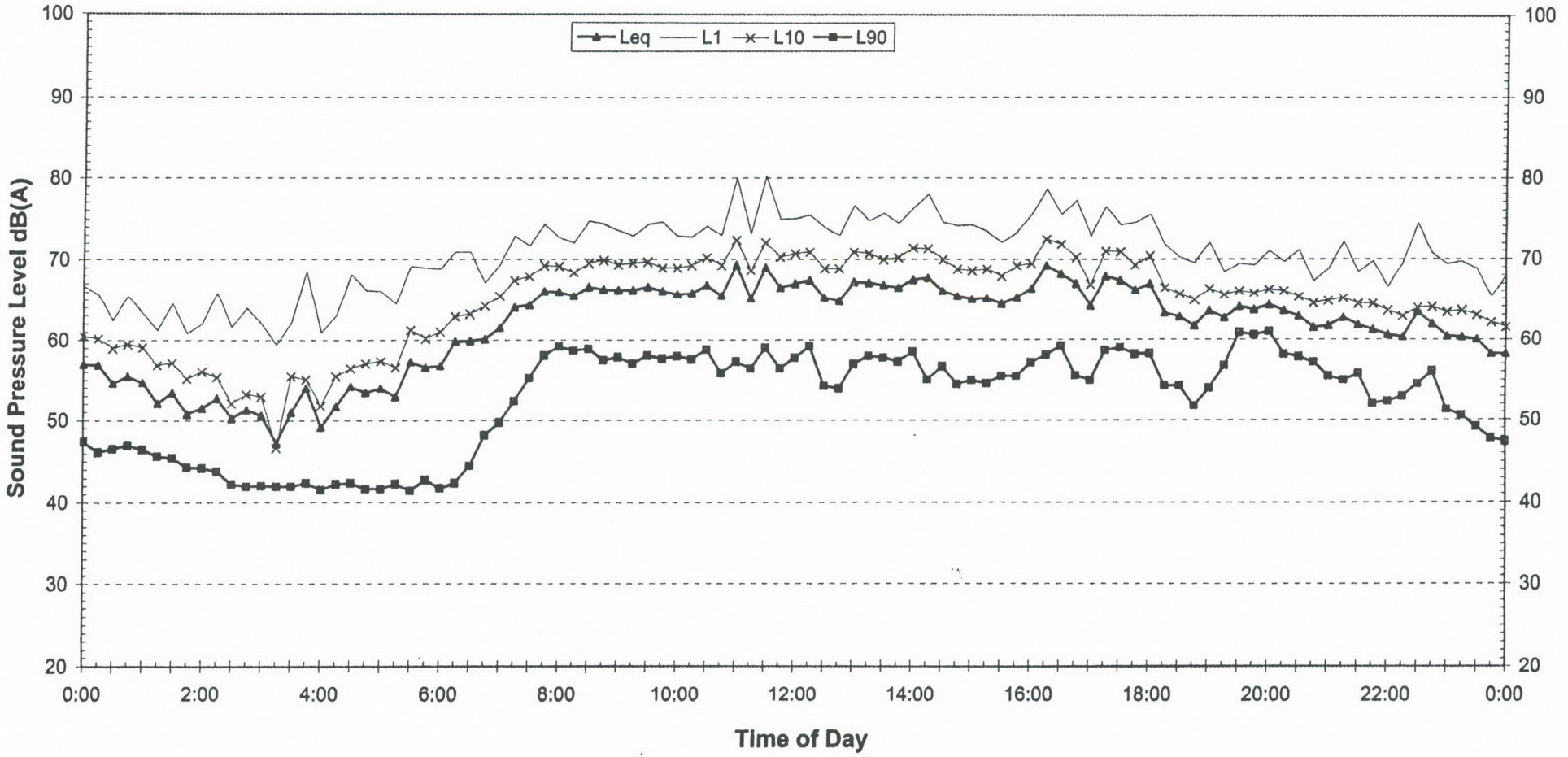
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	-	55.5
Leq 1hr upper 10 percentile	-	60.4
Leq 1hr lower 10 percentile	-	51.1

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Tuesday, 2 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	54.6	52.1	41.4
Leq (see note 3)	64.0	60.3	55.7

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	65.8	58.2
Leq 1hr upper 10 percentile	67.3	61.7
Leq 1hr lower 10 percentile	62.1	53.1

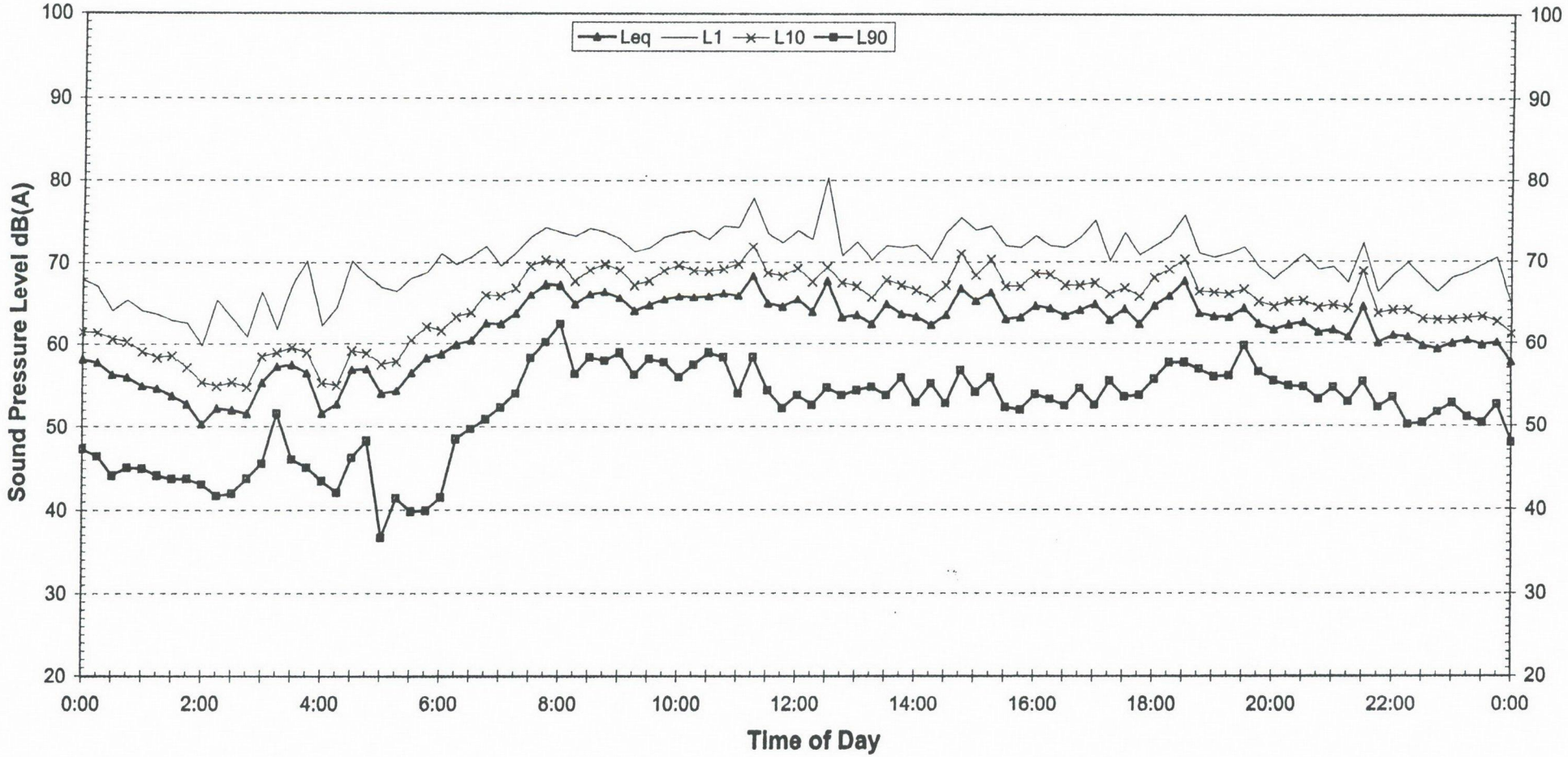
Rev 9 Data File 017.dat

TA741-01S02(rev0)

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Wednesday, 3 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	52.6	53.0	44.0
Leq (see note 3)	62.6	60.9	55.3

NOTES:

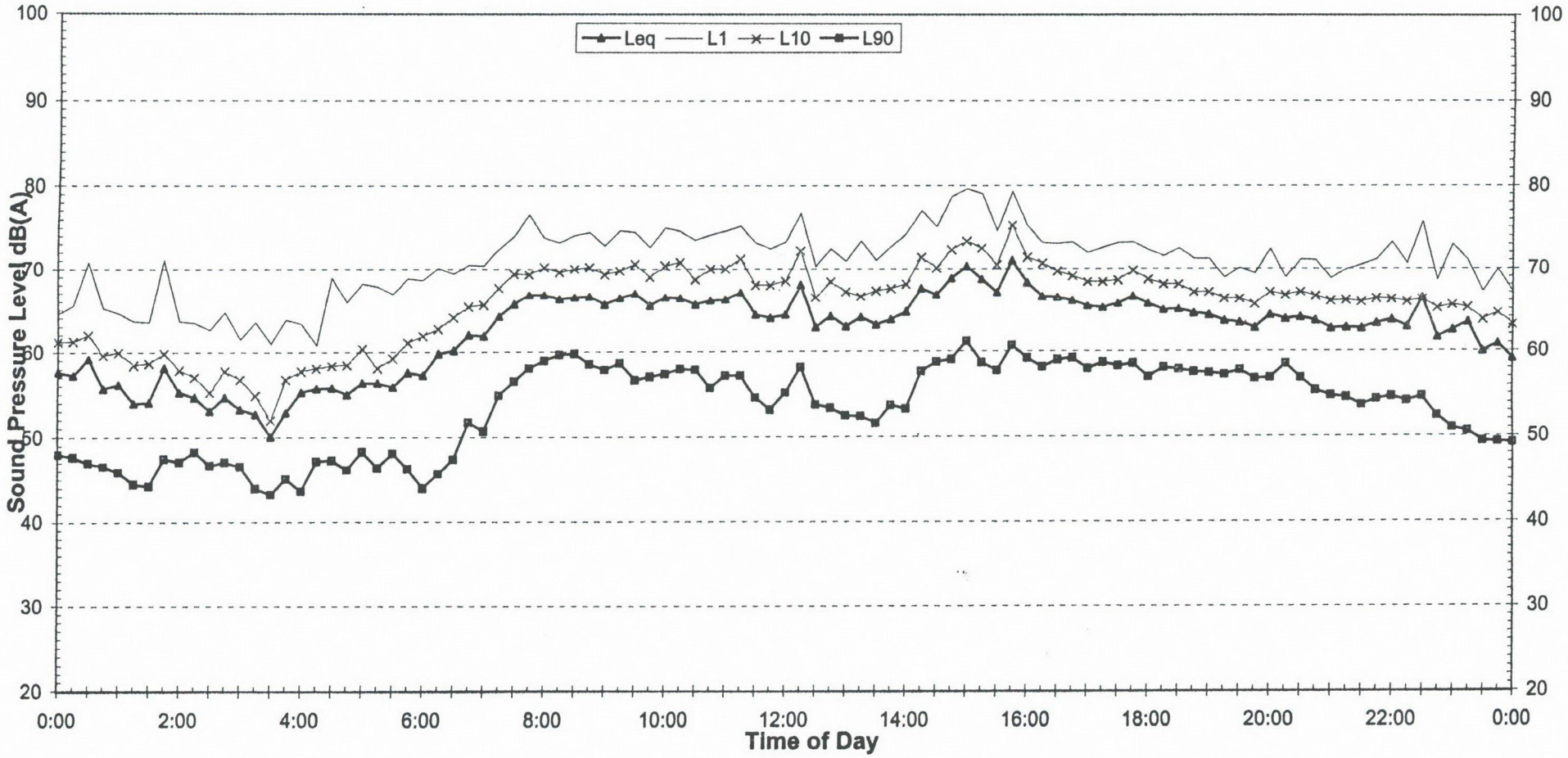
1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	64.7	57.8
Leq 1hr upper 10 percentile	66.2	61.1
Leq 1hr lower 10 percentile	62.0	53.1

EXISTING AMBIENT NOISE LEVELS

36 Elsom Street, Kings Langley - Front verandah facing Sunnyholt Rd

Thursday, 4 April 2002



EPA Industrial Noise Policy (Free Field)			
Descriptor	Day 7am-6pm	Evening 6pm-10pm	Night[2] 10pm-7am
L90	53.3	54.4	49.2
Leq (see note 3)	64.0	61.3	60.2

NOTES:

1. *Bars denote periods adversely affected by rain, wind or extraneous noise - data in these periods excluded from calculations.*
2. *"Night" relates to period from 10pm on this graph to 7am on the following graph.*
3. *Graphed data measured 1m from facade; tabulated results free-field corrected*

EPA Traffic Noise Policy (1m from facade)		
Descriptor	Day 7am-10pm	Night[2] 10pm-7am
Leq 15 hr and Leq 9 hr	65.9	62.7
Leq 1hr upper 10 percentile	68.8	63.8
Leq 1hr lower 10 percentile	63.4	61.2