Lawrence Hargrave Drive

Preferred option for repairing the road

REVIEW OF ENVIRONMENTAL FACTORS

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Preferred option for repairing Lawrence Hargrave Drive (Main Road 185) between Coalcliff and Clifton

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2. Introduction and Background

2.1. Introduction

The NSW Roads and Traffic Authority (RTA) proposes to upgrade the section of Lawrence Hargrave Drive between Coalcliff and Clifton, approximately 25km north of the city of Wollongong (the Proposal). The upgrade would involve the construction of a bridge consisting of both medium and long span sections approximately 645m in length, geotechnical stabilisation treatments and upgrade of existing road where the bridges connect to the existing alignment.

This Review of Environmental Factors (REF) has been prepared by Environmental Technology Branch and LHD Link Alliance on behalf of RTA Southern Region. For the purposes of the Proposal, the RTA is the proponent and the determining authority under Part 5 of the *Environmental Planning and Assessment* (EP&A) *Act 1979*. The purpose of the REF is to describe the Proposal, to document the likely impacts of the Proposal on the environment, and to detail protective mitigative measures to be implemented where appropriate.

The description of the proposed works and the associated environmental impacts have been undertaken in the context of Clause 228 of the *Environment Planning and Assessment Regulation 2000*, the *Threatened Species Conservation* (TSC) *Act 1995*, the *Fisheries Management* (FM) *Act 1994*, and the (Commonwealth) *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*. Consideration has also been given to the provisions set out in Section 38 of the *Coastal Protection* (CP) *Act 1979*. In doing so, the REF helps fulfil the requirements of Section 111 of the EP&A Act, that the RTA examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.

This REF has been prepared in accordance with the RTA's Proforma 2 REF as presented in the RTA's Environmental Impact Assessment Policy, Guidelines and Procedures (RTA 2001).

The findings of the REF would be considered when assessing:

- Whether the Proposal is likely to have a significant impact on the environment and therefore the necessity for an Environmental Impact Statement (EIS) under Section 112 of the EP&A Act;

- The significance of any impact on threatened species as defined by the TSC Act, in Section 5A of the EP&A Act and therefore the requirement for a Species Impact Statement (SIS);
- The potential for the Proposal to significantly impact a matter of national environmental significance or Commonwealth land and the need to make a referral to the Commonwealth Environment Minister in accordance with the EPBC Act;
- Any conditions of concurrence from the Minister for Infrastructure and Planning under the provisions of the CP Act; And
- Any other approvals required as a result of the Proposal proceeding.

2.2. Background

Lawrence Hargrave Drive is a coastal road located between Stanwell Park and Bulli and is mostly situated between the Illawarra Escarpment and the Pacific Ocean. It is recognised as an important road to both the local community and businesses. Local communities rely on the road as an important means of access to the F6 Freeway or Princes Highway both north and south of the study area and also for commuting, access to schooling, other community facilities and shopping. Local businesses additionally rely on the road as a source of tourist and 'pass through' business.

Between Coalcliff and Clifton, Lawrence Hargrave Drive is located in an active geological setting, which presents significant engineering and geotechnical challenges. The section has the highest slope risk of all RTA maintained roads in NSW and carries a history of significant rockfalls and embankment failures.

In 2002, following a State Wide Assessment of Slope Instabilities, an increase in rockfalls nearly hitting cars and a major embankment failure, which continues to widen creating a 0.6m - 1.2m wide tension crack at the edge of the road, the RTA commissioned GHD Longmac to undertake a detailed study of Lawrence Hargrave Drive between Clifton and Coalcliff and to provide options to reduce risks to motorists. The report recommended engineering works to stabilise parts of the cliff face and short-term road closures after cumulative rainfall in excess of 35mm and / or when there had been continuous rainfall with less than three dry days in between.

In early 2003, an independent review of the GHD Longmac report was undertaken by URS Australia. The review assessed the effectiveness of the road closure strategy implemented by the RTA in accordance with recommendations of the GHD Longmac report. The URS review identified that even after completion of the remediation works recommended by GHD Longmac and the implementation of a refined rain closure strategy for the road, Lawrence Hargrave Drive would still impose a safety risk on users. In August 2003, as a result of the URS review, a large embankment failure in the southern amphitheatre and a large rockfall during maintenance works, the RTA closed Lawrence Hargrave Drive between Coalcliff and Clifton to protect road users from risks associated with geological instability and to provide an opportunity to implement a comprehensive and long term solution for the section of road.

Following this closure, the NSW Government announced a $40 million plan to alleviate safety concerns and re-open the closed section by early 2006. To achieve this goal it was announced that the RTA would work with private sector companies on the design and construction of solutions to bring the section of Lawrence Hargrave Drive to within acceptable safety limits. This partnership arrangement is referred to as an 'Alliance', and in November 2003, the NSW Minister for Roads announced the preferred Alliance participants who will work with the RTA to reach this goal. The Alliance participants are the RTA,

Barclay Mowlem, Coffey International and Maunsell Australia. The Alliance partnership is known as LHD Link Alliance.

An Alliance approach to delivery of a project, such as the proposed upgrade of Lawrence Hargrave Drive, is different to the approach normally adopted under, for example, a Design and Construct (DC) project. In a traditional DC project the concept design is finalised prior to environmental approval documentation being prepared. The outcome of the environmental approvals process is then incorporated into the detailed design prior to construction commencing. In an Alliance contract, design may continue after construction has commenced, which partially reflects one of the key attractions of an Alliance, namely to expedite delivery of the project. For this Proposal, the REF documents the current, well advanced, concept design. This includes consideration of the alignment, initial conceptual structural layouts, materials volumes, documentation of construction impacts and the identification and proposed management of potential impacts. Following approval of the REF, refinement of the design would continue, with this process taking into account any issues arising from the environmental assessment and approvals process. The ongoing refinement of the design however, is not expected to result in any additional environmental impacts that are not already identified and addressed in this REF.

In addition to the committed $40 million to upgrade Lawrence Hargrave Drive, the State Government has provided an additional community support fund of $2 million. The funds, which are managed by the RTA, were allocated to relieve socio-economic issues resulting from the road closure. The funds provide for:

- Extra bus services for residents and school children;
- A promotional strategy encouraging tourists to the area;
- A survey of community and business impacts resulting from the closure;
- Design and construction of tourist information bays and signage;
- Promotional support for local events and the shopping centres; and
- Subsidies to offset increases in travel costs for community service organisations.

Rock remediation works have previously been undertaken prior to the commencement of works associated with the upgrade, to allow construction vehicles and personnel to safely enter the site. The works, involving several cranes, included removal of loose rock from the cliffs in the southern section of the site and minor rock bolting. Geotechnical drilling and testing was also undertaken for the length of the site, including the adjacent rock platforms. The results of these investigations were used to assist with the identification and design of the best option to re-open Lawrence Hargrave Drive.

The RTA now proposes works to reopen the road to through traffic. This REF addresses the environmental impacts of those proposed works.

2.3. Methodology

The methodology adopted to prepare this document was as follows:

1. Preliminary discussions were held with representatives of RTA Southern Region and RTA Environmental Technology to consider the Proposal.

2. RTA Environmental Technology representatives undertook an initial site visit on 23 October 2003 to identify potential environmental issues regarding the site and to assist in the option selection process.

3. Consultation was undertaken throughout the preparation of the REF. The consultation program sought to ensure that the relevant stakeholders had opportunities to identify potential risks associated with the proposed Lawrence Hargrave Drive upgrade. Consultation was undertaken with following stakeholders:
   - Wollongong City Council;
   - Department of Environment and Conservation (DEC);
   - Department of Infrastructure, Planning and Natural Resources (DIPNR);
   - Department of Lands;
   - Department of Mineral Resources;
   - NSW Fisheries;
   - NSW Heritage Office;
   - Rail Infrastructure Corporation (now RailCorp);
   - State Rail Authority of NSW (now RailCorp);
   - Waterways Authority of NSW;
   - Australian Heritage Commission;
   - Illawarra Coke Company (ICC) Pty Ltd; and
   - Illawarra Local Aboriginal Land Council (LALC).

4. Identification of potential issues regarding the proposed Lawrence Hargrave Drive upgrade was undertaken by searching the following databases:
   - Australian Heritage Commission Register of the National Estate;
   - NSW Heritage Office State Heritage Register;
   - NSW Maritime Heritage Online Databases;
   - RTA Heritage and Conservation Register (s170);
   - Wollongong City Council Heritage Listings;
   - DEC Aboriginal Heritage Information Management System (AHIMS);
   - National Native Title Claims Search;
   - DEC Wildlife Atlas for threatened flora and fauna records;
   - Department of the Environment and Heritage (DEH) EPBC Act Protected Matters Database; and
   - NSW Fisheries Fish Files Databases.

5. As part of the environmental assessment undertaken for this REF, a series of specialist studies were undertaken to identify Proposal constraints and to provide environmental impact mitigative measures. Specialist investigation, regarding the following, was undertaken during the preparation of the REF:
   - Geology, soils and landforms;
   - Water quality and hydrology / hydraulics and coastal processes;
   - Marine and terrestrial ecology;
   - Socio-economic considerations;
   - Indigenous and non-indigenous heritage;
   - Visual amenity and landscape; and
   - Noise and vibration.

6. A literature review was also undertaken to determine issues relating to:
   - The existing environment; and
   - Statutory position.

7. Assessment was undertaken in accordance with RTA's Environmental Impact Assessment Policy, Guidelines and Procedures (RTA 2001) and other current RTA policies and guidelines.

3. Proposal Description

3.1. Location

The Proposal is located approximately 25km north of the City of Wollongong in the northern Illawarra between the coastal villages of Coalcliff to the north and Clifton to the south (Figure 3.1).

3.2. Description of Site and Surroundings

The study area is defined as the area between Paterson Road, Coalcliff and approximately 200m north of School Parade, Clifton and extends approximately 150m either side of the existing Lawrence Hargrave Drive centre line (Figure 3.2).

The study area consists of three headlands, each including a corresponding rock platform, which has an east to south-easterly aspect. Other landform features present within the study area include the sheer and benched cliff lines of the Illawarra escarpment, scree slopes and two natural amphitheatres (southern and northern). Associated with the two amphitheatres are unnamed drainage lines, which have cut into the underlying soil and geological material. A series of smaller channels also occur within the study area.

Vegetation cover is variable depending on local topographical and geological influences. The area contains a heterogeneous mix of plant communities and ground cover includes bare ground, disturbed areas with mixed native and introduced plant species, coastal scrub with heath and taller shrubs, coastal grassland with scattered shrubs and areas of dry rainforest. Within the study area exotic weeds and grasses, such as Kikuyu (*Penniseteum clandestinum*) and Blackberry (*Rubus fruiticosus*) are common, whilst woodlands of *Eucalyptus spp* occur directly on top, and beyond the limits, of the western cliff line. There is often no distinct boundary between the different plant communities, some of which occur as very small patches within other communities. Most of the vegetation within the study area has been modified by varying degrees of human activities such as, clearing, roadworks, rock stabilisation, landslip control, previous mining activities and modified fire regimes.

The intertidal zone within the study area includes the rock platforms and rocky foreshores of the northern and southern amphitheatres. The rock platforms are tidally influenced and are partially submerged at high tide. The rock platforms also comprise both small and large sized rock pools, which are subject to periodic flushing from wave and tidal action. Flora and fauna assemblages associated with the rock platforms are generally similar throughout the study area, with diverse assemblages of algae and invertebrates present towards the lowshore and sparse assemblages dominated by the snail *Littorina unifasciata* and the limpet *Patelloida latistrigata* towards the highshore. The boulder fields between the rock platforms consist of both small and large boulders. The boulders provide habitat for a wide variety of flora and fauna, which live on the surface and beneath the boulders.

The subtidal zone within the study area consists of a varied substrate of sand, boulders and rocky reefs of varying topographic complexity. The sandy substrate is associated with the nearshore section of the southern amphitheatre and is of generally limited habitat with little in the way of fish, benthic algae and invertebrates present. Further offshore, the substrate becomes more complex, with the depth, the degree to which it is interspersed with sand, and assemblage of flora and fauna varying from north to south. The northern subtidal areas have more complex reef topography and are deeper and support a more diverse range of flora and fauna species than the southern subtidal areas.

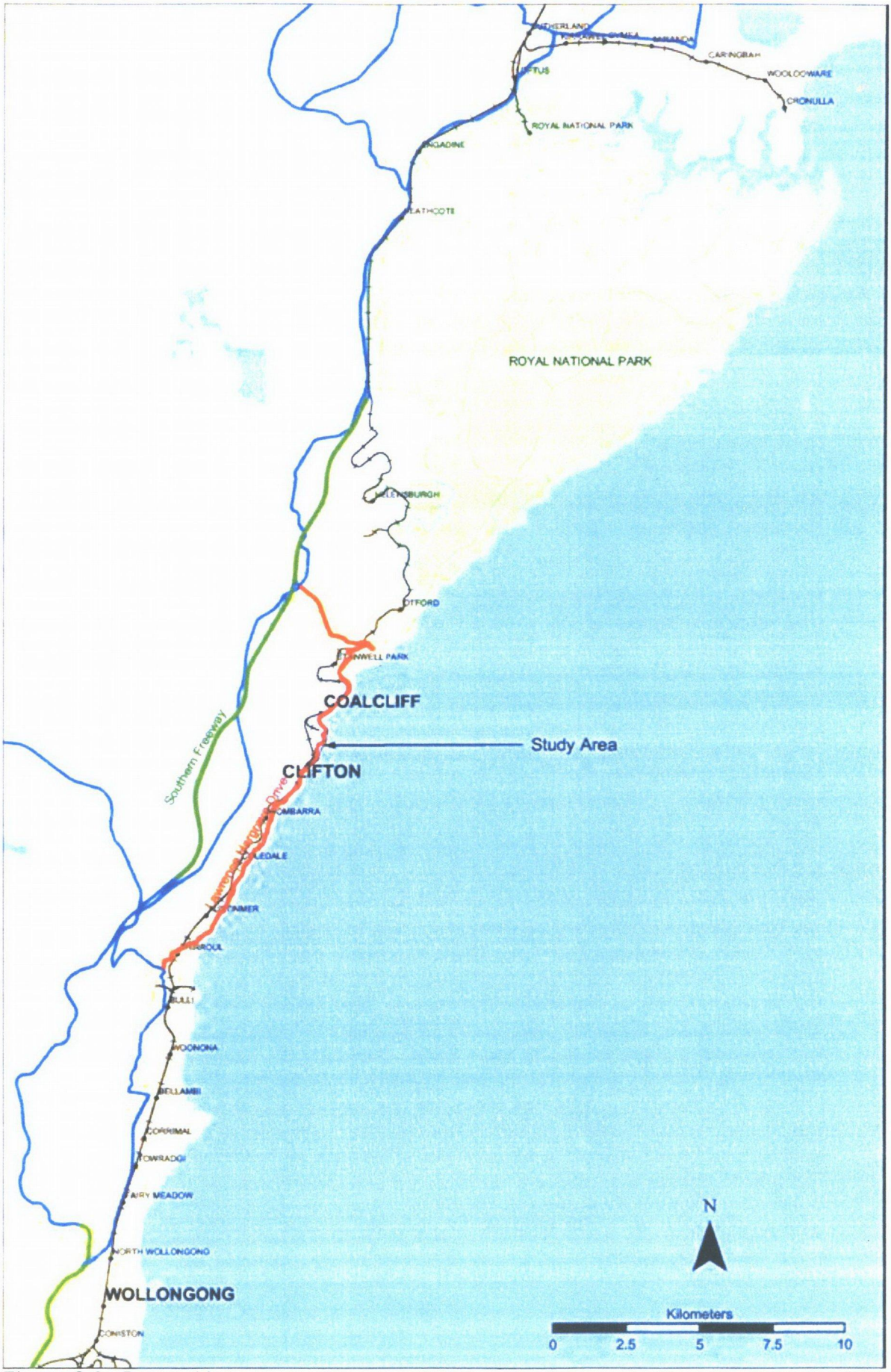


Figure 3.1: Proposal Location

Figure 3.2: Study Area

There are no residential properties or other dwellings within the study area. The closest residence is located on Paterson Road at Coalcliff. Coalcliff is the closest village to the Proposal, located at the northern end of the study area. The smaller community of Clifton is located approximately 200m south of the study area. Past land use practices within the study area are mostly associated with coal mining. Remnant examples of coal mining are located at the cliff base at the southern end of the study area and include the sealed original entrance portals to Coalcliff Colliery and the adjacent remains of the associated jetty.

Other notable features in the vicinity of the study area include the Illawarra Railway Line located to the west. The line runs parallel to Lawrence Hargrave Drive (approximately 130m west) before traversing a tunnel and heading in a northwest direction. Coalcliff Coke Works is located on the site of the former Coalcliff Colliery (decommissioned in 1993), approximately 500m west of the northern end of the study area. The works are operated by Illawarra Coke Company and include stockpile sites, coke ovens and offices. Further north of the study area (approximately 4.2km by line of sight) is Royal National Park.

3.3. Description of the Proposal

3.3.1. Features of the Proposal

Impacts associated with rockfalls, debris slides and coastal processes undercutting the road have resulted in the study area being divided into five Geotechnical Domains (GD1 – GD5) based on differing geotechnical issues associated with each section of road (Figure 3.2). The proposed works are different from one Geotechnical Domain to the next. A summary of the proposed works for each Geotechnical Domain is provided below and a detailed description is provided in Section 8 of this REF.

GD1

The proposed works within this area would involve an upgrade of the road surface to allow the connection of the GD2 bridge to the existing Lawrence Hargrave Drive. The features of the Proposal within this area include:

- Road surface upgrade to accommodate the bridge connection to the existing alignment;
- The section would provide for an improved geometry and allow construction access to the southern amphitheatre;
- Minor geotechnical stabilisation works would be required where the bridge connects to the existing alignment. This would typically consist of a retaining wall structure or rock gabion supporting structure where appropriate. This would be further investigated at detailed design; and
- Minor earthworks and slope stabilisation where required, ensuring that the underlying sandstone is not undercut and the upper slope to the Illawarra Railway Line is not destabilised.

GD2

The proposed works within this area would involve the construction of a long span bridge approximately 435m in length. The features of the Proposal within this area include:

- The bridge would 'bypass' the geologically unstable area and be located a minimum of 45m east of the existing road to ensure that rock falls do not impact on the bridge deck. The bridge would be designed to follow the natural curvature of the coastline;
- The bridge would be a balanced cantilever type construction with an abutment on the southern end and joining a shorter span bridge structure in GD3 at the northern end;

- The bridge would be constructed from reinforced post-tensioned concrete which would be cast in place;
- The bridge would have five spans, requiring four piers. The first and last spans would be approximately 55-60m in length, with three middle spans of approximately 108m in length;
- The bridge deck would be approximately 12.7m wide, incorporating two 3.5m wide lanes, two 1.0m wide shoulders, safety barriers and a separate 2.5m wide shared pedestrian/ cycle access path;
- The construction of the piers would require an access track to be constructed into the existing embankment and along the shoreline of the southern amphitheatre, where a working platform would be constructed for each pier. A maximum reclamation of 10m of the intertidal and subtidal zones would be required in the southern amphitheatre. The reclamation would be permanent and the access track would be used for ongoing maintenance;
- Minor slope stabilisation works would be required under the existing tension crack in GD2 to allow safe movement of vehicles during construction. This would typically consist of regrading the adjacent slope to a safe gradient or constructing a temporary retaining wall or gabion structure to support the unstable material during construction. This would be further investigated at detailed design stage; and
- The access track and working platforms would require approximately 20,000m^3 of material to construct.

GD3

The proposed works within this area would involve the construction of a multiple span bridge approximately 210m in length. The features of the Proposal within this area include:

- The bridge would 'bypass' the headland (as a continuation of the southern amphitheatre bridge);
- The bridge would be an incrementally launched constant radius bridge and would be situated on seven piers;
- The bridge would be constructed from reinforced concrete, which would be cast in a casting yard located on the existing road at the northern end of the bridge;
- The construction of the piers would require an access track to be cut into the existing embankment surrounding the headland where a working platform would be constructed for each pier; and
- The access track and working platforms would require approximately 5,000m^3 of material.

GD4

The proposed works within this area would involve a combination of geotechnical treatments to accommodate debris slides. The features of the Proposal within this area include:

- The excavation of a 'catch ditch' west of the existing road;
- The construction of diversion berms or similar to direct the debris to chutes passing under the existing road;
- The construction of concrete culverts or a concrete plank bridge structure to act as a chute for debris. The structure would be constructed within the existing road alignment and would be approximately 16m in length, 3m in height and up to12m wide;
- Rock armouring would be included at the base of the chute structure in GD4. This would extend northwards towards the southern extent of the

northern rock platform, where there is a particularly narrow embankment in the coastal impact zone. The rock armouring is expected to consist of a rock bund, supporting backfill material that would protect the embankment from further regression and undercutting of the road; and

- Localised improvements to the existing road and stabilisation of embankments above and below the road.

GD5

The proposed works within this area would involve a combination of geotechnical treatments to prevent minor rockfalls. The features of the Proposal within this area include:

- Further removal of the rock overhang above the existing road on the south-facing cliff of the northern headland, which was partly removed by works undertaken in 1967. Recent analysis shows that there are still some unstable areas and approximately 6000m^3 of unstable rock would be removed in this process;
- Targeted removal of approximately 5000m^3 of unstable rock at the point of the northern headland, above the existing road level would be required to prevent further rockfalls; and
- Localised improvements to the existing road and stabilisation of embankments, which would include minor rock bolting, mesh and minor fencing.

Other Features of the Proposal

A shared pedestrian and cycleway would be constructed within the alignment for the length of the Proposal to provide non-vehicle access. The shared path would be 2.5m wide to safely accommodate both cyclists and pedestrians.

Section 8 of this REF provides more details of the Proposal along with sketches of the preferred option including bridge configurations, pier footprints and geotechnical prevention treatments.

3.3.2. Staging

As a result of the timeframe of the Proposal, it is not anticipated that the proposed works would be staged.

4. Statutory Requirements

4.1. Local Environmental Plan

The planning instrument controlling development in the study area is the *City of Wollongong Local Environmental Plan 1990*. Within the study area, the Proposal falls within a number of zones defined in Council's Local Environmental Plan as well as affecting unzoned land. The relevant zoning of the land within the study area is described in Table 4.1 and illustrated in Figure 4.1. Special Uses 5(c) allows for the construction of roads without development consent by virtue of Clause 15 of the LEP, in other instances development consent is required for roads (falling within the definition of 'utility installations') under the LEP.

Table 4.1: Land Zoning in the Vicinity of the Proposal

Zoning	Permissibility
4 (c) Industrial – Extractive	Permitted with development consent
5 (c) Special – Main Roads	Permitted without development consent
6 (a) Public Recreation	Permitted with development consent
7 (a) Environmental Protection – Special	Permitted with development consent

As shown in Figure 4.1 and discussed above, sections of the proposed work are required to be undertaken on land which is unzoned and outside of land zoned under the Wollongong LGA, namely below the mean high water mark. Environmental assessment of this portion of the Proposal can still be undertaken under the provisions of Part 5 of the EP&A Act, however a number of other matters must be taken into account due to it being located within the Coastal Zone as defined under the CP Act, as well as being Crown Land. These are discussed in more detail in the following sections.

4.2. Regional Environmental Plans

4.2.1. Illawarra Regional Environmental Plan No 1

This REP applies to land within the Wollongong LGA and includes general matters for consideration, aimed at maximising the opportunities for the people of the region and the State to meet their individual and community economic and social needs. It makes particular reference to the way in which these needs are related to the allocation, availability and management of the region's land resources, having regard to objectives specified in the REP.

The REP contains no consent requirements that would apply directly to the Proposal. Clause 126 of the REP does require consent for various works related to heritage items listed in Schedule 1 of the Plan, however that clause does not apply to the Proposal due to the operation of clause 3(2) of the Wollongong LEP. Notwithstanding the above, as a matter of good practice, relevant objectives and principles contained in the REP need to be given consideration in this REF.

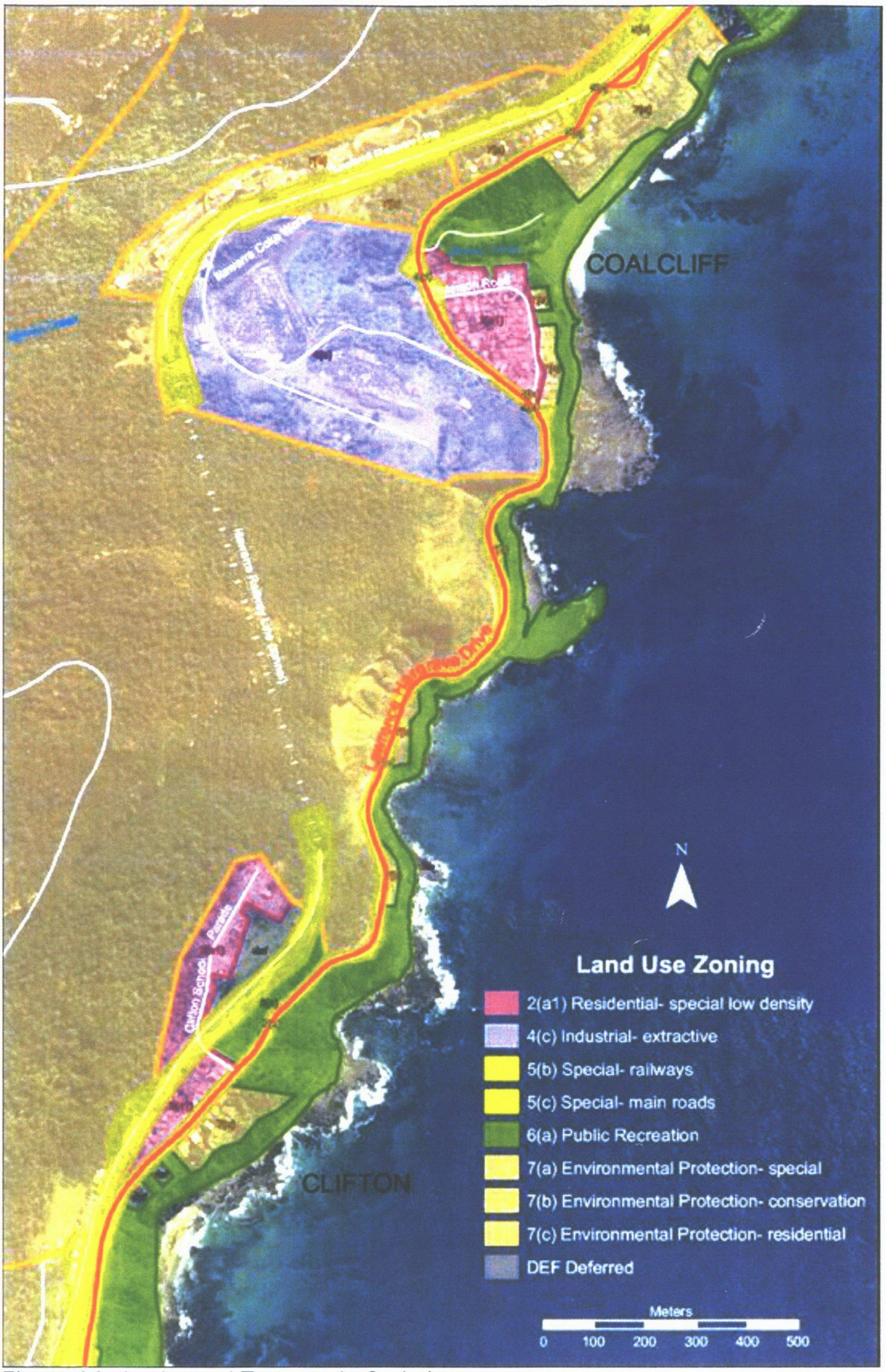


Figure 4.1: Landuse and Zoning in the Study Area

The specific REP objectives relevant to the Proposal are as follows:

Part 3 Objective 42. Activities

> *A determining authority (within the meaning of Part 5 of the Act) should, when considering a proposal for roads, gas or water pipelines, railways, reservoir or transmission lines, consult the Secretary of the Department of Mineral Resources and take into consideration:*
>
> *a) The impact the proposal would have, or is likely to have, on the availability of coal resources;* and
>
> *b) The cost to the community of not proceeding with the proposal or redesigning or relocating the development subject to the proposal compared with the cost to the community of rendering coal resources unavailable.*

The Proposal would not sterilise any coal reserves, as specified by the Department of Mineral Resources, which was consulted during the preparation of the REF (refer Table 5.2 for response).

Part 3 Objective 80. Transport and Service Corridors

The relevant objectives relating to transport and service corridors are:

> *To facilitate the development of a public transport system which enhances the mobility of those without access to private vehicles and provides reasonable alternative to the private car on key routes;*
>
> *To encourage the development of a satisfactory system of urban, inter-urban and inter-regional links to meet existing and future communication and utility installation needs;*
>
> *To improve road safety and protect public investment in main and arterial roads by the control of adjacent land uses; and*
>
> *To accommodate private vehicles which are expected to remain an important mode of passenger transport in the region, in planning provisions.*

This Proposal, which would involve the construction of a safer, more efficient road in terms of fewer closures, would be consistent with the above objectives. In addition, the reconnection of the road would facilitate bus travel and bicycle movement along Lawrence Hargrave Drive.

Part 3 Objective 95. Waste Disposal

The objectives relating to waste disposal are:

> *To dispose of waste materials in a manner which positively contributes to the environment or does least environmental harm; and*
>
> *To encourage the most efficient use of resources by recycling or alternative use.*

The Proposal through the implementation of the waste minimisation and input procurement principles outlined in this document, would meet these objectives.

4.3. State Environmental Planning Policies

4.3.1. State Environmental Planning Policy 4 - Development without Consent and Miscellaneous Complying Development

Clause 11 (2) of SEPP 4 states *'where, in the absence of this clause, development for the purposes of a classified road or toll work, or a proposed classified road or toll work, may be carried out only with development consent being obtained therefore, that development may be carried out without that consent'.*

Lawrence Hargrave Drive is defined as a classified road under the *Roads Act 1993*. SEPP 4 would therefore apply to the Proposal as the proposed works are for the purposes of a classified road as defined by the *Roads Act 1993*. Therefore the RTA would not require the consent from Wollongong City Council for those affected zones described in Table 4.1.

The provisions of SEPP 4, however do not apply in situations where a Proposal affects items described in an environmental planning instrument as a heritage item, an item of environmental heritage or a potential historical archaeological site (Clause 2(6) (a)). In these situations consent may be required under Part 4 of the EP&A Act. However, the Savings provisions in Wollongong LEP (Ref Clause 6 to Schedule 3) apply thereby bringing the assessment process under Part 5 of the EP&A Act. Further consideration of the potential for impacts on items of heritage significance, identified in Council's LEP, as a result of the Proposal is provided in Section 9.8 of this REF.

4.3.2. State Environmental Planning Policy 44 – Koala Habitat Protection

Wollongong LGA is identified within Schedule 1 of SEPP 44 as a LGA in which koalas are known to occur. While the requirements of the SEPP do not technically apply to this Proposal, as it is not subject to Council consent, it is the RTA's practice to consider SEPP 44 criteria in its EIA process. These criteria relate to the percentages of feed tree cover, particularly trees listed under Schedule 2. The assessment criteria consider the percentage cover of known feed trees, and whether these are greater or less than 15% of the total tree canopy.

No listed koala feed tree would be removed as a result of the Proposal and it is not anticipated that potential or core koala habitat would be impacted. Therefore, no further provisions of the SEPP 44 apply.

4.3.3. State Environmental Planning Policy No 71 – Coastal Protection

SEPP 71 was introduced to ensure that development in the NSW coastal zone is appropriate and suitably located. It also aims to ensure that there is a consistent and strategic approach to coastal planning and management through a clear development assessment framework for the coastal zone.

The key provisions to SEPP 71, which regulate coastal development, are in Parts 2 and 3, the former setting out matters for consideration and the latter declaring certain types of development to be state significant pursuant to section 76A of the EP&A Act. These provisions only have effect where the development in question requires development

consent under Part 4 of the EP&A Act. As discussed above, the Proposal is not subject to development consent and therefore the provisions of SEPP 71 do not apply.

4.4. Coastal Protection Act 1979

The Proposal may be subject to the requirements of the CP Act as the Proposal falls within the area subject to that Act. The CP Act requires the RTA, under section 38 to seek the concurrence of the Minister for Infrastructure and Planning prior to undertaking the Proposal for works within the Coastal Zone. The Coastal Zone is defined in the Act as:

> *a) the area within the coastal waters of the State as defined in Part 10 of the Interpretation Act 1987 (including any land within those waters); and*
> *b) the area of land and the waters that lie between the western boundary of the coastal zone (as shown on the maps outlining the coastal zone) and the landward boundary of the coastal waters of the State; and*
> *c) the seabed (if any) and the subsoil beneath, and the airspace above, the areas referred to in paragraphs (a) and (b).*

Those areas comprising the coastal waters of the State in general extend to 3 nautical miles from the coastline. The maps defining the Coastal Zone within the study area have been examined and include the seaward part of the coastal zone only.

The concurrence provisions are stated in Section 38 of the Act as:

> *1) A public authority shall not, without the concurrence of the Minister:*
> *a) carry out any development in the coastal zone, or*
> *b) grant any right or consent to a person:*
> *i) to use or occupy any part of the coastal zone, or*
> *ii) to carry out any development in the coastal zone,*
> *if, in the opinion of the Minister, as advised from time to time by the Minister to the public authority, the development or the use or occupation may, in any way:*
> *b) be inconsistent with the principles of ecologically sustainable development, or*
> *c) adversely affect the behaviour or be adversely affected by the behaviour of the sea or an arm of the sea or any bay, inlet, lagoon, lake, body of water, river, stream or watercourse, or*
> *d) adversely affect any beach or dune or the bed, bank, shoreline, foreshore, margin or flood plain of the sea or an arm of the sea or any bay, inlet, lagoon, lake, body of water, river, stream or watercourse.*

Accordingly a copy of the REF would be provided to the Minister for Infrastructure Planning for the purposes of allowing the Minister to determine whether concurrence is required.

4.5. Other Statutory Planning Approvals Requirements

4.5.1. Protection of the Environment Operations Act 1997

The Department of Environment and Conservation (DEC) is the responsible agency for the administration of the *Protection of the Environment Operations* (PoEO) *Act 1997* in relation to air, noise, water pollution and waste management. The Proposal would not be a scheduled activity under the Act and as such an Environment Protection Licence would not be required. The RTA is aware of the principles of this Act and ensures environmental impacts are adequately managed through its Environmental Management System and the implementation of Environmental Management Plans.

Ancillary activities such as batch plants or crushers would have their own relevant mobile licences and would not be able to operate on site until these have been sighted for currency and applicability.

4.5.2. Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The provisions of the EPBC Act, which regulate actions likely to have a significant impact on a Commonwealth marine area or on Commonwealth land, would not apply to the Proposal. The definitions of 'Commonwealth marine area' and 'Commonwealth land' within the EPBC Act exclude waters that have been vested in the State under the *Coastal Waters (State Title) Act 1987*. Other provisions of the EPBC Act, which regulate action having a significant impact on matters of National Environmental Significance, are considered further in Section 11.

4.5.3. Fisheries Management Act 1994

The Proposal falls within the provisions of the *Fisheries Management Act 1994* (Section 199) pertaining to dredging and reclamation work. This states, *'A public authority must, before it carries out or authorises the carrying out of any such works, give the Minister for Fisheries written notice of the proposed works, and consider any matters raised by the Minister concerning the proposed work within 28 days after giving notice'.* The proposed access road in GD2 would involve up to 10m of reclamation (worst case). The RTA would notify NSW Fisheries in accordance with the provisions of this Act.

Any harm to marine vegetation (namely seagrasses, mangroves or seaweeds) would require a permit under sections 204 and 205 of the Act. No marine vegetation, as defined by the Act would be harmed as a result of the Proposal.

Permits may also be required under Part 5 (clauses 112 -115) of the *Fisheries Management (General) Regulation 2002* for any works which may involve the use of explosives, electrical devices or other dangerous substances within waters. This would include any blasting works to access piers or to create access track cuts. Such activities would not be undertaken for the Proposal.

4.5.4. Coastal Protection (Non-Local Government Areas) Regulation 1994

Clause 5 of the Regulation only applies to that part of the coastal zone that is not within a local government area and is not subject to an environmental planning instrument other than a State environmental planning policy. By Clause 6 the carrying out of development on land to which the Regulation applies requires the concurrence of the Minister.

The seaward boundary of local government areas along the coast is the low water mark unless otherwise defined and as such, the Proposal would be carried out within the Wollongong Local Government Area.

4.5.5. Navigation Act 1901

Division 4 of Part 8 of the *Navigation Act 1901* regulates obstruction in navigable waters. Navigable waters are defined as:

> *any port, harbour, haven, roadstead, channel, navigable river or creek or arm of the sea within the jurisdiction.*

Where *'jurisdiction'* is defined as:

> *the navigable waters lying within one nautical league of the coast and the inland navigable waters of New South Wales.*

One nautical league is approximately 5.556 km, and therefore the Proposal would fall under the definition of the *'jurisdiction'*.

Section 141 of the Act prohibits the driving of piles and certain other works in navigable waters without authorisation. Section 78 of the *Roads Act 1993* effectively deems a bridge constructed across navigable waters to be a lawful obstruction of those waters. The RTA would consult NSW Waterways in relation to this section of the Act and any authorisation required.

4.5.6. Heritage Act 1977

Approval may be required from the NSW Heritage Office in relation to impacts (excavation or disturbance) to non-indigenous items under the provisions of the *Heritage Act 1977*. Impacts regarding non-indigenous heritage items within the vicinity of the proposed works are further discussed in Section 9.9.

4.5.7. Water Act 1912

The *Water Act 1912* is administered by DIPNR. A licence under the Act would be required if water were to be extracted from any waterways or adjacent waterways or if the waterways were to be realigned during construction.

4.5.8. Waste Avoidance and Resource Recovery Act 2001

The Department of Environment and Conservation administers the *Waste Avoidance and Recovery* (WARR) *Act 2001*. The primary objective of the WARR Act is to achieve reductions in waste volumes disposed of in NSW and establish a hierarchy of avoidance, reuse, recycling and reprocessing and disposal. The principles of the WARR Act would be

adopted for the Proposal, ensuring the responsible environmental management of unavoidable waste. These principles are discussed in detail in Section 9.12.

4.5.9. National Parks & Wildlife Act 1974

Should any archaeological sites or relics be uncovered during construction approval would be required from the Director-General of the DEC (Parks Services Division) under Section 87 (1) of the *National Parks & Wildlife* (NPWS) *Act 1974* for a permit to excavate archaeological sites & relics. Under Section 90 (2) of this Act, approval from the Director-General would also be required for a 'Consent to Destroy' permit for any identified archaeological sites or remains should any be found during construction. Specialist studies undertaken for the Proposal have concluded that no such sites have been identified.

There are no works expected to impact on National Park Estate that would require determination by DEC under the NPWS Act and works are not expected to affect any Public land that may be Gazetted in the near future under the NPWS Act.

4.5.10. Threatened Species Conservation Act 1995

The TSC Act is administered by DEC. The Act protects certain classes of threatened wildlife including endangered and vulnerable species, endangered populations, and endangered and vulnerable ecological communities. Processes under the Act and the Section 5A requirements of the EP&A Act were followed in the preparation of the REF.

5. Consultation and Stakeholder Engagement

5.1. Community Consultation

The RTA commenced consultation activities in August 2003 following the closure of Lawrence Hargrave Drive. The RTA's approach to consultation has been to disseminate information in order to advise the local community of progress of the project. The RTA also established a community support fund totalling $2 million to provide services to offset the impacts of the road closure. To date this fund has been used to fund extra bus services, tourist advertising, tourist signage and information bays, promotional support for local shopping centres and events, and a survey of community and business impacts.

The RTA has also undertaken a number of communication activities to provide information to the local communities including media events, community updates, community consultative committee (CCC) meetings and public information sessions and fact sheets.

A summary of the community consultation activities is given in Table 5.1.

Table 5.1: Community Consultation for Lawrence Hargrave Drive

Consultation Program	Activity
March 2003	RTA Community Working Group (CWG) - RTA established a CWG with the purpose of improving communication with the community about the rainfall triggered road closure protocols. The CWG held 6 meetings and was subsequently replaced with the CCC.
August 2003	Public Announcement: NSW Minister for Roads announced a major repair project for Lawrence Hargrave Drive between Clifton and Coalcliff – 29th August 2003.
October 2003	Public announcement: NSW Minister for Roads announced the community and business survey to assess the impact of the road closure- 29th October 2003. Public announcement: NSW Minister for Roads announced the process for engaging Alliance partners to work on design and construction of solutions to bring the road within safety limits.
Community Update	Community Update October distributed by RTA to Northern Illawarra villages. It included a request to apply for CCC membership.
November 2003	Public announcement: NSW Minister for Roads announced the preferred Alliance partners.
December 2003	Public announcement: Member for Heathcote announces selection of CCC members – 4th December 2003 Public announcement: NSW Member for Heathcote announces formal signing of Alliance Agreement – 8th December 2003.

Consultation Program	Activity
	Public announcement: NSW Minister for Roads announces broad options 17th December 2003.
Community Update	Community Update distributed to Northern Illawarra villages, including broad discussion of options.
CCC meeting No. 1	CCC established and first meeting held 17th December 2003.
January 2004	Public announcement: NSW Minister for the Illawarra announces short listed options – 27th January 2004.
RTA Fact Sheets	Two Fact Sheets distributed by letterbox to local communities in the Northern Illawarra 1. "Options for repairing the road" 2. "History and Repair"
CCC meeting No. 2	CCC second meeting held on 27th January 2004.
Newspaper advertisement	Advertisements were placed in three local newspapers to advise of the Information Sessions.
RTA website	Short listed options placed on RTA website.
Static Displays	Wollongong City Council Chamber Foyer and shop window (Bevans) Thirroul.
Laminated Fact Sheets	Fact Sheets were placed at the following locations: • Clifton School of Arts • Pepie's One Stop Shop, Stanwell Park • Scarborough Hotel • Coledale RSL Club • Austinmer Newsagent • Thirroul Newsagent • Thirroul Steel City Cycle Shop • RTA Wollongong office • Otford Community Notice Board
Information Sessions	The short listed options were displayed as follows: • Stanwell Park – 28/1/04 and 4/2/04 • Coledale – 30/1/04 and 4/2/04 • Thirroul – 29/1/04 and 5/2/04

Consultation Program	Activity
Opportunity to Comment	Anyone interested in the short listed options was encouraged to view the display and forward comments to RTA by mail or email. A Community Comment form was available at the Information Session for people to complete at the Information Session or send later.
Submissions	The RTA received a total of 73 submissions.
CCC Meeting No.3	CCC third meeting held on 24th February 2004.

5.1.1. Community Updates

The RTA prepared two "Community Updates" (October 2003 and December 2003), which were distributed by letterbox drop to the local communities in the Northern Illawarra.

The October 2003 Community Update provided information on project background, RTA progress, the expected timetable of activities, current activities on site, a request for applicants for the CCC, an update on briefing sessions with emergency services organisations, additional bus services, updated road signage, and the IRIS (Illawarra Regional Information Service) community and business survey.

The December 2003 Community Update provided updated information including the appointment of the LHD Link Alliance team and development of broad options to repair the road, the expected timetable of tasks and key dates, current site works, embankment crack and monitoring results, additional train stops and new express bus services, IRIS survey update, announcement of the formation of the CCC, community support fund initiatives and other work with Northern Illawarra business operators and Tourism Wollongong and improvements taking place on the F6 Freeway.

The RTA has indicated that Community Updates would continue to be prepared and distributed to local residents and businesses in the Northern Illawarra until the end of the project.

5.1.2. Community Consultative Committee

In December 2003, RTA formed the Lawrence Hargrave Drive CCC, which comprises 16 Northern Illawarra residents and business representatives. The purpose of the CCC is to function as a discussion forum about the Lawrence Hargrave Drive project, as well as considering ways to support the local community throughout the road closure. The selection process comprised advertising in local papers with interested people requested to submit an application for review.

5.1.3. Short List Options Public Information Sessions and Fact Sheet

To obtain community input on the four short listed options, the RTA prepared public display panels/material and a fact sheet based on information provided by LHD Link Alliance. The display material was used at Information Sessions and for static displays. The Fact Sheet provided the same information as was available at the public displays.

Static displays were located at Wollongong City Council Chambers Foyer and a shop window (Bevans) in Thirroul for 2 weeks. The information was also made available on the RTA web site.

The Fact Sheet was distributed by letterbox drop to residents and businesses in the Northern Wollongong coastal villages and at the Information Sessions. Copies were also left in local village newsagents, and laminated copies displayed in 9 locations throughout Northern Wollongong (Table 5.1).

The purpose of the Information Sessions was to provide an opportunity for residents to discuss the options, and provide input and feedback through a comment form or email to RTA. Six staffed Information Sessions were held on 28, 29 and 30 January and 3, 4 and 5 February 2004 for a minimum period of four (4) hours (4 – 8 pm). The Information Sessions were held twice in each of the following three (3) locations - Stanwell Park (north), Coledale (middle) and Thirroul (south). RTA and LHD Link Alliance personnel staffed each Information Session. Attendance at the Information Sessions was Stanwell Park – 65, Coledale – 50 and Thirroul – 45 people.

5.1.4. Issues and Comments

Resident and business issues raised to the end of 2003 included:

- RTA did not warn or consult with the community about the closure;
- The proposed 2.5 years for the repair of Lawrence Hargrave Drive is too long for the residents and businesses to be disrupted;
- Financial losses are being incurred by businesses, which is "killing" the villages and the community;
- Emergency service (ambulance, police, fire services) access is now reduced in the Stanwell Park / Coalcliff areas and is of great concern for residents, particularly ambulance and fire services;
- Family, individual and business travel expenses have increased due to the additional time required to travel between the northern and southern villages;
- The road can and should be re-opened, as the risk is considered (by some residents) to be acceptable to the community;
- The only real problem along Lawrence Hargrave Drive is the "crack" from the embankment failure - the rest of the road is fine;
- The F6 Freeway and Bulli Pass are unsafe to travel along because of the higher travel speeds, frequency of accidents, rock falls and bad driving conditions during wet weather and frequent fog;
- Lawrence Hargrave Drive is a lifeline and needs to be reopened as soon as possible; and
- Families, friends and communities have become separated and isolated, which is causing disruption to social, sporting, education and work arrangements.

Since January 2004, many peoples' comments on the road closure have changed as people better understand the safety issues associated with the road, the dangerous nature of rock falls and the development of solutions to reconnect the northern village communities. However, concerns still exist regarding the potential loss of businesses and the dislocation between families, friends, and communities during the road closure period.

5.1.5. Comments on Options

Based on the public announcement by the NSW Minister for the Illawarra of short listed options and shown in the RTA Fact Sheet "Options for repairing the road", the following comments by the community were made:

- Options A and C - The large majority of people nominated the long continuous bridge options as a preferred option rather than options B or D;
- Option A - The curved continuous bridge was also preferred as it follows the curve of the coast, is similar to the existing road alignment, and would maintain the previous road user experience;
- Option B - tunnel section – many people said that they would not want to walk or cycle through the tunnel. Some people were concerned about the stability of a tunnel in that location. Some people felt the short tunnel would detract from the "scenic tourist attraction" of the road. Those in favour of the tunnel commented that it is only a short distance and would not substantially detract from scenic views;
- Option C – many people preferred the long straight bridge. Concerns were expressed regarding the impact of sea spray and wind conditions on drivers during storm conditions. Many commented about the high seas in the area and queried how the bridge would be constructed in the ocean; and
- Option D – a few people preferred this option, as it was perceived to minimise impacts on the coastal landscape and maintain the alignment, although many did not necessarily understand the nature of the works required. Most people were quickly dismissive, as the option is perceived as making the same historical mistakes and therefore it should not be considered.

A description and illustration of these options is provided in Section 7.3 of this REF.

5.1.6. Concerns, Questions and Suggestions

- Many commented that the road should be reopened as soon as possible due to the impact on the shopkeepers (loss to and closure of businesses), cost to the community (greater travel time/distance), and disruption to families and the community;
- A few suggested that the road should be kept closed, as there is now no through traffic. This was considered highly beneficial for residents due to the reduced traffic noise and, in part, better local access for walking and local travel;
- Numerous people sought reassurance that the road would be repaired and reopened;
- A frequent request was that provision be made for a shared pedestrian/cycleway so that people can walk along the road safely. Others requested that a separate walkway be provided for safety reasons;
- Many commented that a bridge could provide a memorable gateway to the Northern Illawarra and could become a tourist attraction for the area;
- Some people were concerned that a bridge would be visually intrusive and should not be considered;
- Questions regarding the timing of the project milestones (preferred option, REF, commencement of construction) and the cost of each option to get a better understanding of the proposed time frame;
- Some were concerned that bridge railings should not be allowed to obscure driver/passenger cliff and coastal views. Others commented that a safe road was a higher priority than maintaining views;

- Various suggestions were made regarding the location of car parks along, or at either end, of the road, to allow people to stop and walk along the bridge (locals and tourists), to enable people to park and access the rock platforms, and for photo opportunities. Some people also suggested that a parking space be provided on the bridge to allow photo opportunities;
- Some respondents said that they did not have enough information to allow them to assess the options. Other information being sought included environmental, engineering, costing, time schedule, and selection criteria; and
- Some attendees did not want to comment on the four options but identified one or more of the long listed options for consideration (Section 7.3). The alternatives were variations of the long tunnel option to address the Northern Illawarra road and rail transport needs, and/or avoid degradation of the coastal environment, a surface western route to bypass the coast, or a breakwater to create a surf break.

5.1.7. Future Community Involvement Activities

Community involvement activities are expected to continue during the construction phase and be similar to those undertaken to date. The community would be advised of the preferred option and the public exhibition of the REF. The commencement of construction would be announced and the community provided with information on the ongoing activities.

5.2. Government Agencies and Other Interested Parties

During the preliminary environmental investigations undertaken for the Proposal, a number of government agencies were consulted. This initial consultation sought to identify any issues and concerns regarding the Proposal and to discuss matters related to statutory or advisory responsibility. Subsequent to the option selection process, all relevant government agencies were contacted by letter (sent on 22 December 2003), seeking the issues that are required to be addressed in the REF. Summaries of the issues raised and the locations where these issues are addressed in the REF are provided in Table 5.2. In some instances, no reply to the consultation letter dated 22 December 2003 was received during the preparation of the REF, however where this is the case, further opportunity to comment would be available during the Exhibition of the REF.

Original copies of correspondence received are contained in Appendix 1.

Table 5.2: Summary of Issues in Response to the Proposal

Issue	Section where Addressed
Wollongong City Council	
The proponent should consult both the draft Illawarra Escarpment Management Plan and associated heritage study.	9.9
The Proposal affects core escarpment land, identified in Wollongong LEP as an item of state significance. The principles of the relevant clauses of the LEP should be accounted for.	4.1 and 9.9
There are various items of heritage significance as identified in LEP in vicinity of the Proposal. The principles of the relevant clauses of the LEP should be accounted for.	4.1 and 9.9
The original site of the jetty adjacent to the Coalcliff Colliery entrance portal, whilst not being listed in the LEP as an item of heritage significance, is an archaeological relic under the *Heritage Act 1977*.	9.9
The REF should detail the consideration of pedestrian access from Coalcliff to Clifton.	3.3
The Strategic Planning Division would like the opportunity to comment further when more detailed information becomes available.	5.1.7
Department of Environment and Conservation	
❑ ***Environment Protection and Regulation Division***	
The proposed road upgrade works of Lawrence Hargrave Drive would not be a scheduled development under the *Protection of the Environment Operations Act 1997* and as such would not require an Environment Protection Licence.	4.5.1
There is a need to ensure that adequate fire control measures are in place as well as sediment and erosion controls so as not to impact upon any National Park Estate.	9.1; 9.4; and 9.5.
If any Aboriginal objects are found during construction, all works are to stop and the DEC is to be notified immediately.	9.8
The REF should detail if any impacts are likely to affect public land that would be gazetted in the near future under the *National Parks and Wildlife Act 1974* proposed National Park land. Works within National Park Estate would be determined by DEC in a separate REF and assessed under the *National Parks and Wildlife Act 1974*.	4.5.9
Reference should be made to DEC standard guidelines, *'General Guidelines for Impact Assessment'* and *'Guidelines for Developments adjoining NPWS land'*.	Noted

Issue	Section where Addressed
The REF needs to consider all stages of proposed works including the consideration of the following items: • Provide detail on the scope and all stages of the proposed works and associated activities; • Provide an overview of the affected environment; • Should identify and describe all potential sources and characteristics of water pollution and detail a water quality monitoring program; • Undertake an air quality impact assessment in relation to all potential air emissions; • Undertake a noise impact assessment which should include all aspects of ambient noise monitoring and assessment of noise impacts from construction; and • Provide details on the classification and management of all wastes associated with the Proposal.	3; 8; and 9
The REF should also detail environment protection measures, including water controls, noise mitigation measures, dust control measures and waste management.	9
Reference, where possible, should be made to the appropriate technical guidelines produced by Federal, State and Local Governments when assessing and managing potential impacts.	9
All operators need to be aware of their environmental responsibilities on site and be properly accredited and trained in the installation and management of pollution control works.	9.4 and CEMP
❑ ***Parks Services Division***	
As a follow up to the initial consultation letter, the Parks Service Division was contacted by telephone on 11 February 2004. It advised that it had reviewed the issues raised by the Environment and Regulation Division and were satisfied that its concerns had been addressed. Specific issues raised were; • Impact on National Park Estate; and • Off-park ecological issues.	9
Department of Infrastructure, Planning and Natural Resources	
DIPNR would provide detailed comment on the preferred option after it has been fully investigated.	Noted
Any proposed work in and around the area of the shoreline would need to consider coastal hazard issues as well as local structural requirements.	3.3 and 9.6
If the Proposal extends beyond the local government boundary, concurrence by the Minister under the Coastal Protection Act would be required.	4.5.4

Issue	Section where Addressed
The Proposal should include a comprehensive assessment of coastal hazard and full measures to deal with this in design and maintenance/ operational aspects.	9.6
Department of Lands No response to letter dated 22 December 2003	
Department of Mineral Resources The Department recommends consultation with RIC as a result of the rail tunnel, adjacent to Lawrence Hargrave Drive being located in an area of known geotechnical instability. No coal resources of an extractable nature remain within the study area. The study area is underlain by extensive abandoned mine workings and their potential impact on the Proposal would need to be identified. Impacts on truck movements to and from ICC and the rehabilitation of Coalcliff Colliery should be considered. Petroleum Exploration Licenses 442, 444 and 2 partly overlie the study area, however no impact on the exploration activities permitted by these titles is envisaged.	 5.2 Noted 9.5 and 9.9 8.4.4 and 9.11 Noted
NSW Fisheries NSW Fisheries is concerned about potential impacts on aquatic species and habitats in the vicinity of the proposed works, as well as the potential impacts on water quality and hydrology of waterways. An appropriate sediment and erosion control regime and water quality management provisions should be designed in accordance with current industry Best Management Practices and implemented to safeguard the aquatic environment of the entire works area. The design and construction of the Proposal should be undertaken in accordance with the NSW Fisheries Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures 1999. (Note: these Guidelines have now been superseded by the 'Why Do Fish Need to Cross the Road?' And associated fishnote). The upgrade of Lawrence Hargrave Drive should ensure that there is no additional fish passage barriers constructed within the catchment. NSW Fisheries should be involved throughout the design phase of any waterway crossing.	 9.4 and 9.6 9.4; 9.6 and CEMP Noted Noted

Issue	Section where Addressed
More specifically, the environmental impact assessment should include: • Location of works (including topographic map), and name of adjacent watercourses; • Description, method(s), timing and duration of works; • Volume and type of excavated material; • Aquatic habitat conditions at the site; • Potential impacts upon aquatic and riparian habitats (both temporary and permanent) and proposals to mitigate these impacts; • Potential impacts upon water quality and proposals to mitigate these impacts; • Potential impediments to fish passage as a result of the works and possible mitigation measures to negate these impacts; and • An assessment of the potential impact that the Proposal may have on aquatic threatened species, populations and ecological communities.	3.2; 8 and 9
A meeting was held with NSW Fisheries on 18 February 2004 to discuss the Proposal further to the consultation letter. Issues discussed were in reference to: • Reclamation and the construction of an access track and working platforms; • Potential impacts on the boulder field within the southern amphitheatre and the adjacent subtidal environment; • The use of existing boulders in the rock armouring works and the effectiveness of manufactured rock armour units; • Potential impacts on commercial fishers, in particular fishers of the Eastern Rock Lobster Fishery; • Proposed mitigation measures and design requirements, including restoration of disturbed habitats and monitoring programs; and • Statutory requirements under the *Fisheries Management Act 1994.*	9.6
NSW Heritage Office	
The heritage significance of the study area and any impacts the Proposal may have upon this significance should be assessed. This assessment should include natural areas and places of Aboriginal, historic or archaeological significance. It should also include a consideration of wider heritage impacts in the area surrounding the site.	9.9
The appropriate registers and lists should be consulted to identify any identified items of heritage significance in the area affected by the Proposal.	9.9

Issue	Section where Addressed
Non-Aboriginal heritage items within the study area should be identified by field survey. A statement of significance and an assessment of the impact of the Proposal on the heritage significance of these items should be undertaken. Any policies / measures to conserve their heritage significance should be identified.	9.9
The Proposal should have regard to any impacts on places, items or relics of significance to Aboriginal people. Where it is likely that the Proposal would impact on Aboriginal heritage, adequate community consultation should take place regarding the assessment of significance, likely impacts and management / mitigation measures.	9.8
If disturbance to a known or potential archaeological relic is proposed, an excavation permit under the provisions of the *Heritage Act 1977* or an exception to be endorsed by the Heritage Council must be obtained.	9.9
If any unexpected archaeological relic is uncovered during the course of work, excavation should cease and an excavation permit, or an exception notification endorsement must be obtained.	9.8 and 9.9
If approval is required under the *Heritage Act 1977*, the Heritage Council's approval must be sought prior to an approval being issued by the consent authority under the EP&A Act.	9.9
The coke ovens at Coalcliff Colliery are under consideration for listing on the State Heritage Register.	9.9.
Remnant cliff vegetation on Lawrence Hargrave Drive, listed on Wollongong LEP, should be retained. Another Wollongong LEP listed heritage item, Coalcliff Colliery entrance portal, is also listed as a heritage item in the Illawarra REP No. 1. Any potential impacts may require approval from DIPNR.	9.9
Two indicative places listed by the Australian Heritage Commission within the study area are the Coalcliff geological site and the Illawarra escarpment. While this may have no statutory effect, further information should be sought regarding the area's geological and natural heritage values.	9.9
The requirements for the preparation of EIS heritage assessments prepared by DIPNR may also be referred to and applied to the preparation of the REF.	Noted
The design of the Proposal should minimise the extent of large areas of cut, fill or retaining walls. The Proposal should 'tread lightly' on the cliff face of this scenic section of road and minimise landscape scarring.	Noted
The opportunity to 'build in' heritage interpretation of the area's heritage values through signage or other means in roadside shoulders or rest areas should be pursued.	9.9

Issue	Section where Addressed
NSW Police No response to letter dated 22 December 2003.	
Rail Infrastructure Corporation & State Rail Authority of NSW (Now RailCorp) No response to letter dated 22 December 2003.	
Waterways Authority of NSW Issue of primary interest to the Authority is navigation-related matters concerning the proposed bridge, during and post construction. Requested to be kept informed as the project progresses.	5.1.7
Australian Heritage Commission The *Australian Heritage Commission Act 1975* was repealed on 1 January 2004. As a result, the Commission was replaced with the Australian Heritage Council, and no longer exists as a statutory authority. The EPBC Act has been amended to provide for the protection of places on the National Heritage List and Commonwealth Heritage List. Section 391A of the EPBC Act retains the Register of National Estate as an indicator of heritage values for purpose of the operation of the EPBC Act. If the proposed action would result in a significant impact then the matter should be referred to the Minister of Environment and Heritage for a determination. It is recommended that enquiries to the State or Local Government heritage agencies be undertaken with regards to the Proposal.	Noted 9.9 and 4 5.2
Illawarra Coke Company Pty Ltd Works undertaken to upgrade Lawrence Hargrave Drive should avoid destabilisation of adjacent ICC land. Truck movements required for the upgrade of Lawrence Hargrave Drive should be coordinated with ICC truck movements (Monday – Friday) to avoid adverse impacts on ICC business operations. The REF should consider the following issues regarding truck movements: • Noise; • Spillage; and • Road safety. The REF should also consider issues associated with: • Dust generation; and • Sedimentation of Stoney Creek. ICC requests to be kept informed and involved in any on-going consultation with regards to the Proposal, to minimise any potential impacts on ICC business.	9.1 9.7.1. 9.11; 9.4; 9.13 and 9.16 9.3 and 9.4 5.1.7

Issue	Section where Addressed
Greens Northern Coaches No response to letter dated 22 December 2003.	

6. Strategic Stage

6.1. General

Lawrence Hargrave Drive is an important commuter link between the townships of Clifton, Wombarra, Coledale, Austinmer and Thirroul to the south, and Coalcliff and Stanwell Park to the north. It is also recognised as a Tourist Drive Route promoting the tourist attractions of the local area by providing access and views of the coastline and Illawarra Escarpment.

The Proposal has been considered with regards to the following State and regional planning strategies.

6.1.1. Action for Transport 2010

The State Government's *Action for Transport 2010 – An Integrated Transport Plan for NSW* outlines the future transport and road initiatives for NSW. The State Government is directly responsible for a network of 20,370km of roads and highways in NSW, much of it in rural areas. To achieve the long-term vision of Action for Transport 2010, a 12-point transport action plan was developed. The action plan ensures that land and transport decisions link together for the community's benefit throughout NSW and protects the natural environment.

In following Action for Transport 2010, the State Government developed the companion document, Road Safety 2010, to help achieve the goals of the 12-point transport action plan. Road Safety 2010 sets out a plan to halve the road toll by 2010 and promotes community understanding and involvement in road safety initiatives and strategies.

In supporting the initiatives of Action for Transport 2010, the Proposal:

- Meets the need of Illawarra's growing and changing population by upgrading an important north-south link;
- Safeguards the environment through the implementation of environmental mitigation measures;
- Improves access for local and regional communities of the Illawarra and recognises the importance of regional tourism;
- Upgrades a section of road that has a history of disrupting traffic and provides for a transport route that includes certainty and predictability of road availability; and
- Incorporates the framework set out in Road Safety 2010, by upgrading an existing road to provide a safer road and traffic environment.

The Proposal is part of an ongoing commitment by the RTA to address road safety in accordance with its responsibilities for ensuring a maximum level of service to road users and to maintain appropriate services for adjacent landholders.

6.1.2. Draft Illawarra Escarpment Strategic Management Plan

The draft Illawarra Escarpment Strategic Management Plan is currently on exhibition for public comment until 2 May 2004. The draft Plan is a comprehensive document that assesses the current condition of the Illawarra escarpment, identifies the threatening processes that degrade the asset and outlines the proposed planning, management and implementation strategies to sustainably plan and manage the escarpment into the future.

The draft Plan has identified the escarpment as an iconic feature of the Illawarra region that requires active conservation, remediation and management. The vision for the escarpment outlined in the draft Plan is to:

> *Protect, conserve and manage the environmental values and assets of the Illawarra Escarpment consistent with the Principles of Ecologically Sustainable Development (ESD)*

The ongoing design and environmental assessment process for the Proposal has recognised the Illawarra escarpment as an iconic and unique cultural feature with minimisation of impacts on headlands and other escarpment features being a major factor in option selection and assessment. In addition the visual impact assessment and urban design have also taken this issue into account, in order to make the Proposal as compatible as possible with the visual and scenic values of the escarpment.

6.1.3. Draft Illawarra Escarpment Heritage Study

Wollongong City Council is currently preparing an Illawarra Escarpment Heritage Study. The study is designed to support the draft Illawarra Escarpment Strategic Management Plan in the context of its heritage values and is being prepared to gain an understanding of the escarpment through its historical and geological context and also recognise its cultural values as well as its natural attributes. The study recognises those heritage items already identified in such planning instruments as the Illawarra REP No. 1 as well as the Wollongong LEP.

A copy of the draft study was viewed during the preparation of this REF to ascertain any potential impacts. Of particular note and of relevance to the Proposal is the recognition of the escarpment view from Bald Hill, at Stanwell Tops, which is not currently recognised in any planning instrument.

The impacts of the Proposal on this view shed have been taken into consideration and are discussed in detail in Section 9.10.

6.2. Need for the Proposal

Between Coalcliff and Clifton, Lawrence Hargrave Drive is located in an active geological setting, which has presented significant engineering and geotechnical challenges for over 100 years and has also resulted in a number of short-term road closures. In 2002, following an increased number of near misses from rockfalls, the RTA commissioned GHD Longmac to undertake a detailed study of Lawrence Hargrave Drive and to provide options to reduce risks to motorists. The report recommended engineering works to stabilise parts of the cliff face and short-term road closures after cumulative rainfall in excess of 35mm and / or when there had been continuous rainfall with less than three dry days in between.

In early 2003, an independent review of that report was undertaken by URS Australia. The review was to assess the effectiveness of the road closure strategy implemented by the RTA in accordance with recommendations of the GHD Longmac report. The URS review stated that even after completion of the recommended remediation works and the implementation of a refined rain closure strategy, the road would still exceed guideline tolerability limits for safety. In August 2003, as a result of the URS review, the RTA closed Lawrence Hargrave Drive between Coalcliff and Clifton to protect road users from risks associated with geological instability and to provide an opportunity to implement a comprehensive and long term solution for the section of road.

Whilst the closure was aimed at protecting the safety of motorists, local media reports suggested that the closure of Lawrence Hargrave Drive was having an impact on the community. To quantify the level of impact, the RTA commissioned the Illawarra Regional Information Service (IRIS) to conduct consultative research into the ongoing impact of the closure on the surrounding community (IRIS, 2004). The results of the surveys are summarised in Section 9.7.

The IRIS surveys document the impacts that road closure is having on the local communities and businesses. Permanent closure of the road would continue to exacerbate these impacts on households. Some of the main findings of the survey included;

- The round trip to and from work has increased between 28km and 44km per day depending on location of residence;
- The total time taken to travel to and from work has increased by between 34 minutes and 44 minutes per day depending on location of residence;
- The average weekly cost associated with travel to work from affected households has increased by $24;
- Disruption and extra time and costs to access schools and shops have occurred; and

As well as the social impacts outlined above, the closure of Lawrence Hargrave Drive has also had economic impacts on businesses in the Thirroul to Helensburgh area.

Although the State Government has provided a community support fund of $2 million to help relieve socio-economic issues associated with road closure, permanent opening of the road is the only mechanism by which the documented impacts can be reversed.

7. Concept Stage

7.1. Proposal Objective and Option Selection Process

The objective of this Proposal is to link the Lawrence Hargrave Drive communities quickly, safely and sustainably through the investigation, assessment and design of a solution that will enable the section of road between Coalcliff and Clifton to be reopened by February 2006. To achieve this LHD Link Alliance set a number of objectives in relation to road availability, safety, time for completion, cost, environmental impact, community impact, quality and road user risk.

To assist in the development of options, a multi criteria analysis (MCA) process was developed to allow comparative assessment and evaluation of options under a number of criteria including road availability, safety, time for completion, cost, environmental impact, community, availability and road user risk. This MCA process involved:

- The development of an initial broad range of options;
- Selection of a long list of options based on mandatory criteria;
- Evaluation of the long listed options to allow comparative assessment;
- MCA of long listed options to develop a shortlist of options;
- Further evaluation of the short listed options; and
- MCA of short listed options to select the preferred option.

The options developed generally followed one of three philosophies for addressing the geotechnical risk associated with this section of road:

- Use of stabilisation measures;
- Protection with structural cover; or
- Avoidance by relocating the roadway away from the risk area.

7.2. Initial Option Development and Selection of a Long List of Options

A two-day workshop was held (26 – 27 November 2003) to develop an initial range of broad options that met the Proposal objectives mentioned above. Attendees included geologists, community consultation specialists, environmental scientists and planners, design engineers, constructors and RTA representatives. Some 70 potential schemes were generated to open the road and these were discussed, combined or eliminated to produce an initial list of 26 broad options. Mandatory criteria levels were then set to eliminate options that would not meet the Proposal objectives. The mandatory criteria were:

1. Direct design and construction cost less than $35m;
2. Restoration of a two lane road;
3. Road user risk of ARL 3 (assessed risk level 3) or better (risk of loss of life in the range 1 in10,000 years to 1 in 1,000,000 years);
4. Time for Proposal delivery less than 2 ½ years;
5. No more than 14 days closure per annum on average; and
6. Whole of life cost of $40m plus the net present value of maintenance for an equivalent road.

Each option was evaluated against the mandatory criteria to assess if it warranted further investigation. As the detail on each option was limited at this stage of the evaluation process, options that were marginal in relation to meeting some of the criteria were retained for further development. This was particularly relevant to cost, which is difficult to determine until detailed engineering is undertaken.

This application of mandatory criteria resulted in the 26 broad options being reduced to a long list of 17. Appendix 2 provides a tabulation of the 26 broad options and descriptions of the 17 long listed options with Figures showing the alignments.

At the workshop's conclusion, comparative criteria were developed to allow options to be further assessed on their ability to meet Proposal objectives. Comparative criteria were weighted by relative importance by each participant and the weightings aggregated across the group (Table 7.1).

Table 7.1: Comparative Criteria and Aggregate Weightings

Criterion		Key Performance Indicator	Weighting
1	Cost	Direct design and construction cost	11%
2		Planned maintenance and operation costs	6%
3		Contingency associated with capital cost	4%
4		Contingency/risk of unplanned maintenance	3%
5	Time	Time for project delivery	17%
6	Safety	Safety during construction and maintenance	12%
7	Road Availability	Operational availability	11%
8	Environment	Environmental impact	6%
9		Visual amenity (local and distant)	6%
10	Community	Other user amenity (pedestrian, cyclist and/or recreational)	6%
11		Potential for temporary connection	5%
12	Geotechnical/ Road User Risk	Road user risk of ARL 3 or better	13%
			100%

7.3. MCA of Long Listed Options

The above 17 options were further developed to provide sufficient information to allow comparative analysis through the MCA process. To apply the comparative criteria, a two-day workshop was held (11-12 December 2003) with a similar makeup of attendees to the previous workshop. The group was split into three teams and each team scored each option on how well it met the criteria. Each option was scored between zero (failed to meet criteria) and ten (fully met criteria) on a previously agreed sliding scale. The scores were averaged and entered into the MCA analysis. Any widely diverging scores were revisited to check for differences in interpretation and application of the criteria. Results of the comparative scoring of the 17 options (actually 18 scores were given with Option 1 being split into two sub-options) based on the weighted comparative criteria are provided in Table 7.2.

Table 7.2: Results of MCA Scoring – Long Listed Options

Ranking	Option	MCA score (max. of 1000)
1	10	679
2	1.1	671
3	12	628
4	17	611
5	1.2	581
6	16	513
7	3	496
.8	4	493
9	5	460

Ranking	Option	MCA score (max. of 1000)
10	13	419
11	6	392
12	9	390
13	11	389
14	2	371
15	8	355
16	14	332
17	7	294
18	15	232

The scoring identified the preferable options and the areas in which other options were found to be inferior to the higher scoring ones. Table 7.3 summarises the findings of the MCA.

Table 7.3: Summary of MCA Findings

Option	Findings
1.1 Continuous bridge nearshore	• Short listed
1.2 Continuous bridge offshore	• Short listed
2 Bridge above the headlands	• Capital cost prohibitive • Time for delivery would exceed 2.5 years • Visually intrusive • Inherently risky for construction • Unacceptable user road risk
3 Elevated road on existing alignment	• Unacceptable user road risk • No potential temporary connection • Construction safety risk high
4 Dedicated Road Tunnel	• Capital cost prohibitive • High ongoing operational costs • Precludes pedestrian and cyclist access • Removes visual amenity/vista – no coastal views
5 Combined road and rail tunnel	• Capital cost prohibitive • Time for delivery would exceed 2.5 years • Precludes pedestrian and cyclist access • Removes visual amenity/vista – no coastal views

Option	Findings
6 Road on breakwater	• Capital and maintenance cost prohibitive • Time for delivery would exceed 2.5 years • Very low availability for road-users (during heavy sea conditions) • Environmental impacts high – marine, material sources and transportation
7 Floating roadway	• Capital cost prohibitive • Time for delivery would exceed 2.5 years • Construction safety – high risk • Low availability for road-users (during heavy sea conditions) • Environmental impacts high – marine, material sources and transportation
8 Low level causeway	• Capital cost prohibitive • Time for delivery would exceed 2.5 years • Construction safety – high risk • Low availability for road-users (ocean) • Environmental impacts high – marine, material sources and transportation
9 Road on new reclamation	• Capital cost prohibitive • Construction safety – high risk • Environmental impact – material transportation • No potential for temporary connection • Road user risk unacceptable
10 Bridges between headlands	• Short listed
11 Combined rail/road bridge above headlands	• Capital cost prohibitive • Time for delivery would exceed 2.5 years • Environmental impact – vegetation, scarring, visual intrusion • Road user risk unacceptable
12 Combined bridge and tunnel	• Short listed
13 Cut and cover tunnel	• Operational costs excessive • Precludes pedestrian and cyclist access • Removes visual amenity/vista – no coastal views
14 Widened embankment with retaining structures	• Capital cost prohibitive • Time for delivery would exceed 2.5 years • Construction safety – high risk • Visually intrusive • No potential for temporary connection • Road user risk unacceptable

Option	Findings
15 Road above lower cliff	• Road user risk unacceptable • Construction safety – high risk • Visually intrusive • Availability for road users unacceptably low • Sections would be in tunnels which precludes pedestrians and cyclists
16 Continuous debris/rock shelter	• Capital cost prohibitive • No potential for temporary connection • Visually intrusive • Construction safety – high risk
17 Bridge, tunnel, shelter	• Short listed

All options were identified as having a degree of environmental impact. Where environmental impacts were identified as being manageable based on existing information, no specific mention has been made in the assessment summary in Table 7.3. A precautionary approach was therefore taken in regard to impacts. If no information was available or an option was located in a sensitive area, impacts were assumed to be high.

At the completion of this process, the workshop participants were divided into groups to discuss and recommend alternative geotechnical treatments that would address the problems found along the existing road alignment. On the basis of this work and the MCA scoring (Table 7.3), four short listed options (with two sub-options) were selected for further evaluation, these are

Option A Refinement of Option 10 and/or 1.1
Nearshore bridges spanning the southern and northern amphitheatres (GD2, GD4) and geotechnical treatment of, or a bridge bypassing, the middle headland (GD3). The southern and northern headlands would also require geotechnical treatment (Figure 7.1)

Option B Refinement of Option 12 and/or 17
Nearshore bridge spanning the southern amphitheatre (GD2), a short tunnel through the middle headland (GD3) and either a rock shelter or short bridge through the northern amphitheatre (GD4). The southern and northern headlands would also require geotechnical treatment (Figure 7.1).

Option C Refinement of Option 1.2
A long span offshore bridge (approximately 1200m) bypassing both amphitheatres (GD2, GD4) and the middle headland (GD3). The southern and northern headlands would also require geotechnical treatment (Figure 7.1).

Option D An existing road alignment option using geotechnical stabilisation treatments
Discussions identified that an option that maximised the safe use of the existing road should be developed and included in the final assessment. These included on-road solutions such as rock shelters, catch fences, catch ditches, rock bolting and netting, retaining structures etc. (Figure 7.2).

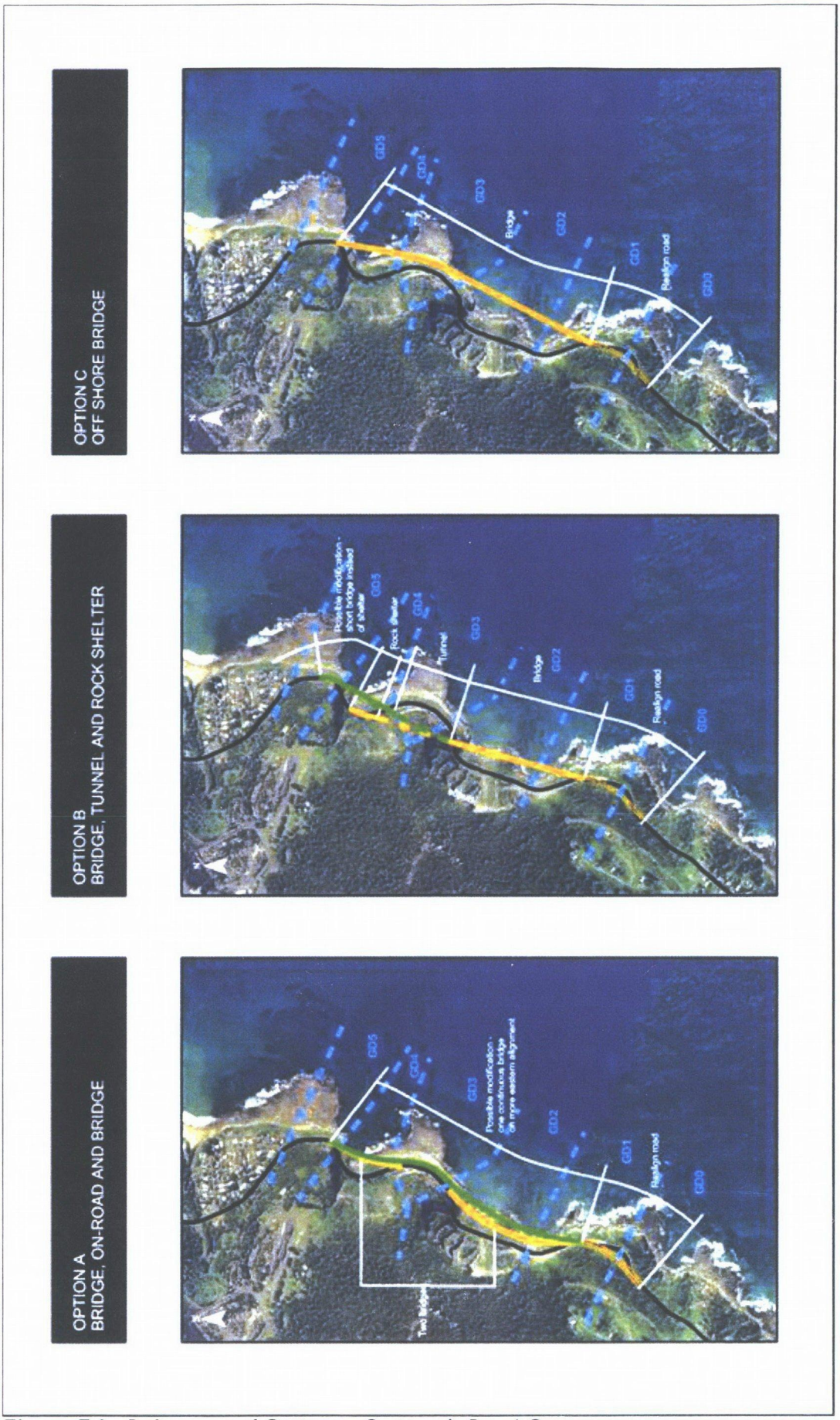


Figure 7.1: Refinement of Options – Options A, B and C

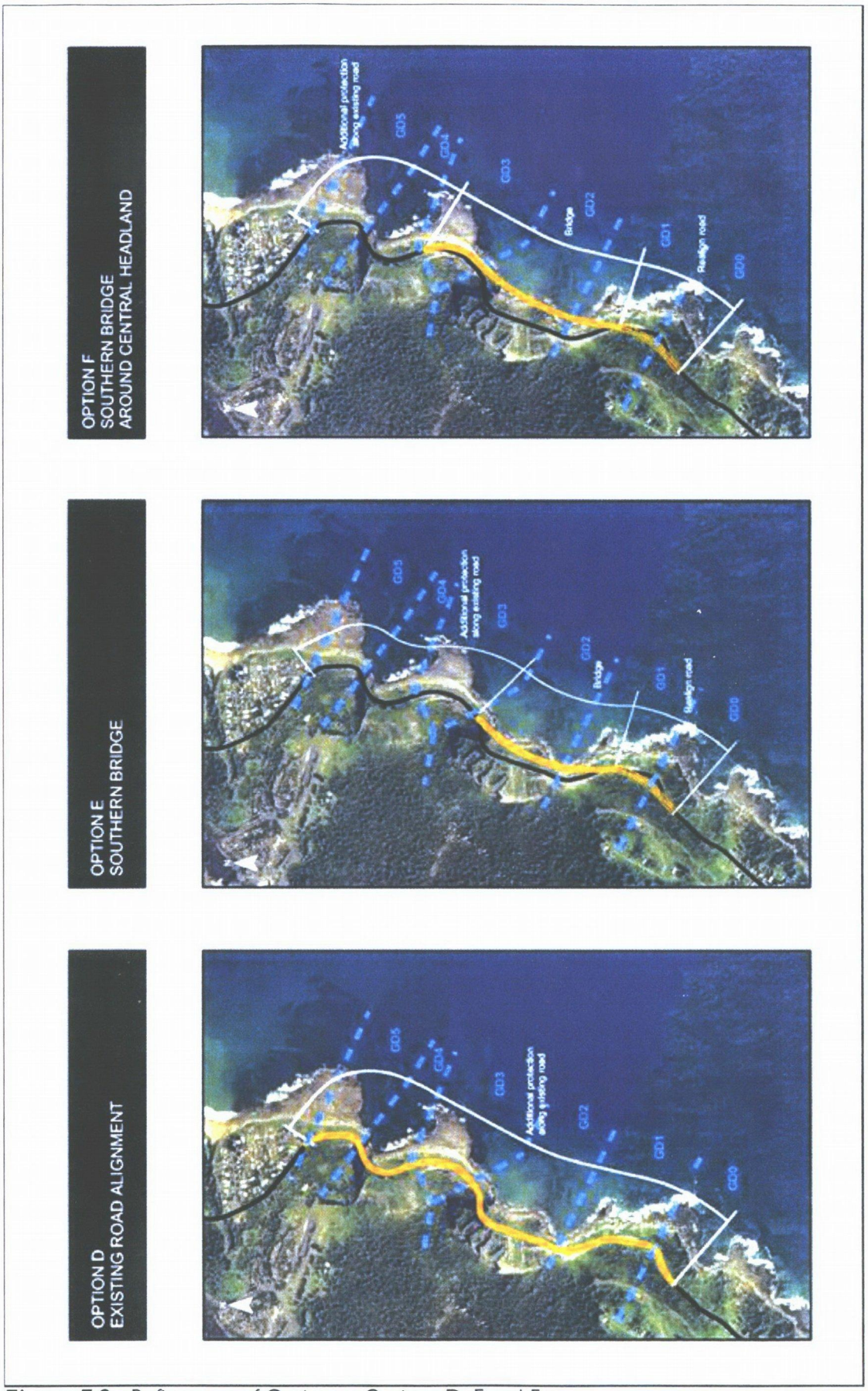


Figure 7.2: Refinement of Options – Options D, E and F

7.4. Sensitivity Analysis of Long Listed Options

To ensure that options were not rejected due to the MCA model being highly sensitive to the weightings or from an inherent bias, a sensitivity analysis was conducted to measure the robustness of the model. Although each criterion has some impact on all stakeholders, one way to group criteria is by the principal stakeholder affected (Table 7.4).

Table 7.4: Stakeholder Criteria

Stakeholder	Criteria
Owner	• Cost (4 criteria) • Time • Construction & maintenance safety
Community	• Environmental impact • Visual amenity • Other user potential • Potential for temporary connection
Road user	• Operational availability • Public road user risk

Various weighting scenarios were tested that moved the emphasis between the three stakeholder groups. The relative weightings of each criterion as developed originally (Table 7.1) was maintained within each stakeholder group and the weightings were then reapplied to show the top 5 ranked options under each scenario (Table 7.5).

Table 7.5: Sensitivity Tests of Long Listed Options

Weighting = Owner 53%, Community 23%, User 24%						
Initial assessment	Ranking	**1**	**2**	**3**	**4**	**5**
	Option	10	1.1	12	17	1.2
	Score	679	671	628	611	581
Weighting = Owner 25%, Community 50%, User 25%						
Community dominated	Ranking	**1**	**2**	**3**	**4**	**5**
	Option	10	1.1	1.2	12	17
	Score	660	649	632	599	588
Weighting = Owner 25%, Community 25%, User 50%						
User dominated	Ranking	**1**	**2**	**3**	**4**	**5**
	Option	1.2	10	1.1	4	12
	Score	669	655	652	629	618
Weighting = Owner 38%, Community 30%, User 32%						
Cost - zero weighting	Ranking	**1**	**2**	**3**	**4**	**5**
	Option	1.1	10	12	17	1.2
	Score	721	699	664	656	615

7.5. Selection of the Preferred Option

Further development of the four short listed options allowed a more informed comparative assessment of each option under the 12 comparative criteria. A one-day workshop was held (13 January 2004) with the same mixture of attendees as identified in Section 7.3. The same methodology adopted previously for assessing and ranking the options (Section 7.3) was reapplied. The results of the comparative scoring on the four major options (including sub options) based on the weighted comparative criteria are provided in Table 7.6.

Table 7.6: Results of MCA Scoring – Short Listed Options

Ranking	Option number and sub option	MCA score (max. of 1000)
1	A 1.1	697
2	B 12	585
3	B 17	568
4	C 1.2	567
5	A 10	509
6	D	322

Table 7.7 summarises the outcomes of the assessment.

Table 7.7: Results of the MCA Assessment

Option	Findings
A 1.1 - continuous near shore bridge	• Highest initial score • Exceeds project budget • Best meets safety criteria
A 10 - separate near shore bridges	• Major risk was construction safety and long term maintenance concerns of geotechnical works on middle headland • Extensive use of shotcrete lowers visual amenity • Slightly cheaper than A 1.1
B 12 - combined bridges and tunnel	• Second highest initial score • Some risk with tunnel costing and need for pedestrian provisions
B 17 - combined bridge, tunnel, shelter	• Some risk with tunnel costing and need for pedestrian provisions
C 1.2 - continuous offshore bridge	• Most expensive, exceeds project budget • Environmental impacts on marine area
D - existing road stabilisation	• Very high construction safety risk • High ongoing maintenance • Extensive use of shotcrete lowers visual amenity

Option E

This was a bridge in GD2 with other treatments (stabilisation etc) on GD1, 3, 4 and 5 (Figure 7.2). GD3 would have a high maintenance requirement and GD4 would be provided with an enlarged catch ditch and berm. This option scored 567, ranking it equal fourth.

Option F

This was a modification of Option A 1.1 where the bridge in GD4 was eliminated and the treatments outlined in E adopted (Figure 7.2). This option scored 707 and was subsequently developed as the preferred option.

7.6. Sensitivity Testing of Short Listed Options

Before proceeding with the refinement of the preferred option the sensitivity test developed for the initial MCA (Section 7.4), which changed emphasis between the stakeholder groups, was re-run (Table 7.8).

Table 7.8: Sensitivity Tests on Short Listed Options

Relative Weighting = Owner 53%, Community 23%, User 24%				
Initial Assessment	Ranking	1	2	3
	Option	F	A 1.1	B17
	Score	707	697	568
Relative Weighting = Owner 25%, Community 50%, User 25%				
Community dominated	Ranking	1	2	3
	Option	A 1.1	F	C 1.2
	Score	643	636	618
Relative Weighting = Owner 25%, Community 25%, User 50%				
User dominated	Ranking	1	2	3
	Option	A 1.1	C 1.2	F
	Score	743	732	696
Relative Weighting = Owner 38%, Community 30%, User 32%				
Cost - zero weighting	Ranking	1	2	3
	Option	A 1.1	F	C 1.2
	Score	724	690	618

The sensitivity analysis demonstrates that when the emphasis is strongly weighted in favour of specific stakeholder groups, option F continues to rate extremely highly. Option A 1.1 scores only slightly higher than option F when the criteria weightings are biased towards particular user groups (Community dominated 1.1%, User dominated 6.8% and cost- zero weighting 4.9%). Option F is therefore confirmed as the preferred option due to its high scoring across all criteria, which thus delivers best value for money for all stakeholders.

8. Design Considerations

8.1. Existing Road

The current alignment of Lawrence Hargrave Drive south of Bald Hill has a posted speed limit of 60km/hr with warning signs on a number of bends with substandard curves. The general speed environment however promotes driver alertness with residences abutting the road for much of the length and constant changes in vertical and horizontal geometry.

Other characteristics of the existing section of Lawrence Hargrave Drive between Clifton and Coalcliff include:

- Undivided bitumen sealed road with variable lane widths generally between 2.5 to 3.0m wide and no consistent shoulders;
- Limited provision for pedestrians and cyclists;
- No street lighting;
- W-Beam type safety barriers along the eastern side; and
- Kerb and guttering along both sides of the road with a series of pipe culverts allowing for the direct discharge of stormwater into the ocean.

8.1.1. Traffic Data

The closest Traffic Data Station (07.754) to the Proposal is located immediately south of Clifton on Lawrence Hargrave Drive. The annual average daily traffic (AADT) for Lawrence Hargrave Drive prior to the closure is included in Table 8.1.

Table 8.1: Traffic Volume Data for Lawrence Hargrave Drive

Year	AADT
1992	2214
1994	2922
1997	2214
1998	2169
2000	3113

The RTA undertook heavy vehicle counts in May 2002 at Station 07.754. The daily heavy vehicle percentage was determined to be 4.8%.

Prior to the closure of Lawrence Hargrave Drive, tourist traffic varied depending on seasonal weather conditions. It is not anticipated that forecast traffic volumes would increase substantially after Lawrence Hargrave Drive is re-opened in February 2006.

8.2. Design

8.2.1. Urban and Regional Design

The draft Illawarra Escarpment Strategic Management Plan (Wollongong City Council) identifies the escarpment as an iconic feature of the Illawarra region that requires active conservation, remediation and management. It spans many tenures and agencies and has, at a local scale, many unique management requirements.

The plan recognises the important visual and landscape components of the region and articulates a vision to:

> *'Protect, conserve and manage the environmental values and assets of the Illawarra Escarpment consistent with the principles of Ecological Sustainable Development (ESD)'*

The plan is based on a number of guiding principles including recognition of the escarpment for its natural and cultural heritage, recognition that the asset is in a degraded state and therefore continual improvement is required and the need for an adaptive management approach to provide flexibility and assessment of effective actions.

The design principles for this Proposal have been prepared in accordance with:

- Urban Design Advice Note, Urban and regional design as part of environmental assessment;
- *Environmental Impact Assessment Guidelines Version 4 April 2001* 'Landscape and Visual section' (RTA 2001); and
- *Bridge Aesthetics, Design guidelines to improve the appearance of bridges in NSW* (RTA 2003).

In order to ensure the local context is protected, negative impacts avoided and a positive project developed, the following design principles have been adopted by the LHD Link Alliance:

- An extremely simple and elegant bridge to complement not conflict with the rocky textured coastline;
- Minimise adverse visual impacts;
- A structure that touches the ground (and sea) lightly with careful attention to how the ends of the bridges meet with the landscape (particularly in terms of vertical geometry);
- Careful attention to the scale relationship with the landscape (including the sea);
- Careful attention to detail, especially the support structure and deck;
- Minimisation of impact on heritage elements and remnant bushland; and
- Creation of outstanding scenic views from the bridge.

In brief the bridge would have a simple form and geometry and would be designed to minimise potential adverse visual impact.

8.2.2. Design Parameters

The following design criteria would be followed for the bridges:

- Design speed of 60km/hr;
- Maximum design vehicle equivalent to a 19m semi trailer;
- Lane widths of approximately 3.5m;
- Shoulder widths of 0.5m and greater; and
- Bridge design load of T44 and L44 (Australian Bridge Design Code 1996).

All relevant RTA standards and specifications would be followed to satisfy current road and bridge standards as well as materials specifications.

8.2.3. Design Features

The main design features of the Proposal are summarised below and sketches of the preferred option including bridge configurations, road alignment and geotechnical prevention treatments are included as Figures 8.1 and 8.2.

Bridges

A number of influences were considered in selecting the form of the bridge structures:

- Location of bridges to avoid rock falls;
- Alignment of bridges to be sympathetic with natural topography;
- Minimisation of impacts on the coastal environment; and
- Constructability constraints of the difficult and unstable terrain.

Rockfall simulation was undertaken using ROCFALL (v4.038) to make an assessment of the runout distance, trajectory distance and impact energy of boulders being generated from various stratigraphic units along the route.

The major sections of rockfall concern where in the southern amphitheatre and around the middle headland. The analysis determined that a bridge structure should be located some 45m east of the inner side of the existing road to ensure rockfall impacts where eliminated. Similarly the analysis concluded that a bridge around the middle headland should be located 25m east of the inner side of the existing road.

The trajectory analysis also found that the bridge should remain at essentially the same level as the existing roadway so that falling rocks could pass under without impacting on the structure.

The stability of the roadway embankment, below the existing roadway, is severely compromised in a number of locations and construction access for pier and foundation construction is very difficult. The preferred location for this construction given the instability of the material and the need to provided safe construction working areas, was near the current shoreline.

A number of different construction techniques were considered for the bridge. Safety of access for construction and future maintenance personnel combined with urban design and structural economy, led to a balanced cantilever construction being adopted across the variable terrain in the southern amphitheatre. The bridge changes to an incrementally launched construction once the alignment reaches the rock shelf in front of the middle headland. This can accommodate the required tighter radius and can be constructed faster and more economically.

The span configuration, depth of deck, curvature of the superstructure and height above foundation are all considered to provide an aesthetic urban design solution that would be structurally economic and safe to construct and maintain. Careful consideration was also given to the form of the connection between the two structural types to provide an integrated visual transition.

The design would provide protection to the piers to ensure that any rocks falling towards the bridge piers are diverted before impact. Additional safety provision would include strengthening the piers to accommodate potential impact loads even though the chances of direct impact are considered low.

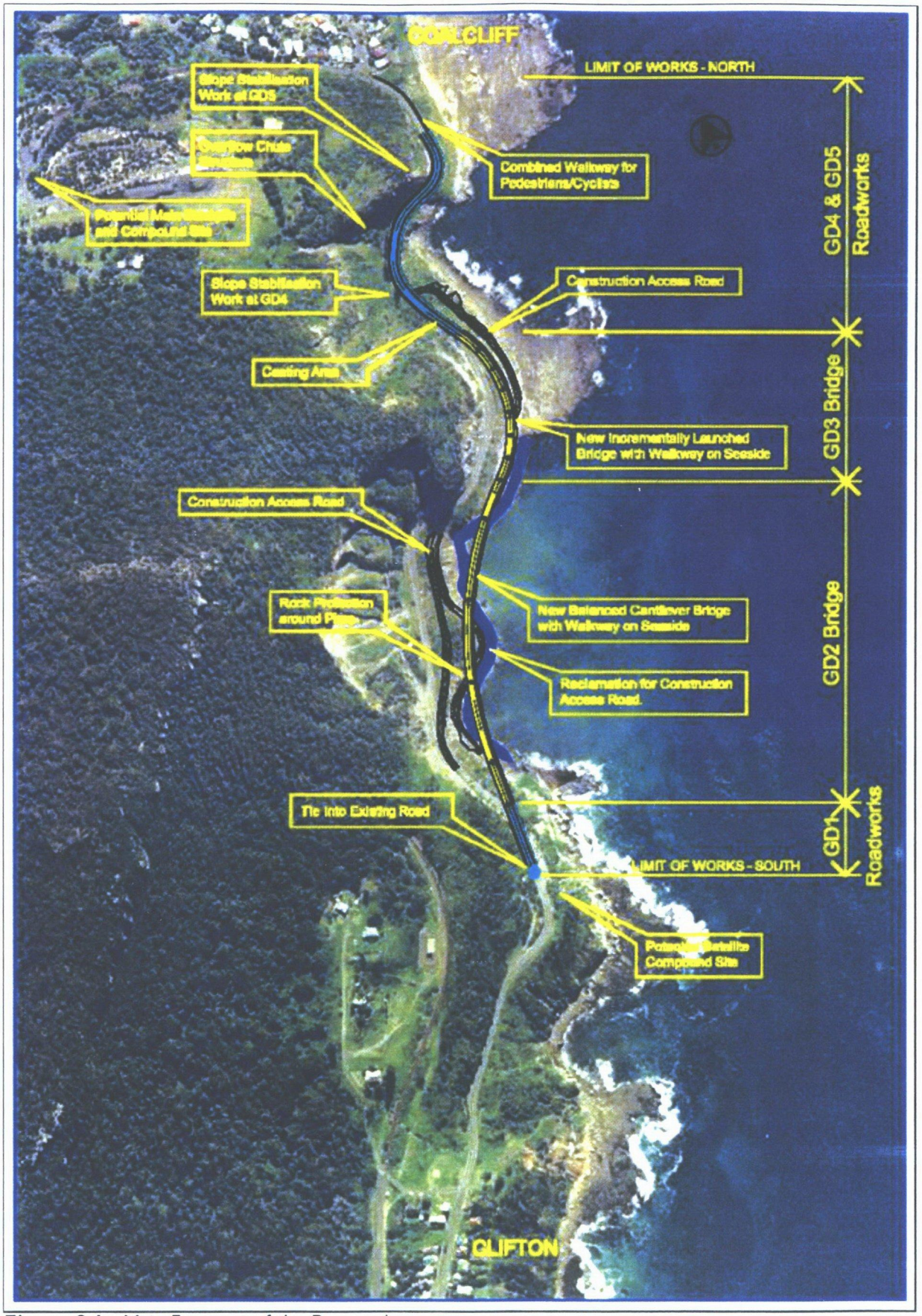


Figure 8.1: Main Features of the Proposal

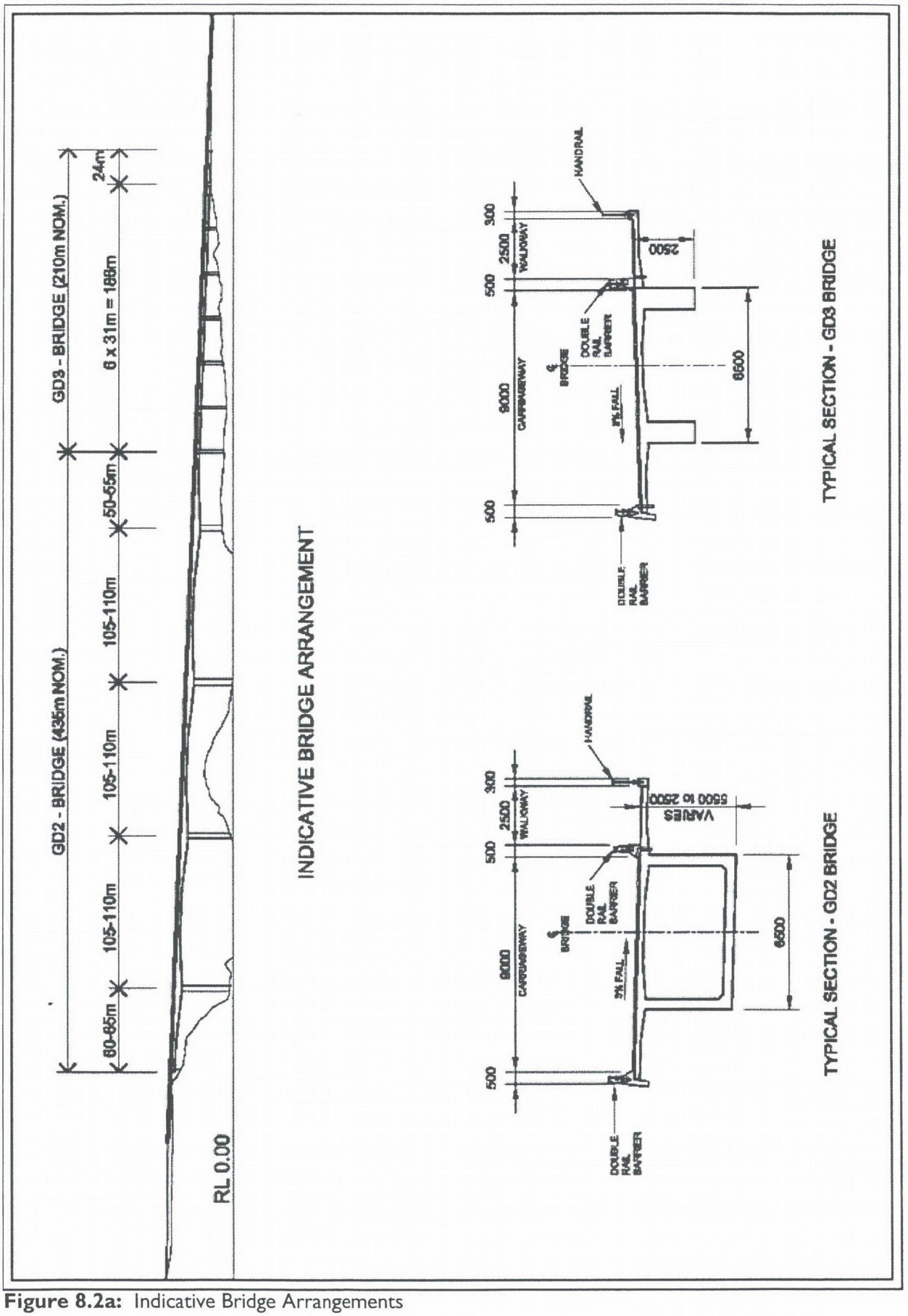


Figure 8.2a: Indicative Bridge Arrangements

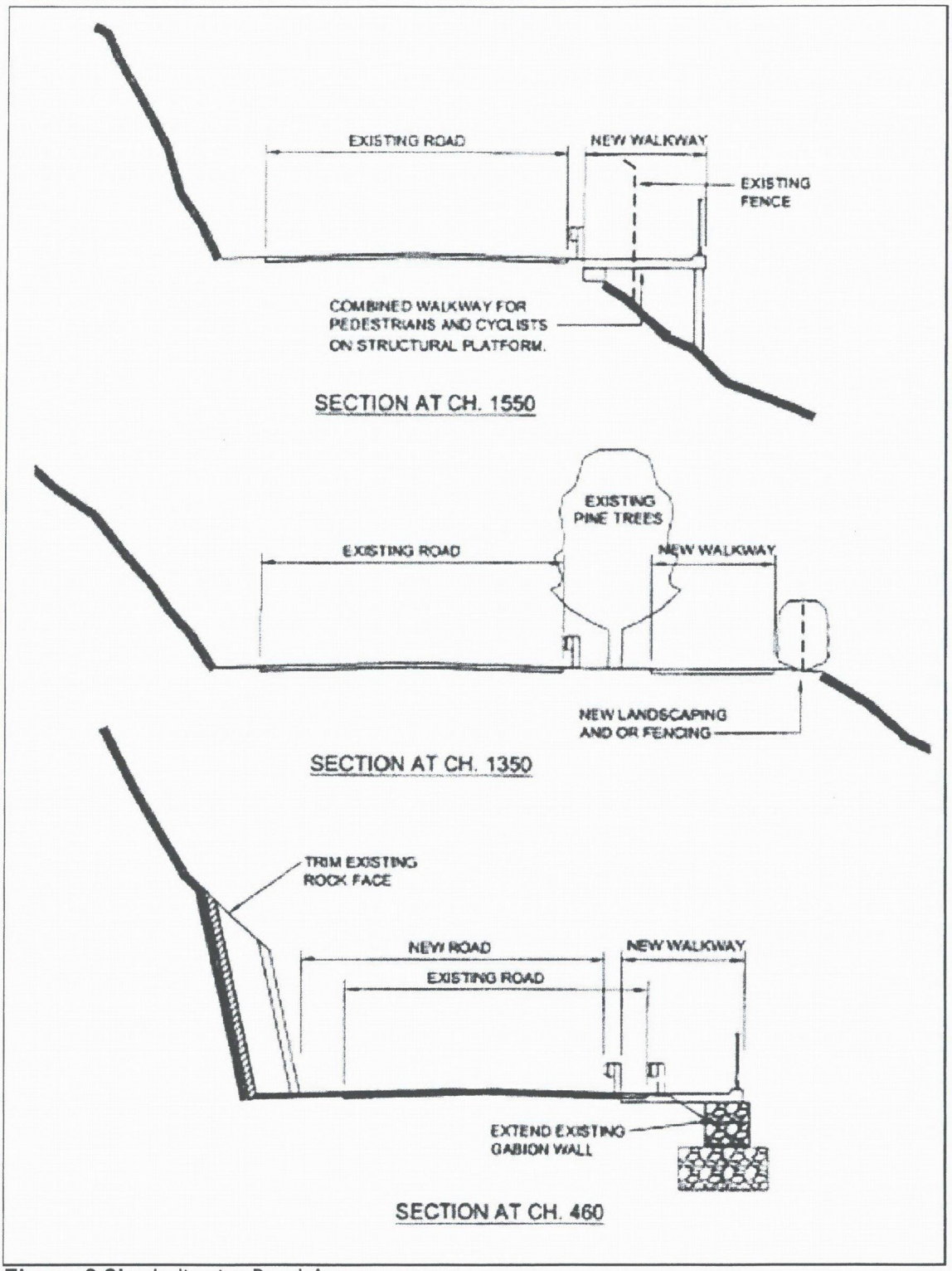


Figure 8.2b: Indicative Road Arrangements

Balanced Cantilever Long Span Bridge

The balanced cantilever bridge in GD2 would include the following features:

- The bridge would be approximately 435m in length, located a minimum of 45m east of the existing road, and be approximately 41m (at the southern end) to 24.5m (at the northern end) above mean sea level;
- The bridge deck would be approximately 12.8m wide and would include two 3.5m wide lanes, two 1.0m wide shoulders, barriers and a separate footway 2.5m wide shared pedestrian/cyclist access path;
- Traffic barriers would be included at the edge of the road shoulders and would consist of a concrete parapet and metal railing arrangement. A 1.1m high pedestrian barrier would also be included on the eastern side of the footway;
- The alignment of the bridge would follow the natural curvature of the coastline;
- The bridge would feature five spans, requiring four piers. The first and last spans would be approximately 55-60m in length, with three middle spans of approximately 108min length.; and
- The bridge piers would be approximately 6.5m by 3.5m in dimension and would consist of six piles per pile cap. Each pile would be 1.2m in diameter and approximately 20m deep. Durable rock armour and concrete armour units would be required around each pile cap to protect it from coastal processes and erosion.

Multiple Span Bridge

The multiple span bridge in GD3 would be incrementally launched and include the following features:

- The bridge would be approximately 210m in length, with six spans of 31m and an end span of 23m, located approximately 25m east of the existing road at the southern end of the bridge before joining the existing road at the northern end;
- The bridge deck would be approximately 12.8m wide, configured as discussed above;
- Traffic and pedestrian barriers would also be as discussed above;
- The bridge alignment would be of constant radius following the natural curvature of the headland in GD3;
- The bridge would feature seven piers and all of the structural support members would be located below the bridge deck; and
- The bridge piers would be approximately 6.5m by 1.5m in dimension and would consist of two piles per pile cap. Each pile cap would be approximately 2m by 6m and each pile would be approximately 1m in diameter and approximately 20m deep. Durable rock armour would be required around each pile cap.

Bridge Connection

The bridges would connect to the existing Lawrence Hargrave Drive alignment in GD1 and GD4 with associated road surface upgrade. The features of the Proposal within these areas include:

- Minor earthworks and slope stabilisation where required, ensuring that the underlying sandstone is not undercut and the upper slope to the Illawarra Railway Line is not destabilised in GD2.
- The road width at the bridge connections would be consistent with the existing road. The lanes would be separated by line marking and would

include provision for pedestrians and cyclists in the form of a shared path for the length of the Proposal

- Minor geotechnical stabilisation works would be required where the bridges connect to the existing alignment. This would typically consist of a retaining wall or rock gabion supporting structure where appropriate and would be further investigated at detailed design; and
- The pavement design would consist of a flexible pavement with an asphalt surface similar to the existing road surface.

Geotechnical Prevention Treatments

The geotechnical treatments proposed for GD4 would include the following features:

- A 'catch ditch' would be created by the excavation of existing debris upslope of the road and the existing embankment would be raised;
- Diversion berms or similar would be constructed west of the existing road. The function of the treatment is to direct debris to chutes passing under the existing road. The size of the berms would be approximately 3m in height and approximately 3m in width;
- A chute structure would be constructed under the existing road alignment, in the vicinity of the existing stormwater culvert in GD4 (Figure 8.1). The chute would be approximately 16m in length, 3m in height and up to 12m in width. The chute design would either be a simple concrete plank structure or culvert arrangement, with an appropriate pedestrian and cyclist safety barrier included; and
- Localised stabilisation of the embankments above and below the existing road would also be undertaken, including the addition of rock armouring at the base of the chute structure in GD4. This would extend northwards towards the southern extent of the northern rock platform, where there is a particularly narrow embankment in the coastal impact zone. The rock armouring is expected to consist of a rock bund, supporting backfill material that would protect the embankment from further regression and undercutting of the road.

The geotechnical treatments proposed for GD5 would include the following features:

- Removal of the rock overhanging on the south-facing cliff of the northern headland. This work would be a continuation of works undertaken by the then Department of Main Roads in 1967 and it is anticipated that approximately 6000m^3 of unstable overhanging rock would be removed;
- Minor removal of unstable rock at the point of the northern headland above the existing road would be undertaken. It is anticipated that approximately 5000m^3 of rock material would be removed; and
- Localised stabilisation of the embankments above and below the existing road would also be undertaken, which would include rock bolting, meshing and minor fencing.

Drainage

The drainage structures for the Proposal would include the following features:

- Transverse drainage structures, such as pipe culverts, in conjunction with standard road drainage would be used along the realigned road section in GD1, GD4 and GD5. The flow width and capacity of the structures would be designed to withstand the heavy rainfall events that are experienced within the study area; and

- Scuppers would be used to drain stormwater from the bridge deck. The scuppers would be located at 3m intervals and would consist of a 75mm by 100mm unplasticised polyvinyl (upv) box-out type.

8.3. Engineering Constraints

8.3.1. Access and Material Availability

- Access to the site area would be required for the transportation materials and plant along adjacent sections of narrow and steep local roads with due consideration to the condition and existing traffic volumes of those roads;
- The nature and quality of the existing sandstones present on site make them unsuitable for permanent engineering works and large quantities of durable materials would need to be imported for the permanent protection works;
- Access to the pier locations would require the construction of an access track through GD2. To construct a safe access, a road with grades approximately 1:6 is required to allow plant to reach the pier site. The access road to achieve this geometry would need to traverse the existing slip failure in GD2, and any works in the vicinity of the tension crack described in Section 9.1 would require some temporary stabilisation works. This would typically consist of regrading the adjacent slope to a safe gradient or constructing a temporary retaining wall or rock gabion structure to support the unstable material during construction; and
- A 10m wide access track would be constructed to traverse the embankment below GD3. Vehicles would be able to turn around at the base of the track and at the working platforms associated with the piers.

8.3.2. Foundation Conditions

- The foundation conditions for the bridges and stabilisation works below the existing road are variable and present significant structural challenges;
- The presence of decommissioned coal workings in the Bulli coal seam below the southern headland would also need to be considered when designing the structure founding in this area; and
- Significant slips are apparent in both the southern and northern amphitheatre areas. If they are encountered foundations constructed in these areas would have to be designed to accommodate the resultant lateral ground forces.

8.3.3. Sea State

- The coastal processes at work along this section of Lawrence Hargrave Drive are quite severe and are a major contributor to the current instability of the roadway. It is known that extreme wave heights in excess of 5m have been observed in this vicinity and even the effects of regular 1-2m wave action on the erosion of the coastline is readily apparent;
- Major embankment construction works undertaken in 1988 have been totally undermined and a major crack has opened up in the southern amphitheatre that threatens the integrity of the current road surface;
- To construct any foundations on stable bedrock within the amphitheatres, access to pier locations in the vicinity of the surf zone would be required. This would entail constructing a substantial access track along the shoreline which would need to be engineered to withstand the high sea states generated in this area; and

- Programming of works to minimise the exposure to the wave conditions could not be undertaken as a result of the irregularity of high wave activity. Any access track constructed would need to be designed to withstand substantial wave heights. Works in this environment are associated with high cost and would be minimised where possible.

8.3.4. Safety during Construction

- The unstable geotechnical conditions below the ground and the ever present risk of rockfalls from above the road make the Proposal site a particularly hazardous area. Risks would be exacerbated during construction operations, which would require the use of heavy machinery, high reach lifting equipment, and the disturbance of already unstable areas;
- The embankment in GD2 would require some temporary stabilisation works to ensure the safety of any construction traffic below or in the vicinity of the existing tension crack;
- In adopting the hierarchy of control, the primary aim is to avoid any safety risks. Construction of any structure outside the rockfall zones therefore provides the safest construction method when assessed against the potential for a rockfall incident;
- The inclement weather conditions are of particular concern, as rockfall and debris slide incidents are much more likely after rain and the site would need to be closed for extended periods after rainstorms. The area is also subject to highly variable winds that are further accentuated by the cliffs;
- Working at height would be a substantial risk on the project, especially with any geotechnical stabilisation works on the Scarborough Sandstone cliffs, which extend up to 30m vertically above the existing road. Installation of geotechnical treatments would require extended periods of exposure to works at height;
- Due to the nature of the required safety measures for working at height, production rates are considerably reduced, increasing exposure time to potential incidents. Considerable constraints are imposed on construction activities when overhead works are being carried out in the vicinity, due to the threat of rockfall; and
- As highlighted in previous sections, works in a marine environment would be required. With the high probability of significant wave action, any works in this area would attract safety issues such as stability of access roads, impact of waves, and drowning.

8.3.5. Site Spatial Limitations

- The physical limitations on available level ground would be a major constraint on construction operations. Major bridging operations would require level terrain behind abutments for casting beds and launching areas;
- In order to maintain a trafficable path through the site for construction vehicles, temporary works are likely to be required. These would include temporary retaining walls to support access tracks, as well as programming the works in such a manner to ensure that access can be maintained;
- Access to any works below the road would be particularly difficult, with the construction of access tracks being required to facilitate the establishment of piers and pile caps on suitable rock formations;

- Access to the site would be required from both the northern and southern ends of the site as the existing road would not be able to be used as a thoroughfare for all vehicles during construction; and
- Vehicles would be able to turn around at the base of the access track and at working platforms associated with the piers.

8.4. Construction

8.4.1. Construction Tasks

The following construction tasks would be involved in the Proposal:

- Site establishment and preliminary works which include:
  - Establishment of stockpile and compound site(s), including concrete batch plant as required and casting area; and
  - Commencement of pre-construction mitigative measures, which would be outlined in the Construction Environmental Management Plan, such as installation of erosion, sediment and water quality controls.
- Clearing and grubbing of vegetation;
- Stripping, stockpiling and management of topsoil;
- Bulk earthworks, including the construction of access tracks and working platforms in GD2 and GD3;
- Construction of bridge(s);
- Geotechnical stabilisation works;
- Drainage works;
- Foundation works and pavement construction, including localised enhancements;
- Signposting, line-marking and installation of other road furniture;
- Topsoiling, rehabilitation and revegetation; and
- Finishing works.

8.4.2. Construction Materials

Based on the information obtained through the concept design process, it is anticipated that the following construction material types and approximate volumes would be required for the Proposal:

- Fill material – 60,000m^3;
- Hard rock (used for rock armour) – 4,000m^3;
- Concrete – 10,000m^3;
- Base material (aggregates) – 2,000m^3;
- Wearing course (asphalt) or spray seal – 12,000m^2; and
- Reinforcement and structural steel – 2,000 tonnes.

It is anticipated that fill material and hard rock required for the reclamation works and rock armouring would be sourced from geotechnical works undertaken in GD4 and GD5. However, if this material proves to be unsuitable for the purpose, fill material may be imported from an outside source. All other materials required for the Proposal would be sourced from within in the Illawarra region where possible.

8.4.3. Construction Equipment

It is anticipated that standard construction and earthwork equipment and plant would be required for the proposed works. Typical equipment and plant would include:

- Cranes;
- Excavators;
- Haulage trucks and other heavy transport;
- Graders;
- Vibratory rollers;
- Water cart;
- Concrete pumps;
- Concrete agitators;
- Piling rigs;
- Bitumen spraying and asphalt paving plant;
- Service vehicles; and
- Hand held plant.

8.4.4. Truck Movements and Haulage Routes

The Proposal would require 40 additional heavy vehicle movements per day as a result of the transport of material and manufactured items to the site and the removal of any spoil or waste materials from the site. It is anticipated that the number of truck movements for both ends of the site would be similar.

Anticipated haulage routes to and from the Proposal site are described below:

- *Northern access,* via Lawrence Hargrave Drive off the F6 Freeway at Helensburgh, passing through Stanwell Park and Coalcliff; and

- *Southern access,* via Lawrence Hargrave Drive off the Princes Highway at Bulli, through Thirroul and all the villages between Thirroul and Clifton.

If a concrete batching plant is required during construction, up to 80 additional truck movements associated with the transport of concrete would be anticipated. These movements may result in up to 30 movements at peak times.

Discussion on the potential impacts of additional truck movements and haulage routes on local traffic and communities is provided in Section 9.11 of this REF.

8.4.5. Stockpile and Compound Sites

It is anticipated that two site compounds (a main site and a satellite site) would be established as a result the Proposal. The main site would provide full site services, including:

- Offices and meeting rooms for site personnel;
- Reception and general administration area;
- Amenity and first aid facilities;
- Storage for light equipment and tools;
- Materials and fuel storage areas; and
- Communication facilities and parking areas.

These facilities would require connection to electricity and communications networks and water supply, as well as appropriate stormwater management measures. Fencing with security points to control access would enclose the site compounds. Appropriate security lighting would also be required around the compounds.

The location of the site compounds has yet to be determined, however, there is potential to establish the main site compound at the northern end of the study area within Illawarra Coke Company property. The satellite site compound could potentially be established at the southern end of the study area in the vicinity of the existing RTA offices / amenities, which were used during the pre-construction activities.

As a result of the quantity of concrete to be used for bridge construction, there is potential to establish a temporary concrete batching plant to produce a quality assured constant supply of concrete. The most suitable location for a concrete batching plant would be within Illawarra Coke Company property, adjacent to the main site compound.

Using the incremental launching technique for construction of a bridge involves casting lengths of the bridge superstructure in a specially built casting area. To enable the multiple span bridge to be incrementally launched, a casting area would need to be established. It is envisaged that the casting area would be located within the existing road alignment in GD3.

The potential environmental impacts associated with any stockpile and compound sites, including a concrete batching plant and casting area, are specifically addressed in Section 9 of this REF.

8.4.6. Workforce and Working Hours

Construction activities would be undertaken by LHD Link Alliance and it is anticipated that the workforce required for the Proposal would consist of approximately 50 construction personnel.

The proposed works would be performed during normal working hours recommended within the Environmental Noise Control Manual (EPA 1999), which are described in Table 8.2.

Table 8.2: Normal Working Hours

Day	**Start Time**	**Finish Time**
Monday – Friday	0700	1800
Saturday	0700	1300
Sunday / Public Holidays	No Work	

If construction noise is audible at residential premises on Saturday, it is likely that the start time would be rescheduled to 0800.

There is scope for work to be undertaken outside of the standard working hours. Should this work be required the procedure contained in the RTA's *Noise Management Manual*, 'Practice Note vii – Roadworks Outside of Normal Working Hours' would be followed.

8.5. Reclamation and Access Tracks

Construction of the balanced cantilever bridge in GD2 requires the establishment of an access track and working platforms. To construct a safe access track, a road with grades approximately 1:6 is required to allow the establishment of plant at the pier site. The access track would be approximately 10m wide and would traverse the embankment below the existing road before reaching each pier site. Each pier site would have a working platform approximately 20m by 30m in dimension and be located approximately 5m above the mean high water level. It is anticipated that both the construction of the access track and working platforms would require approximately 20,000m^3 of fill material. Both the access track and working platforms would be subject to a highly active marine environment and would therefore require durable rock armour with additional concrete armour units. There is scope for the access track in GD2 to be retained after construction to enable access for future maintenance purposes. Vehicles would be able to turn around at the base of the access track and at the working platforms associated with the piers. The footprint of the first four bridge piers (from south to north), including dimensions and anticipated reclamation are shown in Figures 8.3 – 8.6.

As a result of the spatial limitations within GD2, it is proposed to reclaim approximately 3,000m^2 of the existing coastal boulder-field foreshore environment. The reclamation would provide for the access track and working platforms, including rock armouring, which would consist of a rock bund of medium to large sized rocks with a layer of geofabric behind, to prevent any washout of the reclamation material (refer Section 9.1). Details of the statutory obligations and potential environmental impacts with regards to reclamation are described in Sections 4.5 and 4.6 and Section 9 of this REF respectively.

Similarly, the construction of the piers for the multiple span bridge requires the establishment of an access track. The access track would be approximately 10m wide and would traverse the embankment below the existing road in GD3. No reclamation would be required to accommodate the access track, however rock armouring would need to be included to protect against the erosive effects of the surrounding environment and the associated coastal processes. The armouring would be similar to that applied to the reclamation in GD2 and consist of a rock bund made up of medium to large boulders, similar to those occurring currently. The construction of the access track would not remove any material, however approximately 5,000m^3 of fill material would be required. It is not anticipated that the access track would be retained after construction as routine maintenance could be performed from the bridge deck.

8.6. Rehabilitation

8.6.1. Revegetation

The removal of existing vegetation would be minimised wherever possible, and revegetation of disturbed areas with species endemic to the northern Illawarra would be undertaken using a combination of hydromulch and hand planting where appropriate. Native seed stock would be collected where possible from the local area.

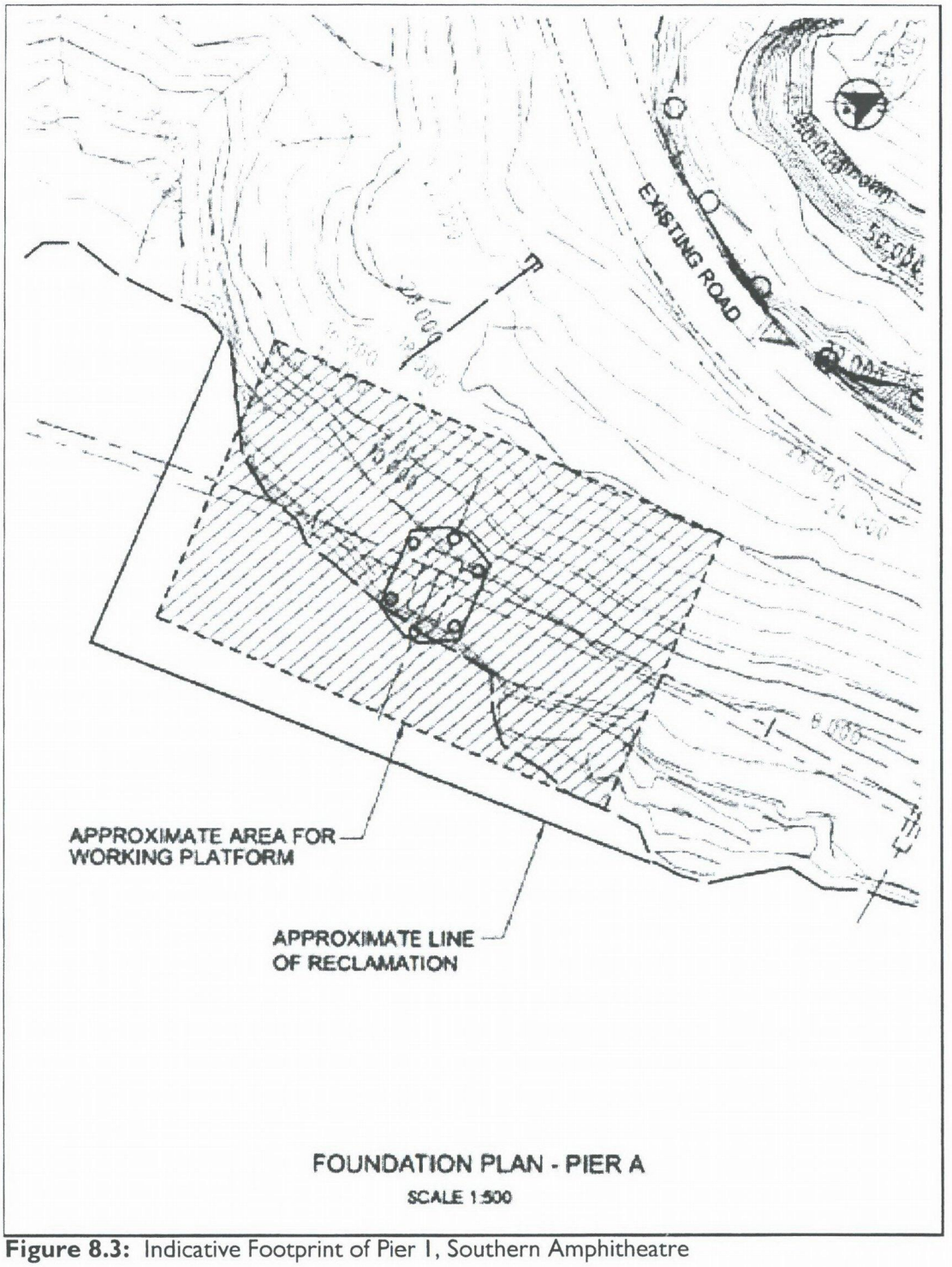


Figure 8.3: Indicative Footprint of Pier 1, Southern Amphitheatre

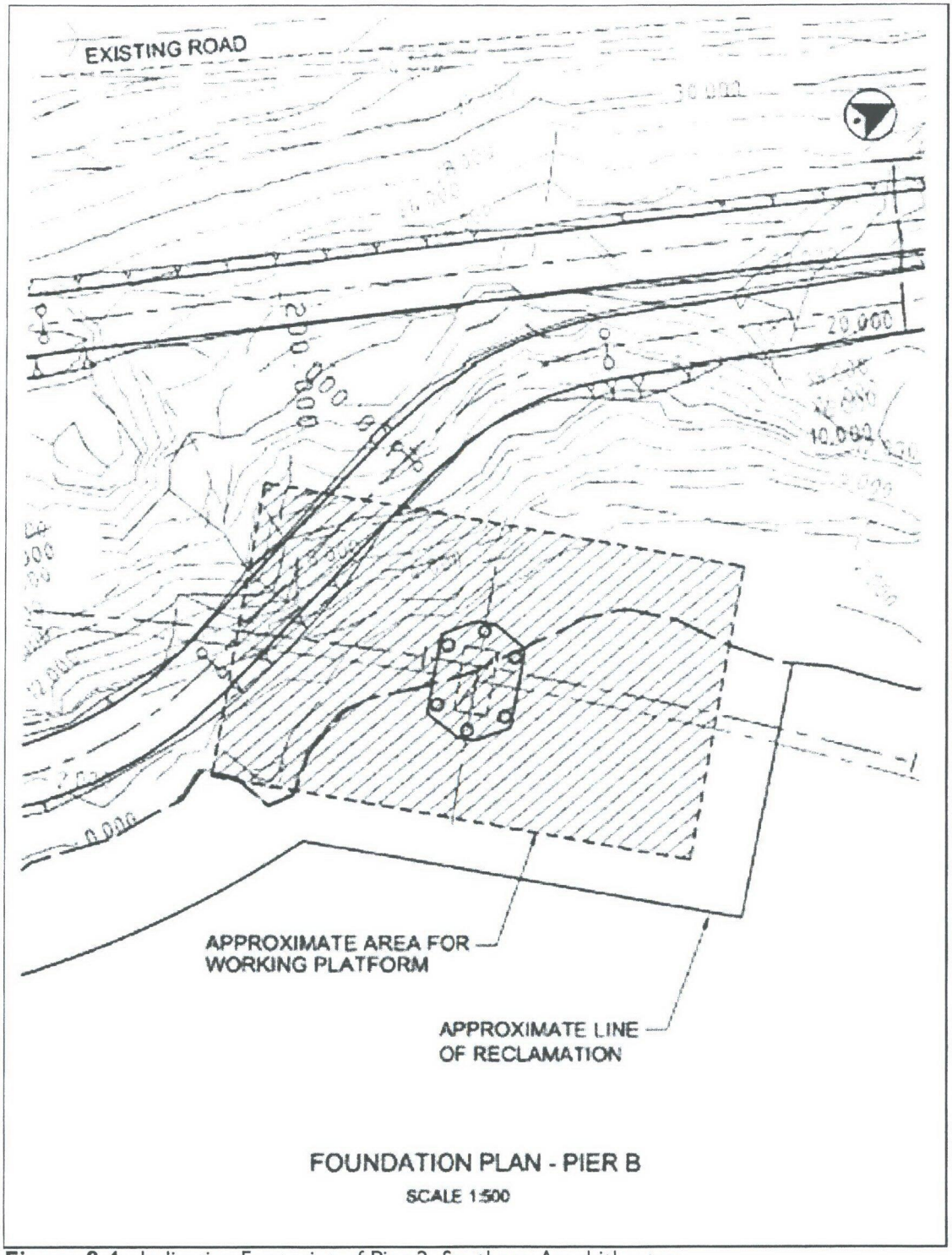


Figure 8.4: Indicative Footprint of Pier 2, Southern Amphitheatre

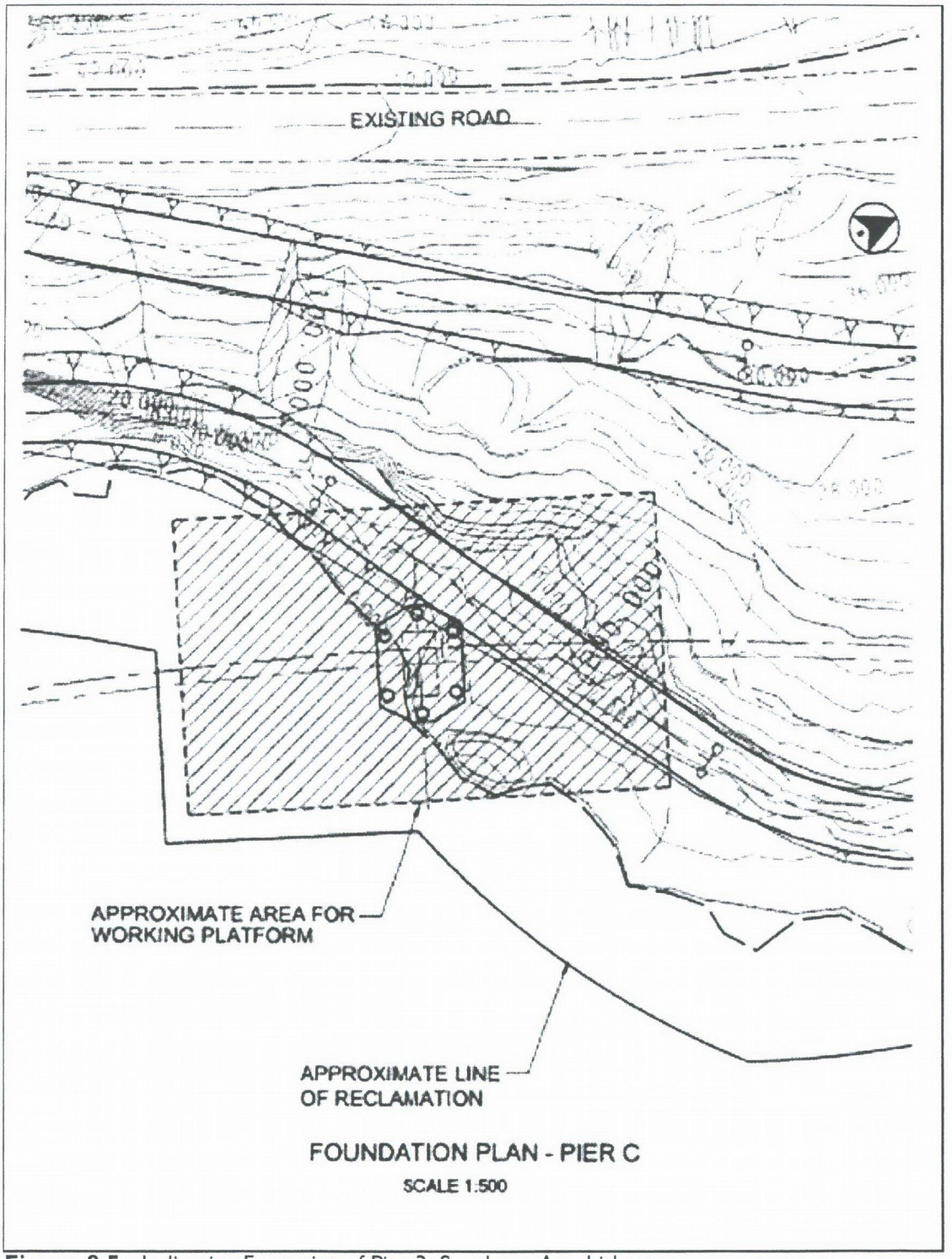


Figure 8.5: Indicative Footprint of Pier 3, Southern Amphitheatre

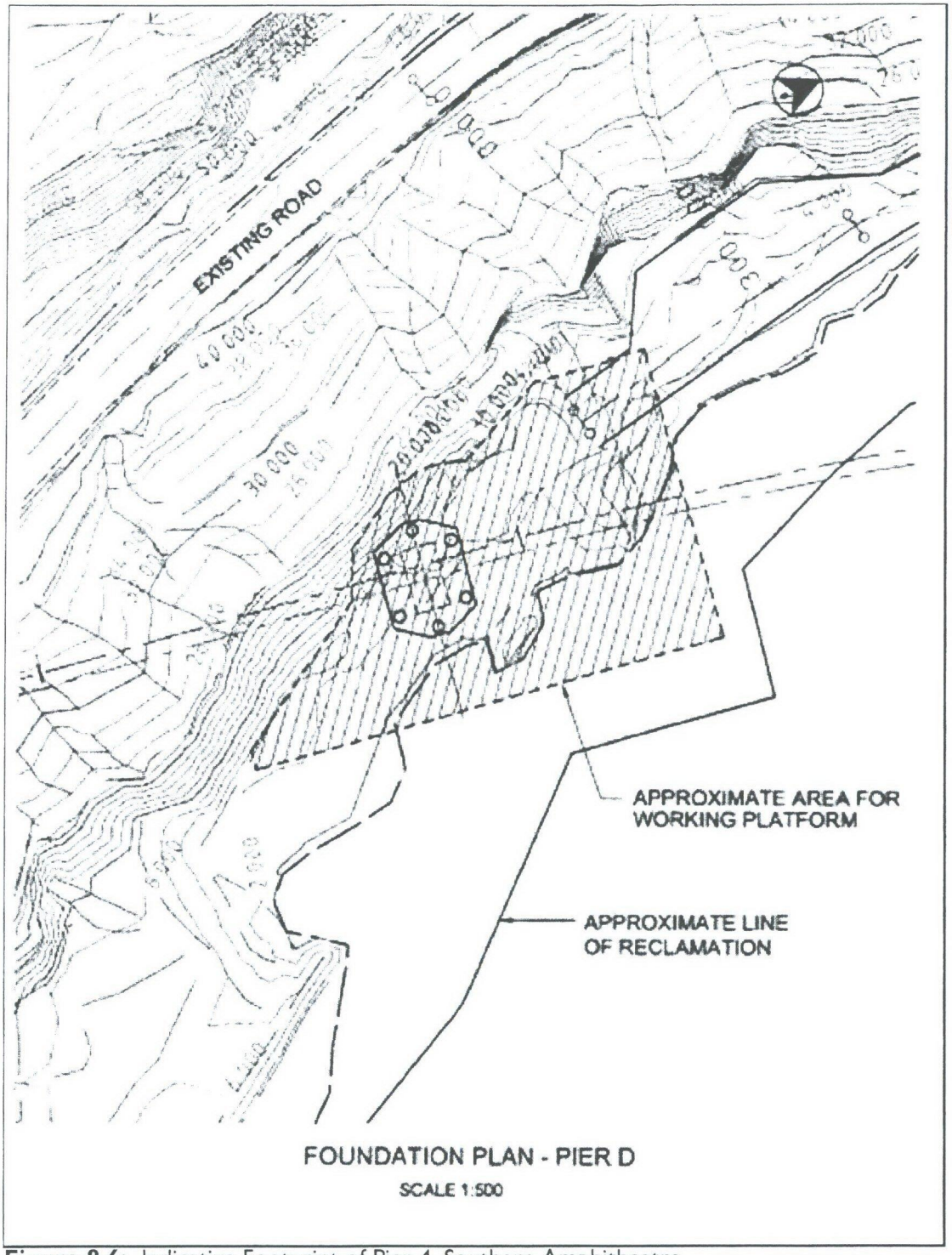


Figure 8.6: Indicative Footprint of Pier 4, Southern Amphitheatre

8.6.2. Existing Road

Following completion of construction activities, a section of the former Lawrence Hargrave Drive between the southern headland (GD1) and the northern section of the middle headland (GD3) would no longer be required. Ongoing stabilisation and maintenance of the cliffs and the embankment below the road and maintenance of the section of road itself would cease. Any rocks falling on the road would not be removed and erosion of the embankment below the road would be allowed to continue under natural erosion processes.

To maintain public safety and to deter access to this section of redundant road, it is proposed to erect fencing to prevent vehicle and pedestrian access.

It is not proposed to remove and rehabilitate the existing pavement, as access would still be required for maintenance purposes, particularly to the bridge piers in the southern amphitheatre where regular inspections would be required. No direct access would be required to the piers on the central headland as these are above the high tide mark and can be inspected from the bridge deck.

8.7. Property Acquisition

The RTA's Land Acquisition Policy outlines the procedures and guidelines for the transfer of land between the Authority and affected property owners. The policy sets out the procedures for partial acquisition and special conditions that apply to total acquisition, compulsory acquisition and hardship acquisition.

The Proposal would result in minor property acquisition from Wollongong City Council, DIPNR and the Illawarra Coke Company, however the approximate land area required is currently unknown and subject to detailed design. Negotiations are currently being undertaken with the concerned landholders.

8.8. Utilities

Existing utilities to be affected by the construction of the Proposal are limited to the 11 kV overhead transmission line. Within the study area, the overhead transmission line is located along the existing alignment of Lawrence Hargrave Drive.

Negotiations are currently underway with Integral Energy and there is scope to relocate the transmission line to within the bridge superstructure.

9. Environmental Assessment

9.1. Topography, Soils and Geology

9.1.1. Existing Environment

Topography

Lawrence Hargrave Drive is located directly to the east of the Illawarra Escarpment, which is the dominant landform throughout the Wollongong region. The Escarpment consists of steep to very steep slopes, grading down to a plateau, which drops off to the sheer cliffs immediately west of Lawrence Hargrave Drive.

The overall slope in the study area consists of a series of near vertical cliffs separated by steep slopes above road level and steep slopes below the road down to a rocky shoreline. Along the shoreline are rock platforms extending from three headlands. The topography of the rock platforms, which are only totally exposed at low tide, varies from large flat open spaces with gentle inclines into the sea to steep areas with large to very large boulders and steep drop offs.

The subtidal zone varies from a gently inclined flat bedrock shelf strewn with boulders, gravel and sand, to raised areas of complex topographical reef with numerous vertical rock walls, crevices and caves. The maximum water depth in the area immediately adjacent to the study area is approximately 10.5m.

Within the study area, Lawrence Hargrave Drive extends around the shoreline between Coalcliff and Clifton (Figure 9.1) at an elevation of between 20 – 45m above sea level and traverses three headlands and two amphitheatres.

Soils

The soils in the study area belong to the Watagan group (Hazelton and Tille 1990). The soils are characterised by four main dominant soil materials ranging from loose, stony, brownish black fine sandy loam, with a porous sandy fabric in the upper layers (usually as topsoil) to strongly pedal clay, generally occurring as subsoil.

Development limitations for the upper layers include stoniness, low water-holding capacity, strong acidity, low fertility and high potential aluminium toxicity. Similarly, the subsoil layers are limited by low wet-bearing strength, low permeability, low fertility, strong acidity and very high aluminium toxicity potential (Hazelton and Tille 1990).

The upper layers have low erodibility, consisting predominantly of highly permeable coarse sand grains, with moderate erodibility occurring through the other soil materials. However, despite the low to moderate erodibility of the soil materials, steep slopes produce an extreme erosion hazard. Soils are generally shallow and therefore slightly reactive, but large variations in soil properties occur over short distances, resulting in the potential for unpredictable surface movement. Other landscape limitations include mass movement and rock fall hazard, as clearly demonstrated by problems associated with the current road.

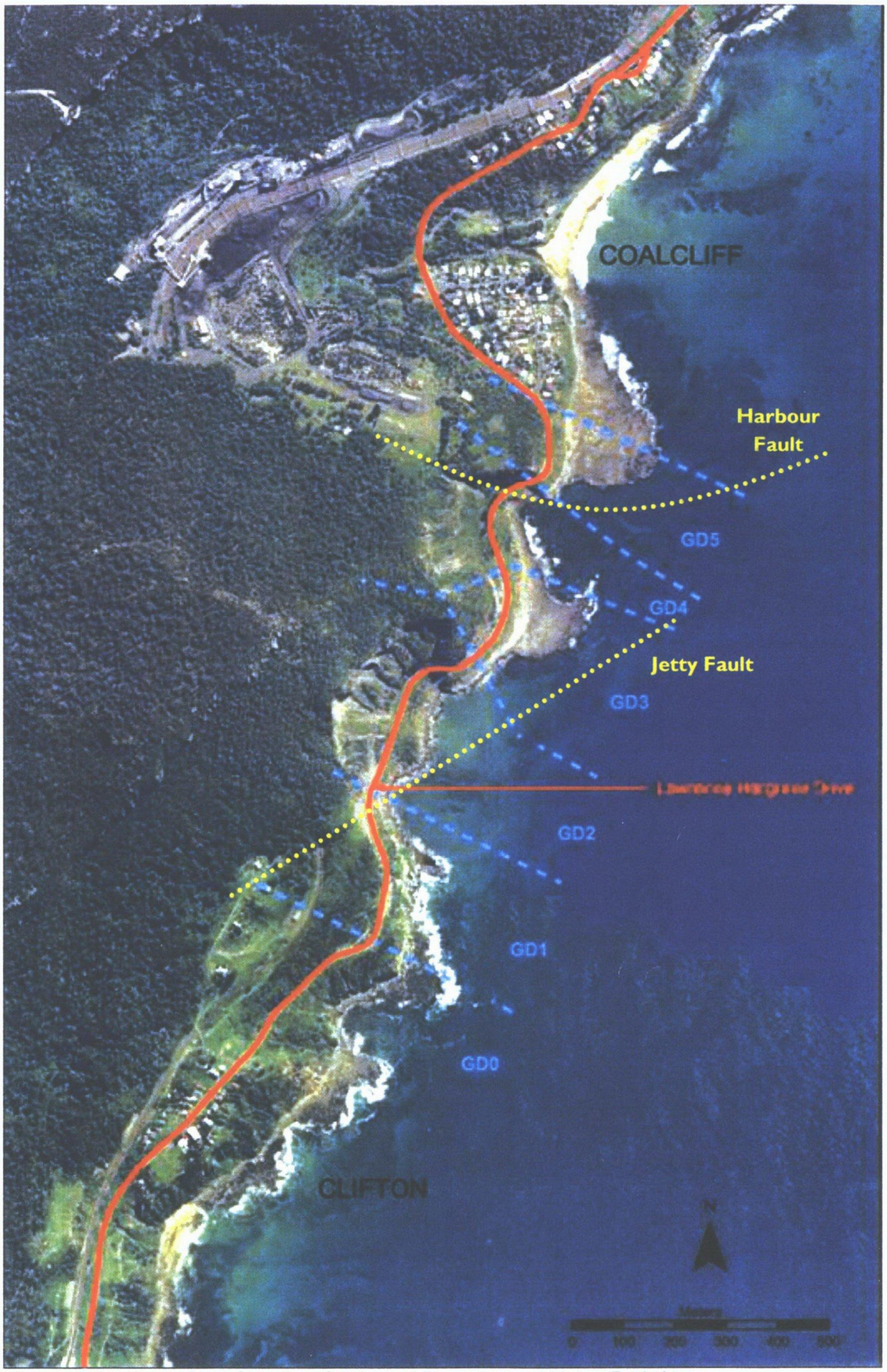


Figure 9.1: Study Area Showing Geological Domains and Major Fault Lines

Acid Sulfate Soils

Acid sulfate soils (ASS) are soils that contain iron sulfides. When these naturally occurring sulfides are disturbed and exposed to air, oxidation occurs and sulfuric acid is produced, which can drain into waterways causing severe environmental impact.

The Department of Land and Water Conservation (now DIPNR) ASS risk maps (1995) indicate that there is no known occurrence of acid sulfate materials in the study area.

Geology

The geological formations of the cliffs / escarpment belong to the Narrabeen Group and continue offshore. The main geological formations of the Narrabeen Group present in the study area (Figure 9.2) are:

- *Bulgo Sandstone:* This is a massive sandstone formation, comprising the Bald Hill/Bulgo Colluvium (up to 180m high) with a slope of up to 45° and the Bulgo Cliff (up to 80m high) that forms the upper cliff line in the study area. Jointing and undercutting of blocks from this formation are a major source of rock fall in the 'southern amphitheatre' (GD2 in Figure 9.1);
- *Stanwell Park Claystone:* This claystone formation (30m to 40m high) is immediately below the Bulgo Sandstone and lies at an angle of 35°. Talus materials form on this claystone;
- *Scarborough Sandstone:* This forms the lower cliff line (30m high) adjacent to the road. The formation is noticeably fractured, jointed around headlands and prone to the effects of wind erosion. Undercutting of loose blocks and columns of this formation are a major contributor to the rock fall problem;
- *Wombarra Claystone:* The road has been constructed within the Wombarra Claystone (20m high). Within this formation the Otford Sandstone Member is present and is evidenced by exposures of this sandstone layer on the headlands. Wombarra Claystone is prone to rapid weathering and causes undercutting of the Otford Sandstone as well as the overlying Scarborough Sandstone; and
- *Coal Cliff Sandstone:* This formation (10m high) lies at about sea level and contains the Bulli Coal Seam. Underground coalmines dating from the 1870's extend below the roadway.

The Hawkesbury Sandstone cannot generally be seen from road level and forms the top of the Illawarra Escarpment at about 300m above sea level.

The Escarpment is an intrinsically unstable area on the New South Wales south coast and within the study area the road has been problematic for over 100 years with rock falls, debris slides, embankment failures and severe coastal erosion compromising the safety of the road. This is due to a combination of high rainfall, elevated topography and stress relief towards the coast, marine erosion, incised drainage channels, mine subsidence and preferential weathering of specific stratigraphic units that undermine the more competent units leading to steeper slope angles and cliffed areas.

The section of road has been divided into five separate geotechnical domains (Figure 9.1), with each domain affected by a range of geotechnical hazards (Table 9.1).

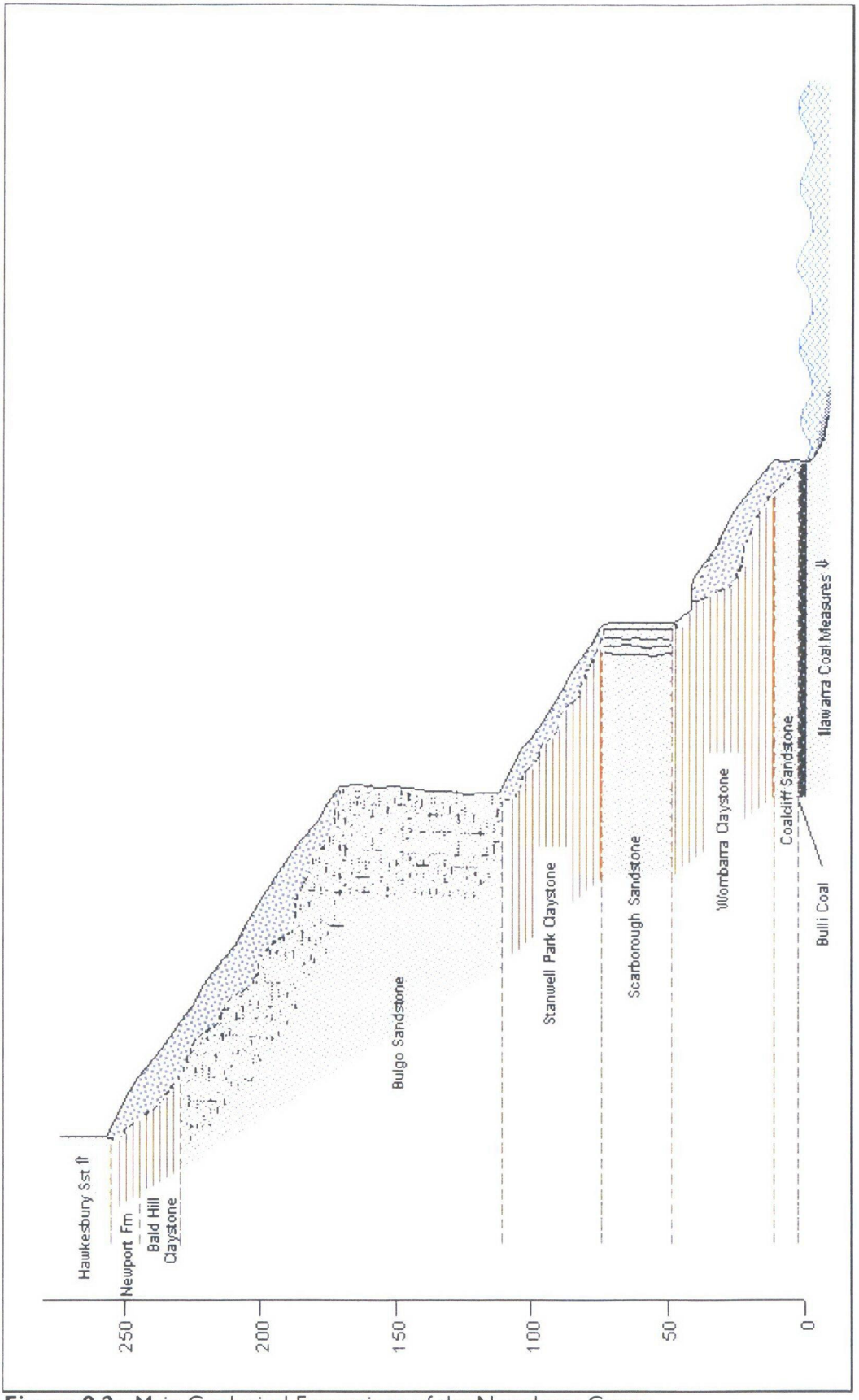


Figure 9.2: Main Geological Formations of the Narrabeen Group

Table 9.1: Summary of Geotechnical Domains

Geotechnical Domain	Location	Geotechnical Hazards
GD1	Southern Headland	• Rock fall hazards are sourced from boulders on the Stanwell Park Claystone slopes and the Scarborough Sandstone rock face. • Boulders from the Stanwell Park Claystone could generate substantial trajectory / velocity to impact approximately 15m to 20m east of the existing road. • Boulders derived from the Scarborough Sandstone whilst not generating significant trajectory/velocity across the underlying Wombarra Claystone, have high impact energy (approximately 18MJ).
GD2	Southern Amphitheatre	• The larger Hawkesbury Sandstone boulders in the northern section of GD2 are not likely to reach the Bulgo Cliffs and would rest on the Bulgo-Bald Hill slope. • Boulders from the Bulgo cliffs run to the ocean with energy of approximately 1.5MJ prior to reaching the ocean. • In the southern section of GD1, boulders derived from the Hawkesbury Sandstone cliffs and Bulgo – Bald Hill slope have trajectories beyond 45m from the inside edge of the existing road with an impact energy of some 6,000 to 8,000MJ.
GD3	Middle Headland	• Only two source areas were defined for the boulders in GD3, namely the Stanwell Park and Scarborough units. • Events from the Stanwell Park unit are likely to be rare and there are few source boulders. • Boulders from the Scarborough could launch off the Wombarra Claystone and land up to 5m out from the inside edge of the existing road. Impact energies from these 4m wide boulders could be up to 24MJ.
GD4	Northern Amphitheatre	• The analyses indicate most rocks roll across the road rather than fly onto or over the road. Selected profiles indicate that some 4m wide boulders derived from the Bulgo cliffs would come in contact with the road.
GD5	Northern Headland	• Boulders from the Scarborough cliffs fall vertically and land on the road by bouncing off the Wombarra Claystone slope above the road. Some 4m wide boulders would land approximately 1.5m beyond the inside edge of the existing road.

Note: One mega joule (MJ) is equivalent to a one tonne boulder falling 100m; therefore 500MJ is equivalent to a rock the size of a small house falling off a ten storey building.

There are two prominent fault lines in the vicinity of the Proposal (Figure 9.1). Jetty Fault, traversing GD1, 2 and 3 and Harbour Fault in GD4 and 5, are both inactive.

Rockfall History

Over the last 125 years there have been a number of reports, including "newspaper comment" of substantial landsides and rockfall events along this section of road including:

- January 1879: '200 tons of earth and rock' in GD2
- March 1894: 'Hundreds of tons of rock'
- March 1913: 'At times the road is completely blocked with thousands of tons of debris'
- December 1920: 'Heavy rain with slump below the road onto Boiler House and road closed for 3 days'
- May 1921: '100 tons of rock'
- 1931: '50 tons of boulders on road' in GD2
- June 1943: Below-road tension-crack in GD2. Failures onto road
- July 1949: '50 tons of rock on road'. Plate 9.1 indicates about 200m^3 of debris
- April 1950: 'Huge landslide covered the road at southern end'. Road closed for 4 months
- February 1958: '150 ton rockfall'
- May 1963: 'Hundreds of tons of debris fell into the sea' road closed for 1 day
- November 1967: Major rockfall (1000m^3 boulder flow) in GD2 and lesser in GD4. Approximately 150m^3 reaching the road in GD4. Road closed for about two months for works
- 1987: 600 ton rockfall in GD1 (Plate 9.2)
- April 1988: Mudflows in GD2 and GD4. GD2 embankment failure. Road closed for 6 months for embankment reconstruction.
- July 2003: Embankment failure in GD2 (Plate 9.3)

In 1988 the RTA undertook extensive reclamation and rehabilitation works in GD2 (Plate 9.4), which required the use of imported slag and other fill material. As such, much of the existing shoreline in GD2 is comprised of imported material.

Rock falls present the highest risk hazard to the road user, with records to date indicating some 120 boulder size landslides and larger reaching the road. The rocks are derived from the lower and upper cliffs as well as talus deposits on the 35° slope between the cliffs. Debris slides and mudflows are generally derived from the upper cliff and the Stanwell Park Claystone slope between the two cliff lines.

Mudflows and embankment failures tend to follow prolonged rain periods. The current embankment failure in GD2 (Plate 9.5), which continues to widen, was caused by marine erosion. The May / June 2003 rains mobilised the fill and colluvium embankment below the road, creating a 0.6m – 1.2m wide tension crack at the edge of the road.

In 1967 the northern headland in GD5 was treated as part of rock stabilisation works to remove unstable sections of rock from an exposed face. The treatment process involved planting a light explosive (in many instances only detonation cord is used) into pre-drilled rock to remove the unstable rock face before it falls or becomes a serious rockfall hazard. Plate 9.6 shows the extent of the existing treatment, and an area of shattered rock on the headland, left by previous blasting, which must be removed to eliminate the risk of future rockfall.

Plate 9.1: July 1949 Landslide (Source: Wollongong City Library File No. P04\P04167)

Plate 9.2: Plate 9.2 Major slab failure in1987 (source RTA)

Plate 9.3: July 2003 Embankment Failure (Source: RTA)

Plate 9.4: Reclamation works, 1988 (Source: RTA)

Plate 9.5: Current Embankment Failure GD2, July 2003

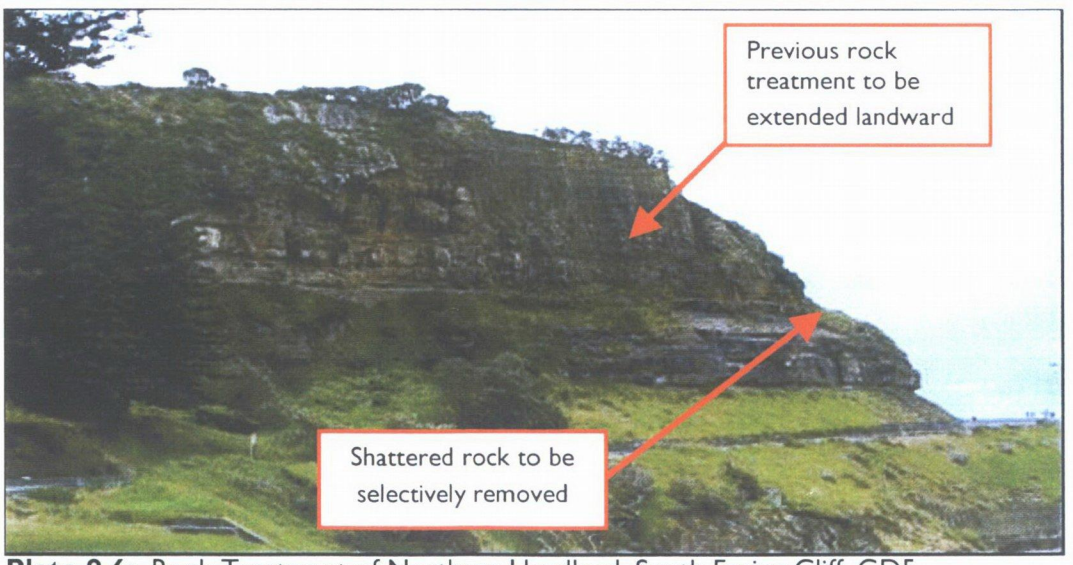


Plate 9.6: Rock Treatment of Northern Headland, South Facing Cliff, GD5

Contaminated Lands

There are no known contaminated soils associated with the proposed works or within adjacent land. The closest area of potential environmental concern would be within the Coalcliff Coke Works, where there would be the potential to expose contaminated soils as a result of activities associated with past mining. The location of the compound sites have yet to be determined, however there is potential to establish the main compound site (including a possible concrete batching plant) within the Coalcliff Coke Works. However, it is not anticipated that there would be any excavation or other disturbance of the ground in this location, which would expose any potential contaminants.

The reclamation works and construction of the access tracks have the potential to disturb some of the previously imported slag, used during the 1988 rehabilitation works. The slag used in the rehabilitation works was a 'blast furnace iron rock slag' and is a reasonably inert by-product of the removal of iron from iron ore and is consistent with material used in numerous other NSW road upgrade projects. The slag has the potential to produce a leachate with a pH of 8 and a conductivity of less than 200µS/cm and, as such, is not expected to release any contaminants that may impact on the surrounding environment, if disturbed during construction activities.

9.1.2. Potential Impacts

The Proposal would require a maximum of ten metres of reclamation of the existing coastal boulder field foreshore environment in GD1 and GD2, to accommodate an access track for use during construction and maintenance (Figure 8.1). Environmental impacts associated with this work are also discussed in detail in Sections 9.4 'Water Quality and Hydrology' and 9.6 'Marine Ecology'.

The reclamation would require the use of imported material for the backfill if local material is found to be unsuitable. Imported backfill material is likely to be basalt, however fines would not be used. Local rock material would be used, where available, to construct the seaward face of the reclamation in order to replicate the existing boulder field environment as closely as possible. A layer of geofabric would be placed behind the seaward face of the reclamation to protect the backfill from erosion and washout from wave action.

The Proposal would extend the existing stabilisation treatment on the south-facing cliff of the northern headland (GD5) removing approximately 6000m^3 of cliff face material. This material would be used elsewhere on the project where possible, for example to construct the seaward face of the reclamation works. The extension of the treatment would serve to remove an intrinsically unstable section of the headland to protect road users and is not expected to have an adverse effect on the local geology and topography.

Additional rock stabilisation works would take the form of selected rock removal from the northern headland, which were left shattered by previous rock blasting in 1967. Approximately 5000m^3 of unstable rocks would be removed without affecting the overall topography and profile of the headland, and used elsewhere on the project where appropriate.

Tallus flow and other debris currently impact the road in GD4. The Proposal would modify the existing flow patterns at the base of the escarpment by constructing rock bunds to funnel debris flows through two culverts under Lawrence Hargrave Drive. The rock bunds would be constructed from excess material from elsewhere on the project, where appropriate, to minimise importation of material.

The modification would maintain the natural west – east flow of debris and prevent a build up of tallus and other material west of the road, improving safety and the longevity of the road surface. The culverts would be constructed with a concrete base to promote debris movement and minimise maintenance.

Erosion and sedimentation patterns have the potential to be affected by the Proposal. Removal of vegetation, earthworks and the construction of the access tracks and geotechnical stabilisation treatments would potentially increase the amount of exposed topsoil to erosion by wind and rain. This would potentially result in the degradation of aquatic habitats and water quality through sedimentation as well as the reduced aesthetic values of surrounding land and coast through accumulation of soils and sediments. However, the study area is subject to an existing high level of erosion as a result of the area's active geological processes. The extent and duration of potential impacts associated with the Proposal are therefore expected to be minor and short term in comparison to the existing situation. Furthermore, any potential impact would be managed by implementing the sediment and erosion mitigation measures outlined below.

9.1.3. Mitigation Measures

The Proposal is a direct response to the impacts of an intrinsically unstable local geology on the safety of a public road. To ensure that impacts associated with the reconstruction are appropriately managed, a Soil and Water Management Plan (SWMP) would be prepared as part of the Construction Environmental Management Plan (CEMP) and in consultation with the DEC prior to the commencement of construction. Section 9.4.3 of this REF also describes specific mitigation measures that would be included within the SWMP.

The following specific mitigation measures would be included in Erosion and Sedimentation Control Plan (ESCP). The ESCP would be prepared to supplement the SWMP and would be implemented during construction to reduce erosion hazard and prevent any off-site sedimentation:

- The ESCP would be prepared and implemented in line with the Department of Housing's *Managing Urban Stormwater Guidelines* (DoH 1998) 'Blue Book' prior to the commencement of works;
- Regular inspection of the work site would be undertaken during construction activities to ensure that the ESCP is properly implemented and maintained;
- Geofabric sediment fences would be installed downslope of all disturbed areas, particularly those areas adjacent to gullies (capable of channelling rain runoff) and the ocean;
- Temporary stockpiles would not be located adjacent to drainage lines, the ocean or the existing road and would be suitably fenced on the downslope side, with appropriate geofabric sediment fences;
- Sandbags or gravel bags would be used to protect existing stormwater culverts;
- Water pumped from boring activities during the construction of the bridge piers, would be appropriately contained and treated prior to discharge to prevent off-site sedimentation. Re-use options would be investigated where appropriate;
- Vegetation clearance and soil disturbance would be limited to those areas required for construction purposes; and
- Revegetation of disturbed areas would occur where practical, immediately after completion of works in that area.

With regard to contaminated lands the following would be undertaken:

- Should unexpected contaminated material be disturbed during earthworks, control measures would be implemented to divert surface runoff and the material would be removed from site and disposed of at an approved DEC site; and
- If imported fill material is required, it would be sourced from an approved stockpile site or supplier.

9.2. Climate

9.2.1. Existing Environment

Climatic details recorded from the Wollongong Post Office are indicative of the climatic conditions within the study area. The coastal area of Wollongong has a mild to warm climate with a distinct maritime influence. Summer experiences warm to hot days with average minimum and maximum temperatures for January being 17.9°C and 25.6°C respectively, whereas winters are mild to cold with average minimum and maximum temperatures for July being 8.4°C and 17.0°C respectively (http://www.bom.gov.au).

Rainfall within the Wollongong coastal area is variable according to location and proximity to the escarpment, for example, annual rainfall varies from 1,600mm on the edge of plateau / escarpment to 1,200mm on the coastal plain (Hazelton and Tille 1990). Most rainfall occurs over January to June (March has the highest monthly average of 173mm) with a distinct drier period over July to September. The study area often experiences short periods of intense rainfall with extreme 24 hour events of over 500mm being previously recorded in the Illawarra region (http://www.bom.gov.au).

Fogs occur predominantly within the winter and early spring months and are usually early in the mornings, however they can persist throughout the day especially when sea mists settle in. Summer winds are usually from the south to southeast, and there is a tendency for onshore north-easterly winds in the afternoon. Winter winds are predominantly from the south or southwest. Morning and afternoon average annual wind speeds vary between 9.8km/h to 13.8km/h respectively (http://www.bom.gov.au).

Other meteorological events that require consideration regarding the study area include storms. Storms, generally caused by low atmospheric pressures, are of a temporary nature and are characterised by strong winds, rough seas and possibly heavy rain. Storms are responsible for the generation of large and potentially destructive waves. Minor to moderate storms (significant wave height of less than 5m) occur frequently along the NSW coastline, with the prevailing weather patterns resulting in the majority of waves approaching the NSW coastline from a south-easterly direction. Severe and extreme storms, in which the significant wave height exceeds 5m, can be expected to occur on average four times per year somewhere along the NSW coast (http://www.deh.gov.au).

9.2.2. Potential Impacts

The inclement and variable weather conditions associated with the region including heavy seas, rain, fog and high winds all have the potential to impact on worker safety and equipment and environmental integrity during construction. Impacts could include accidents due to poor visibility with potential spillages and environmental degradation.

Construction problems such as sediment-laden water draining from the site or construction materials and equipment falling into the ocean could be amplified during adverse weather conditions.

9.2.3. Mitigation Measures

Measures proposed to mitigate potential impacts arising from climatic conditions include the following:

- The CEMP for the Proposal would include procedures that cover construction activities and safety during inclement weather such as fog and heavy rain;
- A Traffic Management Plan (TMP) to meet the requirements of the RTA's *QA Specification G10 – Control of Traffic* would be prepared to manage vehicle movements around and within the construction area. Implementation of the plan would ensure safe working and driving conditions particularly during periods of inclement weather including fogs;
- Works in and adjacent to the intertidal zone would only be undertaken during periods of calm to slight seas and low swell conditions. No works would be undertaken during storm events and all equipment would be moved out of the impact zone of waves on such occasions; and
- All mobile plant would be removed from the working platforms and other areas within or adjacent to the intertidal zone at the completion of the daily activities.

9.3. Air Quality

9.3.1. Air Quality Criteria

The Department of Environment and Conservation (DEC) 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).

In 1998, the National Environment Protection Council of Australia (NEPC) introduced a new set of national air quality goals under the National Environment Protection Measure (NEPM) for Ambient Air Quality.

In 1998, the NSW Government released 'Action for Air' (NSW EPA, 1998), a policy targeted at the long-term protection and improvement of air quality across NSW. Air quality goals outlined under the NEPM for Ambient Air Quality were subsequently adopted for NSW, ensuring that NSW air quality guidelines were consistent with national NEPM air quality guidelines.

New South Wales ambient air quality goals are illustrated in Appendix 3. Other air quality goals for air toxics and odorous compounds are also listed. These goals have been drawn from WHO and the United Kingdom.

9.3.2. Dispersion Meteorology

The wind data available for this study were collected by Holmes Air Sciences in 1996 for Corrimal Coke Works. These data consist of hourly records from Corrimal for 1996. The Corrimal data are considered to contain wind and dispersion patterns that would be representative of those experienced in the area.

The wind data have been compiled into annual and seasonal wind-roses, shown in Appendix 3. Annually the most predominant winds are from the southern to western sectors with winds from the north-northeast also common. This pattern is evident in most seasons with the exception of winter where westerly winds are the most common.

9.3.3. Existing Environment

Air quality across the Illawarra region is highly variable and primarily related to domestic and industrial emissions in conjunction with prevailing weather conditions. Similar to other major population centres of NSW, the Illawarra's main sources of air pollutants are from motor vehicles, industry and domestic activities. These emissions result in ozone, photochemical smog and brown haze (Wollongong City Council 2002). Also the Illawarra region is only 80km to the south of the Sydney region. It is likely that, on occasion, pollutants such as photochemical smog would be transported between the two, particularly from Sydney to Illawarra (EPA 2001).

As the major topographic feature of the Illawarra, the escarpment is a dominant influence on meteorology and hence air quality in the region. The escarpment can steer or deflect winds, changing the apparent direction at the surface, as well as supporting the formation of inversions that limit the dispersion of pollutants (EPA 2001).

No ambient air quality monitoring has been undertaken specifically for the Proposal, however DEC has a network of monitoring sites in the Illawarra area that provide an assessment of the required pollutants in the area. The closest monitoring site to the Proposal is at Wollongong (Gipps Street), approximately 25km south. The maximum 8 hour average concentration of CO at the Wollongong site was 1.6 ppm in 2002 with a maximum 1 hour average concentration of 2.7 ppm. Annual average and maximum 1 hour NO_2 concentrations were 2.3 pphm and 4.2 pphm respectively in 2002.

The measured CO and NO_2 concentrations at the Wollongong site were all below their respective air quality goals. The major source of CO in the area is industry while motor vehicles and industry are the most important contributors to NO_x emissions.

Fine particles in the area originate mainly from motor vehicles, woodfires and industry. The annual average PM_{10} concentration (measured using a Tapered Element Oscillating Microbalance) was recorded at 21 $\mu g/m^3$ with 45 $\mu g/m^3$ (at 0°C) being the maximum 24 hour average concentration for 2002. The annual average $PM_{2.5}$ concentration for 2002 was 11 $\mu g/m^3$. The measured PM_{10} concentrations at the Wollongong site were all below their respective air quality goals.

Minor sources of pollutants would be expected to originate in the adjacent villages of Coalcliff and Clifton. Coalcliff Coke Works located approximately 500m west of the study area, would also influence local air quality. The Coke Works is a scheduled premise that is licensed by the DEC with regard to its potential to impact on air quality. Emissions resulting from the production of coke include both coarse and fine particulates and SO_x and odours from the quench plume.

The closest air quality receptors to the Proposal are residential dwellings located on Paterson Road, Coalcliff, adjacent to the northern end of the study area. As a result of the topography of the study area and the surrounding region, it is not anticipated that there would be any future change in receptors as a result of further residential development.

9.3.4. Potential Impacts

Construction

The Proposal has the potential to generate dust during construction works, which could affect the closest residential dwellings on Patterson Road, Coalcliff at the northern end of the study area. Additionally, where large quantities of dust are generated, there is the potential to affect local water quality by deposition and increased turbidity. Dust also has the potential to settle on local roads, which can turn into mud during periods of rain and create an unsafe driving environment.

The most likely equipment to be used in the Proposal would include vibratory rollers, excavators, graders, concrete trucks, bitumen spraying and asphalt paving plant and haulage trucks. The major sources of dust would be from the graders, excavators, haulage trucks and wind erosion during construction. Activities such as blasting and vehicle movements need to be appropriately managed to minimise the potential for fugitive dust.

Potential dust impacts are likely to be short term, and can be controlled through the application of relevant construction mitigation measures.

There are no national guidelines for dust fallout. However the DEC has set a goal for a maximum acceptable level of 4g/m^2/month for areas with low existing fallout. Given the local topography, the shielding effects of the headlands and the separation distance between the main work areas and the closest receptors, the dust fallout generated by the Proposal is expected to meet this target. Additionally, the nature of construction is mostly associated with bridge building and concrete pouring and there would not be large amounts of grading and vegetation clearing, which is activities typically associated with dust generation during road construction projects.

Emissions from plant and equipment may also impact air quality during construction. Construction traffic on local roads and idling equipment on site would be the most likely sources of pollutants. Impacts would be short-term and effectively minimised by implementing the mitigation measures outlined below.

During construction, the Proposal could potentially increase the number of odour sources within and surrounding the study area. The potential odour sources could include:

- Stack emissions from the concrete batching plant;
- Emissions associated with water-based concrete curing agents; and
- Emissions from fuel storage tanks.

Odours emitted from these potential odour sources would be short term and considered to be minor in nature.

Operation

The nature and level of traffic resulting from the commissioning of the Proposal, is likely to be similar to that experienced prior to closure. It is expected that the increase in congestion due to additional traffic generated by the closure as shown in Table 9.2 would be alleviated as a result of the Proposal.

Table 9.2: Daily Traffic Volumes for 2003 (Vehicles/day)

Section	Prior to closure	After closure	Increase (%)
Mount Ousley, Mt Ousley Road	39,900	40,510	1.5
Bulli Pass, Princes Highway	10,454	11,985	14.6
Bulli Tops, Princes Highway	1,199	1,730	44.3

Local commuters and a resurgence in tourist and small business traffic would generate the majority of traffic, as the road re-establishes the north south coastal connection between the towns of Clifton and Coalcliff and the wider Illawarra region. The Proposal is unlikely to generate any new sources of heavy industry and additional heavy traffic is likely to be limited. Consequently the Proposal is not expected to generate levels of traffic-generated air pollution, beyond that previously experienced.

Emissions from individual vehicles are predicted to decrease substantially over time despite the increase in vehicles kilometres travelled due to improved fuel quality and new emission standards. NSW Transport Facts 2001 predicts an annual decrease of 24.9%, 37.4% and 36.4% in particulates, NO_x and CO respectively by 2010 in NSW, thereby partly offsetting future increases in traffic flow.

9.3.5. Mitigation Measures

An Air Quality Management Plan would be prepared in consultation with the DEC for the construction phase of the Proposal, and would be included as part of the CEMP. Given that the impact of dust generation is expected to be minor, a visual monitoring program would be implemented in the first instance. If any air quality impacts are encountered, a further monitoring program would be implemented in consultation with the DEC.

The following mitigation measures would be implemented for the Proposal:

- Watering would be carried out at regular intervals to dampen disturbed areas and reduce dust generation, particularly during windy conditions;
- Dust generating activities that cannot be adequately controlled by watering or other means would be ceased during windy conditions;
- Water carts and other dust control equipment would be properly maintained so that it is available for use without delay, in the event of dust generation;
- Materials transported to the site would be appropriately covered to reduce dust generation in transit;
- Mud and other debris would be removed from the wheels and bodies of haulage equipment on leaving the site and before entering public roads or sealed pavements. Facilities such as truck washdown bays and 'cattle grid' type shakers would be considered for the purpose;
- Any mud or other construction debris spilt on public or sealed roads would be removed before dust generation becomes a potential issue;
- Any stockpiles or material stores would be kept damp and/ or covered and screened by dust screens where appropriate;
- Any waste material capable of generating dust, such as excavated material that is unsuitable for recycling during construction, would be removed from site as soon as possible and taken to an approved waste disposal site;
- No vegetation, timber or other combustible materials would be burned. Material that is unsuitable for reuse or recycling on site would be removed to an appropriate location for subsequent storage, reuse, recycling or disposal;

- Reformed surfaces would be revegetated as soon as possible to minimise dust generation and topsoil dispersion;
- Any complaints in relation to dust generation from the works would be promptly addressed and the dust source eliminated;
- All equipment, machinery and vehicles used on site (including those used for transporting materials, equipment and workers to and from the site) would be regularly maintained to the relevant Australian Design Rules and manufacturers specifications in order to minimise potential emissions;
- All emission controls used on construction equipment would comply with DEC requirements; and
- Vehicles and equipment would only be left idling when required for construction works.

9.4. Water Quality and Hydrology

9.4.1. Existing Environment

Terrestrial

The Illawarra region contains numerous small catchments, draining to the Pacific Ocean. Many of these catchments are steep and heavily forested in their upper reaches, with middle and lower sections grading from moderately steep to relatively flat. Urban development is generally confined to the middle and lower sections of the catchments.

One permanent watercourse exists immediately to the north of the study area. Stony Creek originates at the top of the Illawarra Escarpment and flows north before turning east past the Coalcliff Coke Works and through the residential area of Coalcliff. Several tributaries flow into Stony Creek from the north and south and the creek receives runoff from the Illawarra and Boomerang Golf Courses and the Coalcliff Coke Works before it discharges at Coalcliff beach.

Due to its location outside of the study area and the minimal potential for the project to impact on the water quality of Stony Creek and its catchment, background water quality surveys were not conducted.

There are a number of roadside stormwater drains within the study area. The drains discharge directly into the adjacent intertidal zone and currently transport runoff from the natural drainage lines of the cliff face and gullies as well as the road surface.

Given the steepness of local topography and the active terrestrial erosion processes, much of the runoff that drains directly to the ocean is heavily sediment laden and contributes to high levels of turbidity in the adjacent intertidal zone.

Preliminary background water quality data (pH, Salinity, Turbidity and Total Suspended Solids) were collected for the unnamed ephemeral drainage line that flows down the gully to the west of the existing road close to the boundary of GD4 and GD5 (Table 9.3). The drainage line flows during and immediately after rain events and the local topography is such that water drains quickly from the site, without pooling or stagnating, through an existing box culvert under the road and drains directly to the intertidal zone.

Table 9.3: Baseline Water Quality Data for Unnamed Drainage Line

Properties	Measurements
pH (pH Units)	7.4
Salinity (ppt)	11
Turbidity (NTU)	3
Total Suspended Solids (mg/l)	2

The data show relatively standard levels for most properties, however salinity is slightly elevated, which is likely to be caused by the aeolian influence of sea spray generated in the coastal zone.

Marine

Water quality is generally good in the Illawarra region. Bacterial content of coastal waters is monitored through the DEC Beachwatch Program. Austinmer Beach is the closest monitored Illawarra beach and it has recorded 100% compliance with faecal coliform criteria for the previous five summer seasons. The Beachwatch data is only indicative of recreational water quality and it is not expected that the Proposal would affect recreational water quality.

Baseline water quality data was collected within the adjacent intertidal areas as part of the REF and is shown in Table 9.4. Data were collected on two occasions at four locations in the study area, SW1 adjacent to the southern headland, SW2 in the southern amphitheatre, SW3 on the middle headland and SW4 in the northern amphitheatre.

Table 9.4: Baseline Water Quality Data for the Adjacent Intertidal Areas

Properties	SW1		SW2		SW3		SW4	
	A	B	A	B	A	B	A	B
pH (pH Units)	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Salinity (ppt)	31	30	31	31	30	31	30	31
Turbidity (NTU)	2	4	2	4	2	4	2	4
Total Suspended Solids (mg/l averaged)	9		8		16		14	

Note: A – Sampling date 12/02/04 B – Sampling date 06/03/04

The results were generally consistent with default trigger values applicable to NSW, as outlined by the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000). Local topography and erosion processes in the vicinity of Lawrence Hargrave Drive mean that runoff into the adjacent intertidal zone is generally sediment laden. During field investigations, it has been noted that turbidity levels vary daily as a result of rainfall, coastal processes and wave action. Turbidity is not considered to be a very useful indicator in estuarine and (coastal) marine waters. The measurement of light attenuation in preference to turbidity is recommended by ANZECC (2000) within these areas.

Waves are the dominant phenomena that shape the region's coastline. The coastline is frequently subjected to storms and heavy sea conditions, which are largely responsible for the high level of shoreline erosion that has contributed to previous land failures. Wave action can affect the amount and rate of longshore drift, which is responsible for the relocation and deposition of coastal sediment, including that deposited by runoff from the adjacent land area. Breaking waves can cause strong longshore currents and when combined with local bathymetry may also induce the formation of local rip currents.

Recent analysis of Port Kembla historical offshore wave data (1987- 2003) by Lawson and Treloar shows extreme wave heights (Hs) for typical Average Return Interval (ARI) (Table 9.5).

Table 9.5: Extreme Wave Heights (Port Kembla Historical Offshore Wave Data)

Extreme Wave Heights	
ARI (Years)	**Hs (m)**
1	5.8
2	6.2
5	6.9
10	7.5
20	8.0
50	8.6
100	9.5

When the Port Kembla offshore wave height data is compared to historical offshore wave data obtained at Long Reef, Sydney over the same time period, a very close correlation is evident. The similar wave climates at these two locations indicate that the wave climate experienced in the study area would also be comparable to those outlined in Table 9.4 (Lawson and Treloar 2003).

Tidal plane data is available for Sydney (Fort Denison) and Port Kembla from the Australian National Tide Tables, 2004 (Table 9.6).

Table 9.6: Tidal Planes (Australian National Tide Tables, 2004)

Tidal Planes (m)							
Port	**HAT**	**MHWS**	**MHWN**	**AHD**	**MLWN**	**MLWS**	**LAT**
Sydney	2.0	1.6	1.3	0.9	0.6	0.3	0.0
Port Kembla	2.0	1.5	1.3	0.9	0.5	0.3	0.0

Mean sea level (MSL) is approximately equal to AHD

The data in Table 9.6 indicate that the tidal planes at Sydney to the north of the Proposal and at Port Kembla to the south, exhibit very minor differences and can be extrapolated to the study area.

The storm climate in the study area would be similar to that of Sydney, though variances would occur on an individual event basis. It follows that the extreme water levels (storm values) outlined in Table 9.7 can be applied to the study area. The various storm types generally display a distinct seasonality, which means that certain types of storm would be more likely to occur during a particular period of the year. Minor to moderate storms (significant wave heights of 2.5m – 5.0m) occur frequently along the NSW coast as a whole. Such storms generally have little impact on the coast or coastal developments. Severe storms (significant wave heights of over 5.0m – 6.0m) can be expected to occur on average four times per year at least somewhere along the NSW coast (Department of Environment and Heritage 2004).

Table 9.7: Extreme (Storm) Water Levels (MSB Sydney Ports Authority 1993)

Extreme Water Levels	
ARI (Years)	**Water Level (m)**
0.5	2.00
1	2.03
2	2.09
5	2.16
10	2.21
20	2.26
50	2.33
100	2.35

Water Level (m) is described as level above MSL

Offshore current data is available for several locations in the area including Providential Head and Sydney. However, offshore currents are unlikely to affect or to be affected by the Proposal, either during construction or operation.

9.4.2. Potential Impacts

The Proposal has the potential to impact on the water quality and hydrology within the study area during both construction and operation. The majority of potential impacts would apply to typical road construction projects and can be effectively managed by implementing a series of mitigation measures. Impacts can be divided into construction and operational impacts.

Construction

The construction of the Proposal has the potential to impact on water quality by allowing sediment-laden or polluted runoff from exposed surfaces to enter adjacent watercourses or the ocean, where construction sites border the intertidal zone. These impacts are directly related to those associated with soil erosion and geology, as discussed in detail in Section 9.1. The potential impacts would be easily minimised through standard soil and water management techniques.

The construction of the bridge structure, including both the superstructure and piers, has the potential to impact directly on the water quality of both the intertidal and subtidal areas of the southern amphitheatre. Bridge construction undertaken directly above could potentially result in materials and equipment accidentally falling into these areas. The likelihood of construction materials and equipment accidentally falling into the intertidal and subtidal areas must be considered, however the potential impacts on water quality would be considered minimal and management procedures described below would further minimise any impacts.

There would be the potential for accidental chemical, fuel and lubricant spills to occur as a result of construction activities. Such spills could potentially impact on both terrestrial and marine water quality through direct runoff and infiltration. The likelihood of a spill occurring is low and the management procedures described below would address any impact.

Should a concrete batching plant be required for the Proposal it would be located within the Coalcliff Coke Works site. The site for the batching plant has not yet been finalised and should it be located close to Stony Creek, all appropriate management measures would be introduced to minimise the likelihood of polluted runoff entering the creek.

Large scale earthworks have the potential to interrupt overland hydrology flows if not appropriately managed. As excavation, stockpiling, cutting or filling is carried out overland

flows can be blocked and new pathways may be created through unsuitable material that may generate dirty or sediment-laden runoff.

The construction of the bridge structures and associated piles, piers and access track would require some reclamation of the intertidal zone. At the worst case (reclamation would be limited to the minimum required for effective construction) 3000m^2 of reclamation would be required in GD2, which has the potential to impact on the active coastal processes outlined above. Any change of coastal form has the potential to alter patterns of sedimentation, deposition and longshore drift as well as affecting wave action or the generation of inshore currents. Likewise, coastal processes can impact the construction and integrity of the final structure and these impacts would be subject to ongoing consideration during the detailed design stage.

Local rock material would be used where possible to construct the seaward face of the reclamation, such that impacts on coastal processes and marine hydrology would be minimal. The reclamation would be left in place after construction and would be subjected to the same erosion processes as the existing coastline. It is expected that the reclamation would eventually become naturalised through ongoing erosion.

The proposed construction of an access track and working platforms may influence the wave climate in the immediate offshore vicinity of the study area by changing wave reflection patterns. Although the reclamation is to mirror the existing coastline, the more uniform slope and curve of the construction compared to the natural irregular rocky shoreline may induce more regular, coherent reflected wave crests in the area of the offshore boulder field.

Operational

The bridge structures would be designed to drain directly into the ocean through a series of scuppers spaced at three metre intervals. The scuppers would allow runoff from the surface of the road to drain directly into the receiving environment. Stormwater runoff from the bridge structures would not be expected to contain high percentages of particulates, hydrocarbons and associated heavy metals. The expected traffic volumes during operation would be low (approximately 3,500 AADT) and similar to those experienced prior to closure. This volume of traffic is expected to contribute a negligible amount of contaminants to the road surface.

The principle behind the use of scuppers in terms of water quality is that stormwater runoff is not concentrated to one or two large input channels. The spreading effect of the scuppers allows the runoff into the marine environment to be received with less of an impact. Therefore it is not anticipated that there would be any localised decreases in salinity within the intertidal areas as a result of the Proposal.

There would also be the potential for accidental spills during operation of the Proposal, resulting in pollutants, such as fuels and oils, entering the surrounding marine environment. However, the nature and level of traffic resulting from the Proposal is likely to be similar to that expected prior to closure. During operation of the existing road there were no reported incidents involving accidental spillage of pollutants. The risk of accidental spills resulting from the operation of the Proposal is therefore considered minimal.

Impacts on the water quality of the surrounding environment as a result of a pollutant spill during the operation of the Proposal would be direct and considered higher from a bridge structure than was previously experienced on the existing road. However, as stated above, the potential for accidental spills is considered low and therefore the risk to the water quality of the surrounding environment would also be considered to be low.

Given the low risk of accidental spills which would potentially impact on the water quality of the surrounding environment, the inclusion of a stormwater / pollutant treatment technique (for example, trapping systems and catch basins) is not considered to be justified at this time. Furthermore, the area required to construct a catch basin that would contain runoff from the bridge is not available within the study area.

9.4.3. Mitigation Measures

The mitigation measures outlined in Section 9.1.3 would be applied to minimise potential water quality and hydrology impacts. In addition, the following specific water quality and hydrology mitigation measures would be implemented during construction and operation where appropriate:

- The reclamation and extent of construction would be minimised and designed to mirror the form and bathymetry of the existing shoreline and intertidal zone;
- During construction, drainage and flow structures such as culverts would be constructed as early as possible to maintain existing flows and minimise the risk of flooding;
- A Water Quality Management Plan (WQMP) would be incorporated into the SWMP described in Section 9.1.3 and ongoing monitoring would be undertaken prior to, and during, construction. The WQMP would be developed to evaluate the ambient water quality against triggers in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000). Should refinement of the of the trigger values be needed to address local conditions, prior agreement from the DEC would be obtained;
- Precautions to prevent scour during construction would also be incorporated into the SWMP;
- The feasibility of including a stormwater / pollutant treatment technique into the Proposal would be further investigated during the detailed design stage;
- Refuelling or maintenance of plant and equipment, mixing of cutting oil with bitumen, or any other activity which may result in the spillage of a chemical, fuel or lubricant on any location with direct drainage to a waterway, overland flowpath or the ocean would not be permitted without the provision of appropriate temporary bunding;
- Refuelling or maintenance of plant and equipment, mixing of cutting oil with bitumen, or any other activity which may result in the spillage of a chemical, fuel or lubricant would not be allowed to be undertaken on the working platforms within GD2;
- Refuelling operations would not be left unattended while in progress;
- Adequate quantities of suitable material such as sand to contain spillage, would be kept readily available on site;
- A catch platform with vertical sheeting would be used whilst construction activities are undertaken on bridge structures to prevent materials and equipment falling into either the intertidal or subtidal areas;
- Materials or equipment that has fallen into either the intertidal or subtidal areas would be recovered immediately and the area would be treated if required;
- Bunding and spill management would be undertaken in accordance with the requirements of:
  a) Relevant legislation and Australian Standards;
  b) EPA's (DEC) Bunding and Spill Management Guidelines contained within the EPA Environmental Protection Manual for Authorised Officers; and
  c) The RTA Code of Practice for Water Management, 1999.

- Chemical, fuel and lubricant storage areas would be suitably located and protected to minimise spill impacts;
- Storage areas would not be located within 20m of built or natural drainage lines or on slopes steeper than 1:10, or near vegetated areas;
- Impervious bunds around stores would have sufficient capacity to contain at least 120% of the stored chemical, fuel or lubricant volume;
- Details would be included in the CEMP on how bunded areas would be monitored and drained to meet environmental requirements and to ensure bund capacity is maintained;
- Where it is essential to remove chemical containers from bunded areas, they would not be left unattended. Where this is not practicable they must be managed to minimise the risk of spillage. They must only be removed for use on that day and safe overnight storage procedures must be implemented as well as safe removal to bunded areas when conditions change that may create a risk to the environment; and
- Drums or other containers used as markers would not contain any chemicals, fuels or lubricants.

9.5. Terrestrial Ecology

9.5.1. Existing Environment

Terrestrial ecology investigations of the study area were undertaken by LesryK Environmental Consultants during October 2003 and February 2004. The initial investigation (LesryK Environmental Consultants 2003) provided a comprehensive opportunities and constraints assessment of the study area. During the February investigation, those portions of the study area initially identified as possible constraints to the undertaking of the Proposal were thoroughly surveyed. The assessments undertaken give consideration to the obligations of the EPBC Act and the TSC Act, and determine if the undertaking of the proposed works within the study area would have a detrimental impact on any state and / or nationally listed threatened plants or animals, their populations, ecological communities or habitats. A summary of the recent investigations is provided below and the full report is contained in Appendix 4.

Survey methods employed during the field investigations included:

- The identification of all plants within the area likely to be directly or indirectly impacted;
- The identification of the structure of those vegetation communities and fauna habitats present;
- The direct and indirect observation of any fauna species within, or adjacent to, the proposed works site;
- Targeted searches for species of state or national conservation significance that were identified during the overview review stage of the project; and
- The use of appropriate survey techniques including spotlighting and echolocation detection.

As part of the investigation of the study area, a variety of literature sources and databases were consulted to identify previous records of animals and plants, vegetation communities and fauna habitats of conservation significance that have been previously recorded, or could occur within the study region: These literature resources included:

- A review of environmental factors previously prepared within the study area (National Environmental Consulting Services 2001);
- Wollongong City Council's State of the Environment Report (Wollongong City Council 2002);
- A flora and fauna survey prepared for the Illawarra Coke Company Pty Ltd (Kembla Environmental Consultants 2000);
- A report on the birds of the Illawarra, Shoalhaven and adjacent tablelands (Chafer et al. 1999);
- A publication of the vertebrate fauna of the Northern Illawarra Escarpment (NPWS 1998);
- An inventory of the wetlands of the Illawarra Catchment (Chafer 1997);
- A bushland regeneration plan for the Illawarra Escarpment State Recreation Area (LesryK Environmental Consultants 1997);
- A flora and fauna report prepared for the proposed emplacement of coal washery reject material (Gunninah Environmental Consultants 1995);
- A flora and fauna survey of the Wombarra drainage catchment (Gutteridge Haskins and Davey Pty Ltd 1993);
- A fauna impact statement for embankment stabilisation works at Coalcliff (Quality Environmental Management Pty Ltd 1992);
- The Department of the Environment and Heritage (DEH) Online Database (DEH November 2003); and
- The NSW National Parks and Wildlife Service (NPWS) Atlas (NPWS November 2003).

The literature review and database consultations undertaken indicate that a total of 20 flora and fauna species of conservation significance were identified as having been recorded within the surrounding region (Table 9.8).

Table: 9.8: Previously Recorded Flora and Fauna Species of Conservation Significance from the surrounding region

Species	Status	
	EPBC Act	TSC Act
Flora		
Syzygium paniculatum	V	V
Daphnandra sp 'Illawarra'	E	E
Acacia baueri subsp. bauerii	-	V
Epacris purpurascens var purpurascens	-	V
Pultenaea aristata	V	V
Fauna		
Eastern Pygmy Possum (*Cercartetus nanus*)	-	V
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V
East-coast Freetail Bat (*Mormopterus norfolkensis*)	-	V
Powerful Owl (*Ninox strenua*)	-	V
Eastern Reef Egret (*Egretta sacra*)	M	-
Artic Jaeger (*Stercorarius parasiticus*)	M	-
Black-faced Monarch (*Monarcha melanopsis*)	M	-
Barking Owl (*Ninox connivens*)	-	V
Sooty Owl (*Tyto tenebricosa*)	-	V
Masked Owl (*Tyto novaehollandiae*)	-	V
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V
Red-crowned Toadlet (*Pseudophryne australis*)	-	V
Green and Golden Bell Frog (*Litoria aurea*)	V	E
Littlejohns Tree Frog (*Litoria littlejohni*)	V	V

E – Endangered; V – Vulnerable; M – Migratory

Flora

A total of 122 plants were recorded in the study area during the surveys, 47 of which were exotic species. No plants listed as endangered or vulnerable under the TSC Act or EPBC Act were identified during the field investigations.

No individuals or populations of the threatened Magenta Lilly Pilly (*Syzygium paniculatum*) or Socketwood (*Daphnandra sp 'Illawarra'*) were recorded. Both these species were identified as potentially occurring within the southern portion of the study area during the initial

investigation as a result of the presence of suitable habitat requirements. Targeted searches were undertaken within the southern portion of the study area for these threatened plants and as neither of these species was observed, and as the conditions was conducive to their detection, it is not considered that any viable populations of either of these plants are present within the study area.

Drooping She-oak (*Allocasuarina verticillata*) was the only species of regional significance detected during the field survey. Coastal populations of this species in the Sydney region are considered vulnerable because of their small size (Benson and McDougall 1995). All other species recorded within the study area occur frequently in similar habitats throughout the region and none are restricted or unique to the survey site. The Drooping She-oak is located upslope of the existing road alignment and would not be affected by the Proposal.

The northern amphitheatre was thoroughly searched for members of the Orchidaceae family because of anecdotal reports of orchids having been sighted in this area. The only orchid species found during the field investigations was the Wax-lip Orchid (*Glossodia minor*), which was recorded upslope of the existing alignment of Lawrence Hargrave Drive, within the Coastal Scrub community. Large numbers of this orchid were recorded at this location during the field investigations.

Two plant species listed as Noxious Weeds in the Wollongong LGA were found during the field survey. These were African Love Grass (*Eragrostis curvula*) and Blackberry (*Rubus fruiticosus*). The control of these species would be addressed as part of a Weed Management Plan described in Section 9.5.4.

The study area consists of a heterogeneous mix of plant communities. Often there is no distinct boundary between these communities. The study area has been modified by human activities to varying degrees, due to clearing, roadwork, rock stabilisation, landslip control and modified fire regimes. There are four broad vegetation communities present within, and adjacent to, the study area. A brief description of each community and vegetation structure is provided in Table 9.9. A detailed description and the general locations of these communities are provided in the terrestrial ecology assessment in Appendix 4.

Table 9.9: Vegetation Communities within the Study Area

Community	Structure	Common Species	Conservation Value
Disturbed environments	Varies between grasslands to open heaths, dominated by introduced species	Kikuyu (*Penniseteum clandestinum*), Lantana (*Lantana camara*), and Coast Rosemary (*Westringia fruiticosa*)	Nil
Coastal scrubs	Varies between open heaths to closed scrub. Presence of pure stands of native shrubs.	Coast Banksia (*Banksia integrifolia*) and Coast Tea-tree (*Leptospermum laevigatum*) and Drooping She-oak (*Allocasuarina verticillata*)	Low - Moderate
Coastal grasslands	Predominantly dominated by native grasses with shrubs from the Coastal Scrub community randomly occurring.	Kangaroo Grass (*Themeda australis*) and Coast Tussock Grass (*Poa poiformis*)	Low - Moderate

Community	Structure	Common Species	Conservation Value
Dry rainforests	Community is generally 8 – 12m tall with a canopy cover of over 90% forming a low closed forest with a very sparse understorey.	Lilly Pilly (*Acmena smithii*), Port Jackson Fig (*Ficus rubiginosa*) and Maidenhair Ferns (*Adiantum spp*)	High

Fauna

A total of 62 native species were recorded within the study area (and those habitat types that occur immediately adjacent) during the surveys, comprising 12 mammals, 43 birds, five reptiles and two frogs. Of these species, five are of state or national conservation significance. These include:

- Sooty Shearwater (*Puffinus griseus*) – EPBC Act;
- White-bellied Sea-eagle (*Haliaeetus leucogaster*) – EPBC Act;
- Rufous Fantail (*Rhipidura rufifrons*) – EPBC Act;
- Common Bentwing-bat (*Miniopterus schreibersii*) – TSC Act; and
- Sooty Oystercatcher (*Haematopus fuliginosus*) – TSC Act.

No locally viable populations of any of the threatened species identified above were recorded to be dependent on the study area. Within, and in close proximity to, the study area, no breeding records for any of the migratory birds were obtained and no habitats critical for the survival of either the Common Bentwing-bat or Sooty Oystercatcher were recorded. Despite targeted survey, no other species listed, or currently being considered for listing under the Schedules to either the TSC or EPBC Acts were recorded within the study area.

The Common Bentwing-bat was identified during the February 2004 survey within the vicinity of the old entrance portal to Coalcliff Colliery, east of the existing road. At this location, an additional five species of microchiropteran were also detected. Whilst the Common Bentwing-bat was recorded near a possible roosting site, it is noted that no calls characteristic of an individual leaving a roosting site were obtained, particularly on dusk. In relation to the detection of this threatened bat, based on its time of detection and the results of surveys, it is considered that this species was only foraging within the study area, along with a number of other species. During the October 2003 survey, it is noted that this species was recorded within Illawarra Coke Company lands, which would not be impacted on as a result of the Proposal. At this location, suitable foraging and roosting sites were present, which are common throughout the Illawarra Escarpment.

During the October 2003 and February 2004 fauna surveys, the potential for those species listed in Table 9.7 to occur within or adjacent to the study area as a resident population was considered. However, the results of the surveys revealed that the study area is not considered to constitute a significant resource for any of those animals listed in Table 9.7. Whilst it is acknowledged that some of the species listed in Table 9.7 could traverse over the study area on occasion, particularly the avifauna, it is not considered that the Proposal would remove any habitats necessary for the movement patterns of these species.

By the completion of the field investigations, four habitat types were identified within the study area, these being:

- Disturbed environments (these corresponding to the disturbed environments described above, but also including portions of the coastal scrub and grasslands);
- Aquatic environments;
- Native shrublands (corresponding to the dry rainforests described above, but also including portions of the coastal scrub); and
- Rock escarpments.

Disturbed Environments

Of the four habitat types recorded, the disturbed environments dominate the study area. This habitat type would be the one predominantly affected by the proposed works. The disturbed environments include the existing road and those areas that occur immediately adjacent to these (including the scree slopes, physically modified areas and the portion of land east of the existing road in GD2 that would be impacted as a result of construction activities and the access track).

This habitat type supports weeds and both exotic and native grasslands, these all being to half a metre in height and of a medium to high density. Isolated native shrubs and exotic vines are also present. Where present, the native shrubs are to two metres in height and most had been affected by wind sheer. In addition to the native shrubs, roadside plantings of Norfolk Island Pines are also present, these being up to 15m in height. No tree hollows suitable for the roosting needs of any native species were recorded within the disturbed environments, and no nesting sites were observed. There are no unique habitat features within the disturbed environments.

Aquatic Environments

Two aquatic environments are present within the study area, these being the freshwater ephemeral drainage lines and intertidal areas (platforms and foreshore areas). Within the study area, no unique aquatic habitat features were observed in any of those drainage lines surveyed, all being highly disturbed and modified as a result of the past road works activities. As a fauna habitat type, the rock platforms and foreshore areas are not unique to the study area, these being regularly recorded north and south of the study area. The rock platforms are easily accessible to introduced predators and as such, no evidence of breeding within these areas was recorded during the surveys.

The Sooty Oystercatcher was observed during the October 2003 survey foraging on the northern and middle rock platforms of the study area. No Sooty Oystercatchers were recorded in association with the smaller southern rock platform. Based on the observations made during the field survey, the southern rock platform is not considered to be of sufficient size or structure for the foraging and / or sheltering needs of the Sooty Oystercatcher compared to the other rock platforms.

Native Shrublands

Native shrublands are present at several locations within the study area, particularly at the northern and southern limits. The shrubland supports a mixture of native and exotic species of plants, these being between 8-12m in height and of a medium to high density. The ground cover is composed of seedlings, forbs, native and exotic grasses and weeds. The ground cover varies in density from sparse to high depending on the extent of light penetration and ground disturbance. Leaf litter and ground debris is common, as are occurrences of dumped urban refuse and wind blown rubbish. Within the main body of the shrubland itself, the understorey is relatively open. Rock outcrops, boulders, small cliff lines and ephemeral drainage channels occur in association with this habitat type. Within this area, no nesting

sites (including bird and mammals) were observed and no hollows suitable for the life cycle needs of native animals were recorded.

Rock escarpments
Rock escarpments including sheer cliffs and batter slopes are present at several locations within the study area. The cliff lines are highly weathered and provide a series of overhangs and ledges. Caves also appear to be present and, where accessible, were generally in the form of small weathered openings that would potentially permit access to the former coal mine tunnels. As with the other fauna habitats recorded, the rock escarpments are a common habitat feature of this region, particularly in association with the Illawarra Escarpment itself. The rock escarpments occur in association with several of the region's conservation reserves and other protected lands and this habitat type is considered to be well conserved in this area.

9.5.2. Legislative Considerations

NSW Legislation

Though targeted, no plants, endangered ecological communities or populations listed under the Schedules of the TSC Act were recorded or indicated as occurring within the study area. Giving consideration to the life cycle requirements and habitat needs of those species previously recorded within this portion of the Wollongong LGA, none are likely to occur as a viable local population dependent on the study area.

Whilst *Syzygium paniculatum* and *Daphnandra sp 'Illawarra'* were identified as potentially occurring within the southern portion of the study area during the initial investigation (within the Dry Rainforest community), they were not found during any subsequent, or previous, surveys. Therefore, as neither of these state listed plants occur as resident populations within the study area, it is not considered necessary to further consider the impacts of the Proposal on these species through use of the eight part test, as listed under Section 5A of the EP&A Act.

Illawarra Subtropical Rainforest in the Sydney Basin Bioregion has been listed under the TSC Act as an Endangered Ecological Community. Within this community, three 'Types' are present, including Type 1 (Subtropical Rainforest), Type 2 (Moist Subtropical Rainforest) and Type 3 (Dry Subtropical Rainforest). Characteristic tree species in the Illawarra Subtropical Rainforest are *Baloghia inophylla, Brachychiton acerifolius, Dendrocnide excelsa, Diploglottis australis, Ficus spp., Pennantia cunninghamii* and *Toona ciliata*. Giving consideration to the information provided within the Final Determination for this Endangered Ecological Community, it is not considered that the Dry rainforest community that is present within the study area conforms to any component of the Illawarra Subtropical Rainforest listing. Within the study area, the Dry Rainforest community is dominated by different species and is situated well north of the Berkeley Hills (the community's listed northern known limit). Therefore, the Dry Rainforest community present within the study area is not considered to be, or form a 'Type' of, a listed endangered ecological community.

Though the clearing of native vegetation is listed as a *Key Threatening Process* under Schedule 3 of the TSC Act, as no threatened plants or endangered ecological communities were recorded, none would be affected as a result of the undertaking of the Proposal. As such, it is not considered necessary to prepare a Species Impact Statement (SIS).

Two fauna species, the Common Bentwing-bat and the Sooty Oystercatcher, listed as vulnerable under the TSC Act, were recorded within or immediately adjacent to the study area during the field surveys. In determining the potential impact on these threatened fauna species as a result of the Proposal, it is appropriate to apply the eight part test as provided

under Section 5A of the EP&A Act. These criteria are designed to determine 'whether there is likely to be a significant affect on these threatened species, their populations, ecological communities, or habitats', and consequently, whether a SIS is required.

The eight part test undertaken for the Common Bentwing-bat concluded that the Proposal would not disturb, remove, modify or fragment any habitats critical to the life cycle requirements of this species. No habitats were observed within the area of potential impact (including both direct and indirect impacts) that would be considered significant for the conservation and preservation of this species. Due to its ability to negotiate open space areas and urban infrastructure, no Bentwing-bat dispersal or movement corridors would be disturbed, and no significant areas of local or regional habitat would be removed or isolated. During the surveys, no roosting populations of this species were recorded within the study area even though suitable artificial caves are present. As such, no locally viable populations of this animal are considered to occur. Therefore, the expected impacts associated with the Proposal on the Common Bentwing-bat are considered to be minimal and the preparation of a SIS would not be necessary.

The eight part test undertaken for the Sooty Oystercatcher concluded that the Proposal would not disturb, remove, modify or fragment any habitats critical to the life cycle requirements of this species. No habitats were observed within the area of potential impact (including both direct and indirect impacts) that would be considered significant for the conservation and preservation of this species. Due to its ability to negotiate open space areas, water bodies and urban infrastructure, no Sooty Oystercatcher dispersal or movement corridors would be disturbed, and no significant areas of local or regional habitat would be removed or isolated. During the surveys, no breeding populations of this species were recorded within the study area and recordings were only associated with foraging and sheltering individuals that restricted their activities to the middle and northern rock platforms. No locally viable populations of this animal are considered to occur within the study area and the expected impacts associated with the Proposal on the Sooty Oystercatcher are considered to be minimal. Therefore, the preparation of a SIS would not be necessary.

Commonwealth Legislation

By the completion of the recent field surveys, no plants or animals listed under the threatened species Schedules of the EPBC Act had been recorded within, or in the vicinity of, the study area. Similarly, no nationally listed endangered ecological communities or populations had been recorded.

Three listed migratory birds, the Sooty Shearwater, White-bellied Sea-eagle and Rufous Fantail were detected within the study area during the October 2003 survey. In addition to these species there is also the potential that the Eastern Reef Egret, Artic Jaeger and Black-faced Monarch to occur on occasion. In relation to these species and the resources upon which they are dependant, through reference to the criteria provided under the EPBC Act Administrative Guidelines on Significance for a listed migratory species, it is not considered that the Proposal would:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in invasive species, that are harmful to the migratory species, becoming established in an area of important habitat for a migratory species; or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

As such, in relation to those migratory birds recorded in the study area, the Proposal would not have a significant impact on the occurrence of these species, or their necessary habitat requirements. Therefore the Proposal would not require referral to the Federal Minister for the Environment for further consideration and approval.

9.5.3. Potential Impacts

Based on the results of the flora and fauna surveys, and the review of literature and database sources, it is considered that there are no ecological constraints to the Proposal proceeding. The Proposal would not remove or significantly affect any habitats of local, regional, state or national conservation significance.

The proposed removal of vegetation as a result of the Proposal would consist of vegetation predominantly within the Disturbed Environment and Coastal Scrub communities. Vegetation would be required to be removed in the following areas:

- Within GD1 to allow for the connection of the bridge to the existing road;
- Within GD2, east of the existing road, to allow safe access during construction of the piers; and
- Within GD4 and GD5 to allow for the connection of the bridge to the existing road and the construction of geotechnical stabilisation treatments.

Plant species that would be required to be removed within these areas would include native species such as, Coast Banksia (*Banksia integrifolia*), Coast Tea-tree (*Leptospermum laevigatum*), Bracelet Honey-myrtle (*Melaleuca armillaris*), Coast Rosemary (Westringia fruiticosa), Fireweed (*Senecio linearifolius*), Fan-flower (*Scaevola calendulacea*), Spiky Mat-rush (*Lomandra longifolia*) and Coast Wattle (*Acacia longifolia var sophorae*). It is also envisaged that a number of introduced species would be required to be removed, including Norfolk Island Pines (*Aracauria heterophylla*). Vegetation removal within these areas, however, would not significantly affect any populations of any native plants such that they are placed at risk of extinction.

During the field investigation one regionally significant plant, Drooping She-Oak (*Allocasuarina verticillata*) was recorded. This plant occurred in association with the coastal grassland and coastal scrub communities. Whilst these communities are not endangered they have been largely cleared elsewhere in the coastal portions of the Wollongong LGA. Although this is the case, given the observations made during the field survey, it is noted that no individuals of Drooping She-oak are likely to be affected by the Proposal. As such, the local and regional presence of this species would not be adversely affected by the undertaking of the proposed works.

Wax-lip Orchid (*Glossodia minor*) is a common orchid species in the Sydney area and is not considered to be of conservation significance. During the field investigations, no orchids of state or national conservation significance were recorded within, or adjacent to, any portions of the study area.

The removal of vegetation as a result of the Proposal would consist of vegetation predominantly within the Disturbed Environment and Native Shrublands fauna habitat types. These habitat types do not present unique habitat features or provide nesting sites (for bird and mammals) or hollows suitable for the life cycle needs of native animals. Vegetation removal within these habitat areas would not significantly affect any populations of any native animals such that they are placed at risk of extinction.

The Proposal is not considered to affect, threaten or have an adverse impact on any of those plants or animals listed under the EPBC Act. Therefore, it is not considered that the matter

would require referral to the Federal Minister for the Environment for further consideration or approval.

Within the areas of likely disturbance, the habitats and vegetation communities present are considered to be of low ecological value. These areas would not be important for any of the threatened species listed under the TSC Act that have been detected within the study area, or previously recorded in the region. The Proposal would therefore not result in any of these threatened species, their populations, ecological communities, or habitats being significantly impacted upon such that a viable local population of that species is placed at risk of extinction. Similarly, the works would not fragment, disturb or alter any movement or dispersal corridors, or isolate any proximate areas of suitable habitat, for any threatened flora or fauna. Therefore, giving consideration to the assessment criteria listed under Section 5A of the EP&A Act, the preparation of a SIS for any threatened plants or animals would not be required.

Caves suitable for the roosting needs of the Common Bentwing-bat are present within the study area and are identified in association with the old entrance portal to Coalcliff Colliery. Whilst occurring in the study area, the entrance portals would not be directly impacted as a result of Proposal (refer to Section 9.9). Mitigation measures proposed below and in Section 9.9.4 would ensure that these resources are not directly or indirectly affected.

9.5.4. Mitigation Measures

The following mitigation measures would be implemented for the Proposal:

- Prior to construction, all personnel would be advised of the limits of clearing and would be made aware of the importance of the regionally significant Drooping She-oak (*Allocasuarina verticillata*);
- Native trees removed during clearing and grubbing would be used in conjunction with soil erosion and sediment control measures where possible. All other native trees removed would be converted to mulch and stockpiled for use during revegetation works;
- No vehicles or machinery would be stored or parked within any native vegetation areas proposed for retention or under the dripline of trees;
- Revegetation works would be undertaken progressively through the construction phase and would be undertaken using a combination of hydromulch and hand planting where appropriate. Locally occurring native plant species would be used except where a rapid cover of vegetation is required to prevent erosion. In these areas sterile grasses would be used;
- Revegetation works would include locally occurring plants that are characteristic of the adjacent vegetation communities. The inclusion of Drooping She-oak (*Allocasuarina verticillata*) individuals grown from locally collected seed and native grasses would also benefit the long term presence of this plant and the Coastal grassland / shrub communities;
- Landscaping and revegetation works should be maintained for a period of no less than twelve months. During this time any dead or dying plants would be removed and replaced;
- A Weed Management Plan would be included in the CEMP. Weeds would be removed and disposed of in accordance with the requirements of the Wollongong City Council. The Weed Management Plan would specifically address the following:
  - All noxious weeds (such as Blackberry and African Love Grass) would be removed by a contracted qualified bush regenerator if applicable and in accordance to the criteria under the *Noxious Weeds Act 1993*, and the NSW Department of Agriculture Guidelines, 1999;

- Herbicide usage would be in accordance with manufacturer's instructions and applied to only those areas designated for treatment;
- All spraying would be carried out so as to avoid damage to any surrounding native vegetation;
- Topsoil potentially containing introduced grasses or weed propagules would be removed from the site. Contaminated topsoil would not be reused for the proposed works, including site rehabilitation;

- With regards to the surrounding vegetated areas and fire precautions, all construction activities would be undertaken to comply with the requirements of the *Rural Fires Act 1997* and the *Local Government Act 1993* and be guided by the NSW rural Fire Services 'Equipment and Machinery Use in Bush fire Prone Areas'. Fire equipment would be provided, as required, and no cutting, welding, grinding or other activities likely to generate fires would be undertaken in the open on 'total fire ban' days;
- Prior to construction, all personnel would be provided general information on the Common Bentwing-bat (*Miniopterus schreibersii*) and the Sooty Oystercatcher (*Haematopus fuliginosus*), threats to their survival and the legislative penalties incurred following any harm to them;
- Injury to protected wildlife caused by through or because of any construction activity must be reported to the DEC Parks Services Division;
- Contact details for wildlife rehabilitation groups, such as WIRES Illawarra, and DEC Parks Services Division, would be kept on site and in the event of injury to fauna would be contacted immediately;
- Disturbance of the old entrance portal to Coalcliff Colliery would be avoided. These mines offer roosting opportunities for the threatened Common Bentwing-bat. The locations of these areas would be identified on any construction plans, and the sites being protected from any direct or indirect impacts;
- Prior to the construction activities being undertaken, the entrance portals would be fenced (or similar), including a buffer, and all access and activity within this area would be excluded. The fencing requirements and buffer area would be developed in consultation with a qualified ecologist; and
- The location of the abandoned mine adits would be considered when finalising the location of the bridge piers. If an unmapped adit is exposed, works at these locations are to cease immediately. A qualified ecologist would be engaged to inspect any exposed adits to ensure that no roosting colonies of any cave dependant bats are present. Where these are identified, appropriate mitigation measures would be developed in consultation with the DEC Parks Services Division.

9.6. Marine Ecology

9.6.1. Existing Environment

Marine ecology investigations of the study area were undertaken by The Ecology Lab to determine the effects of the Proposal on threatened species, populations, habitats and threatening processes, intertidal and subtidal habitat and associated biota, commercial fisheries and recreational activities. Initial surveys were carried out in October 2003, assessing the impact of preliminary geotechnical investigations of the rock platforms in the study area and continued through to February 2004 where a detailed investigation of the potential impacts of the Proposal on the marine environment was undertaken. The overall purpose of the assessment was to meet legislative requirements and to address matters relevant to NSW Fisheries. A summary of the recent investigation is provided below and the full report is contained in Appendix 5.

A desktop review of existing information was conducted to collect background information on likely potential species that may be found in the study area. The review included interpretation of aerial photography to identify intertidal and subtidal habitats that may be affected by the Proposal.

A search of the Fishfiles Pilot database maintained by NSW Fisheries was undertaken using the 'Hawkesbury Shelf' search option. This search focused on threatened species protected under the FM Act that have been recorded in coastal habitats along the mid-north coast of NSW. A further search of the Australian Museum online fish database was conducted to generate a list of threatened fish species recorded within and surrounding the study area. Additionally, a search of the Atlas of NSW Wildlife database maintained by DEC was undertaken for threatened marine mammal species listed under the TSC *Act* 1995.

Following the desktop review, The Ecology Lab visited the study area on four occasions (between October 2003 and February 2004) to investigate habitat and associated biota living in intertidal boulder fields, rock platforms and subtidal areas close to the shoreline. Data collected was used to identify trends but no formal statistical tests for differences were carried out as part of the study. Further details of the study methodology are detailed in Appendix 5.

The survey documented two main types of habitat in the study area, intertidal habitats and subtidal habitats. These habitats are summarised below.

Intertidal Habitats

Intertidal habitats can be grouped broadly into two categories, boulder fields and rock platforms (Figure 9.3).

Boulder Fields

Boulder fields occur where large or small boulders accumulate on a shore, as occurs between the rock platforms in the study area. Intertidal boulder fields provide a habitat for a wide variety of animals and plants, which can live on both the boulder surface and underneath. While many species living on the surface of boulders are generalists and often found in other intertidal habitats such as rock platforms, some species are found only on the underside of boulders and can be considered habitat-specialists. Intertidal boulder fields are a high-energy zone and as a result individual boulders are subject to regular disturbance, either as a result of wave action or from sand inundation. Disturbance is thought to affect diversity, with boulder fields more frequently disturbed thought to be more diverse.

Within the study area, boulder fields comprised approximately 0.7ha, or 13%, of the total intertidal habitat (approximately 6.3ha) in the study area. The remainder of intertidal habitat consisted of rock platforms and a small amount of beach with boulders between Boulder Fields 2 and 3 in the southern amphitheatre.

Boulder Field 1 was generally wider than the others, had predominantly a very gentle slope and consisted mainly of boulders with a diameter of about 20 – 40cm. Boulder Fields 2 and 3 were narrow, had a variable slope and consisted mainly of large boulders interspersed with smaller ones. Boulder Fields 1 and 2 were of similar size (3,006 and 3,320m^2 respectively). Boulder Field 3 was much smaller (199m^2) and represented only 11% of the total boulder field habitat. Intertidal boulder field habitat in the southern amphitheatre represented 57% of the total intertidal boulder field habitat in the study area.

Figure 9.3: Dominant Intertidal Habitats in the Study Area (Source: TEL)

Algae was virtually absent from boulders in all three boulder fields apart from a strip in the lowest part of the lower intertidal zone and some green alga, *Enteromorpha sp.*, in Boulder Field 2. There were more species and individuals observed on the underside of boulders in Boulder Field 1 than in the other boulder fields. Boulder Field 2 had the least diversity and abundance of the three boulder fields. Species on the underside of boulders consisted mostly of gastropods (marine snails) although platyhelminthes (flatworms), anthozoans (anemones), polyplacophorans (chitons), polychaetes (worms) and cirripeds (barnacles) were also found.

Some sessile species (e.g. barnacles and polychaetes) were in great abundance on the underside of boulders, but not always in every boulder field. A few of the species found on the underside of boulders are obligate to this particular habitat (for example, *Ischnochiton lentiginosus*, the blue spot chiton) while most were generalists, and also found on the tops of boulders and / or on rock platforms (for example, the limpet *Cellana tramoserica* and the periwinkle *Nodilittorina unifasciata*). Diversity on the tops and sides of boulders followed a similar pattern to that observed on the underside of boulders.

Rock Platforms

The most general intertidal habitat is the broad expanse of a rock platform. Where rock is relatively soft, such as sandstone, platforms tend to be broad with a steep drop at the seaward end where waves can affect them even at low tide. They usually have a cliff at the landward end, which has not yet been eroded, by the sea. The effects of waves and tide influence the types of plants and animals in the intertidal habitat, which vary from low to high levels on the rock platform. As a result, assemblages on intertidal rock platforms are usually considered in the low, mid and high shore. In addition to the flat expanse of a rock platform that is affected by the rise and fall of the tide, there are also areas that are permanently wet, even during low tide. These areas, known as rock pools, may provide shelter to organisms so they are not exposed to air when the tide falls. Many marine plants and animals are known to occur in rock pools including species with conservation value such as the Black Cod (*Epinephelus daemaelii*), of which juveniles of the species have been found in rock pools on intertidal rock platforms close to the study area (Griffiths 2003).

Rock platforms were the dominant intertidal habitat in the study area, comprising over 55ha. This constitutes approximately 87% of the total intertidal habitat. There are three large rock platforms in the study area, the northern rock platform, the middle rock platform and the southern rock platform.

The northern rock platform is approximately 250m long (at the base of the cliff) and 150m wide (from the base of the cliff to the furthest seaward point) and is the largest of the three platforms in the study area. There are some large boulders at the base of the cliff. It drops sharply into the sea on the southern and eastern side but slopes gently into the sea on the northern side. An area at the rear of the platform would generally not receive tidal inundation or sea spray except when unusually large seas are running. Consequently, there are virtually no intertidal organisms living there. Mid shore habitat accounts for 45% of intertidal habitat on the platform and rock pools only 3%. Low shore habitat is found only on the northern, and some of the eastern, side of the platform.

Up to 5 taxa of algae and sessile invertebrates and up to 11 taxa of mobile invertebrates were recorded at sites in the high shore and mid shore areas of the platform respectively, but the high and mid shore assemblages of the rock platform were dominated by the snail *Littorina unifasciata*, the limpet *Patelloida latistrigata*, and barnacles, particularly *Tesseropora rosea* and *Chaemaesipho tasmanica*.

A diverse assemblage of algae, up to 17 taxa at some sites, covered much of the low shore, dominated by a covering of *Corallina officinallis* with few mobile invertebrates. Sites 1 and 2 (northern side of the northern rock platform) appear similar in terms of the composition and abundance of particular species but mid and high shore assemblages for these two sites appeared to differ from Site 3 (southern side of northern rock platform). This is most likely to be because Site 3 is on the opposite side of the platform to the other sites and has a different aspect. Site 3 is on the edge of a sharp drop to the sea whereas the other two sites are on a gentle slope to the sea.

The middle rock platform is approximately 150 m long (at the base of the cliff) and 120 m wide (from the base of the cliff to the furthest seaward point). Although smaller, this platform has many similar features to the northern platform. High shore habitat accounts for over 50% of intertidal habitat on this rock platform, while the percentage of the platform covered by rock pools is similar to the northern platform at about 4%. As was the case for the northern platform low shore habitat is only found on the northern side and some of the eastern side of the platform.

As the northern and middle platforms have very similar characteristics, it would be expected that assemblages on the platforms would be similar. The assemblage at Site 4 on the middle platform tended to be similar to sites on the northern platform with a similar aspect (Sites 1 and 2). That is, similar numbers of taxa of algae and invertebrates were observed in the low shore, high shore and mid shore areas of the platform respectively.

The high and mid shore assemblages of the rock platform were dominated by the snail *Littorina unifasciata*, the limpet *Patelloida latistrigata*, and barnacles, particularly *Tesseropora rosea* and *Chaemaesipho tasmanica*. At the low shore there was a diverse assemblage of algae, few mobile invertebrates, and habitat was dominated by a covering of *Corallina officinallis*. However, at Site 5 (middle platform) the high shore and mid shore assemblages were quite different from Site 7 on the southern platform and from the sites on the northern platform. There were very few organisms on the high shore, and the mid shore was dominated by blue-green algae.

The southern rock platform form is approximately 50 m long (at the base of the cliff) and 75 m wide (from the base of the cliff to the furthest seaward point). It has many similarities to the other platforms however, it is backed by the remnant Coalcliff Colliery Jetty and the edge drops sharply into the sea on most sides. In addition, 35% of the platform comprises permanent shallow rock pools. Although the size of rock pools on this platform is greater than for the other platforms, the combined area of the rock pools on the platforms is fairly similar. This platform is lower than the other platforms, has no high shore areas and is totally inundated at high tide.

Assemblages on this platform were similar to the other platforms, in terms of numbers of taxa of algae and invertebrates present. Like sites on the other platforms, the low shore assemblages here were diverse in algae, had few mobile invertebrates, and were dominated by a covering of *Corallina officinalis*. The mid shore sites were dominated by the limpet *Patelloida latistrigata*, the barnacles *Tesseropora rosea* and several species of mobile invertebrates and chitons.

Subtidal Habitats

Much is known of the near-shore subtidal habitats of NSW. Subtidal fringing reef can dominate for long stretches of coastline, as can sand, and in many areas reef and sand may be interspersed. Assemblages of plants and animals on near-shore subtidal fringing reefs of NSW vary as a result of many factors, including locality and the amount of exposure to wave action.

Sand made up 26% of the substratum in subtidal areas of the study area out to a depth of approximately 10–13m. The rest of the substratum was composed of mostly flat bedrock (32%), fractured bedrock (8%) or boulders on bedrock (28%). There were also some areas where sand was interspersed among rocky reef, such as where boulders existed on sand (2%), or in combination with sand and bedrock (1%) (Figure 9.4).

Substratum close to the shore in the southern amphitheatre was mostly sand, although a thin band of subtidal boulder fields was adjacent to the shore in most areas between the rock platforms. Some very large solitary boulders, partly emersed, in the northern part of the southern amphitheatre were present on sand close to the shore.

An area of bedrock, some of which also had boulders upon it, extends from the shore in the middle of the southern amphitheatre into the deeper areas offshore. Fractured bedrock was observed close to the shore and further offshore in the northern areas of the southern amphitheatre. The substratum in the northern amphitheatre was more uniform than the southern amphitheatre, being mostly boulders on bedrock.

The number of species of fish, invertebrates and algae in the study area was high due to the diversity of substratum and habitat, with species observed being typical of the region. Most of the species of algae observed occurred in the mixed algae bed habitat as other habitats of *Phyllospora camosa*, *Ecklonia radiata* and *Caulerpa filiformis* were generally mono-specific to these species.

The majority of subtidal, rocky reef habitat in the study area was made up of beds of mixed algae and this was 42% of the total habitat. In mixed beds of algae the habitat was dominated by a combination of two or more of Bubble-weed (*Phyllospora camosa*), Kelp (*Ecklonia radiata*) and *Caulerpa filiformis*. *Caulerpa* or *Ecklonia* were mostly found on the lower parts of the reef while *Phyllospora* was mostly found on the higher parts, particularly the tops of boulders.

Mixed algae beds were found throughout the study area but were most common in the southern amphitheatre, although not close to the shore. A thin band of subtidal reef close to the shore in the southern amphitheatre and in much of the northern amphitheatre was composed of beds of *Phyllospora*.

Other subtidal habitats observed in the study area included beds of *Ecklonia*, which were mainly in deeper areas, and barrens. The barrens were also in deeper areas and were mainly devoid of foliose algae and dominated by the Purple Sea Urchin (*Centrostephanus rodgersii*); and beds of *Caulerpa*. Patches of *Caulerpa* were also found in the southern and northern amphitheatre.

Twelve invertebrate taxa were observed in the study area and most of these were observed where the habitat was topographically complex, consisting of crevices and caves, because they require shelter. Examples of invertebrates included Sydney Turban Shell (*Turbo torquatus*) and Cunjevoi (*Pyura stolonifera*).

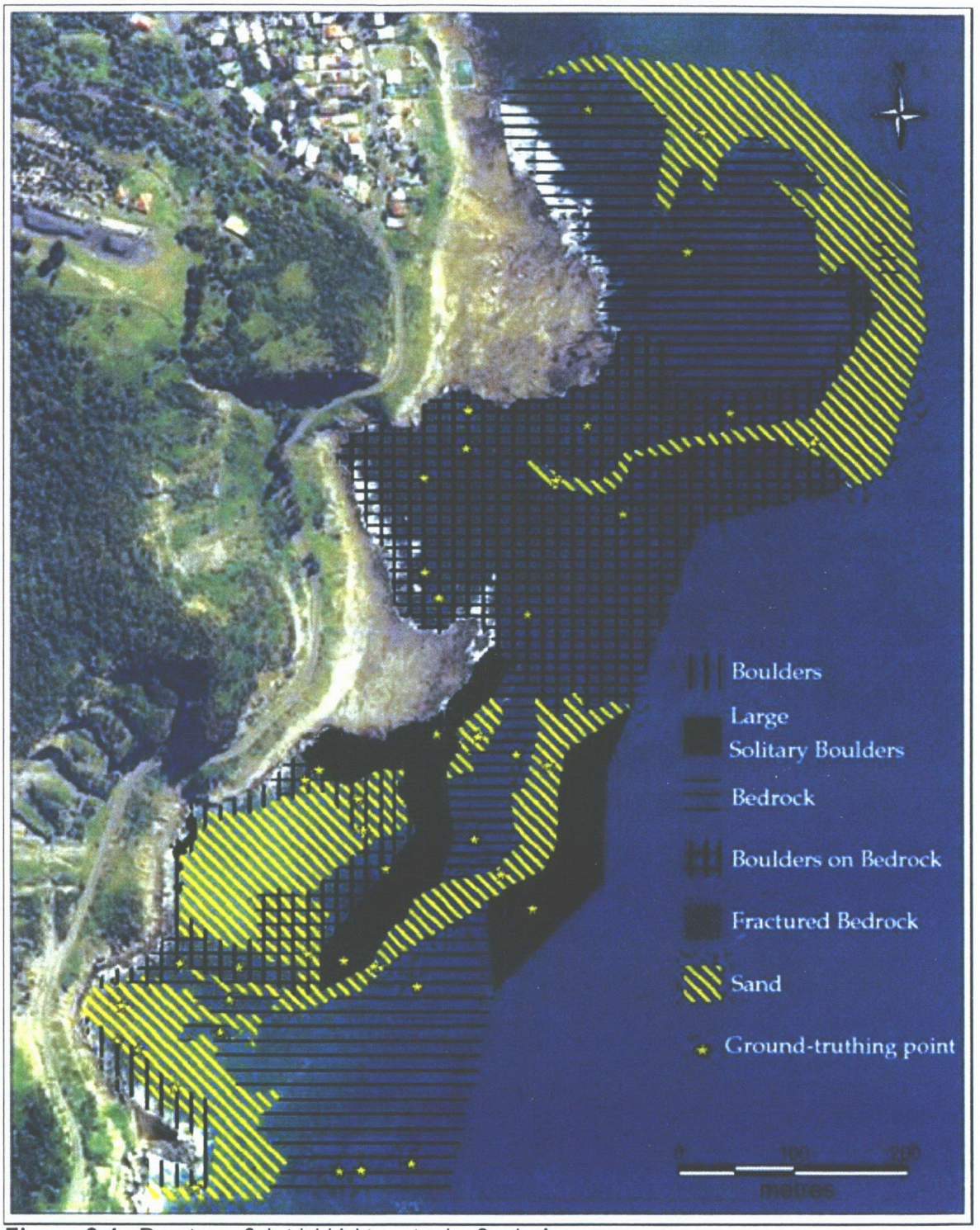


Figure 9.4: Dominant Subtidal Habitats in the Study Area

The majority of fish species observed were those commonly associated with rocky reefs. Examples of these were Blue Groper (*Achoerodus viridis*), Reef Leatherjacket (*Eubalichthys bucephalus*) and Rock Cale (*Crinodus lophodon*). These species made up 81% of all the fish species observed. In addition, some of the species were only observed on subtidal reefs in the study area where the habitat was topographically complex because they require shelter. Examples of these species were White-ear Parma (*Parma microlepis*), Girdled Parma (*Parma unifasciata*) and Common Bullseye (*Pempheris multiradiata*). These species tended to be less common in the southern amphitheatre, where much of the reef consisted of flat bedrock.

Two species typical of sandy habitats were also observed. These were Sand Whiting (*Sillago ciliata*) and Stingaree (*Urolophus sp.*). In addition, four species were non-specific to sand or reef. These were Snapper (*Pagrus auratus*), Smooth Stingray (*Dasyatis brevicaudata*), Yellowtail (*Trachurus novaezelandiae*) and Eagle Ray (*Myliobatis australis*). Fish associated with sand, or were non-specific to a particular habitat, were observed only in the southern amphitheatre.

Commercial and Recreational Fisheries

The region encompassing the study area also supports a number of commercial fisheries as well as recreational fishing and diving activities. These activities are described in more detail in Section 9.7.2 of this REF. Potential impacts on the habitat requirements of species of commercial and recreational importance are provided below.

9.6.2. Legislative Considerations

NSW Legislation

The Proposal is unlikely to affect any state listed threatened and protected fish, marine mammals or marine reptiles as listed under the FM Act and TSC Act. During the surveys undertaken in October 2003 and February 2004, no species of conservation significance was recorded within the study area, however in accordance with the legislative requirements, eight part tests were undertaken in relation to relevant species listed under the FM Act and the TSC Act, which could potentially be impacted on as a result of the Proposal.

In relation to the FM Act, three species of threatened fish have been recorded on the Hawkesbury Shelf, which encompasses the study area. Five species of marine mammal and three species of marine reptile listed under the Schedules of the TSC Act have also been recorded in areas and habitats relevant to the to the study area. In determining the potential impact on these threatened species as a result of the Proposal, it is appropriate to apply the eight part test as provided under Section 5A of the EP&A Act. These criteria are designed to determine 'whether there is likely to be a significant affect on these threatened species, their populations, ecological communities, or habitats', and consequently, whether a SIS is required. Table 9.10 lists the species of conservation significance that have been recorded in areas and habitats relevant to the study area.

Table 9.10: Marine Species of Conservation Significance

Species	Status		
	EPBC Act	**TSC Act**	**FM Act**
Grey Nurse Shark (*Carcharias taurus*)	CE*	-	E
Great White Shark (*Carcharodon carcharias*)	V	-	V
Black Cod (*Epinephelus daemelii*)	-	-	V
Whale Shark (*Rhincodon typus*)			
Blue Whale (*Balaenoptera musculus*)	E	E	-
Southern Right Whale (*Eubalaena australis*)	E	V	-
Humpback Whale (*Megaptera novaeangliae*)	V	V	-
Sperm Whale (*Physeter catadon*)	-	V	-
Sei Whale (*Balaenoptera borealis*)	V	-	-
Fin Whale (*Balaenoptera physalus*)	V	-	-
Australian Fur-seal (*Arctocephalus pusillus doriferus*)	-	V	-
Loggerhead Turtle (*Caretta caretta*)	E	E	-
Leatherback Turtle (*Dermochelys coriacea*)	V	V	-
Green Turtle (*Chelonia mydas*)	V	V	-
Hawksbill Turtle (*Eretmochelys imbricata*)	V	-	-

CE* - Critically endangered (east coast population); E – Endangered; V - Vulnerable

The eight part tests undertaken for the threatened species listed under the FM Act and TSC Act concluded that the Proposal would not have a significant impact on either any of these species such that a locally viable population of these species would be placed at risk of extinction. Although these species were recorded within areas and habitats relevant to the to the study area, the habitat within the study area is not considered critical to the life cycle needs of these species. Based on the outcomes of the eight part tests, it was concluded that the preparation of a SIS would not be necessary for the species listed under the FM Act and TSC Act (as described in Table 9.10).

In addition to the threatened species listed under the Schedules of the FM ACT, Part 2 (19) of that Act allows for the declaration of 'protected species'. There are eight marine species that are totally protected in NSW Waters. They cannot be captured by any means and should be considered if likely to be captured as part of an activity. It is anticipated that any of the species listed as protected would be caught as a result of the Proposal. Therefore no further consideration is required.

Commonwealth Legislation

The Proposal is unlikely to affect any nationally listed threatened fish, marine mammals or marine reptiles as listed under the EPBC Act. During the surveys undertaken in October 2003 and February 2004, no species of national conservation significance was recorded within the study area. However, in accordance with the legislative requirements, the nationally listed species listed in Table 9.10, which could potentially be impacted on as a result of the Proposal, were assessed against the relevant criteria provided under the EPBC Act Administrative Guidelines on Significance.

The assessment against the relevant criteria provided under the EPBC Act Administrative Guidelines on Significance for the threatened species listed under the EPBC Act concluded that the Proposal would not:

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of the listed species;
- Fragment an existing population into two or more populations;
- Adversely affect habitat critical to the survival of the species;
- Disrupt the breeding cycle of the population;
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the listed species are likely to decline;
- Result in invasive species that are harmful to listed species becoming established in the listed species' habitat; or
- Interfere with the recovery of the listed species.

As such, in relation to those nationally listed species described Table 9.10, the Proposal would not have a significant impact on the occurrence of these species, or their necessary habitat requirements. Therefore the Proposal would not require referral to the Federal Minister for the Environment for further consideration and approval.

In addition to threatened species, the EPBC Act also includes 'Listed marine species'. The 'Listed marine species' (Section 248 of the Act) constitute a diverse group of marine animals, including reptiles, mammals, fish and birds and many of them occur rarely in the Wollongong area, for example, sea snakes. One group that does require some consideration includes the seahorses, pipefish and sea dragons (*Syngnathidae*) and the ghost pipefish (*Solenostomidae*). The Weedy Sea Dragon (*Phyllopterx taeniolatus*) frequents rocky reefs in central and southern NSW and extending further south (Kuiter 1993). Typically, they occur around the edges of kelp beds and there are populations at Botany Bay to the north, and on deeper reefs off Wollongong to the south. Weedy Sea Dragons may inhabit the deeper subtidal rocky reefs within the study area containing dense kelp beds. However, given that these habitats are more than 300 m from where construction would be undertaken and no individuals were recorded during surveys, it is unlikely that the Proposal would affect Weedy Sea Dragons.

9.6.3. Potential Impacts

The construction of the four bridge piers in southern amphitheatre would require machinery to be driven to the very edge of the water to excavate footings into solid rock. This would require a track being cut into the existing embankment from the level of the present road to just above sea level, where a working platform would be constructed for each pier. The access tracks would be 10 - 12m wide and each working platform would be 20m x 30m and situated about 5m above Mean High Water. The working platforms would be 30m to 40m below the existing road.

The construction of a track down to the platforms and linking each of them would require the removal of no material but would require approximately 20,000 m^3 of material. It is anticipated that fill material and hard rock required for this would be sourced from geotechnical works undertaken in GD4 and GD5. If this material is structurally inadequate for the purpose of the access track and working platforms, fill material may be required from other sources.

As a result of the spatial limitations within the southern amphitheatre, it is proposed to reclaim up to 3,000m^2 of the existing coastal boulder field foreshore environment. The reclamation would provide for the access track and working platforms, including rock armouring. The reclamation would occur along the shore of the southern amphitheatre in the vicinity of the bridge alignment. The width of the reclaimed areas would be a maximum of 10m wide.

Generally, it is considered that the greatest potential for impacts to the marine environment would be associated with construction activities and long term alteration of habitat. It is considered that issues associated with shading, lighting and runoff from the bridge would have little or no effect on marine ecology, due to the height and width of the bridge, limited use of lighting and expected levels of traffic. A detailed assessment of impacts for coastal habitats and biota is provided below.

Intertidal Habitats

Boulder Fields

The key area of consideration for boulder fields is the proposed reclamation of the intertidal boulder fields in the southern amphitheatre. Large areas of these boulder fields would need to be reclaimed in the southern amphitheatre in order to provide suitable working platforms and access track for the construction and ongoing maintenance of the four bridge support piers.

In the worst case, about 80% of the intertidal boulder field in the northern section of the southern amphitheatre would be reclaimed and about 90% of the boulder field in the southern section. This would amount to a maximum reclamation of about 46%, or approximately 3,000m^2, of the total intertidal boulder field habitat in the study area. Intertidal boulder fields are relatively uncommon in the region and potentially harbour some species with conservation value although none have been identified as a result of the recent surveys. The implementation of appropriate restoration measures is an important way of ensuring that this type of habitat (albeit altered) is conserved.

If not appropriately contained during construction, spoil and earth works have the potential to affect all of the intertidal boulder fields in the study area. Spoil can clog spaces between boulders where a diverse assemblage of biota are found. This would have the greatest impact on species, which live only on the underside of boulders.

At the northern end of the northern amphitheatre a concrete culvert would be required. The culvert would be constructed along a natural watercourse and so would not increase the amount of sediment into the intertidal boulder field in the northern amphitheatre. It would also be constructed to slow the velocity of discharged water.

Rock Platforms

The intertidal rock platforms face similar issues to the intertidal boulder fields regarding the potential effects of spoil and turbid runoff during construction. If spoil and runoff are not contained the most affected rock platforms would be the southern platform of the southern amphitheatre and the southern platform of northern amphitheatre. Release of spoil onto these platforms has the potential to fill up rock pools, cracks and crevices which act as

habitat for many species. Discharge of turbid runoff onto rock platforms has the potential to affect many species, particularly algae. Many species on these rock platforms are prey items of the sooty oystercatcher, which is known to forage there. Therefore, it is important to ensure that there is maximum containment of spoil and turbid runoff during construction.

The proposed alignment of the section of the bridge by-passing the middle headland is very close to the edge of intertidal habitat on the middle rock platform and any working platforms needed for the construction of piers may need to be built over some intertidal habitat.

This could potentially result in some intertidal habitat being covered by the working platforms and the access tracks linking them. It is also possible that some organisms in the intertidal habitat of this rock platform would be adversely affected by trampling during construction of the working platforms and access tracks, hence areas of general disturbance would need to be minimised.

Subtidal Habitats

The key area of consideration for subtidal areas is the potential for the direct impact of reclamation works in the southern amphitheatre. Large areas of subtidal boulders covered with *Phyllospora camosa*, sandy habitat and a bed of the green alga *Caulerpa filiformis* would be reclaimed to provide suitable working platforms for the construction of the four large supporting piers and an associated access track.

Although this represents a large proportion of the southern amphitheatre the substratum and habitats are well represented in the study area and the region. It is estimated at the worst case reclamation would remove about 30% of the subtidal boulders adjacent to the shore, about 5% of sandy areas, about 10% of the *Phyllospora* habitat and about 20% of the *Caulerpa* bed in the southern amphitheatre.

The loss of habitat through reclamation would also cause mortality of invertebrates associated with these habitats and displace fish to other similar habitats.

Without appropriate containment, spoil and turbid runoff resulting from construction has the potential to affect subtidal habitats. Spoil entering the ocean has the potential to fill up cracks and crevices on subtidal reefs which act as habitat for many species, or to inundate low-profile reefs and smother algae. Areas that have the potential to be most affected would be the fringing subtidal reefs of the middle rock platform and the reefs in the middle of the southern amphitheatre.

Even though waters in the study area appear to be very turbid on occasion turbid runoff during construction has the potential to increase turbidity above natural levels and reduce light penetration into the water thereby altering the growth of algae. This would need to be assessed against natural levels in a program of monitoring. To minimise the risk of such effects, a broad range of measures is being recommended in Section 9.6.4.

Commercial and Recreational Fisheries

Some commercial fishers would be affected by the Proposal, mainly because some subtidal areas in the southern amphitheatre would be reclaimed. Least affected would be fishers in the Ocean Haul Fishery and Trap and Line Fishery because the shallow areas to be reclaimed are rarely, if ever, used by operators in these fisheries. However, fishers in the Eastern Rock Lobster Fishery, Abalone Fishery and the Sea Urchin and Turban Shell Fishery could potentially harvest on shallow, subtidal reefs within, and adjacent to, the study area.

The direct impact of reclamation would be to remove less than 1% of subtidal reef in the study area presently worked by these fishers. However, the potential for sand inundation of other reef habitat as a consequence of any changes to local hydrodynamics has the potential to increase this figure.

Some recreational fishing activity would be affected by the Proposal. However, the Proposal would not result in the loss of areas known to be popular with recreational fishers nor would it result in the loss of habitat vital to the life cycle needs of recreational fishing species. It is also anticipated, that the permanent structure of the new bridge would not affect land or sea based recreational fishing.

9.6.4. Mitigation Measures

A broad range of measures has been developed for this REF. Those water quality and hydrology management measures outlined in Section 9.4, specifically in regard to water quality, would apply to the management of the marine ecology in the study area. In addition, appropriate erosion controls as detailed in Section 9.1 would be used to manage spoil and turbid runoff during construction.

Among other objectives, these measures address the concerns of NSW Fisheries regarding the effects of the Proposal on the marine environment and proposals to mitigate them. Mitigative measures would also take into account the NSW Fisheries guidelines, *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003) and *Fishnote: Policy and Guidelines for Fish Friendly Waterway Crossings* (NSW Fisheries 2003).

In addition, the following measures would be adopted for mitigating the impacts of the Proposal on the intertidal and subtidal habitats and commercial and recreational fisheries:

- As far as practicable the area of habitat to be reclaimed would be minimised;
- NSW Fisheries would be notified regarding the proposed reclamation works, under the provisions of the *Fisheries Management Act 1994*, prior to construction;
- Restoration would be undertaken in conjunction with the reclamation works to restore the lost or degraded habitat;
- Restoration techniques would be developed during the detailed design stage of the reclamation works through consultation with NSW Fisheries, the relevant Management Advisory Committees for affected fisheries and a qualified marine ecologist prior to construction;
- Restoration would create a similar area of boulder field habitat to that reclaimed on the seaward edge of the reclaimed areas;
- To make the restored boulder fields similar to those that would be removed in terms of appearance and ecological function, the slope of the front of the reclaimed areas and material used there would be as similar as practicable to the boulder fields that would be reclaimed. Boulders from intertidal boulder fields to be reclaimed could be mixed in with rock armour on the seaward edge of the proposed reclaimed areas;
- Working platforms and access tracks needed to construct piers for the section of the bridge in GD3 would be restricted as far as practicable to the rear of the rock platform so that minimal intertidal habitat is covered;
- Construction activity would be confined above the limits of the intertidal zone as far as practicable to avoid trampling of intertidal species; and

- A monitoring program would be developed based on the habitats and areas most likely to be affected by the Proposal and would include the intertidal boulder fields, the middle rock platform, the southern rock platform of the southern amphitheatre and the subtidal habitats within the southern amphitheatre. The monitoring program would be developed in consultation with NSW Fisheries and a qualified marine ecologist and would address the following:
  - Baseline information would be compiled prior to construction commencing at areas most at risk as well as control locations where disturbance is unlikely;
  - Monitoring would also consider temporal and spatial changes to biota and water quality to address the effects of natural variability;
  - Monitoring would continue throughout the construction period and approximately 6 months post-construction; and
  - Data collected during the construction period and post-construction would be compared against the baseline information and would assist in modifying those mitigation measures described above if necessary or used to formulate additional measures where required.

9.7. Socio-economic Considerations including Land Use

9.7.1. Existing Socio-economic Environment

For most Environmental Impact Assessments, socio-economic impacts are assessed from an existing situation where there has been no disruption to the *status quo.* Projections are made to assess the socio-economic impacts post construction. In this assessment the impact is derived from the current situation where a long term closure has resulted in adverse social and economic impacts to both individuals and businesses which have relied on the continual operation of Lawrence Hargrave Drive for their daily routines of commuting, transport and business.

To quantify the level of impact, the RTA commissioned Illawarra Regional Information Service (IRIS) to conduct consultative research into the ongoing impact of the closure on the surrounding community. For the purposes of describing socio-economic issues, the affected communities have been assumed to be those identified in the IRIS surveys (IRIS 2004) as a geographic area bounded by Helensburgh in the north to Thirroul in the south.

A summary of the surveys is provided below.

Impact on Work

The two major pockets of workers affected by the closure were those commuting to Sydney from the Clifton to Wombarra area and commuters travelling to Wollongong City and suburbs from Coalcliff and Stanwell Park. In the Clifton and Wombarra area over 70% of households that stated that the route taken to work was affected by the closure, 75% travel to Sydney for work. In the Stanwell Park and Coalcliff area 44% of households report that the routine of getting to work has been affected by the road closure. Of these latter households, 95% work in Wollongong CBD or other parts of Wollongong. These commuters generally travelled in private vehicles via the coast before the road closure, but are now more reliant on rail. Those that continue to use private vehicles and divert around the closure have experienced an increase in travel distance time and cost.

The survey found that the average travel time to work from affected households has increased by 19 minutes since the road closure resulting in a round trip increase of 38 minutes. In terms of cost, the survey found the average weekly cost associated with travel

to work from affected households has increased by $24.00 since the road closure. Other social impacts and concerns related to impacts on home routine, safety fears about the F6 and increased traffic in the southern suburbs.

Impact on Education

The IRIS survey identified that the road closure has had an adverse impact on students, (pre-schoolers, primary school children and high school students) particularly those living in Stanwell Park and Coalcliff. Transport modes had shifted leading to increased travel time and disrupted routines.

The impact on post – secondary students was similar to that experienced by commuters. Students that live to the north of the road closure and attend educational institutions in the suburbs of Wollongong, and those that live to the south of the road closure and attend institutions in Sydney, have had to change from private road transport to rail or travel via alternative routes.

Impact on Shopping and Services

There has been no disruption to local household's regular shopping patterns. The majority of households have had to change shopping locations and reduce the frequency of shopping for essential items and services. The Stanwell Park and Coalcliff area is by far the most affected with 76% of households reporting that the closure has had impacts on the use of shops and other services. On average the survey found that affected households are travelling an extra 36km for a round trip to the shops and taking 36 extra minutes to get there and return. It was also found that on average an extra $14.00 per week was spent on shopping related travel.

Social and Lifestyle Issues

Over half (52%) of households stated that accessibility of family and friends had been adversely impacted by the road closure, with the result that travel distances have increased and visits are less frequent. The areas just north (Stanwell Park and Coalcliff, 77%) and just south (Clifton, Scarborough and Wombarra, 76%) of the closure were the most impacted.

In terms of leisure activities just over half (54%) of all households reported that their participation in leisure activities had been adversely impacted by the road closure. Again, Stanwell Park and Coalcliff were the most affected, with 75% reporting that the road closure had impacts on their participation in recreation activities. Of these 58% participate in leisure activities less often or have ceased participants in sport / leisure activities.

Alternative Transport Arrangements

Many households have been forced to change modes of transport in order to travel to their regular destinations. There is now a heavy reliance on train services.

Households in Stanwell Park and Coalcliff who regularly rely on public transport are generally unhappy about the current levels of transport arrangements. Over two thirds (69%) of households in that area who use the train believe that current services are inadequate for their household's needs. The main issue was the perception that train services for people in this area do not operate frequently enough. Furthermore, only 23% of households in Stanwell Park and Coalcliff that regularly travel by bus feel that the service to their area is adequate.

Impacts on Businesses

In addition to the impacts described by the IRIS survey above the closure has also had an economic impact on businesses. This is due to a decline in the volume of passing traffic (particularly Sydney visitors taking weekend trips in the Illawarra), which has resulted in lower sales output of many businesses in the area.

Major concerns of local businesses included a reduction in takings, difficulties faced by suppliers in servicing the business, the extra distance required to travel to work, a reduction in passing trade and inconvenience to customers.

Response to Current Impacts

In response to this current social and economic disruption caused by the road closure, the State Government has provided an additional community support fund of $2 million. The funds, which are managed by the RTA, were allocated to relieve potential socio-economic issues on the local communities as a result of the road closure. The funds provide for:

- Extra bus services for residents and School children;
- Subsidies to offset increased travel costs for community service organisations and schools;
- Advertisements encouraging tourists to the area;
- Design and construction of tourist information bays and signage;
- Promotional support for local events and shopping centres; and
- A survey of community and business impacts as a result of the closure.

9.7.2. Current Land Uses

The study area is bordered by only a small number of land uses, which is mainly a result of the existing topography. Existing land use patterns generally reflect the underlying zoning, which is shown in Figure 4.1.

The villages of Clifton and Coalcliff are located immediately south and north of the study area respectively and constitute the closest residential areas to the study area. Illawarra Coke Company's Coke Works lie immediately west of Coalcliff village and adjoin the existing road at the study area's northern extremity. Land situated between the existing road and the ocean is undeveloped with some heritage items associated with the old Coalcliff Colliery mine portal and remnant jetty being present. Consideration of the commercial and recreational fishing practices within the intertidal and subtidal areas is provided below.

The majority of the land to the west of the study area is open space and has been identified as new area proposals for the Illawarra Scenic Conservation Area. One parcel of land identified for addition to the SCA lies east of the existing railway line at Clifton and Lawrence Hargrave Drive with a smaller parcel lying between the existing road and the ocean. DIPNR has notified the RTA that DEC does not require this land east of the Illawarra Railway Line for addition into the SCA due to its being prone to rock fall. The RTA has been requested to accept the transfer of this land.

Major transport routes through the study area include the Illawarra Railway line, which enters Coalcliff tunnel at Clifton and emerges within the Coalcliff Coke Works. Within most of the study area the railway is located within this tunnel. The existing alignment of Lawrence Hargrave Drive forms the only other major transport link.

Commercial Fisheries and Recreational Fishing and Diving

There are several commercial fisheries in the region encompassing the study area. The fisheries most likely to be affected by the Proposal include the Eastern Rock Lobster Fishery, the Abalone Fishery and the Sea Urchin and Turban Shell Fishery. The NSW lobster fishery is a small but valuable fishery with approximately 105 tonnes caught each year worth approximately $4.6 million (reported commercial catch). Eastern rock lobster (*Jasus verreauxi*) is the main species harvested and the fishery extends from Queensland to Victorian borders and includes all waters under jurisdiction of NSW to around 80 miles from the coast. It is characterised by inshore and offshore sectors. Inshore lobster fishers use small beehive or square traps in waters up to 10 metres in depth. During a site visit undertaken for the marine ecological assessment, The Ecology Lab estimated between 10 - 40 commercial lobster traps within the study area. The abalone fishery is one of the most valuable fisheries in NSW with approximately 300 tonnes of Blacklip Abalone (*Haliotis rubra*), worth more than $9 million at first point of sale, harvested annually. In practice, most commercial abalone fishing takes place on the south coast of NSW, primarily from Jervis Bay to the Victorian border, with most abalone found close to the shore. The Sea Urchin and Turban Shell Fishery is a small fishery worth less than $200,000 annually that targets three species of sea urchin and two species of turban shell (www.fisheries.nsw.gov.au).

Recreational fishing is widespread throughout the Illawarra region, with recreational fishers seeking similar inshore species to commercial fishers. A recent estimate of the number of recreational fishers in the Illawarra totalled approximately 20% of the population (Henry and Lyle 2003). The majority of fishers are shore-based, although a substantial component is boat-based, and there are also snorkellers who spearfish and take abalone and rock lobsters. Discussions with a local NSW Fisheries Compliance Officer (Illawarra Office) indicated the northern rock platform within the study area is very popular with shore-based recreation fishers, particularly in summer. Access to the middle rock platform and the southern rock platform restricts the amount of recreational fishing effort there to a lesser extent than the northern rock platform.

SCUBA divers use the study area infrequently. Although boat dives within the study area are rare, some groups occasionally use the northern rock platform as the base for a shore dive. However, on these occasions divers are thought to restrict their activities mostly to the northern side of the rock platform because of difficulties entering and exiting the water on the southern and eastern sides.

9.7.3. Potential Impacts

Socio-economic

Long-term positive socio-economic impacts would result in a reversal of the current adverse impacts being experienced by households and businesses. These positive impacts are identified as:

- Reconnection of the communities of Coalcliff and Clifton;
- Re-establishment of commuting patterns for workers and students;
- Cost and timesaving in travel distances for commuting and shopping;
- Resumption in tourist trade for local businesses; and
- Potential extra tourism traffic as a result of a unique engineering solution.

It is anticipated, that during construction of the Proposal the communities identified above may experience further negative impacts. The potential impacts are:

- Local residents and businesses (including Illawarra Coke Company) would be temporarily affected by extra traffic during construction, but would benefit in the long term for the reasons stated above; and
- Local residents may also experience construction noise impacts associated with this extra traffic.

Land Use

The Proposal would not result in any impacts on 'land-based' land use practices, as there would be no transformation or loss of existing or future land use practices within the study area. It is not anticipated that the proposed works would result in indirect impacts, such destabilisation, to occur on surrounding land use practices.

A minor amount of property would need to be acquired as part of the Proposal, however the final area is currently subject to detailed design. It is unlikely that any property required would be severed and it is anticipated that only strip acquisition would be undertaken. Negotiations are currently being undertaken with the concerned landholders, which include Wollongong City Council, DIPNR and the Illawarra Coke Company.

The Proposal would result in impacts to commercial and recreational fishing practices during and after construction. Commercial fishers of the Eastern Rock Lobster Fishery, Abalone Fishery and the Sea Urchin and Turban Shell Fishery would be likely to be impacted as they generally harvest on shallow, subtidal reefs, similar to those adjacent the study area. Although there has been an area closure in the region for abalone for some time because disease has reduced stocks dramatically, and fishers in the Urchin and Turban Shell Fishery fish mostly south of Wollongong in the region, the reclamation of some subtidal reef in the southern amphitheatre would remove potential fishing ground for these fishers. The fishers who may be most affected by the proposed reclamation works would be fishers in the Eastern Rock Lobster Fishery. Potential impacts to the habitat of fish species from these fisheries are provided in Section 9.6.3.

Some recreational fishing activity would be affected by the Proposal. The rock platforms in the study area, particularly the northern platform, are popular for shore-based recreational anglers. Recreational anglers would probably not be able to access the middle platform and the southern platform during construction but would still be able to fish from the northern platform. Boat-based anglers, spearfishers and snorkellers would be able to carry out activities in most parts of the study area during construction apart from the near-shore areas of the southern amphitheatre.

Although some shore-based SCUBA diving activity occurs occasionally around the northern rock platform, it occurs mostly from the north side of the rock platform and would be unaffected by the Proposal.

9.7.4. Mitigation Measures

The communication activities undertaken by the RTA to date (Section 5.1) to provide information to the local communities would be continued for the duration of the Proposal. These activities, including media events, Community Updates, Community Consultative Committee meetings and public information sessions and fact sheets, would continue to inform the community about the construction activities and proposed schedule.

Impacts associated with noise from construction traffic are discussed in Section 9.11 of this REF. Mitigation measures associated with the potential loss of habitat with regards to commercial and recreational fish species is provided in Section 9.6.4 of this REF.

The following specific mitigation measures would be implemented for the Proposal:

- A project phone number would be established that residents could utilise to register concerns, complaints or other comments about construction. Protocols described in *RTA Community Involvement: Practice Notes and Resource Manual* (1998) would be followed;
- A Traffic Management Plan (TMP) would be developed for the Proposal in accordance with RTA's *QA Specification G10 – Control of Traffic*. The TMP would outline the construction vehicle movement plan(s), which would be developed in consultation with the Illawarra Coke Company to minimise obstruction to heavy vehicle movements of the Coalcliff Coke Works as well as local traffic;
- All property acquisition where necessary would be undertaken prior to construction and be negotiated in accordance with the RTA's *Land Acquisition Policy* and compensation would be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*; and
- The relevant Management Advisory Committees for the Eastern Rock Lobster Fishery, Abalone Fishery and the Sea Urchin and Turban Shell Fishery would be notified and provided with a schedule of works prior to construction.

9.8. Indigenous Heritage

9.8.1. Existing Environment

An indigenous heritage assessment of the study area was undertaken by Dominic Steele Consulting Archaeology in December 2003. The assessment aimed to identify any known or potential indigenous archaeological concerns within the study area. A summary of the report that was produced is provided below and the full report is contained in Appendix 6.

Desktop Review

A search of the DEC Aboriginal Heritage Information Management Systems (AHIMS) Register was undertaken for a 5km long and 4km wide area around the section of Lawrence Hargrave Drive under investigation. A total of 25 sites were located within the area searched, although all but two of these were located above or along the Escarpment above and west of the study area. No previously recorded Aboriginal sites are located within the study area.

A search of the National Native Title Tribunal register revealed that there are no current Native Title Claims or non-claimant applications existing over the study area. The study area falls within the administrative boundaries of the Illawarra Local Aboriginal Land Council (ILALC) and the Wodi Wodi Elders Corporation (WWEC), which represents the traditional Aboriginal owners of the area. Both ILALC and WWEC were consulted during the archaeological assessment and invited to attend a site survey of the study area.

Predictive Model

On the basis of environmental and archaeological contextual information, it is possible to predict the types of Aboriginal site, which may possibly occur within the study area, and to give an indication of the likelihood of their occurrence.

From the site prediction, the evidence for Aboriginal occupation which may exist in the study area is expected to be scant and consist of low density scatters of Aboriginal flaked stone artefacts with the possibility for individual stone artefact finds to occur throughout.

Field Survey Results

A site survey was conducted on 11 December with Mr Shaun Suddery of ILALC, Paul Irish of Dominic Steele Consulting Archaeology and Suzanne Malligan, RTA Southern Region Aboriginal Programme Consultant (APC), in attendance. The survey was carried out on foot but due to the nature of local topography, the inspection was largely restricted to those areas visible from the road, with limited access to some of the lower cliff lines west of the road.

Frequently used criteria inclusive of landform, aspect, topography and subsurface integrity were used in the survey to define open areas of Potential Archaeological Deposit (PAD). Also using these criteria, areas unable to be adequately appraised for their archaeological potential (e.g. due to restricted access or lack of surface exposure) were defined as areas of Potential Archaeological Sensitivity (PAS).

Given the limited access in the study area (survey coverage did not extend up the slopes more than approximately 50m from the existing road alignment), an estimate of approximately 5.0% effective survey coverage (ESC) was documented for the site. No items of Aboriginal archaeological heritage were located during the site survey. Visual assessment of inaccessible areas concluded that they have little or no potential to contain traces of Aboriginal occupation or use, if indeed these areas were utilised.

The survey observations were consistent with the archaeological, environmental and ethnographic data, which suggest that the steep topography, lack of drinking water and unstable landform in the area are unlikely to have supported intense Aboriginal activity in the past. Furthermore, within several kilometres to the north, south and west of the study area, there are areas with permanent drinking water, gentler topography and resources similar to, and probably richer than, those found in the study area.

Additionally, if the area was used for a specific resource or possible ceremonial purpose, it is not expected that these would have generated significant quantities of physical remains and it is likely that substantial traces of Aboriginal use in the area would have been destroyed or highly disturbed by the actions of erosion from the upper slopes and the unstable nature of its landscape as well as previous road construction activities.

Cultural Heritage

A copy of the draft archaeological report was forwarded to the WWEC for an assessment of the cultural heritage of the study area. The Corporation has advised that due to the ground sloping steeply towards the top of the escarpment as well as seaward it found it unlikely that there would have been aboriginal occupation in the study area and there are no cultural constraints to the Proposal proceeding.

9.8.2. Potential Impacts

There are no archaeological constraints on the Proposal, and no further archaeological work is required within the potential area of impact for the Proposal. It is considered highly unlikely that extensive or intact deposits of Aboriginal stone artefacts would exist within the study area. Whilst there is a low possibility that low densities of stone artefacts occur in disturbed contexts or individual stone artefacts from these or other origins may be present, they are not considered to have scientific / archaeological significance. However, should any

archaeological material be uncovered during construction the mitigation measures identified below would be implemented to minimise impacts.

There are also no cultural constraints on the Proposal.

9.8.3. Mitigation Measures

The following mitigation measures would be implemented for the Proposal:

- Should any relic, artefact or material (including skeletal remains) suspected of being Aboriginal in origin be encountered, all work would cease that may expose the relic, artefact or material to damage or disturbance. The RTA's Southern Region Environmental Adviser and APC would be notified immediately, who would then arrange for an officer of DEC's Parks Services Division and a member of ILALC and the WWEC to be consulted; and
- All personnel working on the site would receive training regarding their responsibilities under the *National Parks and Wildlife Act 1974.*

9.9. Non-indigenous Heritage

9.9.1. Existing Environment

Lawrence Hargrave Drive, formerly known as the 'Lower Coast Road' was established in the 1860's. At its southern extremity it connected with the Princes Highway at the foot of Bulli Pass. The road consisted of little more than a dirt track and is noted that in 1877 the heavy drays used to transport timber to the site of the jetty made the road unusable for ordinary traffic. The road was renamed Lawrence Hargrave Drive in 1947 after the Australian aviation pioneer. Ongoing development of coastal villages and increased commuter and tourist traffic has resulted in the road being an important alternative to the Princes Highway, F6, Mt Ousely Road route from Sydney to Wollongong.

Initial investigation into the non-indigenous heritage of the study area was undertaken using desk based surveys. The following registers and lists were reviewed during the desk assessment:

- Australian Heritage Council Register of the National Estate (RNE);
- NSW Heritage Office State Heritage Register and Inventory;
- NSW Maritime Heritage Online Databases;
- RTA Heritage and Conservation Register (s170);
- Illawarra REP No. 1 Heritage Listings (REP); and
- Wollongong City Council Heritage Listings (LEP).

A summary of non-indigenous heritage sites within or surrounding the study area is provided in Table 9.11.

Table 9.11: Heritage Items within or Surrounding the Study Area

Item	Location	Details	Listing	Potential Impact
Entrance Portal, Coalcliff Colliery	Cliff face, below Lawrence Hargrave Drive, Coalcliff	Archaeological Item	LEP, REP	Yes
Stand of Norfolk Island Pines	Lawrence Hargrave Drive, Coalcliff	Landscape Item	LEP	Yes
Moranga Park	Lawrence Hargrave Drive, Clifton	Landscape Item	LEP	No
Remnant Cliff Vegetation	Clifton, North of Moranga Park	Landscape Item	LEP	No
School of Arts	338 Lawrence Hargrave Drive, Clifton	Built Item	LEP	No
Escarpment Core Area	Illawarra Escarpment	Landscape Item	LEP	Yes
Coke Ovens, Coalcliff Colliery	Coalcliff Colliery, Coalcliff	Archaeological Item	LEP	No
Railway Tunnel No. 8	Illawarra Railway Line, Coalcliff	Archaeological Item	LEP	No
Coalcliff Geological Site	Lawrence Hargrave Drive, Coalcliff	Landscape Item	RNE	Yes
Illawarra Escarpment	4km west of Wollongong, Macquarie Pass to Stanwell Park	Archaeological and Landscape Item	RNE	Yes

Note: No maritime heritage significant sites (namely shipwrecks) were found within or surrounding the waters of the study area.

As a result of the Proposal to potentially impact on heritage items, a Statement of Heritage Impact (SOHI) was undertaken by RTA Environmental Technology in February 2004. The SOHI is required in order to determine the potential heritage impact of the Proposal on a heritage item and whether it is acceptable. A summary of that assessment, including a description of items that may be potentially impacted as a result of the Proposal, is provided below and the full report is contained Appendix 7.

Other heritage items not identified in any of the above listings and potentially impacted by the Proposal were also assessed.

9.9.2. Heritage Items

Entrance Portal, Coalcliff Colliery

In April 1877 the tunnel mine was opened to work the Bulli seam outcropping some 10m above sea level and exposed at the waters edge. This consisted of two tunnels driven westward approximately 120m under the mountain. The main tunnel was nine feet wide and six feet high, to facilitate double rail lines. The second tunnel was built for ventilation purposes. The section of the mine that the portal serviced was closed in 1912 due to safety concerns.

When the Coalcliff Colliery was closed in December 1993 the entrance portal was sealed with a combination of concrete and backfill. As the entrance portal was the main tunnel and source of activity in the mine before 1912 it is assessed as being of high heritage significance.

The Entrance Portal is listed as a heritage significant item on both the Wollongong LEP and Illawarra REP No. 1.

Jetty, Coalcliff Colliery

The jetty was constructed for the purposes of transporting coal from the original mine. Suitable foundations for mining structures were not initially available at the base of the cliffs and structures were erected on a rough beach where boulders were utilised to raise the jetty and other facilities. The jetty was the lifeline for the colliery and was approximately 150m in length. The first commercial output from the mine occurred in 1878.

The jetty and associated structures are not listed as an item of heritage significance in any of the listings described in Section 9.9.1, however as a result of its history the jetty was assessed during the SOHI. Below is a summary of the heritage significance of the jetty, which was undertaken using the 'grading of significance of items or places of heritage value', described in the *NSW Heritage Office Heritage Manual.*

Access Path and Brick Retaining Wall

The path, with intermittent flights of stairs, replaced a 150 feet long slide as the means for miners to access the mine site in 1878. The path is now poorly defined in parts and the pipe handrail would not be considered to be an effective pedestrian barrier. In the immediate vicinity of the path, a red brick wall has been erected to retain the weathered unit of inter-bedded shale. The retaining wall is of a utilitarian construction that is of poor integrity, having suffered a partial collapse in the past. Sections of the footpath were constructed of similar material and they have also proved to be only partly durable. It is therefore assessed as having no heritage significance.

Rock-faced platform (southern end)

The rock-faced platform was built in 1881 to replace the original timber trestle arrangement and was founded on locally sourced sandstone boulders and consolidated with bituminous material and coal ash in order to produce a level surface for the operation of coal skips from the main tunnel to the jetty. Following the closure of this mine site in 1912, almost all of the removable iron from the railway tracks, boiler house, screens and workshop were salvaged. Given the level of intactness of the rock-faced wall and the progressive cycle of construction that is preserved in the cross section this area has been classified as being of high heritage significance.

Rock-faced platform (northern end)

Since the closure of the mine site in 1912, the northern section of the rock-faced platform has collapsed and the accompanying fill has been steadily degraded by wave action. The wave action has also resulted in a small amount of ferrous material being redeposited close to the northern edge of the platform. This material is extensively corroded and is of indeterminate use. Given the high level of disturbance the northern end of the rock-faced platform has been assessed as being of low heritage significance.

Boiler

Following the closure of the mine site in 1912 the majority of available equipment was salvaged for reuse. However, a largely intact boiler was left behind, which consists of seven cylindrical hoops riveted to form a boiler of dimensions 4.00m long with diameter 0.60m. The fact that it has maintained its structural integrity despite such extensive corrosion suggests that the metal used was wrought iron instead of steel. As a largely intact example of early 19th industrial technology it has been assessed as being of high significance.

Brick Footings

Brick footings were observed at the base of cliff at the northern end of the rock-faced platform. The bricks are machine made of similar type to those used in the access path and brick retaining walls. A workshop and boiler house were in operation at the rear of jetty when mining operations were being undertaken and given the proximity to the boiler detailed above, it appears likely that these constitute the footings of the boiler house. As the only surviving structure the brick footings have been assessed as being of high significance.

Site of Jetty

The jetty was rebuilt in 1878, 1881 and 1904, as heavy seas routinely undermined the structure. While no signs of this structure are now evident, the orientation of the jetty can still be determined through the location of a series of drill holes, which supported the timber pilings along the southern edge of the rock platform. In addition, a row of iron pins was observed parallel to the drill holes. As a result of the poor preservation of the site it has been assessed as being of low heritage significance.

Coalcliff Colliery

In 1909, Coalcliff Collieries Limited was floated and a new colliery was based around a shaft sunk adjacent to the northern portal of the Clifton railway tunnel, approximately 900m to the north of the original mine. From the commencement of operations, the coal output was dispatched by rail to Wollongong and a rail siding linked the mine to the Illawarra Railway. The mine was modernised in the 1950's and at the time was heralded as the country's most impressive and technically efficient mining installation. In 1980 the colliery was Australia's largest underground mine employing 988 staff and producing a yearly output of 1.7 million tonnes.

The mine closed in 1993 due to difficult mining conditions, problems with coal quality and increasing underground distances between ingress and egress points. The colliery site is now operated as Coalcliff Coke Works, which is owned by the Illawarra Coke Company.

The former Coalcliff Colliery site is not listed on any heritage registers and lists, however the site does contain two items of heritage significance; the Coke Ovens and Railway Tunnel No. 8, both of which are listed as heritage significant items under the Wollongong LEP. It is also noted that the Coke Ovens are under consideration for listing on the State Heritage Register.

Escarpment Core Area

The Escarpment Core Area has been listed under the Wollongong LEP as an item of heritage significance, however the draft Illawarra *Escarpment Strategic Management Plan* has re-examined the issue of 'core escarpment' and stated that the determination of core escarpment is derived principally from a scientific perspective and draws on criteria for assigning conservation value of biophysical features. Core escarpment areas also include culturally significant sites and important landscape features such as Mt Kiera and Mt Kembla. The core escarpment includes those areas that have high levels of risk to the natural and cultural values from development. The draft plan also stated that landslip, both at the point of failure and down slope, is of particular significance in this regard. The draft plan went on to describe, that the current system is broad scale and not until the release of the Risk-Hazard maps will a fine scale, site-specific approach be undertaken.

The Commission of Inquiry (COI) into the Long Term Planning and Management of the Illawarra escarpment held in 1998/99 identified core escarpment lands as having the following values:

- Areas of high visual scenic and landscape quality;
- Areas of known or potential land instability;
- Areas of high environmental (natural and cultural) and conservation value;
- Existing native vegetation areas exhibiting biodiversity, habitat, wildlife corridor values;
- Soil conservation and related benefits of slope stability and water quality generally undisturbed riparian areas to at least 40m from the top of creek banks;
- Land offering opportunity for tourism, recreation and scientific research for the establishment of an Escarpment Regional Park under the *National Parks & Wildlife Act 1974*; and
- All land zoned *'7(a) Environmental Protection – special'* under the Wollongong LEP.

The proposed boundaries of the Draft Management Plan exclude land east of Lawrence Hargrave Drive but also includes land to the west within the study area although areas adjacent to the Illawarra Coke Company land is also excluded. Discussions with Wollongong Council would be undertaken regarding boundary adjustments once final design is complete.

Coalcliff Geological Site and Illawarra Escarpment

Coalcliff Geological Site and the Illawarra Escarpment are both listed as an 'Indicative Place' on the Register of the National Estate (RNE). The Illawarra Escarpment forms a magnificent backdrop to the developed Wollongong industrial areas. Cliffs of the escarpment are generally sheer and spectacular, extending in relatively unbroken lines, with contrasting views of sandstone exposures and dense vegetation. The area has a number of historic features including mining sites with adits and collieries from previous and current mining activities. Coalcliff Geological Site, which forms a part of the Illawarra Escarpment, is an area of coastal landforms and geological exposures extending south of Stanwell Park (located within GD3 – 5) and is in physically good condition. As both sites are listed as an 'Indicative Place' they are therefore subject to further assessment to determine whether or not the site would be listed on the RNE. While a listing on the RNE has implications for projects funded from Federal sources, a RNE listing has no statutory implications for works planned by a State Government body using State funds. However, any potential impacts would be minimised through mitigation measures detailed below.

Sandstone Block Retaining Wall

The sandstone block retaining wall is not listed as an item of heritage significance in any of the listings described in Section 9.9.1, however the wall was assessed during the SOHI.

The sandstone block retaining wall is located approximately in the middle of the southern amphitheatre on the eastern side of the existing road. It consists of regularly shaped sandstone blocks that have been mortared and laid in up to a dozen courses. It represents an early method of stabilising the material below the existing road and forms a strong contrast with other more modern treatments such as the gabion baskets used in adjacent sections. This wall is attributable to the 1930s when the road was sealed and improved. The retaining wall is utilitarian in nature and post-dates the majority of other heritage items and has been assessed as being of low significance.

Stand of Norfolk Island Pines, Coalcliff

The stand of Norfolk Island Pines (13 individuals) is located on either side of the existing road in the northern amphitheatre and they are considered to be of significant landmark value along this section of Lawrence Hargrave Drive. Ornamental plantings involving Norfolk Island Pines are relatively common along the Illawarra coastline and can be seen at a number of sites in the vicinity to the study area including to the north at Coalcliff Beach, and to the south at Moranga Park, Coledale and Austinmer.

The stand of Norfolk Island Pines is listed as a heritage significant item on the Wollongong LEP.

9.9.3. Potential Impacts

The Proposal has been designed to avoid any direct impacts on the former entrance portal and it is anticipated that only indirect impacts would occur and these would be visual in nature. Mitigative measures outlined below would ensure the significance of the entrance portal is given long term protection.

A proposed bridge pier would be located near the northern section of the rock-faced platform associated with the remnant jetty. The northern section of the platform was assessed as being of low heritage significance and has collapsed and the accompanying fill has been steadily degraded by wave action. As a result of the Proposal it is anticipated that sections of collapsed fill and some ferrous material may be impacted during construction. However, this area has been so heavily disturbed that it can be considered to have lost any archaeological potential and therefore it would not be necessary to obtain an excavation permit for the works from the NSW Heritage office.

The proposed bridge pier would also be in located in the vicinity of the largely intact boiler and the remnant brick footings, both of which were assessed as being of high heritage significance. It is anticipated that these items would not be impacted on as a result of the Proposal Mitigative measures outlined below would ensure the significance of the items is given long term protection.

There is the possibility that the proposed main compound site, including the concrete batch plant would be located within the Coalcliff Coke Works. As described above two items of heritage significance are located within the Coalcliff Coke Works site. If the main compound site is located within this site, the facilities would be located on vacant land and would not interfere with any heritage items.

The Proposal would impact on the area identified as 'Escarpment Core Area' at two locations between the existing road and the ocean as well as at the northern end of the Proposal along the existing alignment. This latter work would involve a continuation of the existing remedial treatments currently being undertaken and would result in the minor alteration the existing profile of the Escarpment. The areas between the existing road alignment and the ocean have been heavily disturbed by the continual rock falls and remedial works and have not been included within the new boundaries identified in the draft *Escarpment Strategic Management Plan.* The subsequent rezoning of this land would be further discussed in consultation with Wollongong City Council. Existing statutory requirements regarding this issue and impacts on heritage items are outlined in Section 4 of this REF.

The two items listed as indicative in the 'Register of the National Estate', although not requiring formal approval, have been taken into consideration in the design and selection of options, and mirror the attributes identified in the draft Illawarra Escarpment Strategic Management Plan. The visual assessment as well as the urban design principles adopted for the Proposal has taken these attributes into account.

To facilitate the construction of the incrementally launched bridge in GD3 and to provide safe approach geometry from the existing road alignment it is proposed to remove the two southernmost Norfolk Island Pines. The stand of Norfolk Island Pines is listed under the Wollongong LEP and is considered to be of significant landmark value. However, the SOHI undertaken for this REF concluded that while the removal of two Norfolk Island Pines from the stand would constitute a considerable alteration, it is not considered that the removal of two trees from a stand of thirteen would result in a significant reduction in its landmark value and as such the works would be considered acceptable. Furthermore, ornamental plantings of Norfolk Island Pines are relatively common along the Illawarra coastline and examples can be found both north and south of the study area.

9.9.4. Mitigation Measures

The following mitigation measures would be implemented for the Proposal:

- Should any item be encountered which is suspected to be a relic of heritage value, including items of maritime heritage value, all work would cease that may expose the item to damage or disturbance. The RTA's Southern Region Environmental Adviser would be notified immediately, who would then arrange for an officer of NSW Heritage Office to be consulted;
- All personnel working on the site would receive training regarding their responsibilities under the *Heritage Act 1977* and would be made aware of the items discussed above and listed in Table 9.11;
- All heritage items, including the entrance portal, remnant jetty and associated structures, and the Norfolk Island Pines to be retained would be fenced (or similar), including a buffer, and all access and activity within these areas would be excluded. The fencing requirements and buffer area would be developed in consultation with a qualified archaeologist;
- The opportunity to 'build in' heritage interpretations of the areas heritage values through signage and other means would be investigated during the detailed design stage.
- The Proposal would respect the recommendations presented in the draft *Illawarra Escarpment Strategic Management Plan*, Volume 2 relating to non-indigenous heritage by seeking the opportunity to utilise the remnant jetty site for interpretation;
- Construction would not interfere with the former entrance portal of Coalcliff Colliery;
- Should a previously unrecorded adit or tunnel be exposed as a result of the bridge pier construction, works would cease until such time that they are recorded in accordance with NSW Heritage Office guidelines;
- A full archival recording of the entrance portal, remnant jetty and associated structures and the stand of Norfolk Island Pines would be undertaken in accordance with NSW Heritage Office guidelines prior to the commencement of the proposed works;
- Removal of the two southernmost Norfolk Island Pines would be undertaken by a certified arborist and to the requirements of Wollongong City Council;
- A formal submission to Wollongong City Council would be prepared regarding the boundaries of the Draft Illawarra Escarpment Management Plan;

- The findings of the REF would be forwarded to Wollongong City Council in its consideration of the draft *Illawarra Escarpment Strategic Management Plan*; and
- Should the main compound site and concrete batch plant be located within Coalcliff Coke Works land, it would be sympathetic to existing operations and heritage values of the site.

9.10. Visual, Landscape and Urban Design

9.10.1. Existing Environment

A landscape analysis of the study area and design development and visual impact assessment of the Proposal was undertaken by RTA's Urban Design Section in collaboration with Johnson Pilton Walker in February 2004. The assessment aimed to address the urban design outcome of the Proposal and covers the analysis of the landscape character, the development of the design proposal and the visual impacts of the Proposal. A summary of assessment is provided below and the full report is contained in Appendix 8.

Landscape Character

The study area is located between the coastal villages of Clifton and Coalcliff within the Wollongong LGA. The landscape within the study area is characterised by a rocky shoreline with extensive flat rock platforms behind which the land rises very steeply to the Illawarra Escarpment and the plateau beyond. Coastal scrub and grasslands are the dominant vegetation communities within the landscape, however there are ornamental plantings of Norfolk Island Pines in the northern amphitheatre. To the south of the study area are sections of dry rainforest with a canopy of 8 – 12m in height and the area to the west consists of undeveloped dry rainforest and woodlands.

The largest feature of the landscape within and surrounding the study area however is the Illawarra Escarpment. This is a dramatic, and in the most part highly attractive landscape feature despite the fact that it has been associated with encroaching residential and industrial development over the years. The power and scale of this feature is such that it still completely dominates both distant and localised views.

The study area and surrounds have a long history of mining operations and many remnant examples, including the original entrance portal to Coalcliff Colliery and the adjacent remains of the associated jetty, can still be seen within the southern amphitheatre. The area also provides evidence of the geological instability of the surrounding cliffs and the associated problems this has had on the section of road. Examples of this are the numerous stabilisation treatments present along the both sides of the existing road. Other notable features of the landscape within and surrounding the study area include remnant cliff vegetation adjacent to the southern end of the study area, as well as areas designated as Escarpment Core Area. Both these features have been identified under the Wollongong LEP as items of regional significance as a result of their aesthetic value within the landscape.

As a result of its coastal location and dramatic landscape, it is therefore considered that the study area and surrounds are located within an area of very high scenic quality and landscape character.

Views

In describing the views of the study area it is appropriate to identify 'receptors' that could be directly or indirectly affected by the Proposal. Given the nature of the topography, the study area is mainly experienced in views from:

- Road users;
- Bald Hill Lookout;
- Northern areas of Stanwell Park; and
- Adjacent rock platforms and ocean.

A 'visibility envelope' with regards to the study area and the Proposal was prepared during the visual assessment (Figure 9.5a and 9.5b).

The existing views from the road are very restricted by the headland / amphitheatre configuration so that in the amphitheatres themselves, views are entirely localised. Road users on approach from the south have limited views to the study area due to a ridge immediately before the headland. From the north, the angle of approach is such that only the northern headland is seen, and then only within the immediate vicinity. The Proposal has been designed to reflect the coastline within the study area and would also utilise the existing road south and north of the proposed bridge. It is anticipated that road user views of the Proposal would also be localised.

The panoramic views experienced from Bald Hill Lookout and the northern areas of Stanwell Park are predominantly restricted to the headlands and rock platforms with limited to no views of both the southern and northern amphitheatres. It is anticipated that views of the Proposal would be partial and middle distant. Visual receptors would predominantly consist of tourists using the facilities.

The Proposal would be predominantly visible from the adjacent rock platforms and ocean. Unlike the other sites described above, these areas do not have any buffers or screens to obscure views. However, compared to those sites, views from the rock platforms and ocean would only be experienced by a limited amount of users, mainly commercial and recreational fishers and recreational boat users.

There are no views from the residential areas of Coalcliff and Clifton. Views are screened from Coalcliff as a result of the northern headland and topography. Whereas, views from Clifton and the villages further south are screened as a result of the ridge immediately south of the southern headland.

Figure 9.5a: Visibility Envelope for Proposal

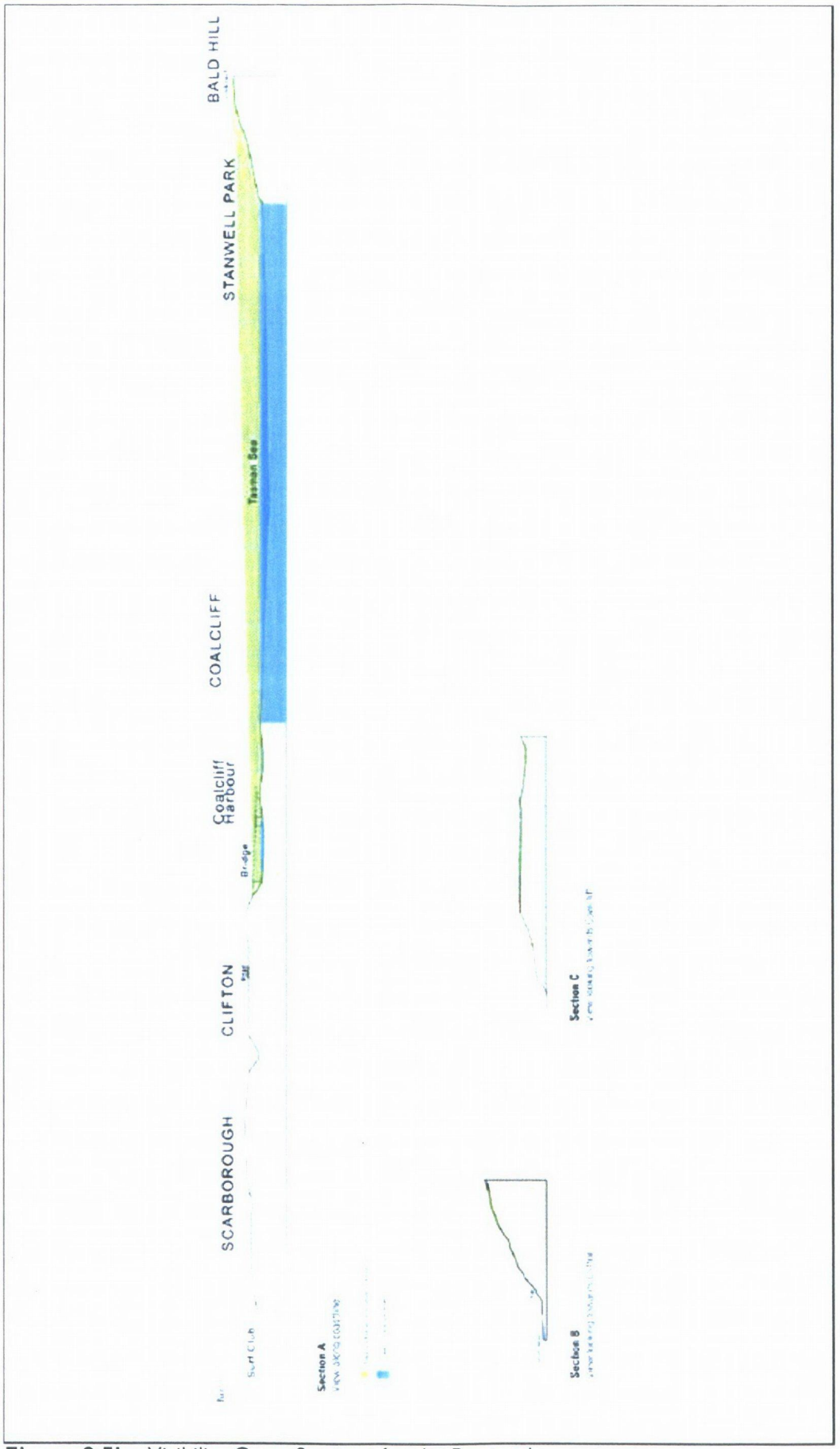


Figure 9.5b: Visibility Cross Sections for the Proposal

9.10.2. Urban / Concept Design

In undertaking the visual assessment of the Proposal, the main design elements of the Proposal were assumed to be:

- A bridge mirroring the existing coastline and comprising two different, but related, superstructure types;
- A symmetrical balanced cantilever superstructure in five launched spans. The three middle spans being 105 – 110m and the two outer spans being 60 – 65m and 50 – 55m;
- An incrementally launched pier and girder bridge (without headstocks) on a constant radius smoothly flowing into the balanced cantilever bridge with a tangent point rather than a straight section connection;
- A continuous parapet across both bridges visually simplifying and integrating the two structures;
- A smooth connection between the girder on the incrementally launched bridge and the narrowest haunch on the balanced cantilever bridge;
- A deep shadow between the bridge deck and girder;
- A 1:100 upward taper in the side elevation, on piers of both superstructures;
- A simple non-textured finish to the concrete with slightly rounded ends to protect edges from damage;
- A continuation of the bridge handrail past the abutments of both bridges;
- No lighting, signage or drainage pipes on the bridge itself;
- Unobtrusive slope stabilisation works. Use of shotcrete would be avoided where feasible, restricted to as small an area as possible and designed so that its colour and texture are unobtrusive and closely fit the landscape; and
- Rehabilitation of disturbed areas with native vegetation would occur as soon as practicable following completion of construction works.

9.10.3. Assessment of Design Features

The Proposal has been assessed in terms of each of the design principles (Section 8.2) and the main design elements described above, in relation to the existing landscape and views.

'An extremely simple and elegant bridge to complement not conflict with the rocky textured coastline'

A well designed bridge can add substantially to the already dramatic landscape of the area. A bridge that incorporates the highest level of design could add to the qualities of the region by becoming a northern gateway to the Illawarra. The bridge could potentially have a positive impact in terms of the scenic quality for the road user. In addition, the design and development of the Proposal has ensured that it is simple, refined and elegant to complement the coastal scenery.

'Minimise adverse visual impacts'

The bridge structure and geotechnical stabilisation treatments are positioned, such that they are not visible to residences to the north and south. Near to middle distance views from these areas are screened as a result of associated headlands and ridges. From longer distances, views from Bald Hill Lookout and the northern areas of Stanwell Park, the bridge would be partially visible in the middle distance. Geotechnical stabilisation treatments however, would not be visible from these areas as views would be screened by the northern headland.

The existing views from the road are very restricted and are entirely localised. The Proposal has been designed to reflect the coastline within the study area and would also

utilise the existing road south and north of the proposed bridge. It is anticipated that road user views of the Proposal would also be partial.

Views from the ocean would be dramatic and include the whole bridge, approaches and the geotechnical stabilisation treatments. Views from the rock platforms again would be dramatic and depending on which platform would include whole or partial views of the bridge structure and the geotechnical stabilisation treatments. However, these latter viewsheds are viewed by a limited amount of users such as recreational fishers and boat users when compared with the larger number of users from Bald Hill Lookout and road users.

The existing man made features in the landscape such as housing, the railway, roads and the distant views of Wollongong and the steelworks reduce the sensitivity of the landscape as viewed from Bald Hill Lookout and the northern sections of Stanwell Park. The bridge's simplicity and elegance and the limited view of stabilisation treatments would ensure that impacts on the existing landscape minimal and is not intrusive. Photomontages of the bridge from various vantage points are provided in Figures 9.6a, 9.6b and 9.6c.

'A structure that touches the ground (and sea) lightly with careful attention to how the ends of the bridges meet with the landscape (particularly in terms of vertical geometry)'

The minimal sized abutments and pile caps, the lightly tapering piers and the continuous simple overlapping parapet have been used in the design to ensure the impacts of the bridge are minimised with regard to the existing landscape. There is a slight continuous fall from south to north that corresponds to the grade of the existing road.

Furthermore, at the base of each of the pile caps and the seaward edge of the reclamation, associated with the working platforms and access track, rock armour used would be of similar geology to the existing situation. It is anticipated that this would minimise the impacts on the landscape character.

'Careful attention to the scale relationship with the landscape (including the sea)'

Balanced cantilever bridges have odd numbers of spans and a 3 or 5 span bridge tends to provide a balanced structure symmetrical about the centre of the middle span. The proportion of the bridge height to the span (105:40) provides a rectangular rather than square opening, which minimises impacts on the existing landscape. The slenderness ratio (span to girder depth) of the balanced cantilever structure is approximately 23, a value that is generally considered slender and pleasing to the eye. The bridge has also included a sweeping and continuous parapet connecting the two main components (that is, the balanced cantilever and incrementally launched structure). This would allow the design to provide consistency in reflecting the coastline within the study area.

All geotechnical stabilisation treatments would be designed to minimise impacts on the existing landscape, whilst providing the maximum protection to road users. In addition all disturbed areas associated with the stabilisation treatments would be rehabilitated and revegetated progressively through construction, with the aim to reduce the scale of visual impacts.

'Careful attention to detail, especially the support structure and deck'

Attention has been paid to the relationship between the parapet and girder. In accordance with design guidelines the parapet depth lies between a quarter and half of the girder depth, which provides a refined proportion. The overhang of the deck over the girder has also

been considered and lies between twice and four times the depth of the outer face of the parapet.

The piers have a slight upward taper of 1:100 and this helps them to appear elegant and more responsive to the bridge structure. A simple rectangular cross section has been used which is refined and appropriate in this context.

Pile caps are minimised and screened by rock armour to minimise visual impacts. Drainage pipes have been assessed as unnecessary at this stage and there would be no lighting or signage on the structure.

'Minimisation of impact on heritage elements and remnant bushland'

Minimisation of impacts in heritage elements and remnant bushland is considered in Section 9.5 and Section 9.9 of this REF. Of particular importance is the remnant jetty and associated structures and the original entrance portal of Coalcliff Colliery. The bridge piers have been located to minimise impacts on these two structures. Impacts on the portal would be minor and indirect. The proposed location of the pier in the vicinity of the jetty has been located within an area, which is considered heavily disturbed, such that it has lost any archaeological potential.

There would also be impacts on the stand of Norfolk Island Pines and Escarpment Core Area, both of which are listed under Wollongong LEP as items of heritage significance. Impacts on these items and proposed mitigation measures are discussed in detail in Section 9.9.

'Creation of outstanding scenic views from the bridge and of the bridge'

The simple design of the bridge that reflects the coastline within the study area and the well designed and refined girder and piers would provide a positive feature in the view from the approach road. Road users would be provided with panoramic views of the ocean and coastal landscape, which would be highly scenic. A two rail traffic barrier would be incorporated into the design, which would maximise the potential views from the bridge. The proposed bridge would offer unparalleled views of the ocean and coastline for both road users and pedestrians. The design is such that it would contribute to the scenic quality of the area by providing a reference point in the landscape as well as allowing views from the structure.

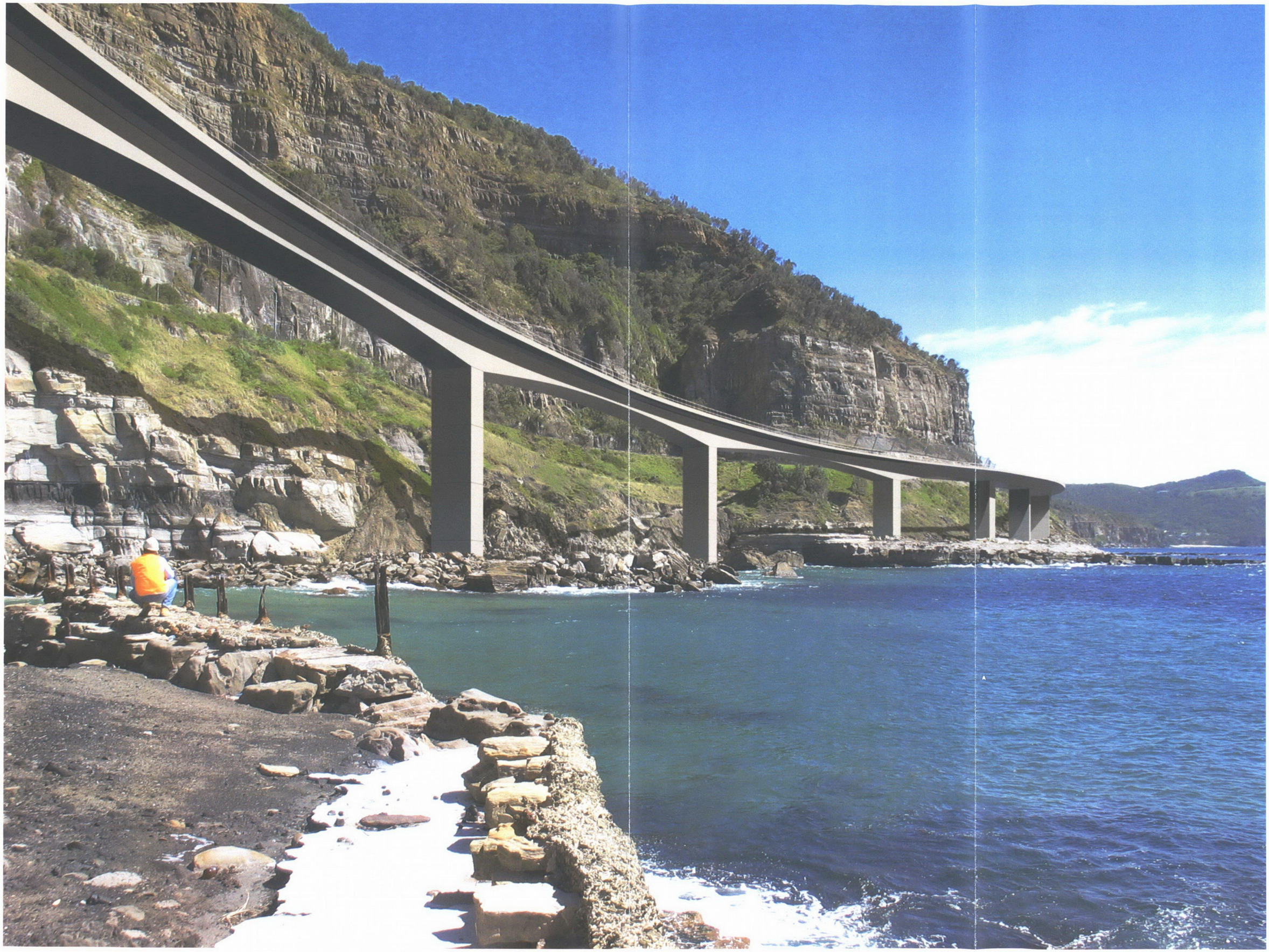
9.10.4. Potential Impacts

Construction

The scenic quality and landscape character of the study area would be decreased as a result of construction activities, including earthworks and construction of stabilisation treatments, bridge construction, the removal of vegetation, the presence of construction plant and equipment and stockpile sites. Impacts on visual amenity associated with these activities could be indirect, for example, earthworks that result in sedimentation of the adjacent intertidal and subtidal areas or dust generation associated with heavy vehicle movements.

As described in Section 9.10.1, affected views would predominantly be associated with Bald Hill Lookout and the northern areas of Stanwell Park and from the adjacent rock platforms and ocean. Views from Bald Hill Lookout and the northern areas of Stanwell Park would be partial and middle distant. Views the adjacent rock platforms and ocean would be near distant and highly visible.

It is also anticipated that residents of Coalcliff and Clifton and villages further north and south of the study area could also experience minor visual impacts. Impacts could include an



accumulation of soils and mud on the local road network released during movements of heavy vehicles and construction equipment to and from the site.

The potential visual impacts during construction would be minimised through best management practice of construction activities and the mitigation measures described below in Section 9.10.5.

Operation

The location of the bridge structure and geotechnical stabilisation treatments has ensured that visibility of the Proposal is limited. There are no views from the residential areas of Coalcliff and Clifton, and intervening headlands provide screening to road users from the near to middle distance. From the longer distance views from the Bald Hill Lookout and the northern sections of Stanwell Park, the bridge would be partially visible in the middle distance, however its simplicity and elegance would ensure that it complemented the landscape and visual impacts would be minimised. The Proposal would be highly visible from the adjacent rock platforms and ocean, however these latter viewsheds are viewed by a limited amount of users when compared with the larger number of users from Bald Hill Lookout.

A balanced cantilever structure has been developed with an incrementally launched approach bridge. Both bridges have been developed in line with RTA's *Bridge Aesthetics Design Guidelines* (RTA, 2003). A sweeping and continuous parapet connects the two bridges providing consistency and a flowing linearity. The slenderness of the girders, the proportions of girder to span, parapet depth and the tapering tall piers, all help to provide a simple refined and elegant bridge. It is anticipated the Proposal would provide unparalleled views of the ocean and coastline for both road users and pedestrians.

All geotechnical stabilisation treatments, especially at the northern headland, would be designed to minimise impacts on the existing landscape, whilst providing the maximum protection to road users. In particular, the selected rock removal from the northern headland (5000m^3) would be undertaken without affecting the overall topography and profile of the headland. In addition all disturbed areas associated with the stabilisation treatments would be rehabilitated and revegetated progressively through construction, with the aim to reduce the scale of visual impacts.

The introduction of concrete armour units in the proposed rock armouring of the reclamation and for the pile caps, though not visible to road users and screened from the near to middle distance by the intervening headlands, would introduce uncharacteristic elements in the existing landscape. However it is anticipated that rock armouring would predominantly utilise material from the site, which would be of similar geology to the existing situation.

9.10.5. Mitigation Measures

Potential visual impacts during construction would be minimised through best management practice and the inclusion of mitigation measures to minimise erosion and sedimentation (Section 9.1 and 9.4), minimise dust generation (Section 9.3), the progressive revegetation works (Section 9.5) and the restoration works associated with the reclamation (Section 9.6).

The following specific mitigation measures would be implemented for the Proposal to reduce the potential visual impacts:

- The detailed design for the Proposal would integrate the engineering and safety objectives with urban and landscape objectives to produce a design outcome that retains the high visual quality of the study area;

- Qualified urban designers would be involved during the detailed design stage of the Proposal. Any alterations to the design during construction would be undertaken in consultation with a qualified urban designer;
- The final bridge design would be reviewed by the RTA Urban Design Panel;
- Geotechnical stabilisation treatments involving the removal of rock would be designed not to affect the overall topography and profile of the existing environment;
- The use of concrete armour units would be minimised where possible and durable rock armour of similar geological type to the existing environment would be given preference;
- Rehabilitation and revegetation of disturbed areas would be in accordance with RTA's *QA Specification R178 – Vegetation*. Revegetation would consist of endemic native flora species; and
- The location of work compounds, parking areas for machinery, equipment and material stockpile sites would consider potential impacts on viewsheds.

9.11. Noise and Vibration

9.11.1. Background

A noise and vibration assessment for the Proposal was undertaken by RTA Environmental Technology in February 2004. The assessment aimed to predict environmental impacts of construction noise and vibration, and future operational noise levels that would result from the Proposal. A summary of the report that was produced is provided below and the full report is contained in Appendix 9.

Due to the closure of the road it was not possible to collect ambient noise data that included a component of existing road traffic noise. By use of traffic data, modelling programs and comparison with roads of similar traffic flow it has been possible to predict the conditions that existed prior to the closure of the road and to the likely levels following reopening of the road. Whilst this method introduces a number of limitations, the data is considered satisfactory for the purposes of supporting this assessment.

There are no residential properties or other dwellings within the proposed works area. The closest residence is located on Paterson Road at Coalcliff, adjacent to the northern end of the study area. Table 9.12 lists residences identified as being potential noise sensitive receivers adjacent to the Proposal. The two receivers are from two distinct catchments with Catchment A being at the southern end and Catchment B being the northern end of the study area.

Table 9.12: Potentially Impacted Receiver Locations

Catchment	No. of Receivers	Distance of Nearest Receiver to Road/Work (m)	Potential Impact Source
A	4	200	Satellite Compound Site
A	4	400	Satellite Compound Site
B	11	100	Main Compound Site
B	11	10	Access Road

Monitoring Site A is defined as 3 School Place Clifton adjacent to the Clifton School of Arts. This residence was chosen as it represents the most exposed site to Lawrence Hargrave Drive and the proposed compound site at the southern end. Monitoring Site B is defined as

271 Lawrence Hargrave Drive at Coalcliff. This residence is immediately opposite the entrance to the Coalcliff Coke Works. These locations are shown in Figure 9.7.

9.11.2. Construction Scenarios

The noise assessment has been undertaken in accordance with the construction methodology outlined in Section 8 of this REF. There are two potential construction scenarios that have been proposed which have been taken into consideration for the purposes of noise assessment. These relate to whether or not a concrete batch plant would be required. Such a decision would be made during the detailed design stage.

1. With a concrete batch plant

This option would mean that concrete agitators would only need to travel from the main compound to the bridge construction site. It would be expected on days when concrete was being poured that there would be approximately 80 truck movements associated with concrete delivery in any one day including up to 30 in a peak hour. There may be up to 40 other daily movements associated with material delivery.

Working hours for this Proposal would be 7am – 6pm Monday to Friday and 7am – 1pm Saturdays. No scheduled work would be undertaken on Sundays or Public Holidays. Due to the type of construction required, it is anticipated that some truck movements may be required to occur outside of normal working hours however this would be limited to less than 5 truck movements between 6am – 7am and no more than 5 truck movements per hour between 6pm and 8pm Monday to Friday when required.

2. With no concrete batch plant

The second scenario is that existing commercial batching plants in Helensburgh and Woonona would supply concrete. This would result in approximately the same number and scheduling of truck movements as Scenario 1, however deliveries would be split fairly evenly between those coming from the north and those from the south.

9.11.3. Noise Criteria

Noise disturbance criteria applicable to roadworks generally fall into two categories, being:

- That which is a result of construction activities and;
- Noise generated from operational use of the final product.

For the purposes of this study, construction noise criteria is defined as that which applies to actual on-site roadworks and bridgeworks including noise from the satellite compound and construction traffic within the works area.

Noise generated by vehicles using public roads such as Lawrence Hargrave Drive is covered by operational noise criteria.

The Coalcliff Coke Works site is covered by an EPA Environment Protection Licence (No. 2150) for its activities. Discussions with the DEC and Illawarra Coke Company, undertaken during the preparation of the noise assessment, have indicated that although the main compound could be located upon Coalcliff Coke Works land, at no point would it be considered that this licence would apply to works associated with the Proposal nor should any of the activities associated with the Proposal result in a non compliance for Illawarra Coke Company in regards to its licence conditions.

Figure 9.7: Noise Monitoring Locations

It has been further suggested by the DEC that due to the duration of construction, should a concrete batch plant be located at the main compound site, then this compound including the batching plant would be subjected to the *Industrial Noise Policy* (2000).

Construction Noise

The NSW Environment Protection Authority (EPA) *Environmental Noise Control Manual* (ENCM) (1993), Chapter 171, sets out noise criteria applicable to construction site noise for the purpose of defining intrusive noise impacts. The EPA guidelines for construction noise are summarised in Table 9.13.

Table 9.13: Construction Site Noise Control Guidelines

Total Construction Period	Acceptable L_{10} Noise Level[1]
4 weeks and under	Background L_{90} plus 20 dBA
4 weeks to 26 weeks	Background L_{90} plus 10 dBA
Greater than 26 weeks	Background L_{90} plus 5 dBA

1 Applicable to normal working hours between the hours of 7.00am and 6.00pm Monday to Friday, and 8.00am to 1.00pm Saturdays. For all other times construction noise must be inaudible at the receiver. No construction work is to take place on Sundays or Public Holidays.

As the expected duration for the majority of works is 22 months, sites where the construction noise criteria applies would therefore be subjected to Background L_{90} plus 5 dBA. The RTA's *Environmental Noise Management Manual* requires that for the purpose of determining construction noise objectives the L_{10} shall be calculated according to the tenth percentile method described in the *Industrial Noise Policy*.

At present, there are no established guidelines for construction work undertaken outside of normal working hours, however, for projects related to major infrastructure which operate outside normal working hours, the EPA (now DEC) generally applies the following criteria:

- For proposed construction hours between 6pm - 10pm (Monday to Friday); 1pm - 10pm (Saturday); 7am – 10pm (Sunday), the L_{10} noise level must not exceed the background noise level L_{90} for that period by more than 5 dBA;
- For proposed construction hours between 10pm –7am, The L_{10} noise level must not exceed the background noise level L_{90} for that period by more than 5 dBA; and
- In addition, the DEC also generally applies the sleep arousal goals provided in *Environmental Criteria for Road Traffic Noise* (EPA 1999) for sleep arousal goals during construction. The DEC sleep arousal guideline requires that *'the L_1 level of any noise should not exceed the ambient L_{90} by more than 15 dB'*. This goal applies to the night period (10pm to 7am).

Operational Noise

The NSW Government's *Environmental Criteria for Road Traffic Noise* (ECRTN) provides the assessment criteria for road traffic noise in NSW. Tables 1 and 2 of these Criteria refer to road categories and corresponding criteria for operational road traffic noise. According to the definitions supplied, the scope of this project, which does not provide for significant changes in alignment or a design increase in traffic volumes or mix, the road traffic noise impact is deemed to be minimal and hence targets in the ECRTN do not apply in this case. This interpretation is confirmed by reference to the flow chart for selecting criteria given in Practice Note 1 of the RTA's *Environmental Noise Management Manual*.

The ECRTN would also apply to any increase in road traffic noise on any route used for transport of concrete from either Woonona or Helensburgh.

Industrial Noise

The objectives of the NSW Government's *Industrial Noise Policy* (January 2000) would apply to noise emissions from any concrete batch plant located in the study area for the purposes of supplying concrete to the Proposal.

The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences; and
- Maintaining noise level amenity for residences and other land uses.

In assessing the noise impact of industrial sources, both components are taken into account for residential receivers, but in most cases only one will become the limiting criterion and form the project-specific noise levels for the industrial source.

Based on the zoning of the Coalcliff Coke Works as *4(c) Extractive Industries* and its historical occupation of the site for more than 100 years it is appropriate to assess the majority of the original coal mining town Coalcliff, and in particular Catchment B as being an urban / industrial interface. As discussed in Section 3.3 of the *Industrial Noise Policy* it would be appropriate to consider the morning period from 6am – 7am as a shoulder period as there is an obvious increase in background noise levels during this period. Averaging the night time and daytime criteria would effectively result in an amenity noise level objective of 57.5 dBA for this morning period.

9.11.4. Existing Noise Levels

A summary of the hourly noise measurements for the two sites is presented in Table 9.14 and Table 9.15.

Table 9.14: Measured Noise Levels at Site A (Clifton)

Days	Date	Night L_{Aeq} (9 hr)	Day L_{Aeq} (15 hr)
Tuesday	17 February	54	57
Wednesday	18 February	54	55
Thursday	19 February	55	56
Friday	20 February	55	59
Saturday	21 February	52	54
Sunday	22 February	49	53
Monday	23 February	52	56
Mean		**53**	**56**

Table 9.15: Measured Noise Levels at Site B (Coalcliff)

Days	Date	Night L_{Aeq} (9 hr)	Day L_{Aeq} (15 hr)
Saturday	14 February	45	55
Sunday	15 February	44	51
Monday	16 February	44	61
Tuesday	17 February	45	60
Wednesday	18 February	47	59
Thursday	19 February	43	61
Friday	20 February	45	60
Mean		**45**	**58**

The background L_{90} noise level was also recorded for each 15 minute interval during the monitoring period and the Rating Background noise Level (RBL) for the monitored site was calculated by following the "tenth percentile method" described in Appendix B of the NSW Governments *Industrial Noise Policy 2000*. As some proposed works would be likely to occur outside normal working hours in order to facilitate concrete curing requirements and to expedite the project, the background noise levels were calculated for the morning (6am – 7am), day (7am to 6pm) and evening (6pm to 8pm) periods. Background noise level results are presented in Table 9.16.

Table 9.16: Measured Tenth Percentile Background Noise Levels L_{90} dBA

Location	L_{A90} 6am – 7am	L_{A90} 7am – 6pm	L_{A90} 6pm – 8pm
Site A	41.2	37.5	38.6
Site B	38.5	40.4	40.8

Corrections to be applied for Traffic

Due to the circumstances that resulted in the closure of Lawrence Hargrave Drive there was no ambient noise data collected prior to through traffic being detoured via the F6 Freeway. The collection of ambient noise data was therefore undertaken during a period when the road was closed, and as such was subjected to a significant reduction in traffic volumes including a total absence of any through traffic. This is not what would be considered as representative of typical traffic conditions. To establish what noise levels would have existed prior to the closure of the road it is necessary to estimate the contribution of road traffic to the noise catchment.

Through traffic volumes on Lawrence Hargrave Drive were reported to be in the vicinity of 3500 per day prior to the closure of the road. Experience in measurements of roads with these levels of traffic, tends to indicate that the presence of road traffic noise would increase the daytime L_{eq} by 6 dBA and the L_{90} by 4 dBA. During the night time period it would be expected that the L_{eq} would increase by 4 dBA and the L_{90} by 3 dBA.

These corrections have not been used to increase construction noise level objectives, however they may be added to increased noise levels in Tables 9.14 – 9.16 to estimate noise levels that would have been experienced prior to closure of Lawrence Hargrave Drive at the monitored locations.

9.11.5. Potential Impacts

Construction Noise

Due to the variety of construction activities being proposed, the major activities have been identified and discussed separately.

Bridgeworks

Actual construction of both the cantilevered and the incrementally launched bridges would not be audible at the nearest residences in Clifton and Coalcliff due to the distance and the natural shielding afforded by the topography.

Roadworks

Roadworks are expected to be minor in nature and would be associated with bridge connections with the existing road. These works would be minor in nature and would not result in any exceedance of the construction noise criteria.

Compound Site(s)

The satellite compound at the southern end would be located some 200m north of the nearest residences in Catchment A at Clifton. It has been predicted that the L_{10} noise levels from this compound site would not exceed 42.5 dBA. Table 9.17 summarises the estimated background noise levels and the corresponding EPA noise goals that would apply for the morning, day and evening periods.

Table 9.17: Predicted Noise Levels for Catchment A

Catchment/Criteria	**LA_{10} 6am – 7am**	**LA_{10} 7am – 6pm**	**LA_{10} 6pm – 8pm**
Predicted Noise level for Catchment A	42.5	42.5	42.5
Construction Noise Criteria	46.2 (41.2 + 5)	42.5 (37.5 + 5)	43.6 (38.6 + 5)

Note: A 2.5 dBA façade correction has been added to the predicted noise level

It is therefore predicted that construction noise criteria would not be exceeded by activities undertaken at the satellite compound.

The main compound site would contain the majority of equipment not on site as well as the major administrative offices, stockpile sites and the concrete batching plant. The assessment of the main compound included the operation of the batch plant but does not include the arrival and departure of material deliveries, which is dealt with separately. It has been predicted that the L_{eq} noise levels from this compound site would contribute less than 40.5 dBA to the noise in Catchment B, which is approximately the ambient levels whilst the road is closed. Table 9.18 summarises the estimated background noise levels and the corresponding EPA noise goals that would apply for the morning, day and evening periods.

Table 9.18: Predicted Noise Levels for Catchment B

Catchment/Criteria	**LA_{eq} 6am – 7am**	**LA_{eq} 7am – 6pm**	**LA_{eq} 6pm – 8pm**
Predicted Noise Level	40.5	40.5	40.5
Industrial Noise Criteria (Intrusiveness)	41.5 (36.5 + 5)	44.4 (39.4 + 5)	43.8 (38.8 + 5)
Industrial Noise Criteria (Amenity)	57.5	65	55

The noise assessment found that it would be possible to meet the objectives of the intrusive noise criteria. Noise levels would be between 17 and 24 dBA below the amenity noise criteria that would apply to residences that are in an urban/industrial interface.

Heavy Vehicle Movements

The noise generated from the truck movements to and from the Coke Works results in relatively high levels, which are of short duration with an L_{max} of around 78 – 84 dBA expected at the side of the road. It may further be expected that the nearest residence (271, Lawrence Hargrave Drive) would experience an L_1 of up to 78 dBA during haulage hours.

The 6m^3 agitator vehicles that would carry concrete from a batch plant at the main compound site to the bridge site would be smaller than those currently used by the Illawarra Coke Company and are expected to be up to 5 dBA quieter. The operation of accessing and departing the Coke Works site would also be a simpler process because there would be no U-turn involved. There would be a possible doubling of the current levels of vehicle movements to and from the Coalcliff Coke Works. The additional truck movements that would occur could also result in doubling of L_{max} events, however, the L_{max} events that occur as a result of haulage to the bridge site would be of a lower sound pressure level than those which currently occur and would add less than 3 dBA to the existing L_{eq}. This would also be the case if concrete was to be hauled from a remote batch plant at Helensburgh.

The highest L_{10} obtained during the week of monitoring was 73.4 dBA with typical L_{10} results of around 65 dBA during the working hours of Coalcliff Coke Works. Typical L_{10} results for 6am – 7am period were around 48 dBA and around 49 dBA for the 6pm – 8pm period. It would be expected that during a concrete pour that an L_{10} 73 dBA would be common which is 28 dBA above the objective but only around 8 dBA above what is typically experienced during normal working hours. For out of hours activity it was expected that the proposed 5 truck movements per hour would result in a L_{10} of 63 dBA at the nearest residence which would be approximately 18 – 20 dBA above the objective but around 14 dBA above what is typically experienced during the out of hours period.

Whilst there are no criteria to cover maximum noise events during normal working hours, outside of working hours it is usual to try to limit the exceedance of the L_{90} by the L_{10} to 5 dBA. During the night time period (10pm – 7am) it is also usual to limit the L_1 to less than 15 dBA greater than the background L_{10}. It is likely that during the period from 6am – 7am, the proposed 5 truck movements per hour would result in a L_1 of 73 dBA at the nearest residence. This would be approximately 35 dBA greater than the background level that would have occurred when the road was open as summarised in Table 9.19.

Table 9.19: Noise Objectives and Predicted Noise Levels for Catchment B

Catchment/Criteria	**LA_{eq} 6am – 7am**	**LA_{eq} 7am – 6pm**	**LA_{eq} 6pm – 8pm**
Usual Background Noise Level L90	41.5	44.4	43.8
L_1 Objective	56.5	N/A	58.8
Predicted L_1	73	N/A	73

It has been estimated that during the period of construction there may be up to an additional 40 truck movements per day associated with material delivery on Lawrence Hargrave Drive equally divided between the south towards Wollongong and the north towards Helensburgh. This has taken into account the scenario if no batch plant was located on site. This level is not considered to be significant and would not result in any appreciable increase in existing noise levels at any receiver location along the proposed route. In the above absence of other traffic the maximum of 15 truck movements in a single hour would result in a L_{eq} (1hr) of 62 dBA at 15m.

Additional Works
This category mainly applies to the proposed treatment of the cliff face in GD5. It has been assessed that due to the remoteness of these works to any residence, coupled with extensive shielding offered by the topography that no work actually associated with the minor blasting would be perceptible at any residence.

Operational Noise
Since the temporary closure of Lawrence Hargrave Drive, existing noise levels for the study area are dominated by the action of waves breaking along the shoreline below the road. Other sources of noise within and surrounding the study area are attributed to remediation work (undertaken by the RTA), coke production at Coalcliff Coke Works and to a lesser extent residential noise and the Illawarra Railway Line. Prior to the temporary closure of Lawrence Hargrave Drive, it is anticipated that road traffic noise would have dominated the noise catchment, however, given the low traffic volumes and speeds it has been estimated that no residences would have been in exceedance of the EPA objectives for existing arterial roads.

It is expected that following the reopening of Lawrence Hargrave Drive that traffic volumes would return to previous levels and again be below DEC guidelines. The re-opening of Lawrence Hargrave Dive could potentially increase short term traffic volume due to additional tourists. However, tourist traffic is dependent on seasonal weather conditions and it is not expected that any short term increases would result in a substantial increase in AADT for Lawrence Hargrave Drive. Therefore, as there is to be no expected change in speed, traffic volume and traffic mix or alignment in the vicinity of residences the proposed works are not subjected to any project specific noise objectives.

Construction Vibration
German Standard DIN 4150 (1999), which sets conservative vibration levels for structural damage at 5mm/second, is generally recognised as setting the most appropriate criteria for architectural assessment. A lower level of 2mm/second is often adopted for heritage structures. These levels would rarely be exceeded by roadworks, however human perception and comfort levels are usually reached at a much lower level. In this regard the British Standard BS6472 provides the most authoritative criteria for assessment of the impacts of construction vibration on the community.

Bridgeworks
The Proposal does not include driven piles and due to the remoteness of bridgeworks to the nearest residence, it is not anticipated that there would be vibrational impacts at any receiver location.

Roadworks
The closest point at which any roadworks would be to residences would be at the southern end where the existing road would tie in to the proposed bridge north of School Parade which is the extremity of residences in Clifton. At this distance, vibration caused by road construction would not be perceptible.

Other Works
Other works that could result in vibrational impacts is the proposed treatment of the cliff face in GD5. It is understood that the rock removal would be achieved with use of cordite detonation only. This would result in very low vibration levels that would not be perceivable at distances greater than 30m. Given that treatment would not occur within 100m of residences it is not unnecessary to further consider vibration impacts from this activity.

9.11.6. Mitigation Measures

A Noise and Vibration Management Plan (NVMP) would be prepared prior to the commencement of works and would form the noise and vibration management section of the CEMP. This Plan would apply best management practice, such as the planning of noisy activities for parts of the day when they would have the least impact, and utilising best practical technology and means to achieve low levels of construction noise. The Plan would adopt RTA protocols and be subject to approval from the RTA's Southern Region Environmental Adviser and implemented in consultation with DEC's Environment Protection and Regulation Division.

The following mitigation measures would be included within the NVMP:

- For works performed outside of the standard working hours, the procedure contained in the RTA's *Environmental Noise Management Manual* 'Practice Note vii – Roadworks Outside of Normal Working Hours' would be followed;
- The number of heavy vehicle movements would be limited to 5 per hour if work is required between the hours 6am - 7am and 6pm and 8pm Monday to Friday;
- The location of the concrete batch plant within the main compound site would be as far as possible from residential properties; and
- A line of communication between the community and LHD Link Alliance construction management would be provided.

9.12. Waste Minimisation and Management

9.12.1. Waste Management Strategies

In following the Resource Management Hierarchy principles embodied in the *Waste Avoidance & Resource Recovery Act 2001* (WARR Act), the RTA is committed to ensuring the responsible environmental management of unavoidable waste and to promoting the reuse of such waste through appropriate measures. The resource Management Hierarchy principles of the WARR Act are as follows:

- Avoid unnecessary resource consumption as a priority;
- Avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling and energy recovery); and
- Disposal is undertaken as a last resort.

By adopting the above principles, the RTA encourages the most efficient use of resources and reduces environmental harm in accordance with the principles of ESD, as outlined in Section 9.16 of this document.

The following materials, potentially generated by the Proposal, can be recycled free of charge at the Wollongong City Council Recycling Depot:

- Scrap metal, aluminium;
- Motor, gear, transmission and heater oil;
- Kerosene (no petrol or fuel); and
- Bulk paper and cardboard.

Green waste would be transported to an appropriate waste depot for recycling. Suitable sites may be Whytes Gully or Helensburgh, where green waste is mulched and provided to residents free of charge. Non-weed species would be mulched for onsite reuse wherever possible, in preference to transportation off-site.

Suitable disposal sites for non-recyclable and non-reusable waste could include industrial waste collection depots at Unanderra and Bellambi. Sites at Helensburgh and Whytes Gully would also be able to accept wastes classified under the DEC guidelines as inert or solid wastes. Any disposal of waste would be in accordance with both the PoEO Act and the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (EPA 1999).

9.12.2. Potential Impacts and Major Waste Streams

The Proposal has the potential to generate various types of waste that can be reused or recycled in accordance with the principles of the WARR Act, and some wastes that would require disposal. Potential sources of waste generated through construction include:

- *Green waste* – Vegetation and other such cleared material that cannot be recycled or used elsewhere on the project;
- *Excavated material* – The Proposal would utilise as much site-generated material as possible. Where appropriate, any material generated by stabilisation works in GD4 and GD5, would be used for the reclamation works or access track construction. This excavated material is not expected to be a major waste stream. However, there may be some waste associated with excavation if material encountered is unsuitable for reuse, for example, uncovered slag (as discussed in Section 9.1.1) during construction of the access track;
- *Building waste* – Packing material, scrap metal, pallets, plastic wrapping, cardboard and general off cuts generated during construction;
- *Contaminated or chemical waste* – Although none is anticipated, excavation has the potential to uncover material that would require appropriate disposal;
- *Indirect waste generation* – The Proposal can indirectly create waste by utilising materials that generate waste at source during production;
- *Plant maintenance generated waste* – such as concrete truck washdown or on-site maintenance procedures, which may for example produce waste oil;
- *General waste* – Compound-generated waste such as rubbish and sewerage from on-site toilets and other facilities. Additionally, the instalment of erosion and sediment erosion control works could generate some minor waste such as fence off-cuts but quantities would be minor and recycled where possible or disposed of at an appropriate site; and
- *Off-site spread of waste* – Waste generated by the Proposal can impact the surrounding environment by spreading if not appropriately secured and transported to the disposal site.

9.12.3. Mitigation Measures

Resource and Waste Management Plan

A Resource and Waste Management Plan (RWMP) would be prepared prior to any construction activities commencing and would include the following factors:

- Quantity and classification of excavated material generated as a result of the Proposal;
- Disposal strategies for each type of material;
- Details of how waste would be stored and treated on site;
- Identification of all non-recyclable waste;
- Identification of strategies to 'reduce, reuse and recycle';
- Identification of available recycling facilities on and off site;
- Identification of suitable methods and routes to transport waste;
- Procedures and disposal arrangements for unsuitable excavated material; and
- Although none are expected, strategies to transport and dispose of contaminated material if encountered, including acid sulfate soils.

In addition to the RWMP and in accordance with the Management Hierarchy principles embodied in the WARR Act, the following specific waste minimisation and impact mitigation measures would be implemented:

- Reuse of materials on-site would have priority over recycling. Where recycling is more feasible, it would be carried out in accordance with the NSW Government's Waste Avoidance and Resource Recovery Strategy 2003;
- Excavated material that is not suitable for on-site reuse or recycling, such as contaminated material would be transported to a site that may legally accept that material for reuse or disposal;
- The appropriate DEC licences and approvals would be obtained prior to the disposal of any contaminated waste generated by the Proposal, and the operators of the appropriate disposal site would be notified in advance;
- Waste materials would be classified in accordance with the DEC's *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*;
- At the end of the construction period, any unused fuel, oils and chemicals would be removed from the site;
- Materials would be sourced so as not to result in the creation of excess waste;
- Any waste oil generated during maintenance would be disposed of at an approved disposal site or recycling facility;
- Concrete delivery trucks would be directed to wash out within a specified washdown bay, which would be appropriately bunded, within the confines of the site compound or return to the batching plant before washing out;
- Portable, self-contained toilet and washroom facilities would be provided on site which would be regularly emptied and serviced by the contractor providing them;
- Putrescible and other waste such as chemical waste, not able to be recycled, would be regularly collected and disposed of at an appropriate disposal site;
- No burning of cleared vegetation or other material would be allowed. It would be recycled where feasible or otherwise disposed of at an appropriate site;
- Secure rubbish bins, with lockable lids would be provided on site, which would be regularly emptied by the supplying contractor;
- Any rubbish loads being transported from the site for disposal would be covered to prevent the spread of waste; and
- The works site would be left tidy and rubbish free on completion of the Proposal.

9.13. Associated Infrastructure and Activities

9.13.1. Concrete Batching Plant

Batching Operations

The requirement for a concrete batch plant is still under investigation. At this stage for the purposes of environmental assessment one has been assumed. The most suitable location for a concrete batching plant would be within Illawarra Coke Company property, adjacent the to main site compound.

Typical operation of a batch plant would see aggregates and sand stockpiled on the batch plant site in adjoining bays. These stockpiles would be situated close to aggregate receival bins for easy loading of materials. Two silos for cement / fly ash storage would be located over the batching enclosure area. A conveyor would transfer material from the aggregate bin to the batching area. Admixture storage tanks would be situated adjacent to the batching area within a bunded area having a storage capacity of at least 120% of the capacity of the storage tanks.

A front-end loader would transfer aggregates to receival bins, which contain weigh hoppers. Cement would be dispensed into separate weigh hoppers from the silos as required to suit the concrete specification. The aggregate, cement, fly ash, water and admixtures would then be fed into the truck mounted agitator mixer. The compounds would be mixed for a set time period to ensure that the product is well combined, then transported to site.

A requirement of the batch plant would be a constant water supply. It is anticipated that water would be obtained from existing supplies at the site.

Production of the plant would be dependent on weather conditions and the progress of bridge construction activities. Given that the batching plant is only a temporary structure, the operation and production would only be required for as long as concrete is needed for the bridge construction.

The batch plant would require a relevant mobile licence under the *Protection of the Environment Operations Act 1997*, as discussed in section 4.6.1 of this REF.

Potential Impacts

The operation of a concrete batch plant during bridge construction has the potential to degrade surface and groundwater quality. Sources of potential contaminated runoff from the batch plant sites include:

- Disturbed areas during the construction phase;
- Washdown from trucks;
- Movement of material from stockpile areas;
- Cement or concrete spills;
- Spill / leakage from admixture; and
- Fuel or oil spills.

Other potential impacts associated with the operation of batch plant include, a decrease in air quality, impacts associated with an increase in noise and vibration levels and the generation of solid and liquid waste.

Mitigation Measures

The operation of the batch plant would comply with other mitigation measures described in Section 9 and would be incorporated into the relevant Environmental Management Plans described. The following specific mitigation measures would be implemented:

- The batch plant would be situated so as to minimise soil disturbance and groundwater infiltration and would have little effect on the drainage within the batch plant site;
- Clean runoff would be diverted around the batch plant site using diversion drains or banks;
- Contaminated runoff from the batch plant site would be diverted to sediment basins for treatment. Water from truck washdown bays would be kept separate from the general site runoff. Water from these activities would be directed into settling ponds where cement, sand and aggregates would be given time to settle out of the water. All erosion, sediment and pollution control devices would be inspected on a regular basis and maintained to ensure effective operation;
- The pH of the contaminated runoff would be monitored and treated to ensure that it is maintained between 6.5 and 8.5, unless reused for batching operations;
- Additives, fuels, chemicals or oils would be stored in a bunded area sized to contain spillage of at least 120% of the largest liquid storage container;
- Regular inspection and monitoring of the bunded areas would be undertaken to ensure proper maintenance of tanks and containment of any spills;
- All bulk cement would be stored in silos. Fabric filters would be used to vent silos to the atmosphere. Filters would be designed to accommodate the maximum discharge rates from vehicles. Each silo would be fitted with a single filter and separate piping to allow for simultaneous filling of silos. A burst-bag detector system with ducting to ground level near the tanker filling point and high level indicators with an automatic alarm would be used;
- Solid concrete waste would be incorporated into site earthworks; and
- The batching operation is not expected to produce any waste oil or grease products, however, should this arise during the operation this material would be collected and disposed of by a licensed contractor.

9.13.2. Stockpile and Compound Sites and Casting Area

Background

It is anticipated that two site compounds (a main site and a satellite site) would be established as a result of the Proposal. The location of the site compounds has yet to be determined, however, there is potential to establish the main site compound at the northern end of the study area within Illawarra Coke Company property. The satellite site compound could potentially be established at the southern end of the study area in the vicinity of the existing RTA offices / amenities, which were used during the pre-construction activities.

Using the incremental launching technique for construction of a bridge involves casting lengths of the bridge superstructure in a specially built casting area. A casting area would need to be established to enable the multiple span bridge to be incrementally launched. It is envisaged that the casting area would be located within the existing road alignment in GD3.

Site Location Criteria

The primary selection criteria for stockpile and compound sites include:

- More than 50m from waterways;
- Sites with low conservation significance for flora, fauna and indigenous and non-indigenous heritage;
- Sites requiring no substantial clearing of native vegetation;
- Consideration of nearby residential amenity;
- On relatively level ground with hardstand area;
- Easy and safe access to the road network; and
- Compounds and activities associated with compounds would have minimal impacts on land use and adjacent properties.

The stockpile and compound sites and casting area would comply with other mitigation measures described in Section 9 and they would be identified and addressed in the relevant Environmental Management Plans described.

9.14. Cumulative Environmental Effects

Clause 228 (2) of the *Environmental Planning and Assessment Regulations 2000* requires that an environmental assessment under Part 5 of the Act take into account any cumulative environmental impact with other existing or likely future activities.

The anticipated cumulative environmental effects of the Proposal relate to the combined effect of individual impacts of the Proposal as well as to the cumulative effect of this Proposal with other nearby projects or planned projects or activities in the locality.

The major developments in the region that the Proposal could have cumulative impacts with include:

- The proposed Wollongong Northern Distributor Extension;
- Potential major maintenance work on the Illawarra Railway;
- The Illawarra – Coalcliff, Stanwell Park, Stanwell Tops and Otford Sewerage Scheme; and
- Proposed residential development of Sandon Point, Bulli.

9.14.1. Environmental Cumulative Impacts

The Proposal would have the potential to contribute to the following cumulative environmental impacts in the region:

- Potential for those aspects of the Proposal located in the existing Coke Works to contribute to a reduction in the water quality of the Stony Creek Catchment and the Pacific Ocean through an increase in the overall pollutant loads entering local drainage lines and through increased sedimentation, increased pollution runoff and an increase in the impervious surface area; and
- Potential for a reduction in the flora and fauna species diversity by contributing to ongoing habitat clearance in the region.

Mitigation measures aim to minimise the ecological and water quality impacts of the Proposal and consequently reduce its contribution to the cumulative impacts of the major developments in the region.

9.14.2. Social Cumulative Impacts

The Proposal would have the potential to contribute to the following cumulative social impacts:

- Improved road user safety by contributing to a reduction in accidents and fatalities;
- Reduced travel times and increased travel efficiency;
- Increase in construction traffic on local roads in the region during the construction period; and
- Temporary reduction in local air quality due to increased machinery emissions and generation of dust during construction.

9.14.3. Economic Cumulative Impacts

The major direct cumulative impacts of the Proposal would be:

- Travel cost savings for motorists due to an improvement of transport links in the region;
- Increased employment during the construction stage;
- Increase in local trade due to the influx of the workforce; and
- Increased economic activity of adjacent commercial areas due to improved accessibility and increased tourist visitations.

No other existing or likely future uses or activities on or adjacent to the Proposal would be disadvantaged. Completion of the Proposal would have positive flow-on effects for local residents and businesses with the restoration of an important commuter and tourist link.

9.15. Operational Hazards and Risks

9.15.1. Hazard and Risk Identification

The Proposal would generate a number of potential hazards and risks. The majority of these would generally apply to all types of road infrastructure. Sources of potential hazards and risks include:

- Hazards and risks associated with construction activities;
- General operational traffic accidents associated with road travel involving single and multiple vehicles, pedestrians and cyclists; and
- Heavy and dangerous goods transportation along the road during both construction and operation.

Potential operational hazards and risks have been assessed against the existing alignment and traffic situation prior to the closure of Lawrence Hargrave Drive. Those hazards and risks associated with construction would be managed through implementing the mitigation measures outlined in Section 9 of this REF.

9.15.2. Potential Operational Hazard and Risks

The Proposal is not expected to generate any additional hazards and risks beyond those associated with a normal coastal road construction. However, the following potential hazard and risk streams associated with the operation of the Proposal would continue to be considered throughout the detailed design phase.

Increased Traffic Volumes

Increased traffic volumes immediately following commissioning have the potential to increase the frequency of accidents on the road. However ongoing traffic levels are expected to revert to similar to those experienced prior to closure, after an initial growth period, and the potential risk is low and manageable.

Higher Speeds

The improved alignment and geometry of the Proposal has the potential to generate higher speeds. However, by its nature a geometrical improvement would increase driver safety and potential for additional hazards and risks are expected to be low.

Bus Traffic

Increased volumes of tourist-generated bus traffic could be encouraged to utilise the Proposal, where access has previously been denied during the road closure. This could potentially cause a collision between opposing vehicles at the bend of the GD5 headland. This would be considered through ongoing detailed design.

Dangerous Height

The construction of two new bridges raises the issue of pedestrian and vehicular safety at a potentially dangerous height. The bridges would be designed to incorporate appropriate safety barriers.

Polluted Runoff

The bridge has been designed to incorporate scuppers for drainage to minimise the impact of concentrated fresh water flows into the ocean during normal rainfall. As such the potential for polluted runoff to drain directly into the ocean in the event of an accident or spill would have a greater potential impact as a result of the bridge structures than was previously the case for the old alignment. However, the Proposal is not expected to generate an increase in dangerous or heavy goods transporters, compared to that previously experienced in the area and potential risk would be considered low. Furthermore, the feasibility of including stormwater / pollutant treatment technique into the Proposal would be further investigated during the detailed design stage.

Interaction between Pedestrians, Cyclists and Vehicles

There would be minor potential for interaction between pedestrians, cyclists and vehicles on the bridges due to pedestrians and cyclists having their own dedicated access path. However the Proposal would be designed to incorporate all appropriate safety measures to Australian Standards to minimise potential risk.

Waste

The introduction of a new pedestrian access across the bridge structures could potentially generate a new waste stream. Discarded rubbish and litter may increase in proportion to increased pedestrian activity and appropriate receptacles would be considered during detailed design to minimise impacts.

Inclement Driving Conditions

Although the structures would be built to withstand the heaviest of weather and sea conditions, there is the potential for inclement driving conditions on the more exposed bridge structures. Heavy fog and rain would cause a safety issue for drivers, but not beyond that for any road construction, especially in a coastal environment.

Maintenance
Ongoing road maintenance generates potential risks to human and environmental health and in response the RTA would incorporate the appropriate safety procedures, common to all road infrastructures.

9.15.3. Operational Hazard and Risk Management

By nature, improvements in performance and efficiency of any road generally attract larger volumes and frequency of traffic. Such increases carry inherent risks that can be expected in most situations. The Proposal is not expected to generate significant operational risks and hazards that cannot be managed through the implementation of appropriate road safety and user guidelines in accordance with the relevant Australian Design Standards.

9.16. Principles of Ecologically Sustainable Development

The principles of ecologically sustainable development (ESD) have formed an integral part of option evaluation, concept design and environmental assessment for the Proposal.

There is no universally accepted definition of ESD, but in 1990 the Commonwealth Government suggested the following definition for ESD in Australia:

> *'Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'*

Broadly speaking, ESD is development aims to meet the needs of Australians today, while conserving natural resources and ecosystems for the benefit of future generations, and its guiding principles need to be considered in the planning and management of transport systems in Australia.

The National Strategy for ESD provides guidance as to what should be addressed when considering the ESD merits of a proposed development. The strategy lists three core objectives and seven guiding principles to be considered in a balanced assessment of the Proposal's ecological sustainability. The three core objectives are:

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- To provide for equity within and between generations; and
- To protect biological diversity and maintain essential ecological processes and life-support systems.

The guiding principles are:

- Decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations;
- Where 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;
- The global dimension of environmental impacts of actions and policies should be recognised and considered;
- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised;
- The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised;

- Cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms; and
- Decisions and actions should provide for broad community involvement on issues, which affect them.

These core objectives and guiding principles have been considered throughout the environmental assessment process for the Proposal, from preliminary and concept designs to the detailed assessment undertaken during the preparation of this REF and would continue to be considered through detailed design, construction and operation.

The NSW Government is committed to the four principles of ESD as defined in Schedule 2 of the EP&A Regulation 2000. These four principles are:

- *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;
- *Inter-generational Equity*, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations;
- *Conservation of biological diversity and ecological integrity,* namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration; and
- *Improved valuation, pricing and incentive mechanisms*, namely, that environmental factors should be included in the valuation of assets and services, such as:
  - i Polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement;
  - ii The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste;
  - iii Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The preferred option for the Proposal as outlined in Section 3 and 8 of this REF has been developed through a continued multi-criteria analysis (MCA) process since inception and is considered the optimal design, accommodating environmental, social and economic requirements. The mitigation measures outlined in this REF would ensure that the four principles of ESD are maintained in accordance with Schedule 2 of the EP&A Regulation 2000.

Additionally, under the provisions of the *Coastal Protection Act 1979* (discussed in Section 4.5), the Minister for Infrastructure and Planning in granting concurrence must, amongst other things, ensure that the Proposal is consistent with the principles of ESD.

Precautionary Principle

The evaluation of options and the assessment of the preferred option have concentrated on avoiding serious or irreversible impact on the environment wherever possible. Environmental studies were undertaken in key areas such as marine and terrestrial ecology and archaeology to assist in the option selection. This ensured that sufficient information was available to accept or reject options, and to provide a level of certainty at this early stage, on potential environmental impacts.

The approach to preparing the concept design for the preferred option has been to minimise impacts on previously undisturbed land, while maintaining engineering feasibility, maximising road-user safety and prolonging the life of the upgrade. This approach was also considered during the detailed assessment of potential environmental impacts relating to aspects such as water quality, marine and terrestrial biodiversity, heritage and geology and was integral to the development of the mitigation measures outlined in this REF.

Inter-generational Equity

The Proposal would re-establish the coast road connection between the towns of Coalcliff and Clifton and a wider north-south link through the Illawarra region. The upgrade would provide long-term improvements to north-south journey times between the Illawarra region and Sydney and Wollongong, and accessibility between Clifton and Coalcliff, which has been severely disrupted due to the road closure.

The economic and social disruption resulting from the closure would be alleviated through a new permanent connection, ensuring ongoing social and economic development for current and future generations through retention of tourist links, with benefits for local businesses.

Conservation of Biological Diversity and Ecological Integrity

The Proposal has been developed with regard to the potential impacts on the ecology of the local area. Specialist studies in terrestrial and marine flora and fauna, water quality and biodiversity indicate that the proposed upgrade would not adversely affect biological diversity and ecological integrity of the Illawarra and NSW as a state. Mitigation measures outlined in this REF have been designed specifically to ensure any adverse impacts associated with the construction of the Proposal are minimised.

Improved Valuation, Pricing and Incentive Mechanisms

The criteria used in the evaluation of options focused on a range of environmental and community factors, as well as economic and engineering considerations. This approach has ensured that appropriate values have been attached to all environmental considerations during assessment. This is discussed in detail in Section 7 of this REF.

A number of project-specific environmental control plans and mitigation measures have also been identified for incorporation into the detailed design and ongoing construction and operation of the Proposal. These measures reflect the value of preserving the natural and built environments affected by the Proposal.

Overall, the assessment documented in this REF demonstrates the Proposal's consistency with the principles of ESD in that it would:

- Improve the social wellbeing of the wider Illawarra and Sydney community as well as those communities immediately benefiting from the Proposal, such as Clifton and Coalcliff;
- Enhance the strategic importance of the Illawarra region for the NSW tourism industry;
- Enhance the economic wellbeing of the small Illawarra coastal towns by re-generating the local tourist industry and improving connectivity; and
- Integrate social, economic and environmental issues into the decision-making process.

9.17. Environmental Summary

9.17.1. Summary of Beneficial Effects

The Proposal would have the following beneficial effects:

- Reconnection of the communities of Coalcliff and Clifton;
- Re-establishment of commuting patterns for workers and students;
- Travel cost time and distance savings for commuters and shoppers;
- Resumption in tourist trade for local businesses;
- Potential extra tourist traffic as a result of a unique engineering solution;
- Protection of road users from risks associated with geological instability and the opportunity to implement a comprehensive and long term solution for this section of Lawrence Hargrave Drive;
- Rejuvenation of native vegetation and fauna habitat as a result of the proposed revegetation program, which involves flora species endemic to the northern Illawarra, and a Weed Management Plan;
- No indigenous archaeological or cultural constraints as a result of the Proposal;
- Limited visual impacts from near and middle distance views and a structure that would be simple and elegant to complement the landscape and minimise visual impacts from the longer distance; and
- The provision for unparalleled views of the ocean and coastline for both road users and pedestrians.

9.17.2. Summary of Adverse Effects

The Proposal would have the following adverse effects:

- Reclamation of up to approximately 3000m^2 would be required in GD2, which has the potential to impact on the study area by altering the active coastal processes, removing 46% of the total intertidal boulder field habitat and result in the loss of subtidal habitat causing mortality of invertebrates associated with these habitats and displacing fish to other similar habitats;
- Potential impact on the stand of Norfolk Island Pines within the northern amphitheatre and the Escarpment Core Area, both of which are listed under the Wollongong LEP as items of heritage significance;
- Potential to impact on caves suitable for the roosting needs of the Common Bentwing-bat, which is listed as a vulnerable species under the TSC Act;
- Short term visual impacts associated with construction activities and the introduction of a new feature into the landscape;
- Potential short term impacts as a result of construction activities including:
  - An increase in erosion and sedimentation within the study area;
  - An increase in dust generation;
  - A decrease in water quality;
  - The removal of native vegetation;
  - The disruption of local traffic movements due to construction vehicles; and
  - An increase in noise levels associated with heavy vehicle movements.

Mitigation measures described above in Section 9 and the inclusion of best management practice through the implementation of a CEMP and associated supplementary management plans would minimise impacts associated with these potential adverse effects.

10. Environmental Management

10.1. Environmental Management Processes

10.1.1. RTA Responsibilities

The RTA has developed an Environmental Management System (EMS), which sets the direction for environmental management for all RTA activities. The EMS enables the RTA to identify and manage environmental risks and to assess its environmental performance overall as an organisation and for individual infrastructure projects.

The EMS also includes processes that ensure the RTA assesses the environmental performance of its contractors against environmental specifications and guidelines specific to roadwork and bridgework contracts. As part of the EMS, the RTA has developed a series of specifications.

The major relevant RTA specifications of environmental management of the Proposal would include:

- *QA Specification G36 – Environmental Protection (Management System);*
- *QA Specification G38 – Soil and Water Management (Soil and Water Management Plan;*
- *QA Specification G40 – Clearing and Grubbing; and*
- *QA Specification R178 – Vegetation.*

Contractor performance would be managed through the specifications, which would be tailored specifically to the project by the inclusion of environmental management measures, which the contractor would need to implement. The *QA Specification G36* requires the Contractor to have an EMS in place.

The assessment of environmental aspects and impacts began as part of the environmental assessment process where potential environmental sensitive sites were identified as part of the option selection process. Development of the preferred option assisted in focussing on managing impacts associated with the Proposal and devising mitigation measures to safeguard the environment from risks.

10.1.2. Responsibilities of LHD Link Alliance

A Construction Environmental Management Plan (CEMP) would be required in accordance with RTA's *QA Specification G36 – Environmental Protection (Management System)* aimed at addressing the specific environmental issues raised by the Proposal.

The CEMP would include as a minimum:

- Details of environmental controls to be implemented by LHD Link Alliance and subcontractors in accordance with the requirements of the Contract.
- Copies of Statutory requirements including approvals and licences;
- Location of environmental control works;
- Timing of environmental control activities;
- Clear definition of roles and responsibilities for each of the LHD Link Alliance members for the proposed activities;
- Procedures and instructions for implementing, maintaining, assessing and monitoring each environmental control;
- Reporting procedures (incident, complaint, non-conformance);

- Details of training for personnel working on the project;
- Procedures and schedules for undertaking and recording environmental inspections and auditing;
- Emergency procedures;
- Corrective action requirements and verification;
- Assignment of authorised personnel and a procedure for changing and issuing the CEMP;
- Details of how the changes to the environmental management documentation and data are to be identified and communicated to relevant project personnel; and
- Mechanism for regular evaluation of environmental performance.

In addition, the CEMP would include supplementary management plans where required, specifically

- Soil and Water Management Plan and / or Erosion and Sediment Control Plan (SWMP / ESCP). The ESCP would detail all site specific measures LHD Link Alliance would implement during construction to prevent an increase in water pollution loads being exported from the site;
- A Water Quality Monitoring Plan would be included in the SWMP to assess the effectiveness of erosion, sediment and water quality controls;
- Dust monitoring plan to assist in the reduction of nuisance dust to nearby residences and businesses;
- Noise and Vibration Management Plan to assist in reduction of noise and vibration impacts;
- Traffic Management Plan;
- Resource and Waste Management Plan;
- Emergency Procedures for chemical spills and other potential incidents; and
- Community Consultation Plan.

The supplementary EMPs would include identification of potential impacts and an outline of the mitigation measures to be implemented. The EMPs would detail measures to comply with specific licence and approval conditions. Individual EMPs would also be structured to fit within the overall framework of the CEMP.

10.1.3. Environmental Inspections and Auditing

Inspections and audits to ensure compliance with the CEMP and supplementary EMPs would be undertaken during construction.

LHD Link Alliance would develop and implement a risk-based auditing program to verify environmental performance. The RTA would engage external providers to review the Alliance's performance at regular intervals throughout construction in accordance with the RTA Quality, OHS and Environmental Audit Package. Activities would be assessed against the CEMP and the contract specifications. The RTA's Southern Regional Environmental Advisor would determine the frequency of audits, inspections and surveillance on a risk basis.

Audits would involve reviewing environmental documents, records and monitoring results to ensure compliance with the requirements of legislation, licences, permits, approvals, contract documentation and the CEMP.

LHD Link Alliance would undertake an audit following completion of construction. The audit would involve a site inspection, review of environmental records and assessment of existing environmental protection controls.

10.1.4. Schedules and Reporting

As part of the CEMP, the following registers or schedules would be developed to provide a record of site conditions and activities:

- Site surveillance, inspection and audit schedule and register;
- Non-conformance/Corrective action register;
- Incident Report Register;
- Complaints Register; and
- Induction and Training Register.

Six monthly environmental performance reports would be prepared to assess the environmental performance of LHD Link Alliance. The reports would include a summary of environmental monitoring results, comparison against guidelines and licence conditions, discussion of issues identified during site audits and recommendations to improve environmental management.

10.2. Summary of Proposed Mitigation Measures

Table 10.1 provides a summary of all mitigation measures identified in the REF for the Proposal. Mitigation measures identified would be incorporated into the CEMP for the Proposal.

Table 10.1: Summary of Proposed Mitigation Measures

Issue	Mitigation Measure	Supplementary Management Plan
Topography, Soils and Geology		
Erosion and Sedimentation	• The ESCP would be prepared and implemented in line with the Department of Housing's *Managing Urban Stormwater Guidelines* (DoH 1998) 'Blue Book' prior to the commencement of works; • Regular inspection of the work site would be undertaken during construction activities to ensure that the ESCP is properly implemented and maintained; • Geofabric sediment fences would be installed downslope of all disturbed areas, particularly those areas adjacent to gullies (capable of channelling rain runoff) and the ocean; • Temporary stockpiles would not be located adjacent to drainage lines, the ocean or the existing road and would be suitably fenced on the downslope side, with appropriate geofabric sediment fences; • Sandbags or gravel bags would be used to protect existing stormwater culverts; • Water pumped from boring activities during the construction of the bridge piers, would be appropriately contained and treated prior to discharge to prevent off-site sedimentation. Re-use options would be investigated where appropriate; • Vegetation clearance and soil disturbance would be limited to those areas required for construction purposes; and • Revegetation of disturbed areas would occur where practical, immediately after completion of works in that area.	Soil and Water Management Plan (SWMP) Erosion and Sedimentation Control Plan (ESCP)
Contaminated Lands	• Should unexpected contaminated material be disturbed during earthworks, control measures would be implemented to divert surface runoff and the material would be removed from site and disposed of at an approved DEC site; and • If imported fill material is required, it would be sourced from an approved stockpile site or supplier.	

Issue	Mitigation Measure	Supplementary Management Plan
Climate		
	• The CEMP for the Proposal would include procedures that cover construction activities and safety during inclement weather such as fog and heavy rain; • A Traffic Management Plan (TMP) to meet the requirements of the RTA's *QA Specification G10 – Control of Traffic* would be prepared to manage vehicle movements around and within the construction area. Implementation of the plan would ensure safe working and driving conditions particularly during periods of inclement weather including fogs; • Works in and adjacent to the intertidal zone would only be undertaken during periods of calm to slight seas and low swell conditions. No works would be undertaken during storm events and all equipment would be moved out of the impact zone of waves on such occasions; and • All mobile plant would be removed from the working platforms and other areas within or adjacent to the intertidal zone at the completion of the daily activities.	Traffic Management Plan (TMP)
Air Quality		
	• Watering would be carried out at regular intervals to dampen disturbed areas and reduce dust generation, particularly during windy conditions; • Dust generating activities that cannot be adequately controlled by watering or other means would be ceased during windy conditions; • Water carts and other dust control equipment would be properly maintained so that it is available for use without delay, in the event of dust generation; • Materials transported to the site would be appropriately covered to reduce dust generation in transit; • Mud and other debris would be removed from the wheels and bodies of haulage equipment on leaving the site and before entering public roads or sealed pavements. Facilities such as truck washdown bays and 'cattle grid' type shakers would be considered for the purpose; • Any mud or other construction debris spilt on public or sealed roads would be removed before dust generation becomes a potential issue;	Air Quality Management Plan (AQMP)

Issue	Mitigation Measure	Supplementary Management Plan
	• Any stockpiles or material stores would be kept damp and/ or covered and screened by dust screens where appropriate; • Any waste material capable of generating dust, such as excavated material that is unsuitable for recycling during construction, would be removed from site as soon as possible and taken to an approved waste disposal site; • No vegetation, timber or other combustible materials would be burned. Material that is unsuitable for reuse or recycling on site would be removed to an appropriate location for subsequent storage, reuse, recycling or disposal; • Reformed surfaces would be revegetated as soon as possible to minimise dust generation and topsoil dispersion; • Any complaints in relation to dust generation from the works would be promptly addressed and the dust source eliminated; • All equipment, machinery and vehicles used on site (including those used for transporting materials, equipment and workers to and from the site) would be regularly maintained to the relevant Australian Design Rules and manufacturers specifications in order to minimise potential emissions; • All emission controls used on construction equipment would comply with DEC requirements; and • Vehicles and equipment would only be left idling when required for construction works.	
Water Quality and Hydrology		
	• The reclamation and extent of construction would be minimised and designed to mirror the form and bathymetry of the existing shoreline and intertidal zone; • During construction, drainage and flow structures such as culverts would be constructed as early as possible to maintain existing flows and minimise the risk of flooding; • A Water Quality Management Plan (WQMP) would be incorporated into the SWMP described in Section 9.1.3 and ongoing monitoring would be undertaken prior to, and during, construction. The WQMP would be developed to evaluate the ambient water quality against triggers in the	SWMP Water Quality Management Plan (WQMP)

Issue	Mitigation Measure	Supplementary Management Plan
	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). Should refinement of the of the trigger values be needed to address local conditions, prior agreement from the DEC would be obtained; • Precautions to prevent scour during construction would also be incorporated into the SWMP; • The feasibility of including a stormwater / pollutant treatment technique into the Proposal would be further investigated during the detailed design stage; • Refuelling or maintenance of plant and equipment, mixing of cutting oil with bitumen, or any other activity which may result in the spillage of a chemical, fuel or lubricant on any location with direct drainage to a waterway, overland flowpath or the ocean would not be permitted without the provision of appropriate temporary bunding; • Refuelling or maintenance of plant and equipment, mixing of cutting oil with bitumen, or any other activity which may result in the spillage of a chemical, fuel or lubricant would not be allowed to be undertaken on the working platforms within GD2; • Refuelling operations would not be left unattended while in progress; • Adequate quantities of suitable material such as sand to contain spillage, would be kept readily available on site; • A catch platform with vertical sheeting would be used whilst construction activities are undertaken on bridge structures to prevent materials and equipment falling into either the intertidal or subtidal areas; • Materials or equipment that has fallen into either the intertidal or subtidal areas would be recovered immediately and the area would be treated if required; • Bunding and spill management would be undertaken in accordance with the requirements of: a) Relevant legislation and Australian Standards; b) EPA's (DEC) Bunding and Spill Management Guidelines contained within the EPA Environmental Protection Manual for Authorised Officers; and c) The RTA Code of Practice for Water Management, 1999. • Chemical, fuel and lubricant storage areas would be suitably located and protected to minimise spill impacts;	

Issue	Mitigation Measure	Supplementary Management Plan
	• Storage areas would not be located within 20m of built or natural drainage lines or on slopes steeper than 1:10, or near vegetated areas; • Impervious bunds around stores would have sufficient capacity to contain at least 120% of the stored chemical, fuel or lubricant volume; • Details would be included in the CEMP on how bunded areas would be monitored and drained to meet environmental requirements and to ensure bund capacity is maintained; • Where it is essential to remove chemical containers from bunded areas, they would not be left unattended. Where this is not practicable they must be managed to minimise the risk of spillage. They must only be removed for use on that day and safe overnight storage procedures must be implemented as well as safe removal to bunded areas when conditions change that may create a risk to the environment; and • Drums or other containers used as markers would not contain any chemicals, fuels or lubricants.	
Terrestrial Ecology		
	• Prior to construction, all personnel would be advised of the limits of clearing and would be made aware of the importance of the regionally significant Drooping She-oak (*Allocasuarina verticillata*); • Native trees removed during clearing and grubbing would be used in conjunction with soil erosion and sediment control measures where possible. All other native trees removed would be converted to mulch and stockpiled for use during revegetation works; • No vehicles or machinery would be stored or parked within any native vegetation areas proposed for retention or under the dripline of trees; • Revegetation works would be undertaken progressively through the construction phase and would be undertaken using a combination of hydromulch and hand planting where appropriate. Locally occurring native plant species would be used except where a rapid cover of vegetation is required to prevent erosion. In these areas sterile grasses would be used; • Revegetation works would include locally occurring plants that are characteristic of the adjacent vegetation communities. The inclusion of Drooping She-oak (*Allocasuarina verticillata*)	Weed Management Plan (WMP)

Issue	Mitigation Measure	Supplementary Management Plan
	individuals grown from locally collected seed and native grasses would also benefit the long term presence of this plant and the Coastal grassland / shrub communities; • Landscaping and revegetation works should be maintained for a period of no less than twelve months. During this time any dead or dying plants would be removed and replaced; • A Weed Management Plan would be included in the CEMP. Weeds would be removed and disposed of in accordance with the requirements of the Wollongong City Council. The Weed Management Plan would specifically address the following: – All noxious weeds (such as Blackberry and African Love Grass) would be removed by a contracted qualified bush regenerator if applicable and in accordance to the criteria under the *Noxious Weeds Act 1993*, and the NSW Department of Agriculture Guidelines, 1999; – Herbicide usage would be in accordance with manufacturer's instructions and applied to only those areas designated for treatment; – All spraying would be carried out so as to avoid damage to any surrounding native vegetation; – Topsoil potentially containing introduced grasses or weed propagules would be removed from the site. Contaminated topsoil would not be reused for the proposed works, including site rehabilitation; • With regards to the surrounding vegetated areas and fire precautions, all construction activities would be undertaken to comply with the requirements of the *Rural Fires Act 1997* and the *Local Government Act 1993* and be guided by the NSW rural Fire Services 'Equipment and Machinery Use in Bush fire Prone Areas'. Fire equipment would be provided, as required, and no cutting, welding, grinding or other activities likely to generate fires would be undertaken in the open on 'total fire ban' days; • Prior to construction, all personnel would be provided general information on the Common Bentwing-bat (*Miniopterus schreibersii*) and the Sooty Oystercatcher (*Haematopus fuliginosus*), threats to their survival and the legislative penalties incurred following any harm to them; • Injury to protected wildlife caused by through or because of any construction activity must be reported to the DEC Parks Services Division;	

Issue	Mitigation Measure	Supplementary Management Plan
	• Contact details for wildlife rehabilitation groups, such as WIRES Illawarra, and DEC Parks Services Division, would be kept on site and in the event of injury to fauna would be contacted immediately; • Disturbance of the old entrance portal to Coalcliff Colliery would be avoided. These mines offer roosting opportunities for the threatened Common Bentwing-bat. The locations of these areas would be identified on any construction plans, and the sites being protected from any direct or indirect impacts; • Prior to the construction activities being undertaken, the entrance portals would be fenced (or similar), including a buffer, and all access and activity within this area would be excluded. The fencing requirements and buffer area would be developed in consultation with a qualified ecologist; and • The location of the abandoned mine adits would be considered when finalising the location of the bridge piers. If an unmapped adit is exposed, works at these locations are to cease immediately. A qualified ecologist would be engaged to inspect any exposed adits to ensure that no roosting colonies of any cave dependant bats are present. Where these are identified, appropriate mitigation measures would be developed in consultation with the DEC Parks Services Division.	
Marine Ecology		
	Mitigative measures would take into account the NSW Fisheries guidelines, *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003) and *Fishnote: Policy and Guidelines for Fish Friendly Waterway Crossings* (NSW Fisheries 2003). In addition, the following measures would be adopted: • As far as practicable the area of habitat to be reclaimed would be minimised; • NSW Fisheries would be notified regarding the proposed reclamation works, under the provisions of the *Fisheries Management Act 1994*, prior to construction; • Restoration would be undertaken in conjunction with the reclamation works to restore the lost	SWMP; ESCP Specific Monitoring Program

Issue	Mitigation Measure	Supplementary Management Plan
	or degraded habitat; • Restoration techniques would be developed during the detailed design stage of the reclamation works through consultation with NSW Fisheries, the relevant Management Advisory Committees for affected fisheries and a qualified marine ecologist prior to construction; • Restoration would create a similar area of boulder field habitat to that reclaimed on the seaward edge of the reclaimed areas; • To make the restored boulder fields similar to those that would be removed in terms of appearance and ecological function, the slope of the front of the reclaimed areas and material used there would be as similar as practicable to the boulder fields that would be reclaimed. Boulders from intertidal boulder fields to be reclaimed could be mixed in with rock armour on the seaward edge of the proposed reclaimed areas; • Working platforms and access tracks needed to construct piers for the section of the bridge in GD3 would be restricted as far as practicable to the rear of the rock platform so that minimal intertidal habitat is covered; • Construction activity would be confined above the limits of the intertidal zone as far as practicable to avoid trampling of intertidal species; and • A monitoring program would be developed based on the habitats and areas most likely to be affected by the Proposal and would include the intertidal boulder fields, the middle rock platform, the southern rock platform of the southern amphitheatre and the subtidal habitats within the southern amphitheatre. The monitoring program would be developed in consultation with NSW Fisheries and a qualified marine ecologist and would address the following: – Baseline information would be compiled prior to construction commencing at areas most at risk as well as control locations where disturbance is unlikely; – Monitoring would also consider temporal and spatial changes to biota and water quality to address the effects of natural variability; – Monitoring would continue throughout the construction period and approximately 6 months post-construction; and – Data collected during the construction period and post-construction would be compared	

Issue	Mitigation Measure	Supplementary Management Plan
	against the baseline information and would assist in modifying those mitigation measures described above if necessary or used to formulate additional measures where required.	
Socio-economic Considerations and Land Use		
	• A project phone number would be established that residents could utilise to register concerns, complaints or other comments about construction. Protocols described in *RTA Community Involvement: Practice Notes and Resource Manual* (1998) would be followed; • A Traffic Management Plan (TMP) would be developed for the Proposal in accordance with RTA's *QA Specification G10 – Control of Traffic*. The TMP would outline the construction vehicle movement plan(s), which would be developed in consultation with the Illawarra Coke Company to minimise obstruction to heavy vehicle movements of the Coalcliff Coke Works as well as local traffic; • All property acquisition where necessary would be undertaken prior to construction and be negotiated in accordance with the RTA's *Land Acquisition Policy* and compensation would be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*; and • The relevant Management Advisory Committees for the Eastern Rock Lobster Fishery, Abalone Fishery and the Sea Urchin and Turban Shell Fishery would be notified and provided with a schedule of works prior to construction.	TMP
Indigenous Heritage		
	• Should any relic, artefact or material (including skeletal remains) suspected of being Aboriginal in origin be encountered, all work would cease that may expose the relic, artefact or material to damage or disturbance. The RTA's Southern Region Environmental Adviser and APC would be notified immediately, who would then arrange for an officer of DEC's Parks Services Division and a member of ILALC and the WWEC to be consulted; and • All personnel working on the site would receive training regarding their responsibilities under the *National Parks and Wildlife Act 1974*.	

Issue	Mitigation Measure	Supplementary Management Plan
Non-indigenous Heritage		
	• Should any item be encountered which is suspected to be a relic of heritage value, including items of maritime heritage value, all work would cease that may expose the item to damage or disturbance. The RTA's Southern Region Environmental Adviser would be notified immediately, who would then arrange for an officer of NSW Heritage Office to be consulted; • All personnel working on the site would receive training regarding their responsibilities under the *Heritage Act 1977* and would be made aware of the items discussed above and listed in Table 9.11; • All heritage items, including the entrance portal, remnant jetty and associated structures, and the Norfolk Island Pines to be retained would be fenced (or similar), including a buffer, and all access and activity within these areas would be excluded. The fencing requirements and buffer area would be developed in consultation with a qualified archaeologist; • The opportunity to 'build in' heritage interpretations of the areas heritage values through signage and other means would be investigated during the detailed design stage. • The Proposal would respect the recommendations presented in the draft *Illawarra Escarpment Strategic Management Plan*, Volume 2 relating to non-indigenous heritage by seeking the opportunity to utilise the remnant jetty site for interpretation; • Construction would not interfere with the former entrance portal of Coalcliff Colliery; • Should a previously unrecorded adit or tunnel be exposed as a result of the bridge pier construction, works would cease until such time that they are recorded in accordance with NSW Heritage Office guidelines; • A full archival recording of the entrance portal, remnant jetty and associated structures and the stand of Norfolk Island Pines would be undertaken in accordance with NSW Heritage Office guidelines prior to the commencement of the proposed works; • Removal of the two southernmost Norfolk Island Pines would be undertaken by a certified arborist and to the requirements of Wollongong City Council; • A formal submission to Wollongong City Council would be prepared regarding the boundaries	

Issue	Mitigation Measure	Supplementary Management Plan
	of the Draft Illawarra Escarpment Management Plan; • The findings of the REF would be forwarded to Wollongong City Council in its consideration of the draft *Illawarra Escarpment Strategic Management Plan*; and • Should the main compound site and concrete batch plant be located within Coalcliff Coke Works land, it would be sympathetic to existing operations and heritage values of the site.	
Visual, Landscape and Urban Design		
	• The detailed design for the Proposal would integrate the engineering and safety objectives with urban and landscape objectives to produce a design outcome that retains the high visual quality of the study area; • Qualified urban designers would be involved during the detailed design stage of the Proposal. Any alterations to the design during construction would be undertaken in consultation with a qualified urban designer; • The final bridge design would be reviewed by the RTA Urban Design Panel; • Geotechnical stabilisation treatments involving the removal of rock would be designed not to affect the overall topography and profile of the existing environment; • The use of concrete armour units would be minimised where possible and durable rock armour of similar geological type to the existing environment would be given preference; • Rehabilitation and revegetation of disturbed areas would be in accordance with RTA's *QA Specification R178 – Vegetation*. Revegetation would consist of endemic native flora species; and • The location of work compounds, parking areas for machinery, equipment and material stockpile sites would consider potential impacts on viewsheds.	
Noise and Vibration		
	• For works performed outside of the standard working hours, the procedure contained in the RTA's *Environmental Noise Management Manual* 'Practice Note vii – Roadworks Outside of Normal Working Hours' would be followed; • The number of heavy vehicle movements would be limited to 5 per hour if work is required	Noise and Vibration Management Plan (NVMP)

Issue	Mitigation Measure	Supplementary Management Plan
	between the hours 6am - 7am and 6pm and 8pm Monday to Friday; • The location of the concrete batch plant within the main compound site would be as far as possible from residential properties; and • A line of communication between the community and LHD Link Alliance construction management would be provided.	
Waste Minimisation and Management		
	• Reuse of materials on-site would have priority over recycling. Where recycling is more feasible, it would be carried out in accordance with the NSW Government's Waste Avoidance and Resource Recovery Strategy 2003; • Excavated material that is not suitable for on-site reuse or recycling, such as contaminated material would be transported to a site that may legally accept that material for reuse or disposal; • The appropriate DEC licences and approvals would be obtained prior to the disposal of any contaminated waste generated by the Proposal, and the operators of the appropriate disposal site would be notified in advance; • Waste materials would be classified in accordance with the DEC's *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*; • At the end of the construction period, any unused fuel, oils and chemicals would be removed from the site; • Materials would be sourced so as not to result in the creation of excess waste; • Any waste oil generated during maintenance would be disposed of at an approved disposal site or recycling facility; • Concrete delivery trucks would be directed to wash out within a specified washdown bay, which would be appropriately bunded, within the confines of the site compound or return to the batching plant before washing out; • Portable, self-contained toilet and washroom facilities would be provided on site which would be regularly emptied and serviced by the contractor providing them;	Resource and Waste Management Plan (RWMP)

Issue	Mitigation Measure	Supplementary Management Plan
	• Putrescible and other waste such as chemical waste, not able to be recycled, would be regularly collected and disposed of at an appropriate disposal site; • No burning of cleared vegetation or other material would be allowed. It would be recycled where feasible or otherwise disposed of at an appropriate site; • Secure rubbish bins, with lockable lids would be provided on site, which would be regularly emptied by the supplying contractor; • Any rubbish loads being transported from the site for disposal would be covered to prevent the spread of waste; and • The works site would be left tidy and rubbish free on completion of the Proposal.	
Associated Infrastructure and Activities		
Concrete Batching Plant	• The batch plant would be situated so as to minimise soil disturbance and groundwater infiltration and would have little effect on the drainage within the batch plant site; • Clean runoff would be diverted around the batch plant site using diversion drains or banks; • Contaminated runoff from the batch plant site would be diverted to sediment basins for treatment. Water from truck washdown bays would be kept separate from the general site runoff. Water from these activities would be directed into settling ponds where cement, sand and aggregates would be given time to settle out of the water. All erosion, sediment and pollution control devices would be inspected on a regular basis and maintained to ensure effective operation; • The pH of the contaminated runoff would be monitored and treated to ensure that it is maintained between 6.5 and 8.5, unless reused for batching operations; • Additives, fuels, chemicals or oils would be stored in a bunded area sized to contain spillage of at least 120% of the largest liquid storage container; • Regular inspection and monitoring of the bunded areas would be undertaken to ensure proper maintenance of tanks and containment of any spills; • All bulk cement would be stored in silos. Fabric filters would be used to vent silos to the atmosphere. Filters would be designed to accommodate the maximum discharge rates from	SWMP; ESCP; TMP; AQMP; NVMP; RWMP

Issue	Mitigation Measure	Supplementary Management Plan
	vehicles. Each silo would be fitted with a single filter and separate piping to allow for simultaneous filling of silos. A burst-bag detector system with ducting to ground level near the tanker filling point and high level indicators with an automatic alarm would be used; • Solid concrete waste would be incorporated into site earthworks; and • The batching operation is not expected to produce any waste oil or grease products, however, should this arise during the operation this material would be collected and disposed of by a licensed contractor.	
Stockpile and Compound Sites and Casting Area	The primary selection criteria for stockpile and compound sites include: • More than 50m from waterways; • Sites with low conservation significance for flora, fauna and indigenous and non-indigenous heritage; • Sites requiring no substantial clearing of native vegetation; • Consideration of nearby residential amenity; • On relatively level ground with hardstand area; • Easy and safe access to the road network; and • Compounds and activities associated with compounds would have minimal impacts on land use and adjacent properties.	SWMP; ESCP; TMP; AQMP; NVMP; RWMP

11. Consideration of Environmental Factors

11.1. Clause 228 Checklist (NSW Legislation)

The following factors, listed in Clause 228(2) of EP&A Regulation 2000, are required to be considered to assess the likely impacts of the Proposal on the natural and built environment.

Factor	Impact
a) Any environmental impact on a community?	
The Proposal would reinstate the road link between Coalcliff and Clifton with subsequent positive socio-economic impacts. Pre-closure travel and commuting patterns would be re-established with subsequent time and cost savings compared to the existing situation. The wider community would benefit from the major tourist route being reopened, with flow on economic effects to local businesses.	Long term + ve
The preferred option would require the road to remain closed during construction, with no public access until completion, which would have a short term negative impact when compared to the 'do nothing' option.	Short term - ve
Minor short term impact in the form of dust, noise and increased traffic on local roads would potentially be experienced during construction. However, the mitigation measures detailed in Section 9 of this Ref and the CEMP would minimise potential impacts.	Short term - ve
b) Any transformation of a locality?	
The Proposal would introduce a new feature, which has the potential to have an impact on the existing visual landscape and alter the main viewsheds of an area already well known for its cultural and scenic quality. However the design of the Proposal would incorporate urban design principles to reflect this quality and the mitigation measures in Section 9 of this REF would ensure that potential impacts are minimised.	Long term - ve
It is anticipated that, over time the Proposal would become a well known landmark feature locally and nationally.	Long term + ve
c) Any environmental impact on the ecosystems of the locality?	
The potential exists for some short term negative impacts during construction. However the mitigation measures outlined in Section 9 are designed to minimise any such potential impacts and there are not expected to be any ongoing environmental impacts on the locality.	Short term - ve
Specialist studies undertaken for the purpose of the REF in marine and terrestrial ecology have not identified any long term adverse impacts on the ecosystems of the locality.	Long term Nil
The opportunity exists in the design of the bridge piers and access tracks for the creation of new marine habitats, which would offset any short and long term impacts associated with the potential removal of habitat areas	Long term Nil

Factor	Impact
during reclamation in the southern amphitheatre.	
d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?	
The Proposal has the potential to generate short term negative visual impacts on the locality when first constructed by introducing a new feature in an area known for its scenic value. These potential impacts are expected to decrease over time as people gradually accept the Proposal.	Short term - ve
In avoiding major earthworks affecting the profile of local headlands, the overall profile of the Illawarra Escarpment would be retained. The preferred option would avoid the requirement of such earthworks.	Long term Nil
Access to local cultural, recreational and scientific features of the locality would be retained and the design and location of the preferred option would avoid such areas.	Long term Nil
The Proposal would introduce a new feature to the area which, in the long term is expected to become appreciated as a landmark, attracting people to the area as well as serving to reopen an important recreational access route and tourist drive along the Illawarra coastline.	Long term + ve
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?	
The Proposal would require the removal of two heritage-listed Norfolk Island Pine trees in the vicinity of the northern amphitheatre. The initial removal would cause a short term negative visual impact. However the trees are part of a stand of thirteen and numerous other examples are available in the immediate vicinity of the Proposal and in the wider Illawarra region. As such there are not expected to be any long term negative impacts and the two trees would be recorded prior to removal and documented for future reference.	Long term Nil
The Proposal has the potential to have short term impact, related to remedial works on the Illawarra Escarpment Core Area in a minor way at two locations but works would not be expected to have long term impacts on the existing profile or visual quality of the escarpment.	Short term - ve
The reopening of Lawrence Hargrave Drive would maintain safe access to the area for a wide range of users, ensuring the preservation of the locality's significance for present and future generations.	Long term + ve
No items of indigenous archaeological value were discovered during investigations.	Long term Nil

Factor	Impact
f) Any impact on the habitat of any protected or endangered fauna within the meaning of the *National Parks and Wildlife Act 1974*?	
Specialist investigations undertaken for the REF concluded that the Proposal would not impact on such features. Additionally, the mitigation measures contained in Section 9 of this REF would ensure that there would be no similar impacts on the wider Illawarra Region.	Long term Nil
g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?	
Specialist marine and terrestrial ecological studies concluded that no such endangering of species would occur.	Long term Nil
h) Any long term effects on the environment?	
The initial introduction of a new man-made structure in an area of high scenic quality would have short term negative impacts until the structure becomes more widely accepted.	Short term - ve
Urban design principles applied to the structure would be sympathetic to the local environment and there are not expected to be any long term negative impacts generated by the Proposal, beyond the initial 'introductory' short term negative impacts.	Long term Nil
i) Any degradation of the quality of the environment?	
There is potential for minor short term environmental degradation in terms of noise, dust, increased traffic on local roads and water quality during construction.	Short term - ve
Mitigation measures outlined in this REF as well as additional measures outlined in the CEMP would ensure that impacts are limited to minor short term impacts and are managed within levels set by regulatory authorities.	Long term Nil
j) Any risk to the safety of the environment?	
The Proposal would remedy an existing unacceptable level of risk to the safety of the environment and a wide range of community and other users. Implementation of the mitigation measures contained in Section 9 of this REF and the effective management of construction through the implementation of a CEMP would ensure that potential environmental risks are minimised. Additionally, environmental and community safety would be paramount during the construction and operation of the Proposal.	Long term + ve

Factor	Impact
k) Any reduction in the range of beneficial uses of the environment?	
There is a potential for the recreational use of the local area to be disrupted during construction. It would be a safety requirement that public access to the area is restricted during construction and the disruption would only be for the life of the construction phase.	Short term - ve
There are not expected to be any negative impacts on the long term beneficial uses of the local environment, such as access to local fisheries and recreational areas.	Long term Nil
l) Any Pollution of the environment?	
There is minor potential for short term negative impacts during construction. However the mitigation measures documented in Section 9 of this REF would ensure that this potential is effectively managed.	Short term - ve
The construction of the Proposal is expected to create a safer driving environment compared to that prior to the road closure. The potential for accidental pollution by spillage is expected to be reduced and, as such there is not expected to be any long term pollution of the environment.	Long term Nil
m) Any environmental problems associated with the disposal of waste?	
A Resource and Waste Management Plan would be prepared as part of the CEMP to manage waste during construction. All waste would be reused or recycled where possible and the mitigation measures contained in Section 9 of this REF would ensure that there would be no impacts associated with the disposal of waste.	Long term Nil
n) Any increased demands on resources, natural or otherwise, which are, or are likely to become in short supply?	
No such resources have been identified in the vicinity of, or are likely to be affected by the Proposal.	Long term Nil
o) Any cumulative environmental effect with other existing or likely future activities?	
The mitigation measures contained in section 9 of this REF and effective management of construction through the implementation of the CEMP would ensure that there are no cumulative environmental effects with other existing or likely future activities.	Long term Nil
Furthermore, the reopening of Lawrence Hargrave Drive would ensure that ongoing access to the area for the carrying out of existing and likely future activities would be maintained.	Long term + ve

11.2. EPBC Act 1999 (Commonwealth Legislation)

Under the environmental assessment provisions of the EPBC Act, the following matters of National Environmental Significance (NES) are required to be considered with regards to the Proposal.

Factor	Impact
a) Any environmental impact on a World Heritage property? Assessments conducted as part of this REF have concluded that there would be no impact on a World Heritage Property as a result of the Proposal.	Nil
b) Any environmental impact on National Heritage places? No impacts have been identified during specialist studies conducted as part of this REF.	Nil
c) Any environmental impact on wetlands of international importance? There are no wetlands of international importance in the vicinity of, or likely to be affected by the Proposal. No impacts have been identified.	Nil
d) Any environmental impact on Commonwealth listed threatened species or ecological communities? Threatened species as listed on the EPBC Act may utilise resources in the area and surrounding, however specialist studies carried out as part of this REF have confirmed that impacts would be unlikely.	Nil
e) Any environmental impact on Commonwealth listed migratory species? Migratory species as listed on the EPBC Act may utilise resources in the area and surrounding, however specialist studies carried out as part of this REF have confirmed that such impacts would be unlikely.	Nil
f) Does any part of the proposal involve a nuclear action? There are no nuclear actions involved in any part of the Proposal.	Nil
g) Any environmental impact on a Commonwealth marine area? The Proposal would not be located within any Commonwealth marine area and it is not anticipated that there would be any direct or indirect impacts upon a Commonwealth marine area.	Nil
In addition; any impact on Commonwealth Land? There would be no direct or indirect impact on any Commonwealth land as part of the Proposal.	Nil

12. Certification

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.

A. B. Cook

Andrew Cook
Environmental Officer

Date: 17 MAR 2004

I have examined this Review of Environmental Factors and the certification by Andrew Cook and accept the Review of Environmental Factors on behalf of the RTA.

Alex Dunstan
Project Manager

Date: 17 MAR 2004

13. Glossary and List of Abbreviations

AADT	Annual Average Daily Traffic
AHD	Australian Height Datum
AHIMS	Australian Heritage Information Management System
ANZECC	Australian and New Zealand Environment and Conservation Council
APC	Aboriginal Program Consultant
AQMP	Air Quality Management Plan
ARI	Average Return Interval
ASS	Acid Sulfate Soils
CBD	Central Business District
CCC	Community Consultative Committee
CEMP	Construction Environmental Management Plan
COI	Commission of Inquiry
CWG	Community Working Group
DC	Design and Construct project
DEC	Department of Environment and Conservation
DEH	Department of the Environment and Heritage
DIPNR	Department of Infrastructure Planning and Natural Resources
DOH	Department of Housing
ECRTN	EPA Environmental Criteria for Road Traffic Noise
EIS	Environmental Impacts Statement
EMP	Environmental Management Plan
EMS	Environmental Management System
ENCM EPA	Environmental Noise Control Manual
ENMM RTA	Environmental Noise Management Manual
EPA	Environment Protection Authority (now a division of the Department of Environment and Conservation)
ESCP	Erosion and Sediment Control Plan
ESC	Effective Survey Coverage
ESD	Ecologically Sustainable Development
GD	Geotechnical Domain
ICC	Illawarra Coke Company
ILALC	Illawarra Local Aboriginal Land Council
INP	EPA Industrial Noise Policy
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
LHD	Lawrence Hargrave Drive
MCA	Multi Criteria analysis
NEPC	National Environment Protection Council of Australia
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council of Australia
NPWS	NSW National Parks and Wildlife Service (now part of DEC- Parks Services Division)
NSW	New South Wales
PAD	Potential Archaeological Deposit
PAS	Potential Archaeological Sensitivity
REF	Review of Environmental Factors
REP	Regional Environmental Plan

RNE	Register of the National Estate
RTA	NSW Roads and Traffic Authority
RWMP	Resource and Waste Management Plan
SEPP	State Environmental Planning Policy
Significant Wave Height	The average height of the highest one third of waves
SIS	Species Impact Statement
SoHI	Statement of Heritage Impact
SWMP	Soil and Water Management Plan
TMP	Traffic Management Plan
upv	Unplasticised polyvinyl
US EPA	United States Environment Protection Agency
WHO	World Health Organisation
WMP	Weed Management Plan
WWEC	Wodi Wodi Elders Corporation

Units of Measurement and Chemical Abbreviations

Co	Carbon monoxide
dB	This is the abbreviation used for decibel which is the measure of sound pressure level.
dB(A)	The "A" denotes that the sound pressure level has been A weighted so that the scale approximates the response of the human ear. The ear is less sensitive to high and low frequency sounds than it is to sounds in the midrange. Most community noise is measured in "A" weighted decibels.
$g/m^2/m$	grams per metre squared per month
kV	Kilovolt
Lmax dB(A)	This is the single peak noise level in dBA that was recorded during the monitoring interval.
L_1 dB(A)	This is the noise level in dB(A) exceeded for 1% of a specified time period. For a 1 hour period the level would be exceeded for 36 seconds but would be less for the remaining 59 minutes 24 seconds. This is sometimes written as L_{A1}.
L_{10} dB(A)	This is the noise level in dB(A) exceeded for 10% of a specified time period. For a 1hour period the level would be exceeded for 6 minutes but would be less for the remaining 54 minutes. This is sometimes written as L_{A10}.
L_{90} dB(A)	This is the noise level in dB(A) exceeded for 90% of a specified time period. For a 1hour period the level would be exceeded for 54 minutes but would be less for the remaining 6 minutes. This is sometimes written as L_{A90}.
L_{Aeq} (9 hr)	The logarithmic average of the hourly LAeq measurements recorded between 10 pm and 7 am (Current NSW EPA night time objective.)
L_{Aeq} (15 hr)	The logarithmic average of the hourly LAeq measurements recorded between 7am and 10pm (Current NSW EPA day time objective.)
L_{eq}	The Leq represents the average noise energy level during the measurement period. When the energy level is A weighted, it may be written as L_{aeq}
mg/l	Milligrams per litre
Mj	Mega joule
NTU	Measurement of turbidity of a solution
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
$PM_{2.5}$	Particulate Matter < 2.5 µm
PM_{10}	Particulate Matter <10 µm

ppm	Parts per million
ppt	Parts per thousand
$\mu g/m^3$	Micrograms per cubic metre
pH	Measurement for acidity or alkalinity of a solution
SO_x	Sulphur dioxide

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