6 Environmental assessment

This chapter provides a detailed description of the potential environmental impacts associated with the construction and operation of the proposal. All aspects of the environment potentially impacted upon by the proposal are considered. Site-specific safeguards are provided to ameliorate the identified potential impacts.

6.1 Landform, geology and soils

A concept design geotechnical investigation for the proposal was completed in 2009. Additional information is also available the preliminary geotechnical investigations undertaken for the broader Princes Highway upgrade program. The results of these combined investigations allowed the design team to make more accurate assessments of the ground conditions and their influence on cuttings, embankments, bridge foundations and earthworks quantities.

The following sections describe briefly the ground conditions and the substantial geotechnical aspects along the proposed alignment.

6.1.1 Existing environment

General description of landform

The landform within the study area largely comprises undulating hills and their associated foothills, to the north-west of the South Coast Railway Line. This landform is dominated by the elevated ground of Mount Pleasant Ridge and Currys Mountain with the low lying areas of Willow Vale and Omega Flat.

Extensive subsoil drainage work has previously been undertaken by the RTA to stabilise a slip zone on the northern side of the existing highway at Mount Pleasant approximately 200 m from the start of the proposal.

Omega Flat is situated between Gerringong and Rose Valley Road and is a lowland marsh / floodplain that is regularly inundated during periods of high rainfall. Fluvial sediments originating from Ooaree Creek and general runoff from Gerringong, the Princes Highway and surrounding pavement areas, contribute to the area's accelerated rate of infilling.

The Crooked River floodplain, where it occurs in the study area, includes the low lying areas to the south-west of Gerringong, generally between Toolijooa Road or the Princes Highway and the railway line. The Crooked River flows south-east from Currys Mountain through Willow Vale and across the study area into the Crooked River coastal lagoon, in the vicinity of Gerroa.

In accordance with the requirements of the RTA’s Erosion and Sedimentation Management Procedure (RTA 2009), a preliminary erosion and sedimentation assessment (PESA) has been undertaken and has concluded that the proposal would likely be a high-risk due to the proximity of the SEPP14 wetland at Werri Lagoon and its potential to receive stormwater discharge during construction of the proposal.
General description of ground conditions

The geology along the proposed alignment falls under the Budgong Sandstone and the Gerringong Volcanic Facies. The alignment is predominantly underlain by weathered rock and residual soils of these formations. Substantial sections along the alignment are underlain by alluvial and estuarine deposits. These are typically highly compressible and occasionally include acid sulfate soils. The ground conditions are variable along the proposed alignment and careful consideration would be given to these ground conditions during detailed design and construction planning in order to minimise construction risk and potential environmental impacts.

Shallow residual soils overlay high strength latite in the vicinity of Mount Pleasant and continue as the proposal approaches the Rose Valley Road interchange. The natural groundwater level is expected to be shallow in this area with depths of up to 0.5 m below ground level.

At Rose Valley Road interchange the ground conditions change markedly to deeper residual soils of between three to seven metres deep, with a natural groundwater level at approximately two to three metres below ground level.

Along the Omega Flat the proposed alignment is within an area underlain by estuarine deposits overlying alluvial and residual soils. The estuarine deposits in this area are normally consolidated, highly compressible and are assessed to have acid sulfate potential. The natural groundwater level is shallow and it was measured to be at approximately one metre below ground level in this area.

Between Omega Flat and the Belinda Street interchange the ground characteristics range from a low lying area underlain by up to four metres of alluvial deposits over residual soils, to a hill underlain by up to 1.8 m of residual soils and extremely weathered sandstone. The bedrock is Kiama Sandstone and approximately 6.5 m below ground level and overlying the Blow Hole Latite. The groundwater level is expected to be approximately three metres below ground level or deeper in this area.

At the Belinda Street interchange the alignment is underlain by shallow alluvial deposits over deeper residual soils. The latite is at approximately 12m below ground level, with the groundwater level expected to be approximately two metres below ground level.

At Willowvale Road the underlying rock is sandstone. The pink coloured sandstone is visible in the existing exposed cut face immediately west of the Willowvale Road junction. The groundwater level is expected to be at approximately three metres below ground level in this area.

The proposed alignment is underlain by the Bumbo Latite and the Kiama Sandstone in the vicinity of the existing shotcreted cutting at the Gerringong Bends. Groundwater is expected at approximately seven to nine metres below ground level.

The alignment after the Gerringong Bends is underlain by fill of the existing embankment that was constructed in 1998. The natural ground beneath the existing embankment consists of shallow residual soils underlain by the Kiama Sandstone with a shallow groundwater level. Drainage measures were installed in the foundations and along the toe of the embankment during construction in 1998.

The alignment between Gerringong Bends and Toolijooa Road intersect some existing minor cuttings in residual and alluvial soils and slightly weathered sandstone. The groundwater level is expected to be encountered at between six to seven metres below ground level.
6.1.2 Potential impacts

Potential impacts on the landform, geology and soils in the study area would be largely associated with the construction of the proposal and particularly erosion of exposed soils and stockpiles and the requirement for earth fill embankments to be placed in areas of alluvial or estuarine soils and cuttings in areas of residual soils and weathered rock. With the implementation of appropriate construction techniques these potential impacts would generally be mitigated and minimised.

There would also be some potential impacts during operation associated with maintaining long-term stability of exposed cut faces and embankments and minimising the potential for erosion.

Potential impacts associated with the most substantial earthworks that would be required by the proposal include:

Cuttings

*Mount Pleasant to Rose Valley Road interchange*

The proposal would impact on the stabilised slip area in the vicinity of Mount Pleasant due to the widening required in this area. Consideration was given to widening to the east of the existing highway, but this would have a greater impact on property and require additional acquisition. Widening to the east would also have an adverse impact on an existing Sydney Water main.

Consultation with the RTA’s geotechnical group and interpretation of the findings of the geotechnical investigation for the proposal suggest that as long as the grade of the existing batter slope is maintained and not steepened, the slip would remain stable. Widening the cut at this location would also require disturbance of the existing subsoil drainage network incorporated as part of the previous stabilisation works. New subsoil drainage with the same functionality of that already existing would need to be incorporated into the widening at this location to ensure the ongoing stabilisation of the slip zone. The extent of the new drainage network would be finalised during detailed design.

Rock in this area is likely to require blasting or rock breaking machinery to remove and this would have a potential noise and vibration impact, which is discussed in Section 6.7.3.

*Rose Valley Road interchange*

The interchange requires the highway to be cut in ‘slot’ over a short length. The slot would require excavation up to 10 m deep in material varying from residual soils to highly weathered latite and sandstone. The proposed cut face would potentially be susceptible to erosion and slope instability during construction until the surface can be stabilised and would require consideration of stabilisation methods to reduce the potential for long-term erosion and slope instability.

The proposed configuration would require a vertical cut face. It is proposed to adopt a near-vertical face in the interim four lane configuration. Should future widening be required the near-vertical face would be trimmed to vertical to accommodate six lanes. The proposed cut face would potentially be susceptible to erosion and slope instability during construction until the surface can be stabilised and would require consideration of stabilisation methods to reduce the potential for long term erosion and slope instability. The use of rock breaking machinery may be required to remove material in this area and this would have a potential noise and vibration impact, which is discussed in Section 6.7.3.
**Sims Road Junction to Belinda Street interchange**

The proposed cutting in this vicinity would be approximately 5.5 m deep with a batter slope of 1h:1v (ratio between horizontal length and rise in height) and the upper one metre of soils would be laid back at a lesser slope to reduce the potential effects of erosion.

**Gerringong Bends**

The proposal would require an existing cutting to be deepened at this location to approximately seven metres below the toe of the existing shotcrete stabilised cuts. It is proposed to introduce another bench and face to the northern side of the existing cutting. The additional face would be cut at a similar slope to the existing faces at 0.75h:1v and it is proposed to adopt shotcrete to be consistent with the treatment adopted for the remainder of the cutting on the northern side of the highway. New subsoil and surface drainage at the toe of the cut with the same functionality of that already existing would be incorporated into the detailed design for the widening at this location to ensure the ongoing stabilisation of the cut face.

There is the potential for erosion of exposed surfaces and slope instability during construction until the surface can be stabilised.

Some blasting may be required in this area for excavation through the Kiama Sandstone and this would have a potential noise and vibration impact, which is discussed in Section 6.7.3.

**Gerringong Bends to Toolijooa Road**

There are two proposed substantial cuts in this area. The first would be approximately 300 m west of the Gerringong Bends on the northern side and up to 7.5 m deep. The second would be located approximately 450 m west of the Gerringong Bends on the northern side of the proposal and would be up to 6.7 m deep. The proposed cuts would potentially be susceptible to erosion and slope instability during construction until the surface can be stabilised.

Some blasting may be required in this area to remove the slightly weathered sandstone in this area and this would have a potential noise and vibration impact, which is discussed in Section 6.7.3.

**Embankments**

**Omega Flat**

An approximately four metre high embankment would be required to provide 1 in 100 flood immunity for the proposed alignment across Omega Flat. Due to the variation in the compressibility and thickness of the underlying estuarine deposits construction of the embankment would result in excessive uneven settlement and possible instability in the shoulders of the embankment. Ground improvement comprising a combination of pre-loading and wick drains would be required. To avoid future construction difficulties and reduce the risk of uneven settlement, the embankment would be constructed to the ultimate six lane width but accommodate four lanes only. There is also the potential for aquifer conductivity impacts associated with preloading and this is discussed in more detail in Section 6.2.2.

**Belinda Street interchange**

An approximately eight metre high embankment spanning the Belinda Street underpass would be located in an area underlain by shallow alluvial soils over residual soils. To reduce the potential for uneven settlement the approximately two metre deep alluvial soils require removal prior to construction of the embankment. Dewatering and undercutting the in situ soils within the existing pond would be also required prior to construction. The water quality impacts associated with dewatering are discussed in Section 6.2.2.
Particular attention to the spanning of the Eastern Gas Pipeline would be required. Structural systems such as piled slabs straddling the pipeline would avoid imposing vertical stresses on the pipe.

**Gerringong Bends**

The existing embankment on the western end of the Gerringong Bends would require substantial widening. The existing embankment was constructed in 1998 to the south of the old Princes Highway. The embankment would be constructed to suit the ultimate six lane configuration to avoid further incremental widening in the future and would have the potential to impact on existing subsurface drainage and cross drainage structures.

**Gerringong Bends to Toolijooa Road**

An up to three metre high embankment would be required to span a low lying area between the Gerringong Bends and Toolijooa Road. Alluvial deposits in this low lying area extend to about 8.5 m below ground level and pre-loading would be required to reduce the potential effects of uneven settlement on the embankment. Wick drains would not be required as the thickness of the compressible soils is limited to three metres.

In addition to the specific areas outlined above, general earthworks required for the proposal would have the potential to increase the susceptibility of exposed soils to instability and erosion particularly on steeper terrain and embankments. Based on the findings of the preliminary erosion and sedimentation assessment conducted by the RTA, the potential to cause soil erosion as a result of the proposal is considered high.

The movement of vehicles and machinery on site may cause leak / spill chemicals or fuels causing localised soil contamination. The potential for soil contamination would be greatest within the site compound areas where chemical storage and refuelling takes place.

The possibility of encountering acid sulfate soils within the low-lying regions of the study area would be relatively high, particularly within Omega Flat. Construction works carried out on Omega Flat that intersect the zone of acid sulfate soils carry a risk of creating potential impacts. These works would include construction of drainage structures such as culverts and storage basins where excavation below the water table is required and soft-soil treatment works including the removal of alluvial soils. There would also be a potential for discharge of acid water from wick drains during preloading and the potential to oxidise in-situ acid sulfate soils if groundwater conditions change as a result of pre-loading. This is discussed further in Section 6.2.2.

### 6.1.3 Safeguards and management measures

- In accordance with the preliminary erosion and sedimentation assessment undertaken, an RTA registered soil conservation consultant would be engaged during the detailed design to assist in the preparation of an erosion and sedimentation management report (ESMR) incorporating specifications outlined in Landcom's Managing Urban Stormwater - Soils and Construction Volume 1 (Landcom 2004) and DECCW's Managing Urban Stormwater - Soils and Construction Volume 2D: Main Road Construction (DECCW 2008).

- The ESMR would incorporate appropriate mitigation measures to minimise the potential for sediment laden stormwater discharge to flow into the SEPP14 wetland at Werri Lagoon.
An acid sulfate soils management plan (ASSMP) would be developed and implemented to mitigate for potential impacts associated with acid sulfate soils, with particular reference to the proposed excavations below the water table for drainage structures on the Omega Flat floodplain. The ASSMP would be prepared in accordance with the RTA’s Guideline for the Management of Acid Sulfate Materials (RTA 2005).

Driven piles would be used for bridge foundations where possible to reduce oxidation of potentially acid sulfate soils to reduce the risk of contamination to Werri Lagoon (SEPP14 Wetland).

Potentially unstable exposed cut faces would be stabilised appropriately.

Widening of the existing slip zone in the vicinity of Mount Pleasant would ensure that the grade of the existing batter slope is maintained and not steepened. The functionality of the existing subsoil drainage network at this location would also be maintained in the new drainage works to ensure the ongoing stability of the slip zone.

Consideration would be given to the potential reuse of material removed during construction such as rock for scour protection and the most appropriate removal technique to maximise reuse opportunity.

All stockpile sites would be designed, established, operated and decommissioned in accordance with the RTA’s Stockpile Management Procedures 2001.

Stockpiles would not be established on slopes greater than 2h:1v.

Stockpiled materials would be stored away from drainage lines.

The stripping of topsoil and stockpiling of surplus material would not be undertaken during heavy periods of rainfall.

Vegetation clearance and soil disturbance would be limited to those areas required for construction purposes.

Where possible, disturbed areas would be progressively restored to their pre-works shape at the completion of works.

Compacted hardstand surfaces would be established where practicable at entry / exit points to worksites.

Careful consideration would be given to the proposal, where it would interfere with all subsoil drainage networks associated with the existing highway. Investigation during detailed design would ensure that the functionality of existing drainage would be incorporated into the proposal.

6.2 Hydrology, water quality and groundwater

Detailed hydrological modelling has been undertaken to inform the development of the concept design for the proposal and a detailed water quality assessment was undertaken for the proposal.

6.2.1 Existing environment

The proposal would cross a total of 24 watercourses spanning the Werri Lagoon and Crooked River catchments. There are two main drainage areas that dominate the study area and that would be crossed by the proposal:
Ooaree Creek drainage

Ooaree Creek and its tributaries flow in a south easterly direction into the Omega Flats floodplain to the north of Gerringong. Omega Flat is a lowland marsh that is regularly inundated during periods of high rainfall. The Omega Flat drains into Werri Lagoon, which forms part of a SEPP 14 wetland and periodically discharges into the ocean at the northern end of Werri Beach.

The floodplain at Omega Flat has been substantially modified by flood mitigation works since the late 1800s, including the creation of drainage channels and the diversion and straightening of existing waterways.

Crooked River drainage

The Crooked River drainage lies immediately to the south of Ooaree Creek drainage. The creeks and streams that form the Crooked River originate at Currys Mountain and flow south east. Just downstream of the crossing of the Princes Highway the Crooked River turns south west and flows across the floodplain where it is joined by tributaries that originated on the south side of Currys Mountain in Willow Vale and the saddle between Toolijooa Hill and the Cambewarra Range.

Similar to Omega Flats, the Crooked River floodplain has been substantially altered through drainage works in the area to improve its use for agriculture. The Crooked River then broadens substantially for its final 2.5 km where it becomes an estuary and enters the ocean at the northern end of Seven Mile Beach adjacent to Black Head and Gerroa.

There are other small watercourses and ephemeral drainage lines throughout the study area that would interact with the proposal.

Water quality

There are numerous water quality issues facing watercourses within the Shoalhaven area due to past and present land use practices. These include elevated nutrient levels, heavy metal contamination, suspended sediment from erosion, low dissolved oxygen, bacterial pollution and drainage of acid sulfate soils.

Water quality within the study area is typical of aquatic ecosystems that have been disturbed by agricultural practices. The long-term agricultural land use in the area has resulted in pollution of surface waters that exceeds levels considered to be required for the sustainability of ecosystem integrity.

The water quality assessment conducted for the proposal documents levels of phosphorus within the Ooaree Creek and Crooked River drainages frequently exceeding the Australia, New Zealand Environment Conservation Council (ANZECC) threshold values for the protection of aquatic ecosystems. The likely source of these nutrients is fertilisers applied to improve grazing pastures and manure. The effects of cattle access to the creeks is also evident as numbers of faecal coliform bacteria in surface water samples often exceeded guidelines for recreational use of water. The estuaries downstream of these watercourses including Werri Lagoon and Crooked River Lagoon have to an extent reflected the elevated nutrient levels found in the catchment and to a lesser extent the high number of bacteria.

Crooked River was within the ANZECC threshold limits for a range of organochlorine pesticides, oxides of nitrogen and trace elements, although it exceeded the ANZECC guidelines for copper and chloride, and recorded concentrations of oil and grease, and suspended solids.
Previous studies within Ooaree Creek and Crooked River have found that water quality was generally within the ANZECC threshold limits for pH and conductivity, and to a lesser extent, turbidity. Sampling carried out during a period of low rainfall found that sites within Ooaree Creek and Crooked River were frequently below the ANZECC lower limits for dissolved oxygen. Low dissolved oxygen values can be caused by low flow conditions and/or high in-stream organic loads. An earlier study had also recorded low dissolved oxygen levels from sites within these two drainages, particularly in Crooked River.

**Groundwater**

As discussed in Section 6.1 groundwater is expected to be encountered along the proposal at depths ranging from approximately 0.5 m below ground level to approximately nine metres below ground level.

### 6.2.2 Potential impacts

Potential impacts associated with the construction and operation of the proposal on hydrology, water quality and groundwater are likely to come from increased runoff, changes in hydrology and flood regimes, sedimentation, pollution caused by accidental spills and runoff, disturbance of acid sulfate soils, changes in groundwater flows associated with substantial earthworks and possibly dewatering.

Earthworks associated with the proposal and runoff over unprotected spoil or disturbed land during construction may result in the mobilisation of sediments into waterways impacting on downstream aquatic habitats. Similarly, dust made airborne during construction works may also enter the local waterways. An increase in sediment load can degrade water quality through a change in physical (light penetration) or chemical (pH, salinity, dissolved oxygen, inorganic and organic matter, and nutrients) parameters.

Preliminary findings from the geotechnical assessment suggest groundwater would be unlikely to be impacted by the proposal during operation although there would be a potential for impact during substantial earthworks, particularly during pre-loading required in the low lying areas. There would also be the potential for aquifer conductivity impacts associated with preloading during construction. Hydraulic conductivity is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and on the degree of saturation. The degree of saturation would be affected by preloading and consultation would be undertaken with the NSW Office of Water (NOW) during detailed design to discuss the management of this potential impact.

Pre-loading and the use of wick drains to accelerate the rate of consolidation has the potential to impact on the water quality of groundwater. Wick drains may act as a conduit through which acidic or potentially contaminated groundwater may flow and there would be the potential for the discharge of acid water from pre-loading and the potential to oxidise in-situ acid sulfate soils if groundwater conditions change as a result of pre-loading.

Dewatering may be required as part of the proposal, which would have the potential to mobilise contaminated and acidic groundwater during construction. Dewatering would require careful management during construction and the removal of alluvial soils, particularly in the low lying areas in the vicinity of the Belinda Street interchange. There would be a requirement for ongoing water quality monitoring during dewatering to ensure that the extracted water is treated to meet the specified water quality criteria prior to discharge. Proposed water quality monitoring and dewatering methodology would need to be addressed in a dewatering management plan in the event that dewatering is required.
During construction of the proposal there would be the potential for accidental spills or pollutants such as hydrocarbons, combustion derivates, lubricating oil, petroleum and other pollutants associated with construction to enter into drainage systems and impact on water quality and aquatic habitats.

The proposed two creek realignments have the potential to change localised hydrology and flood regimes both during construction and operation. Appropriate design to minimise potential changes to flow velocity, rates of scour and existing flood regimes be considered during the detailed design.

Widening the cut at Mount Pleasant would also require disturbance of the existing subsoil drainage network incorporated as part of the previous stabilisation works. New subsoil drainage with the same functionality of that already existing would need to be incorporated into the widening at this location to ensure the ongoing stabilisation of the slip zone. The extent of the new drainage network would be finalised during detailed design and this is not expected to impact on groundwater.

The possibility of encountering acid sulfate soils within the low-lying regions of the study area would be relatively high, particularly within Omega Flat and the management measures discussed in Section 6.1.3 regarding the management of acid sulfate soils would also be applicable to the management of potential water quality impacts associated with the proposal.

An existing bore exists at the toe of the existing embankment on the western end of the Gerringong Bends which would be intercepted during construction and piped to the new embankment interface. These works are not expected to interfere with the operation of the bore, but there would be a requirement for liaison with Industry and Investment NSW (I&I NSW) during detailed design to address potential management issues.

On completion, the proposal would increase the impermeable surface area of the existing highway and increase the amount of road runoff. Without appropriate management this would increase upstream and downstream flooding impacts and may also increase the rate of scouring and erosion along existing drainage lines, road verges or outlets, particularly in steeper conditions such as at the northern section of the proposal.

With appropriate sized drainage structures it is not expected that the proposal would have any adverse affects on the flooding regime in the study area during operation. In fact, with the increased flood capacity associated with the proposal, there is an opportunity to improve existing flooding impacts for road users and where feasible, provide 1 in 100 flood free access along the highway and to Gerringong, where it is not currently provided by the existing highway and adjacent local road network.

During operation of the proposal there would be the potential for accidental spills or pollutants such as hydrocarbons, combustion derivates, lubricating oil, petroleum and heavy metals to enter into drainage systems and impact on water quality and aquatic habitats. The likelihood and extent of this potential impact would be no greater than the existing conditions.

Extensive drainage works would be required as part of the proposal to meet the required flooding design criteria including the provision of bridge structures and other drainage structures (box culverts and pipes). Pavement drainage would be incorporated into the proposal to capture and treat runoff. This would include permanent spill and sedimentation basins for the treatment of pavement runoff and in the event of an accidental spill during operation. Consideration to the appropriate location and sizing would be given during detailed design and would be representative of the sensitivity of the identified receiving environment.
6.2.3 Safeguards and management measures

- An erosion and sedimentation control plan (ESCP) would be developed and incorporated into the CEMP. The plan would incorporate specifications outlined in Landcom's Managing Urban Stormwater - Soils and Construction Volume I (Landcom 2004) and Managing Urban Stormwater - Soils and Construction Volume 2D: Main Road Construction (DECCW 2008), identifying areas requiring management controls, include inspections and checklist sheets and be reviewed by the RTA's Regional Environmental Officer, Southern Region prior to the commencement of works.

- The ESCP would identify ongoing monitoring requirements to manage potential water quality impacts during construction in accordance with the water quality criteria outlined in the EPL. The monitoring program would also document the requirements for water quality monitoring of pre-loading water discharge and dewatering activities.

- In addition the water quality monitoring program identified in the ESCP, visual monitoring of water quality in all waterways would also be undertaken during and 24 hours after periods of rainfall, and records kept and provided at anytime upon request.

- A dewatering management plan detailing process for dewatering and proposed treatment of potentially acidic groundwater prior to discharge would be prepared in the event that dewatering is required for the proposal.

- Ongoing groundwater monitoring would be undertaken through the detailed design using existing piezometers to determine if the design needs to incorporate measures to maintain the flow of groundwater.

- Consultation would be undertaken with I&I NSW during the detailed design of the proposal with regard to potential aquifer conductivity impacts associated with the use of wick drains during pre-loading, particularly during construction in the Omega Flat area. Consultation would also consider the interaction of the proposal with the existing bore associated with the embankment on the western end of the Gerringong Bends.

- Maintenance and checking of the erosion and sedimentation controls would be undertaken on a regular basis and records kept and provided at anytime upon request. Sediment would be cleared from behind barriers on a regular basis and all controls would be managed in order to work effectively at all times.

- Any material transported onto pavement surfaces would be swept and removed at the end of each working day.

- Hardstand material or rumble grids would be implemented at entry and exit points to minimise the tracking of soil and particulates onto pavement surfaces.

- Where runoff is concentrated (eg cut-off drains, V-drains), scour protection and/or concrete lining would be constructed to minimise erosion and sedimentation impacts.

- On the uphill slope above the top of each cut batter, a cut-off drainage channel would be constructed to minimise erosion and sedimentation impacts.

- Where possible, disturbed areas would be progressively restored to their pre-works shape at the completion of works.

- Batters would be stabilised with local native grasses (and/or sterile exotic grasses) and/or local native shrubs in accordance with the landscaping plan and geotextile fabrics would be applied when needed.

- The proposal would be undertaken in accordance with RTA’s Water Policy and Code of Practice for Water Management (1999).

- Temporary stormwater control devices or erosion and sedimentation controls would be implemented at stormwater drains to prevent sediment-laden runoff entering the local stormwater system.
• Should any spillage occur during construction the RTA’s Regional Environmental Officer, Southern Region, would be contacted immediately, and contaminants would be immediately contained, removed, treated (if necessary) and disposed of in accordance with DECCW requirements.

• Pavement drainage would be incorporated into the proposal to capture and treat runoff this would include permanent spill and sedimentation basins for the treatment of pavement runoff and spill control during operation. Consideration to the appropriate location and sizing would be given during detailed design and would be representative of the sensitivity of the identified receiving environment.

• Careful consideration would be given to all areas of the proposal, where it would interfere with all sub soil drainage networks associated with the existing highway. Investigation during detailed design would ensure that the functionality of existing drainage would be incorporated into the proposal.

• An incident emergency spill plan would be developed and incorporated in the CEMP. This would include measures to avoid spillages of fuels, chemicals and fluids into any waterways. All personnel would be made aware of these measures. An emergency spill kit would be kept on-site at all times.

• Where practicable, all fuels, chemicals and liquids would be stored at least 50 m away from any waterways or drainage lines and would be stored within an impervious bunded area within the compound sites.

• Appropriate sediment controls would be installed adjacent to waterways and drainage lines to separate clean and dirty water, and to filter dirty water prior to discharge to drainage lines.

• All sedimentation control structures would be removed only after adequate stabilisation of disturbed surfaces is achieved.

• Culvert extensions would be positioned to ensure that water discharges do not cause backwaters and/or erosion and sedimentation problems.

• All culverts and drainage structures would be designed in accordance with the RTA’s Road Design Guide.

• Any stormwater generated from construction processes would be contained on-site and/or treated using a DECCW certified process prior to its disposal. The release of dirty water into waterways would be prohibited.

• Any on-site concrete works would be undertaken in accordance with the DECCW Environmental Best Management Practice Guideline for Concreting Contractors (2002).

• The maintenance of machinery would be undertaken within impervious bunded areas within the compound sites.

• Vehicle washdowns and/or cement washouts would be undertaken within compound site(s) in a designated bunded area with an impervious surface, or undertaken off site in an appropriately controlled area.

• Creek bed and bank stabilisation works would be completed immediately after completion of culvert works.

• Sediment fencing would be placed to surround all access tracks and working areas.
6.3 Terrestrial ecology

The flora and fauna (Terrestrial Ecology) assessment was undertaken for the proposal and involved three key stages: a desktop examination; field investigations; and impact assessment. The detailed Terrestrial Ecology Assessment Report is included in Appendix E.

The terrestrial ecological field investigations of the proposal were conducted during February 2007, November 2008 and May 2009. Surveys were carried out using a combination of habitat-based assessment, trapping, Anabat microchiropteran call recording, spotlighting and targeted sampling techniques. The study area consists of the area of direct impact by the proposed upgrade alignment (subject site), and a buffer of approximately 50 m on either side of the subject site to account for potential indirect impacts (study area).

6.3.1 Existing environment

The majority of the study area supported cleared agricultural land, cattle grazing being the main agricultural activity of the region. Vegetation generally occurred in the study area as scattered patches on ridge tops and steep slopes at Mount Pleasant; and as thin strips of riparian vegetation along the banks of the Crooked River and associated wetland and tributaries. Roadside native vegetation was limited to small discontinuous segments of native and exotic vegetation cover and ground cover providing limited wildlife corridors and connectivity.

Two vegetation communities were recorded in the study area: Estuarine Saltmarsh and Subtropical Dry Rainforest.

Estuarine Saltmarsh is commensurate with the Coastal Saltmarsh endangered ecological community (EEC) listed under the TSC Act which occurs in the NSW North Coast, Sydney Basin and South East Corner bioregions. Based on the extent of this community identified during field surveys and the DECCW vegetation mapping (DEC 2005t), approximately 19.76 ha of this EEC occurs, relatively disturbed with moderate conservation significance within the locality to the east of Fern Street at the northern end of Gerringong.

Subtropical Dry Rainforest is commensurate with the Illawarra Subtropical Rainforest EEC listed under the TSC Act which is confined to the Sydney Basin Bioregion. According to the vegetation mapping (DEC 2005t), a total of 11007.5 ha of this EEC occurs within the locality as a single relatively undisturbed fragment. It has moderate conservation significance to the east of the proposal at the northern end, in the vicinity of Mount Pleasant (from 8.62 ha Coastal Warm Temperate Rainforest, 1013.26 ha Subtropical Complex Rainforest and 78.87 ha Subtropical Dry Rainforest).

Based on database search results, a total of 12 plant species listed on the TSC Act and/or EPBC Act, or their habitat, have been previously recorded within a 10 km radius of the study area. No threatened plant species were recorded in the study area during the current surveys. An assessment of the potential habitat for the 12 threatened plant species was undertaken and included the proximity of previous records, the presence of identified habitat preferences, and potential habitat. The assessment concluded six threatened plant species may exist within the study area and included *Cynanchum elegans*, *Daphnandra sp.* 'Illawarra' *Irenepharsus trypherus*, *Solanum celatum*, *Syzygium paniculatum* and *Zieria granulata*.

Fauna habitat within the study area ranges from predominantly cleared areas which have low to moderate habitat quality in terms of fauna habitat characteristics, to fragmented small patches of native vegetation, including important habitat features such as tree hollows, rocky shelters, riparian vegetation, fallen logs and feeding resources.
A total of 79 animal species listed under the *TSC Act* and/or *EPBC Act*, or their habitat, have been previously recorded within a 10 km radius of the study area. One threatened (preliminarily listed) Little Eagle *Hieraaetus morphnoides* and two migratory species, *Latham’s Snipe* *Gallinago hardwickii* and the *Cattle Egret* *Ardea ibis*, were recorded during the current surveys, all just outside the study area. Based on the proximity of current and previous records and the presence of identified habitat preferences, potential habitat may exist within the study area for 41 threatened and 21 migratory animal species.

### 6.3.2 Potential impacts

This section details the types of impacts that may result as a consequence of the construction and operation of a road, with specific reference to the proposal. However, many of these impacts can be mitigated, greatly reducing or eliminating the impacts.

Generally, potential impacts resulting from roads on terrestrial ecological values include the following:

- Vegetation clearance and habitat loss.
- Increased fragmentation.
- Edge effects.
- Increased mortality.
- Weed invasion.

Each of these potential impacts is discussed below.

#### Vegetation clearance / habitat loss

Impacts of vegetation clearing would result in the loss of plant species and fauna habitat features that occur in the study area. This would include nesting habitat and roosting hollows (although the potential for tree hollows in the study area is limited), as well as feeding and shelter resources.

The proposal would require a total of 0.01ha of Estuarine Saltmarsh and Subtropical Dry Rainforest to be cleared and would involve removal of vegetation that is already disturbed. While these areas provide a range of food and shelter for vertebrate and invertebrate fauna, the small areas to be cleared would not substantially impact fauna habitats in the study area.

Table 6.1 shows the area of each vegetation community recorded in the subject site and study area that would be removed by the proposal. Overall, only two small fragmented patches of native vegetation would be impacted by the proposed upgrade, with only the edges of these patches being directly impacted. No new edges would be created by the proposed upgrade. The impacts of this vegetation clearing on threatened species habitat are discussed later in this section.

<table>
<thead>
<tr>
<th>Plant community</th>
<th>Impacted area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>direct</strong></td>
<td></td>
</tr>
<tr>
<td>Estuarine Saltmarsh</td>
<td>0.002</td>
</tr>
<tr>
<td>Subtropical Dry Rainforest</td>
<td>0.009</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.01</strong></td>
</tr>
</tbody>
</table>

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**References**

- *TSC Act*
- *EPBC Act*
Fragmentation

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with a new habitat type occurring in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the fauna species remaining within the fragments (MacNally 1999). It can provide suitable conditions for weed species to establish, which may outcompete native plant species. Although the newly created habitat would be used by some species, they are usually generalist species and are often considered aggressive (eg Noisy Miners (Loyn et al. 1983)), further decreasing population levels of the species remaining in the fragments. In addition to the loss of total habitat area, the process of fragmentation can impact on the species within the newly created fragments in a number of ways (eg barrier effects, genetic isolation and edge effects).

The study area has already been highly disturbed and contains small isolated patches of native vegetation. The proposed upgrade generally follows the alignment of the existing Princes Highway, thereby minimising further fragmentation of habitats and barrier effects. The proposed upgrade is unlikely to increase the impact of fragmentation on threatened species and EECs in the study area given the high degree of fragmentation in the existing landscape.

Corridors and connectivity

Limited connectivity is afforded by cleared and disturbed drainage lines including Ooaree Creek and the Crooked River. Currently the existing Princes Highway and the South Coast Railway Line have bridge crossings over these drainage lines. As discussed above, the proposal is not likely to further impact on any local or regional wildlife corridors due to the existing degree of clearing and fragmentation.

Edge effects

Edge effects are zones of changed environmental conditions (ie altered light levels, wind speed, temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators (Berry 2002). This new zone of habitat inside the edge of a fragment can also exacerbate barrier effects.

Specifically, edge effects associated with roads can include the degradation of adjacent habitat through:

- Changes in microclimate (eg temperature, wind, light humidity).
- Changes in hydrology (ie surface and sub-surface water flows).
- Changes in floristics (ie species composition and abundance).
- Alteration to the pattern and frequency of fire.
- Invasion by exotic plant and animal species.
- Increase in sedimentation.
- Increase in tree death (eg dieback, impact on root zone).
- Increase in rubbish and water pollution.
- Improved access for predators (Bali 2000).
Edge effects may not affect both sides of the road equally and may be greater if they are downslope, downwind or surrounded by more suitable habitat (Biosis Research 2000).

The proposed upgrade would not create any new edges in plant communities and habitats in the study area, as the impacted patches are already impacted by edge effects due to their isolation, small size and edge to area ratio. No DECCW estates, crown land or State forests would be impacted by edge effects from the proposed upgrade.

**Mortality**

There is the potential for the proposed upgrade to cause fauna injury or death during construction and operation in two ways:

- *During the break-out phase of construction (when all vegetation is removed to expose a natural earth substrate).* Habitat clearance may result in the injury or death of resident or visiting fauna. Some species can more readily evade injury by flying (birds) or ‘running’ away (e.g. the larger mammals). Many species, however, are unlikely to move quickly enough to avoid being caught. For example, many nocturnal species (possums, gliders, bats) shelter during the day and smaller ground-dwelling species, such as frogs, lizards and snakes, are unable to move rapidly and over large distances.

- *Road kills.* Mortality due to road kill during operation has the potential to affect local fauna species at the sub-population level. In general, rates of road kill mortality are likely to be directly proportional to the distance of native vegetation / fauna habitat crossed by the highway (Forman and Sperling 2002). However, other factors such as the design of the road (e.g. raised or not, presence of walls and fences, fauna underpasses) and volume of traffic also influence road kill mortality. Generally, the effects of road kill mortality on sub-populations cannot be accurately predicted without more detailed demographic data than is available for species in the local area.

The RTA has policies and guidelines in place to manage the risk of fauna mortality during construction (refer to the full report in Appendix E).

**Weeds**

Weed invasion can be a considerable problem along the edges of habitat fragments. Along these boundaries there are changes in the environment (edge effects) including, altered light levels, wind speed, temperature, humidity and runoff. These altered conditions allow the colonisation and growth of weeds which would themselves result in further environmental changes that promote the colonisation and growth of weed species within the area. Due to these environmental changes, weeds may be able to out compete with native plant species and (at worst) could result in the loss of the native plant community in that area. Given the small size, isolation and poor condition of vegetation that would be impacted, the proposed upgrade is not likely to increase the impact of weed invasion in the study area. There were no noxious weeds identified in the study area. However, mitigation measures are recommended to reduce the likelihood of increased weed invasion in the impacted patches.

**Cumulative impacts**

The proposed upgrade occurs in a highly developed landscape dominated by rural development. Consequently, much of the native vegetation of the local area has been cleared and the remaining remnants are small, isolated and fragmented. Due to its location within a highly developed landscape, the proposed upgrade would be one of many developments impacting biodiversity in the local area.
Potential impacts on endangered ecological communities

Two vegetation communities have been recorded in the study area: Subtropical Dry Rainforest; and Estuarine Saltmarsh.

Subtropical Dry Rainforest is commensurate with the EEC, Illawarra Subtropical Rainforest in the Sydney Basin Bioregion as listed under the TSC Act. The proposed upgrade would result in the removal of approximately 0.009 ha of this community to the east of the proposal at the northern end, in the vicinity of Mount Pleasant. According to the vegetation mapping a total of 11007.5 ha of this EEC occurs within the locality (from 8.62 ha Coastal Warm Temperate Rainforest, 1013.26 ha Subtropical Complex Rainforest and 78.87 ha Subtropical Dry Rainforest).

Estuarine Saltmarsh is commensurate to the EEC, Coastal Saltmarsh in the NSW North Coast, Sydney Basin and south-east corner bioregions as listed under the TSC Act. The proposed upgrade would result in the removal of approximately 0.002 ha of this community to the east of Fern Street at the northern end of Gerringong. Based on the extent of this community identified during field surveys and the DECCW vegetation mapping (DEC 2005t), approximately 19.76 ha of this EEC occurs within the locality.

On this basis, assessments of significance under section 5A of the EP&A Act, and section 94 of the TSC Act (as amended by the Threatened Species Conservation Amendment Act 2002) were undertaken for each EEC (see Appendix C of the terrestrial ecology report (see Appendix E)). The results of these assessments concluded that a significant impact on the EEC’s, Illawarra Subtropical Rainforest and Coastal Saltmarsh is unlikely to result from the proposed upgrade.

Impacts on these EEC’s are considered to be minimal, on the basis that:

- The magnitude of impacts on each community resulting from the proposed upgrade is very small.
- The proposed upgrade would not result in the further fragmentation or isolation of any patches of these communities in the study area.
- The areas subject to direct impact is along existing edges of each community where vegetation is largely in poor condition.
- Mitigation measures would be implemented to avoid the potential indirect impacts on each community such as those associated with edge effects.

Mitigation measures have been included in this report in order to minimise the impacts of the proposed upgrade on each EEC.

Potential impacts on threatened plant species

No threatened plant species were recorded in the study area. However, of the 12 threatened plant species considered, six species (Cynanchum elegans, Daphnandra sp. 'Illawarra' Irenephrus trypherus, Solanum celatum, Syzygium paniculatum and Zieria granulata) were considered to have potential habitat within the study area.

On this basis, assessments of significance under section 5A of the EP&A Act, and section 94 of the TSC Act (as amended by the Threatened Species Conservation Amendment Act) were undertaken for each of the six plant species with potential habitat in the study area (Appendix C of the terrestrial ecology report (see Appendix E)). Five (Cynanchum elegans, Daphnandra sp. 'Illawarra' Irenephrus trypherus, Syzygium paniculatum and Zieria granulata) of the six threatened plants species are also listed under the EPBC Act have been assessed against the relevant significant impact criteria (Appendix D of the terrestrial ecology report (see Appendix

**Key threatening processes**

The following key threatening processes, as listed under the *TSC Act*, are relevant to the proposal with potential to impact on threatened plant species or their potential habitat in the study area:

- **Clearing of native vegetation** – approximately 0.01 ha of potential habitat would be cleared for the proposal.
- **Infection of native plants by* Phytophthora cinnamomi*** – there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- **Invasion of native plant communities by exotic perennial grasses** – given the presence of existing perennial grasses within the study area, there is potential for construction vehicles to spread seed of these invasive species into the subject site. As a precaution, vehicles should be washed down prior to use on site.
- **Invasion, establishment and spread of *Lantana camara*** – *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of *Lantana camara*.
- **Invasion and establishment of exotic vines and scramblers** – Coastal Saltmarsh is specifically listed as an ecological community impacted by this key threatening process. Exotic vines and scramblers are present in vicinity of the study area. These invasive species have the potential to invade disturbed areas resulting from the proposal.

The impact assessments concluded that the proposed upgrade would have a minimal impact on threatened plant species or their potential habitat in the locality based on the following:

- No individuals were recorded in the study area despite targeted surveys, including for those that are considered relatively conspicuous.
- The area of potential habitat in the locality compared to that impacted within the study area is considered small.
- Impacts resulting from the proposed upgrade are largely contained to areas that are already cleared and disturbed and include existing road infrastructure.
- The proposed upgrade would not result in the isolation or fragmentation of potential habitat.
- The proposed upgrade would be unlikely to interfere with the pollination and dispersal of native plant species.
- The proposed upgrade would be unlikely to interfere with the existing fire regimes of the study area.
- Native vegetation would be allowed to regenerate within the easement post construction at the Crooked River bridges (within the limits of transmission line safety clearance requirements, and road safety and maintenance requirements).
Potential impacts on fauna habitats

The potential impacts of the proposed upgrade on fauna habitats are likely to be minimal, however, would involve the removal of a small amount of rainforest (0.009 ha) and saltmarsh (0.002 ha) as well as some isolated roadside trees. Ongoing disturbances such as grazing and a high degree of weed invasion continue to threaten the integrity of fauna habitats within the subject site.

Potential impacts on threatened fauna

Where there is potential habitat (foraging or breeding resources) for threatened fauna species in the study area, further consideration must be given to the potential impact of the proposed upgrade on these species. The proposed upgrade may impact on threatened species by causing any of the following:

- Death or injury of individuals.
- Loss or disturbance of limiting foraging resources.
- Loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest / maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However, for some species, limiting resources include specialised foraging habitats that have a restricted distribution (eg koalas feeding only on specific tree species).

Key threatening processes

The following key threatening processes, as listed under the TSC Act, are relevant to the proposal with potential to impact on threatened fauna species or their potential habitat in the study area:

- Clearing of Native Vegetation - the proposal would involve clearing of 0.01 ha of native vegetation.
- Invasion, establishment and spread of Lantana camara - Lantana camara is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of Lantana camara.
- Loss of Hollow-bearing Trees - a minimal number of hollow-bearing trees may be removed by the proposal.
- Removal of Dead Wood and Dead Trees - a minimal amount of dead wood and dead trees expected to be removed from previously disturbed areas and grazed paddocks.

Threatened Species Conservation Act Assessments of Significance

No threatened species were recorded within the study area during the current surveys. The Little Eagle, which has been preliminarily listed under the TSC Act as vulnerable, was recorded just south of the study area at Crooked River. Potential habitat for 41 threatened animal species listed (or preliminarily listed) on the TSC Act was considered present within the study area. Based on the nature of the proposed upgrade, database interrogation, literature review regarding the ecology of each species, and information gathered during field surveys within the study area, 35 of these species were considered as unlikely to be subject to negative impacts resulting from the proposed upgrade. Accordingly, no seven part tests have been prepared for these species.
Seven part tests have been prepared for the remaining six species: Rose-crowned Fruit-dove *Ptilinopus regina*, Superb Fruit-dove *Ptilinopus superbus*, Yellow-bellied Sheathtail Bat *Saccolaimus flaviventis*, Eastern Freetail Bat *Mormopterus norfolkensis*, Eastern False Pipistrelle *falsistrellus tasmeniensis*, and Greater Broad-nosed Bat *Scoteanax rueppellii* (Appendix C of the terrestrial ecology report (see Appendix E)). These significance assessments concluded that the proposed upgrade was unlikely to have a significant impact on these species. An SIS is not considered necessary for the following reasons:

- Breeding habitat is unlikely to be removed.
- Potential foraging habitat to be removed is in poor condition.
- No individuals of this species have been recorded in the locality.
- The proposal would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposed upgrade was not considered to be important for the long-term survival of the species in the locality.
- No limiting foraging resources would be removed.
- Only a small number of disturbed potential roosting / breeding sites would be removed.
- Potential habitat would not be fragmented or isolated.
- Approximately 99.2 per cent of rainforest and 95.3 per cent of saltmarsh would be retained within the locality.

Refer to Appendix B of the terrestrial ecology report (see Appendix E)) for the table outlining threatened fauna listed under the *TSC Act* with potential habitat within the study area against the potential impacts and seven part test requirements.

*Environmental Protection and Biodiversity Conservation ACT Assessments of Significance*

Four species listed as endangered or critically endangered under the *EPBC Act* have potential habitat in the study area: Spotted-tailed Quoll *Dasyurus maculatus maculates*, Swift Parrot *Lathamus discolor*, Orange-bellied Parrot *Neophema chrysogaster*, and Regent Honeyeater *Anthochaera Phrygia*. No limiting of breeding habitat or foraging habitat is expected to be impacted for these species. The proposal was considered unlikely to have a significant impact on these species as there is a low possibility that it would:

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

As such, no assessments were been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).
Four species listed as vulnerable under the _EPBC Act_ that have potential habitat in the study area include the Large-eared Pied-Bat _Chalinolobus dwyeri_, Grey-headed Flying-fox _Pteropus poliocephalus_, Australian Painted Snipe _Rostratula australis_, and Green and Golden Bell Frog _Litoria aurea_. No limiting breeding habitat or foraging habitat is expected to be impacted upon these species. These species are not considered important populations as they are not likely to be key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species range. In addition, the proposal is not likely to:

- Adversely affect habitat critical to the survival of any of these species.
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that any of these species is likely to decline.
- Result in invasive species that are harmful to any of these vulnerable species becoming established in the vulnerable species’ habitat.
- Introduce disease that may cause any of these species to decline.
- Interfere substantially with the recovery of any of these species.

As such, no assessments were been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).

**Potential impacts on migratory fauna**

The list of migratory species under the _EPBC Act_ is a compilation of species listed under four international conventions: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), Republic of Korea-Australia Migratory Bird Agreement (RoKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Twenty nine migratory species have been previously recorded in the locality, two of which _Latham's Snipe_ and Cattle Egret were recorded during the current surveys. Twenty one migratory species were considered to have potential habitat in the study area. The potential impacts of the proposal on fauna habitats were considered likely to be minimal, however, would involve the removal of a small amount of rainforest (0.009 ha) and saltmarsh (0.002 ha) as well as some isolated roadside trees. Including edge effects, less than one hectare of each of these communities would be impacted by the proposal.

Migratory waders are the most common migratory species recorded in the locality. While the Crooked River Estuary in particular is used on occasion or regularly by these species, individuals of these species that have been or may be recorded in the study area were not considered likely to be an ecologically significant proportion of their populations. Similarly, individuals of other migratory birds that have been or may be recorded in the study area were not considered likely to be an ecologically significant proportion of their populations. Potential habitat in the study area was not considered important habitat for the migratory species. Only edge-affected areas of rainforest and saltmarsh would be removed by the proposal. Given the minimal impact expected on the potential habitat for these species in the study area, no assessments have been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).
Safeguards and management measures

The key policy principle of the RTA’s road development and impact on habitat amelioration measures is that “in principle, the planning and construction of roads should, in order of consideration endeavour to:

1. Avoid impacts on habitat though the planning process.
2. Minimise impacts on habitat through the planning process.
3. Mitigate impacts on habitat, through the use of a range of amelioration measures” (Compensatory Habitat Policy and Guidelines RTA 2001).

Where possible important ecological features identified in the study area have been avoided, such as patches of Illawarra Subtropical Rainforest. The proposed upgrade has been designed, where possible, to minimise impacts on habitat. Where sensitive items such as significant vegetation are located, the construction footprint incorporating the road footprint and construction access requirements has been reduced to minimise impacts. Further mitigation measures are discussed below.

Vegetation clearing / habitat loss

In order to mitigate some of the impacts of vegetation clearing and habitat loss, the following actions would be undertaken:

- Vegetation clearing would be restricted to those areas where it is necessary.
- Where clearing does occur, the area would be fenced with highly visible temporary fencing to ensure that clearing does not extend beyond the area necessary.
- Vegetation within the road reserve and adjacent to areas of vegetation clearing would be managed to reduce invasion of noxious weed species, this may include controlling weeds at their point of source (ie the area of clearing).
- A vegetation management plan (VMP) would be prepared prior to construction, detailing measures to minimise impacts to areas of conservation significance. The VMP would also detail appropriate management for revegetation and the potential habitat of threatened plant species adjacent to the proposed upgrade. This may include fencing the habitat, signage and educating contractors of the presence of habitats, its significance and exclusion zones. The VMP would be integrated with the landscape plan for the proposal and be developed during the detailed design.
- To prevent further spread of this invasive species, cleared Lantana camara should be disposed of off-site at an appropriate waste disposal facility.
- Vegetation removed would be chipped / mulched on site and used in revegetation works within the study area
- If additional vegetation is to be removed, the proposed variation of scope would be referred to the RTA’s senior environmental officer (SEO) to determine if additional impact assessment is required.
- Rather than removing whole trees, lopping of branches would be undertaken where possible to retain fauna habitat.
Indirect effects

Mitigation measures related to indirect effects relate generally to reducing impacts outside of the construction footprint, controlling possible impacts at their source within the road reserve and reducing the hardness of the edge between the extent of earthworks and native vegetation. The following measures would be undertaken:

- Disturbance to habitat adjacent to construction would be minimised, for example, through the use of visible temporary fencing.
- Disturbance would be minimised wherever possible to stream banks and streambeds. This may be more easily achieved with some bridges, but would be unavoidable in the case of culverts.
- All ancillary building and works would be sited in cleared or otherwise disturbed areas away from waterways and other sensitive areas.
- Stockpiling of materials on adjacent native vegetation would be avoided.
- General construction activities would be managed to appropriately store waste material and/or contaminants away from adjacent native habitats.
- Soil erosion and sedimentation control measures would be implemented.
- A weed management strategy would be implemented within the road reserve, to be incorporated into the VMP.
- Prominent local landscape species would be used for revegetation in accordance with the landscaping plan.

Mortality

A number of safeguards would be implemented to reduce the risk of mortality. Prior to and during construction:

- Clearance and disturbance of fauna habitat would be minimised, particularly of hollow-bearing trees and other habitat features where fauna may be sheltering. Although this may be difficult to achieve in areas where earthworks are to proceed, it would be particularly noted within the road reserve where temporary sites such as stockpiles may be placed.
- Clearing of vegetation would follow the RTA requirements for fauna rescue on highway projects and include the relocation of rescued fauna and the inclusion of wildlife specialists in the process.
- An ecologist with experience in fauna handling should be present during habitat removal.
- Hollow bearing trees should be left standing a minimum of 24 hours to allow resident fauna the chance to relocate. Ecologists would undertake appropriate surveys eg spotlighting and stag watching at night to determine that the habitat is not being used at the time of further clearing / habitat removal. During this time the ecologist may set traps to capture resident animals if habitat is known to be occupied.
- Fell habitat trees as carefully as possible. If possible use swivelling heads so the habitat trees can be lowered to the ground with minimal impact. Request contractors to roll or lift limbs that may be obscuring hollows or fauna. An ecologist is to guide the clearing contractors as to limbs containing or potentially containing hollows.
- Ecologist to inspect all hollows once tree has been felled for signs of wildlife. Ecologist to guide clearing contractors to expose and turn felled hollow bearing limbs (these may spear into the ground and obscure the hollow entrance when felled).
Hollows potentially supporting fauna can either be cut, or, if there is a risk of injury (animals can be cut in two) the logs can be left on the ground and rechecked the following day or placed on the edge of adjoining habitat.

Ecologist would capture animals that emerge from hollows of felled trees. Animals are to be inspected for injury. The animals would be placed in cloth bags and transferred to a suitable holding location to await release (nocturnal fauna should be released at dusk).

Relocate hollows, coarse woody debris and bush rock to adjacent land if appropriate

To reduce the risk of roadkill once the highway is operational:

- The design would avoid vegetation overhanging barriers that may encourage fauna crossing into the road reserve.
- The design would carefully consider location and type of plant species for the verges and median strip so that they do not attract fauna species.

**Weeds**

A number of safeguards would be implemented to reduce the impact of weed invasion on native plant communities:

- The area of native vegetation disturbed would be restricted to the study area during construction works.
- Stockpiling would be restricted to areas already cleared of vegetation.
- Control drainage that may contain weed seeds or high levels of nutrients.
- Weed populations that establish on disturbed areas would be monitored and controlled by person experienced in weed management, with particular attention to eradication of noxious weeds.
- Weed management strategies would be incorporated into the VMP, detailing necessary weed control works, particularly in areas where the weeds may impact on threatened species and/or their habitats
- Training for site personnel on the identification of noxious weeds and the appropriate management of noxious weeds in accordance with the requirements of Kiama Municipal Council and the Noxious Weeds Act 1993 (NW Act).

**6.4 Aquatic ecology**

An aquatic ecology and water quality assessment for the proposal was undertaken. The full report is in Appendix F.

Field investigations of aquatic habitat, biota and water quality were carried out from 15 to 17 April 2009 along the proposal route. At each waterway a general habitat description, riparian, channel and environmental (RCE) inventory and fish habitat assessment was conducted. Where appropriate, recordings were made of water quality, macrophyte and fish assemblages, and existing waterway road crossings.
6.4.1 Existing environment

The Ooaree Creek and its tributaries flow in a south easterly direction into the Omega Flat floodplain to the north of Gerringong. The Omega Flat is a lowland marsh that drains into Werri Lagoon, a SEPP 14 wetland that periodically discharges into the ocean at the northern end of Werri Beach. The Omega Flat has the potential to contain acid sulfate soils (ASS).

The Crooked River drainage lies immediately to the south of Ooaree Creek. The Crooked River crosses the existing highway to the south-west of Gerringong before flowing into a floodplain and eventually the Crooked River estuary. The estuary is more frequently open to the ocean than Werri Lagoon and supports mangrove, seagrass and saltmarsh habitat. Coastal Saltmarsh is listed as an EEC in NSW.

There are two small freshwater wetland areas within the Crooked River drainage. Both are located outside the study area, degraded and composed of small pondages and creek swamp habitat. They are potentially Freshwater Wetlands on Coastal Floodplains which is a listed EEC in NSW under the TSC Act, although both occur at elevations near the upper limit for this community.

The freshwater habitat within the study area was considerably degraded. Riparian vegetation was often absent, banks were unconsolidated, eroded and trampled by livestock and channel substratum was usually dominated by loose accumulations of soft-sediments. In the low-lying floodplain the waterways have been highly modified by flood mitigation works. The more ephemeral waterways have poorly defined channels and were often colonised by pasture grasses. Water quality was typical of aquatic ecosystems that have been disturbed by agricultural practices, with elevated nutrient levels and bacterial levels and low dissolved oxygen. The presence of instream macrophyte taxa was recorded and a comprehensive range of macrophyte species present.

Aquatic macroinvertebrate assemblages have been used as indicators of disturbance and found waterways within the study area to be moderately impaired, containing fewer macroinvertebrate taxa than expected and were dominated by pollution-tolerant taxa.

A regional inventory of freshwater fish identified a total of 36 species as potentially existing, based on potential habitat and regional distribution, or having historically existed within the study area. Of these, three are introduced and two are listed as threatened. The Macquarie Perch Macquaria australasica, is listed as endangered under the FM Act and the EPBC Act and the Australian Grayling is listed as vulnerable under the EPBC Act.

Of these 36 species however, previous studies recorded only eight freshwater fish species in the study area and only three species were recorded during this study. It is considered likely that this is due to the two catchments of Ooaree Creek and Crooked River being relatively small and with degraded freshwater habitats. The majority of watercourses in the study area were assessed as providing ‘minimal’ to ‘unlikely’ fish habitat (Class 3 – 4 Waterways), with the exception of Crooked River which provides ‘moderate’ fish habitat (Class 2 Waterway).

Werri Lagoon and Crooked River estuary constitute ‘major’ fish habitat (Class 1 Waterways) although both were located outside of the study area. Previous research has recorded fish from 21 families, representing 33 species, 13 of which were of commercial interest. These estuaries, particularly Crooked River, are possible habitat for Syngnathiformes (which includes Pipefish, Pipehorses, Seahorses, Seadragons, and Ghost Pipefish) and large juvenile Black Cod Epinephelus daemelii. Syngnathiformes are afforded protection under the EPBC Act and Black Cod are listed as vulnerable under the FM Act.
Figure 6.1: SEPP 14 Wetland in relation to the proposal
Threatened species and communities

No listed threatened or protected species were observed in freshwater habitat within the study area. Given the small size and degraded nature of the habitat it is unlikely that viable populations of Macquarie Perch or Australian Grayling are present. Nevertheless, the following threatened and protected species, communities and populations are considered in the aquatic ecology and water quality assessment as a precautionary measure (Appendix F):

- Macquarie Perch, listed as endangered under the FM Act and the EPBC Act.
- Australian Grayling, listed as vulnerable under the FM Act and the EPBC Act.
- Black Cod, listed as vulnerable under the FM Act.
- Coastal Saltmarsh, listed as an EEC under the TSC Act.
- Freshwater Wetlands on Coastal Floodplains, listed as an EEC under the TSC Act.
- Syngnathiformes (Seahorses, Seadragons, Pipefish, Ghost Pipefish and Seamoths) are protected species in NSW.

Invasive species

Environmental reporting tool has identified Alternanthera philoxeroides, Alligator Weed as potentially occurring in the area. Alligator Weed has been declared noxious in the control area of Illawarra District Weeds Authority, which includes the local council areas of Kiama, Shellharbour and Wollongong.

Alligator Weed was not observed at any of the sites along the proposal. There is a collection record from Lake Illawarra, south of Wollongong.

Alligator Weed is a noxious weed under the Noxious Weed Act 1993. It poses a substantial environmental and economic threat and is highly invasive. Infestations can take over wetlands such as creeks and drainage channels, displacing native vegetation, prevent flow and reduce oxygen exchange. It can also invade land and displace or cause the failure of agricultural crops. Alligator Weed does not produce viable seed in Australia but instead grows through vegetative reproduction and is spread easily from fragments. It has been spread in landfill and attached to machinery and vehicles (eg bulldozers).

Alligator Weed is a Class 2 noxious weed in the Illawarra region, and as such the land must be kept free of Alligator Weed and it must be eradicated when identified.

6.4.2 Potential impacts

Potential environmental impacts associated with the construction and operation of the proposal on aquatic ecology within the study area, are most likely to come from sedimentation, pollution, changes to hydrology, interaction with acid sulfate soils, proposed creek realignments and possible water extraction.

Sediment mobilisation

Earthworks associated with the proposal and runoff over unprotected spoil or disturbed land may result in the mobilisation of sediments into waterways. Downstream aquatic habitats in the Ooaree Creek and Crooked River drainages, such as the SEPP 14 Werri Lagoon, may also be at risk as increases in suspended sediment can be detectable for long distances (kilometres) downstream of construction sites (Wheeler et al. 2005). Compaction in work areas may reduce infiltration of surface waters and also contribute to sediment load in runoff. Similarly, dust made airborne during construction works may also enter the local waters.
An increase in sediment load can degrade water quality and important habitat features resulting in a loss of biodiversity and a shift towards a more pollution-tolerant biotic assemblage. For example, sedimentation can cause:

- Mortality and decreased growth.
- Degradation of habitat.
- Reduce water quality (physical (light penetration) or chemical (pH, salinity, dissolved oxygen, inorganic and organic matter, and nutrients) parameters).

Increased sedimentation is considered a threat to Australian Grayling, Macquarie Perch and freshwater wetlands. Habitat degradation is also the major threat to Syngnathiformes in NSW.

Freshwater habitat within the study area was considerably degraded. Channel substratum was often dominated by loose accumulations of soft-sediments, covering and infilling interstitial spaces of underlying larger-sized substrata (eg such as cobble, pebble and gravel). This indicates an historical and ongoing mobilisation of sediments from the disturbed catchment into the waterways. As such, the fish and macroinvertebrate taxa most commonly observed in these areas are relatively tolerant to sedimentation and degraded habitat.

**Pollution**

The construction and operation of the proposal has the potential to mobilise contaminants into aquatic habitat within the study area. Possible pollution may include (but may not be limited too):

- Pollutants associated with materials used in the process of road construction, or from spills on site or after construction from long-term runoff directly into aquatic habitats.
- Pollutants associated with heavy vehicles used on site during construction and from ongoing traffic use of the upgraded highway.
- Pollutants bound to disturbed sediments may be mobilised into aquatic habitat.

Pollution is considered a threat to coastal saltmarsh and freshwater wetland. Impacts from pollution would be minimised by ensuring the proper handling, storage, transport and disposal of hazardous materials on-site and the incorporation of standard design features with respect to storm water runoff.

**Acid sulfate soils**

The possibility of encountering acid sulphate soils (ASS) within the low-lying regions of the study area is relatively high, particularly within Omega Flat. Construction works carried out on the Omega Flat that intersect the zone of ASS carry a risk of creating potential impacts (eg construction of drainage structures such as culverts and storage basins where excavation below the water table is required and soft-soil treatment works).

Potential impacts to aquatic ecology within the study area could include habitat degradation, fish kills, outbreaks of fish disease, reduced aquatic food resources, reduced migration potential of fish, reduced fish recruitment, altered aquatic plant communities, weed invasion by acid-tolerant plants, and secondary water quality changes. ASS can also increase the susceptibility of fish to fungal infections which may lead to diseases such as epizootic ulcerative syndrome or ‘red spot disease’. Red spot disease is considered a threat to Macquarie Perch.
6.4.3 Listed key threatening processes

Potential impacts associated with three of the key threatening processes listed under the FM Act, ‘degradation of riparian vegetation’, ‘the removal of large woody debris from NSW rivers and streams’ and ‘instream structures and mechanisms that alter natural flow’ are relevant to the proposal.

Degradation of riparian vegetation

Riparian vegetation was already extremely degraded along most waterways that intersect the proposal. Large woody vegetation was usually absent or composed of exotic species. Therefore, it is unlikely that the proposed works could further degrade riparian vegetation such that it would cause a significant impact on aquatic ecology.

Removal of large woody debris

There was little large woody debris within the sections of waterways that intersect the proposal. Therefore it is unlikely that the proposed works would further degrade riparian vegetation such that it would cause a significant impact on aquatic ecology.

Alteration of natural flow regimes of rivers, streams, floodplains and wetlands

The listed key threatening process ‘alteration to natural flow regimes of rivers, streams, floodplains and wetlands’ is equivalent to ‘instream structures and mechanisms that alter natural flow’.

Work elements associated with the proposal that may affect flow regimes include:

- Extraction of water for construction from local creeks and watercourses.
- Soft soil treatments of Omega Flat.
- Realignment of waterways.
- Introduction of an earth embankment on Omega Flat.
- Introduction of new or altered drainage structures (such as culverts and bridges) required to achieve flood immunity.

Water extraction

The possible extraction of water from local creek(s) would have the effect of reducing flow during the period of extraction. In general, a reduction in flow volume would lead to a concomitant reduction in water velocity, depth, channel ‘wetted width’ and potentially the magnitude and frequency of elevated seasonal flows. This can in turn lead to:

- Reduction in aquatic habitat (eg shallow riffles and bars) and associated biota.
- Encroachment of macrophytes and other plants into the channel.
- Reduction in longitudinal connectivity, reducing access to foraging, spawning and refuge habitat.
- Lower water quality, resulting in a less diverse macroinvertebrate assemblage dominated by pollution-tolerant taxa.
- Reduction in flow-related life-history cues.
There are few substantial waterways within the study area (ie most are ephemeral and only flow briefly during rain events) therefore it is possible that extraction would have an impact on local aquatic habitats and associated biota.

Where practicable, water used during construction would not be sourced from waterways within the study area and consideration would be given to other sources, such as local town water and the Gerroa treated effluent irrigation scheme.

**Soft soil treatments**

The aim of the various soft-soil treatments such as pre-loading is to temporarily drain and permanently compress the soil underlying the proposal construction zone, so as to minimise the long-term settlement of the proposal.

Assuming there are no changes to groundwater recharge, or if successful mitigation measures are implemented, then it is unlikely that there would be impacts on downstream aquatic environments, such as Werri Lagoon.

**Realignment of waterways**

Realignments have been proposed within the road reserve for the Crooked River at the Princess Highway crossing (Appendix E of the Aquatic Ecology and Water Quality Assessment (see Appendix F)), and an unnamed waterway approximately 0.5 km east of the Toolijooa Road interchange (Appendix F of the aquatic ecology and water quality assessment (see Appendix F)). The exact details of the realignments would be determined during the detailed design.

The proposal would realign approximately 100 m of the Crooked River channel at the existing Princes Highway crossing and two short sections of an unnamed watercourse on the north side of the Princes Highway between the Gerringong Bends and Toolijooa Road. The altered creek formations would be designed such that flood flows are contained within the new channel and do not revert back to their previous course of flow.

The existing aquatic habitat and biota in the realigned watercourse sections would be lost. The subsequent realignments can potentially alter channel morphologies and profiles, creating changes to hydrology and geomorphology (including changes to rates of scour, flow rates and existing flood regimes), which can have concomitant effects on aquatic ecology.

The unnamed watercourse on the north side of the Princes Highway between the Gerringong Bends and Toolijooa Road is ephemeral, degraded and considered unlikely fish habitat (Class 4 Waterway). Minor redirection of such waterways is considered unlikely to have a substantial impact on aquatic ecology providing flows are still transferred into original downstream habitats.

Crooked River is considered moderate fish habitat (Class 2 Waterway) although the banks and riparian vegetation have been substantially degraded. Impacts on the Crooked River can be minimised by mimicking the natural channel morphology in the realigned section and restoring riparian habitat.

I&I NSW have a policy of 2:1 environmental compensation for direct loss of aquatic or riparian habitat (Smith and Pollard 1999). Therefore to negate the impacts, the proposal could also include rehabilitation of Crooked River reaches (eg restoration of riparian habitat and restrictions on stock access) upstream and downstream of the proposed realignment.

Consultation with DECCW and I&I NSW would be undertaken during detailed design with regard to the proposed creek realignments.
Earth embankment on Omega Flat

The proposal would be raised on an earth embankment as it crosses Omega Flat to achieve 1 in 100 flood immunity. The flood modelling undertaken by AECOM has indicated that the proposal would have no effect on the existing flooding regime. The construction of appropriate drainage structures as part of the proposal in Omega Flats waterways would maintain surface water recharge of Werri Lagoon.

Provision of drainage structures

Specific guidelines for the design and construction of waterway crossings to maintain fish passage have been developed and are outlined in I&I (then NSW Fisheries) ‘Guidelines and Policies for Aquatic Habitat Management and Fish Conservation’ (Smith and Pollard 1999) and ‘Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings’ (Fairfull and Witheridge 2003). These guidelines include requirements for:

- Crossing structures appropriate for the size and type of watercourse.
- Preferred crossing designs.
- Maintenance of fish passage throughout construction.
- Preservation of spawning grounds.
- Minimisation of disturbance to and removal of snags.
- Minimisation of disturbance to channel upstream and downstream of the crossing.
- Habitat rehabilitation.

Appendix B of the aquatic ecology and water quality assessment in Appendix F details the criteria for assessing suitable waterway crossings that minimise obstruction to fish according to fish habitat class, based on Fairfull and Witheridge (2003). An assessment of minimum recommended crossing requirements for each site assessed in this study has been summarised Appendix F.

Although bridges would generally be preferred to arch structures, culverts, fords and causeways (in this order) because they have the least disturbance to flow or the aquatic habitat of a waterway, the cost, geotechnical and engineering considerations are also important in deciding the selection of a crossing. It is recommended that a bridge is maintained at the Crooked River crossing (see Figure 1.1 of Appendix F), with bridge piers placed outside the main channel to avoid formation of turbulence and bed erosion, and abutments placed away from the bank.

Culverts are considered adequate crossings for the remaining waterways within the study area. Fish passage would be maintained by minimising changes to the natural flow, channel width and water depth through the culvert cells. Additionally fish passage across culverts should consider flow rates and design of artificial substratum that may facilitate fish movement and provide resting areas.

A ford would be an appropriate crossing of the Crooked River for the proposed access track located to the south of Princes Highway. A "wet" crossing would be formed on the channel bed, with flow depths similar to natural stream conditions, minimising changes to hydrology and fish passage.

There would be some short-term direct impacts associated with the construction of drainage structures, which would include potential removal of riparian vegetation, temporary redirection of water flows, mobilisation of sediments and disturbance of the streambed and banks. Disturbance would be minimised wherever possible to stream banks and streambeds. This may be more easily achieved with some bridges, but would be unavoidable in the case of culverts.
Threatened and protected species, communities and populations

As no listed threatened or protected species were observed in freshwater habitat within the study area due to the small size and degraded nature of the habitat, it is unlikely that viable populations of Macquarie Perch or Australian Grayling are present. Provided the recommended mitigation measures outlined in this report are adopted it is unlikely that the works and structures associated with the construction and operation of the proposal would have long-term impacts on threatened species, endangered communities or the wider aquatic ecology of the study area. This includes the Freshwater Wetlands of Coastal Floodplains and downstream habitats and biota, such as Coastal Saltmarsh, Syngnathiformes, juvenile Black Cod, seagrass beds, mangroves or the SEPP 14 Werri Lagoon.

6.4.4 Safeguards and management measures

- The detailed design of drainage structures would take into consideration the guidelines for the design and construction of waterway crossings to maintain fish passage outlined in ‘Guidelines and Policies for Aquatic habitat management and Fish Conservation’ (Smith and Pollard 1999) and ‘Why do Fish need to Cross the Road? Fish Passage Requirements for Waterway Crossings’ (Fairfull and Witheridge 2003).

- An acid sulfate soils management plan (ASSMP) would be developed and implemented to mitigate for potential impacts associated with acid sulfate soils, with particular reference to the proposed excavations below the water table for drainage structures on the Omega Flat floodplain.

- To negate the loss of aquatic habitat and biota from the proposed waterway realignments equivalent biotic assemblages would be restored in the realigned reaches. The rehabilitation program would consider (but not be limited to):
  - Restoration of the natural creek geomorphology. For example:
    - A meandering channel to reduce velocity and scour during high flow events.
    - Natural bed forms, such as an alternating sequence of pools, riffles and runs.
  - Establishment of a complete and broad riparian habitat including removal of exotic species.
  - Stabilised channel bank and bed and the protection of exposed soil until riparian vegetation is completely established.
  - The introduction of engineered log jams to create pooling sections and submerged woody debris (see Brooks et al. 2004).

- Consultation with DECCW and I&I NSW would be undertaken during detailed design with regard to the proposed creek realignments.

- Positive identifications of Alligator Weed within the construction area would be reported to the Kiama Municipal Council. In such an event, heavy machinery would be regularly inspected to ensure that species is not spread to new areas.

- Where large woody debris is encountered and interferes with construction, lopping would be considered the first management response. If this does not resolve the problem relocation of the debris would be considered and removal would only be adopted as a last resort.

- Water used during construction would not be sourced from waterways within the study area and consideration would be given to other sources, such as local town water and the Gerroa treated effluent irrigation scheme.
6.5 Cultural heritage

A cultural heritage assessment was carried out for the proposal. This study was undertaken using a combination of literature and database review, fieldwork and consultation through the Aboriginal focus group (AFG). Refer to Chapter 5 of this report for more details on consultation and Appendix G for the full cultural heritage assessment.

6.5.1 History

Aboriginal ethnohistorical context

References to the Aboriginal history of the Illawarra district can be found in a large number of sources, however most written references tend to be incidental in nature and vary in accuracy or perceived bias. Complementing (and sometimes also contradicting) the written record is an often rich body of oral history.

The very nature of oral history means that it is an ever-changing and dynamic body of information. The core sources of tradition are constantly being reviewed and re-contextualised according to the motivations of the tellers and listeners. This means that the ‘truths’ or facts related in oral histories may not necessarily transpose accurately back to the transformed modern physical world and often the confirmation of oral or written references is impossible due to the disparate or limited nature of potentially corroborative information.

Despite these limitations, references to places in Aboriginal history and story tradition form a valuable source of information which has the potential to illustrate the Aboriginal cultural landscape which has largely been ignored by other forms of the historical record.

Places of known or reported historical and cultural Aboriginal significance

The Yaroma

The Yaroma was one of a number of potentially treacherous creatures believed to inhabit the mountain ranges and forests of Australia’s south-east coast. A traditional story recorded by Mackenzie (1874) from a ‘word for word’ narration by a ‘native of Shell Harbour’ and later reworded by Mathews (1994), makes a direct association between the Yaroma and fig trees. Mackenzie subtitled the account ‘The Spirit of the Fig Tree’. The story relates how a Yaroma hides in the hollow of a base of a fig tree, and catches an unsuspecting gatherer of figs by swallowing him whole. The victim eventually escapes by pretending to be dead after being vomited up and then running away.

Crooked River

There are a small number of references in official and ethno-historic documentation which indicate that the Crooked River estuary at Gerroa was a focus for Aboriginal occupation following European settlement of the Illawarra. This location appears also to have been referred to in a general sense as Black Head and Gerringong.

There was also a long established historic encampment by local Aborigines under fig trees towards the southern end of the Werri Beach sand barrier (between the estuary and ocean beach and at the edge of the European settlement of Gerringong) (pers. comm. January 2010).

References suggest that the settlement was in place from at least the 1830s to the turn of the century and probably beyond. The encampment appears to have developed as a non-government sponsored settlement, centred on the amenity and resources of the river estuary. The settlement may have been reliant upon fishing, occasional government rations such as blankets and the provision of boats, and possibly casual employment.
Some local Aboriginal families have maintained their association with the Crooked River area throughout the twentieth century, using the area for hunting, fishing and bush camping. Many of these activities and associations continue to the present day.

**Seven Mile Beach Reserve**

The establishment in 1899 of a government reserve on 43 acres just one kilometre west of the Crooked River estuary mouth suggests an intention by the Aborigines Protection Board to support, and or impose a level of control over the existing Cooked River settlement (McGuigan n.d:39). It is not known if the reserve location is indicative of the original settlement, or an attempt to move the settlement away from the general recreation reserve which occupied the southern bank closer to the estuary mouth. The reserve was revoked on 25 January 1953 (McGuigan n.d:39). It is not known to what extent the reserve lands were occupied or utilised.

A detailed historical overview of the study area is provided in Chapter 5 of the cultural heritage assessment in Appendix G.

**Non-Aboriginal historical context**

**Historical overview**

The study area lies within the administrative boundaries of the Kiama Municipality - a jurisdiction determined on 11 June 1954. This area originated from the aggregation of smaller town and village-based municipalities, which in turn began as a result of European pastoral activities centred on a number of sizeable land grants in the region as early as the 1820s. By 1850, Alexander Berry had consolidated his estate, which extended close to the southern and western limits of Gerringong. Before the 1820s, except for a few intrepid cedar cutters, the district was mostly unknown to Europeans.

**Settlement and development of Gerringong**

Although the site of the town was gazetted in 1829, it was not until 1854 that the streets of Gerringong were surveyed and the town blocks sold. Many of the original purchasers, such as James Emery, Robert Miller, Margaret Campbell, Thomas Boxsell and John Blow, still have descendants living in the district.

Initially transport to and from the area was by sea, and regular shipments of dairy produce and timber were despatched to Sydney from Boat Harbour. This was a difficult proposition in bad weather, but a jetty was not constructed until 1880. Meanwhile, a road was cleared from Kiama in 1849, winding around the spurs to Mount Pleasant, then across the flats at Omega and up the ridge to the township and on to Crooked River. The railway came to Gerringong in 1893, when the extension from Bombo to Bomaderry was opened.

A fire, fanned by a strong westerly wind, destroyed most of the town in July 1872, shortly after the formation of the Gerringong Municipality on 24 April of the previous year. The original municipal boundaries covered the area from Mount Pleasant to Crooked River and west to the headwaters of Broughton Creek. This area was augmented in 1896 with the addition of Toolijooa, and the Municipality remained in existence until it was absorbed into the Kiama Municipality in 1954.

With the expansion of the dairy industry, dairy factories were established in February 1888 at Gerringong, and at the end of 1889 at Toolijooa. Only the Gerringong Co-op still survives, as one of the oldest continually-operating dairy co-ops in Australia.
By the end of the nineteenth century, the Gerringong area was home to about 400 adults, and probably supported a total population in excess of 1,500. Aside from the commercial area of the town, almost all employment in the district related to the dairy industry.

A detailed historical overview of the study area is provided in Chapter 7 of the cultural heritage assessment in Appendix G.

6.5.2 Policy

Relevant statutory and planning framework requirements that are relevant to the management of potential heritage impacts associated with the proposal are discussed in detail in Chapter 4. In addition to those requirements; and in recognition of the need to manage the impact of its projects on Aboriginal cultural heritage, the RTA has developed its Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI 2008).

The procedure provides the RTA with a process for consultation with Aboriginal stakeholders on Aboriginal cultural heritage issues associated with road planning, development, construction and maintenance activities. The aims of this procedure are to:

- Assist the RTA to meet its legislative responsibilities regarding consultation and investigation.
- Ensure that RTA projects likely to affect Aboriginal cultural heritage receive the appropriate level of assessment and community involvement.
- Ensure that a suitable and consistent standard of cultural and archaeological assessment and reporting is met by the RTA and its consultants on projects across NSW.
- Achieve best practice management associated with Aboriginal cultural heritage.

The procedure sets out a consultation process consistent with the NSW DECCW Interim Community Consultation Requirements for Applicants 2004 and the RTA requires that the procedure is implemented for every RTA project being or to be assessed under the EP&A Act.

Implementation of this procedure helps ensure the RTA meet its legal obligations to:

- Identify appropriate Aboriginal stakeholders for each project.
- Provide information to Aboriginal stakeholders regarding proposed RTA projects where potential cultural heritage impacts have been identified.
- Involve Aboriginal stakeholders and DECCW at an early stage of project development to assist with the early identification of potential cultural heritage issues.

Consultation undertaken for the proposal in accordance with the requirements of PACHCI are discussed in detail in Chapter 5.

6.5.3 Existing environment

Aboriginal

Twelve Aboriginal heritage recordings occur within or near the study area. These consist of one reported subsurface artefact (A5), two sites with surface artefacts (A6 and A7), and nine potential archaeologically sensitive areas (PASAs 31 to 39) general descriptions are provided below and locations are provided in Appendix H. Photographs and detailed descriptions are included in the cultural heritage assessment in Appendix G.
- Artefact A5- Reported subsurface artefact distribution with moderate to high local significance.
- Artefact A6- Isolated find with low local significance.
- Artefact A7- Artefact distribution with low local significance.
- PASA 31- Crest and upper slopes of spurline on eastern fall of Toolijooa Ridge, just north of Toolijooa Road intersection with current highway. PASA located on south side of proposed carriageways and current highway.
- PASA 32- Banks, flats and adjacent slopes associated with unnamed tributary 500 m east of Toolijooa Road intersection with highway.
- PASA 33- Banks, flats and adjacent slopes associated with unnamed tributary immediately west of former Toolijooa Public School, and slightly elevated margin of valley floor coastal plain (former possible wetland basin).
- PASA 34- Crest of locally elevated ridgeline, 250 m west of Willowvale Road intersection with highway.
- PASA 35- Banks, flats and adjacent slopes associated with Crooked River.
- PASA 36- Banks, flats and adjacent slopes associated with unnamed tributary crossing 500 m south of Sims Road intersection with highway. PASA located on western side of current highway.
- PASA 37- Basal slopes on southern margin of former Omega swamp basin.
- PASA 38- Ridgeline crest, and basal and mid slopes on northern margin of former Omega Flat swamp basin.
- PASA 39- Crest and upper slopes of a spurline just north of ‘Dunoon’ Dairy. PASA is located on west side of the current highway.

In addition to these recordings, the Aboriginal cultural value of mature fig trees across the Illawarra region is noted. Mature fig trees are important elements of the landscape and some are also significant to non-Aboriginal heritage. There are five mature fig tree incidences, singly or in groups, in or near to the study area.

The term potential archaeologically sensitive area (PASA) is intended to denote that the archaeological sensitivity of the identified area remains subject to confirmation. The use of this term is deliberately distinct from potential archaeological deposit. In the context of the proposal investigation, the identification of a PASA is more tentative, and based on a less tested regional model, than for a potential archaeological deposit.

The identification of PASAs within the study area was based on the following:
- The predictive model criteria developed during the route options assessment.
- Ethno-historical information.
- A review of landscape characteristics relative to known archaeological site patterning and landscape disturbance.
- Locations suggested by local Aboriginal community representatives.

Two of the PASAs identified are associated with recorded surface artefacts (A6 and A7). It should be noted that, due to the continuity of the landforms involved, four of the PASAs are paired together, and would therefore be treated simply as two areas: PASA 32 / PASA 33 and PASA 34 / PASA 35.

The PASA locations identified consist of landform types with predicted potential to have archaeological sensitivity. All of the landform types are well represented in adjacent areas and
across the southern Illawarra coastal plain. Typically these comprise the riparian corridors of rivers and creeklines, and the basal slopes fringing valley floors and former wetland basins. The PASAs within the study area are therefore not considered to be rare or unique incidences.

Although locally representative of such contexts, the PASAs have undergone a high degree of landuse disturbance due to the proximity of the existing Princes Highway. In many cases the current highway occupies a section of spurline crest, and has consequently removed a portion of the PASA, which also extends to either side of the spurline. For this reason, many of the equivalent landforms situated in adjacent areas and across the local area, will display greater integrity and less landuse disturbance than the PASAs associated with the proposal.

The significance of the nine PASAs can only be finalised following archaeological testing. Excavation would be undertaken to realise their archaeological potential and the proposal would not be determined until the results of the investigations has been interpreted and level of impacts can be quantified with more vigour.

It can be surmised however, that while the identified PASAs have statutory, scientific and cultural value for the dual purposes of determining the presence and nature of Aboriginal objects, and for testing and refining the predictive local Aboriginal site model, it is probable that any archaeological material encountered, would also be present across similarly located landforms elsewhere across the region.

Non-Aboriginal

Fourteen non-Aboriginal heritage recordings occur within or near the study area. These consist of one cultural landscape description, and 13 specific site descriptions. The site recordings consist of four with standing structures (H32, 34, 38, and 40), three containing archaeological remains of former structures (H31, 37 and 42), three disused highway remnants (H33, 39 and 41), one surface dump of disused vehicles (H35), one agricultural dry stone wall (H36) and a property driveway entrance (H43).

General descriptions are provided below and locations are provided in Appendix H. Photographs and detailed descriptions are included in the cultural heritage assessment in Appendix G.

- Southern Illawarra Coastal Plain and Hinterland Cultural Landscape, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- H31- Homestead site, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- H32- Former Toolijooa Public School, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- H33- 1990s Highway remnant, which is considered to be of no significance.
- H34- Aorangi homestead and grounds, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- H35- Vehicle dump, which is considered to be of no significance.
- H36- Agricultural dry stone wall, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- H37- Site of Stationmaster’s residence at Gerringong, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- H38- Renfrew Park Estate and grounds, which is listed as having local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007.
The Southern Illawarra Coastal Plain and Hinterland cultural landscape

This recording provides an outline of the landscape values which characterise the Southern Illawarra as a distinct cultural landscape of particular value and significance. The proposal passes through this landscape and is likely to impact upon some of these values.

The area of the National Trust listing covers approximately 35,000 ha and "embraces the coastline south of Kiama, some 30 km southwards to Greenwell Point, the undulating coastal plain and the flood plain on both sides of the lower Shoalhaven River and including the steep, benched slopes rising up to the escarpment of the Illawarra plateau".

There are no items listed as significant on the NSW State Heritage Register within the study area.

6.5.4 Potential impacts

Aboriginal

With reference to Appendix H showing locations, the degree of impact for each of the identified Aboriginal heritage recordings is summarised in Table 6.2. Photographs and detailed descriptions are included in the cultural heritage assessment in Appendix G.

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Degree of impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artefact A5</td>
<td>Reported subsurface artefact distribution</td>
<td>Low impact- the artefact is at the edge of the proposed alignment</td>
</tr>
<tr>
<td>Artefact A6</td>
<td>Isolated find</td>
<td>High impact- proposed alignment lies over the top of the artefact</td>
</tr>
<tr>
<td>Artefact A7</td>
<td>Artefact distribution</td>
<td>High impact- proposed alignment lies over the top of the artefact</td>
</tr>
<tr>
<td>PASA 31</td>
<td>Crest and upper slopes of spurline on eastern fall of Toolijooa Ridge, just north of Toolijooa Road intersection with current highway. PASA located on south side of proposed carriageways and current highway.</td>
<td>Medium to high impact- proposed alignment lies over the top of approximately 50 per cent of the PASA</td>
</tr>
<tr>
<td>PASA 32</td>
<td>Banks, flats and adjacent slopes associated with unnamed tributary 500 m east of Toolijooa Road intersection with highway</td>
<td>Low impact- edge of proposed alignment would encroach into the PASA</td>
</tr>
<tr>
<td>ID</td>
<td>Description</td>
<td>Degree of impact</td>
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<tr>
<td>PASA 33</td>
<td>Banks, flats and adjacent slopes associated with unnamed tributary immediately west of former Toolijooa Public School, and slightly elevated margin of valley floor coastal plain (former possible wetland basin)</td>
<td>Low impact- edge of proposed alignment would encroach into the PASA</td>
</tr>
<tr>
<td>PASA 34</td>
<td>Crest of locally elevated ridgeline, 250 m west of Willowvale Road intersection with highway</td>
<td>High impact- proposed alignment lies over the top of the PASA</td>
</tr>
<tr>
<td>PASA 35</td>
<td>Banks, flats and adjacent slopes associated with Crooked River</td>
<td>High impact- proposed alignment lies over the top of the PASA</td>
</tr>
<tr>
<td>PASA 36</td>
<td>Banks, flats and adjacent slopes associated with unnamed tributary crossing 500 m south of Sims Road intersection with highway. PASA located on western side of current highway</td>
<td>Medium impact- alignment encroaches into PASA</td>
</tr>
<tr>
<td>PASA 37</td>
<td>Basal slopes on southern margin of former Omega swamp basin</td>
<td>Low to medium impact- edge of proposed alignment would encroach into the PASA</td>
</tr>
<tr>
<td>PASA 38</td>
<td>Ridgeline crest, and basal and mid slopes on northern margin of former Omega Flat swamp basin</td>
<td>High impact- proposed alignment lies over the top of the PASA</td>
</tr>
<tr>
<td>PASA 39</td>
<td>Crest and upper slopes of a spurline just north of ‘Dunoon’ Dairy. PASA is located on west side of the current highway</td>
<td>Low to medium impact- edge of proposed alignment would encroach into the PASA</td>
</tr>
</tbody>
</table>

**Non-Aboriginal**

The proposal would have the potential to impact on non-Aboriginal heritage to varying degrees in the following ways:

- Destruction or disturbance to: above and below-ground structures and relics, ground relief features, and archaeological deposits present within the construction footprint. This can be expected to involve up to 100 per cent within the footprint, although there may be some limited potential for site remnants to survive outside of the footprint.
- Destruction or disturbance to above and below-ground structures and relics, ground relief features, and archaeological deposits present within the construction footprint and storage depots and other ancillary areas situated outside of the footprint.
- Destruction or disturbance to a strip of land which forms part of the associated grounds or a property block within which a heritage item / place is situated, such as a homestead building, or associated tree(s).
- Indirect impacts (such as to the contextual values of place(s) and/or item(s)) which are now adjacent to or closer to the upgraded highway; or to the overall values of the landscape through which the upgrade passes.
- Indirect impact to items of movable heritage which may have been moved to avoid direct impact and as a consequence lost contextual integrity.
With reference to Appendix H showing locations, the degree of impact for each of the non-Aboriginal heritage recordings that are identified as having some heritage significance, are summarised in Table 6.3. Photographs and detailed descriptions are included in the cultural heritage assessment in Appendix G.

**Table 6.3:** Non-Aboriginal heritage recordings identified as having some heritage significance

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Level of significance</th>
<th>Degree of impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>H31</td>
<td>Homestead site</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Located immediately adjacent to the upgrade, and although not directly impacted by earthworks, existing property boundaries may be affected to a minor extent depending on the width of the easement required</td>
</tr>
<tr>
<td>H32</td>
<td>Former Toolijooa Public School</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Marginally impacted by earthworks conducted within existing property boundaries, but in areas where the risk of impacting heritage values would be low</td>
</tr>
<tr>
<td>H34</td>
<td>Aorangi homestead and grounds</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Directly impacted but to a limited extent, within existing property boundaries</td>
</tr>
<tr>
<td>H36</td>
<td>Agricultural dry stone wall</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Directly impacted but to a limited extent, within existing property boundaries</td>
</tr>
<tr>
<td>H37</td>
<td>Site of Stationmaster’s residence at Gerringong</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Situated outside of the direct construction footprint but within a possible construction traffic and ancillary facility area</td>
</tr>
<tr>
<td>H38</td>
<td>Renfrew Park Estate and grounds</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Directly impacted but to a limited extent, within existing property boundaries</td>
</tr>
<tr>
<td>H39</td>
<td>1940s highway remnant</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Marginally impacted by earthworks conducted within existing property boundaries, but in areas where the risk of impacting heritage values would be low</td>
</tr>
<tr>
<td>H40</td>
<td>Former Omega Public School</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Located immediately adjacent to the upgrade, and although not directly impacted by earthworks, existing property boundaries may be affected to a minor extent</td>
</tr>
<tr>
<td>ID</td>
<td>Description</td>
<td>Level of significance</td>
<td>Degree of impact</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>by land acquisition depending on the width of the easement required</td>
</tr>
<tr>
<td>H41</td>
<td>1940s Highway remnant</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Directly impacted but to a limited extent, within existing property boundaries</td>
</tr>
<tr>
<td>H42</td>
<td>Site of Homeleigh homestead</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Directly impacted but to a limited extent, within existing property boundaries</td>
</tr>
<tr>
<td>H43</td>
<td>Innisfail property entrance</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>Fully impacted and would require removal</td>
</tr>
<tr>
<td></td>
<td>Southern Illawarra Coastal Plain and Hinterland Cultural Landscape</td>
<td>Local heritage significance on the draft Kiama Heritage Inventory (DKHI) 2007</td>
<td>The identified cultural landscape would be impacted, but moderated by the already dominant presence of the highway, and the small proportion of land effected relative to the whole</td>
</tr>
</tbody>
</table>

6.5.5 Cultural heritage issues and the Rose Valley Road interchange

See Appendix G for further details.

The proposed interchange at Rose Valley Road would be constructed in close proximity to two items of cultural heritage significance. The existing carriageway separates Renfrew Park and two established specimens of *Ficus macrophylla* (Moreton Bay Fig trees), both of which are part of cultural value to the local Aboriginal community.

A number of options for the interchange design have been considered with specific regard to their varying degrees of impact on both Renfrew Park and the fig trees following feedback from the Aboriginal focus group (AFG). A comparative analysis of the value of these two items was undertaken for the proposal.

Renfrew Park consists of a homestead and grounds which have high non-Aboriginal cultural heritage significance within the local context. The homestead and immediate grounds have been listed on the Kiama LEP 1996 and Illawarra REP 1986, recorded on the National Trust (NSW) Register and the residence is included in the Draft Kiama Heritage Inventory 1997.

The area was originally surveyed in 1826, purchased by Robert Miller in 1835, with the existing homestead built in 1862. Formal garden partitions and symmetrical plantings are evident in the homestead grounds in 1958 and 1971 aerial photographs, but are no longer evident except for a fig tree in the south-west corner. The fig tree in the north-west corner and north-western portion of grounds were removed within the last 15 years to construct a new vehicle entrance and driveway to the homestead. The grounds appear to have been shortened to provide space for previous widening of the highway and the root zone of the remaining fig tree in the south-west corner has been truncated by widening of the highway carriageways and the recent installation of a water main.
The two fig trees to the west of the carriageway are not specifically listed on any heritage schedules but feedback from the AFG suggests they are of high Aboriginal cultural significance due to their association with the Yaroma spirit and past use of fig trees by Aboriginal people for shelter and food.

The larger of the two, the eastern tree may be a planted component of the Renfrew Park homestead garden given its symmetry with the historical plantings. The minimum age of the trees is estimated to be at least 160 years for the larger tree and 110 for the smaller westernmost tree.

The trees occur within PASA 38 and in relative proximity to Aboriginal artefact scatter A7. The eastern tree is vigorous and healthy and has a 40+ safe useful life expectancy (SULE). The western tree is not as vigorous but has a SULE of up to 40 years. Neither tree appears to have suffered significant disturbance in the past.

The optimal cultural heritage management strategy would be to conserve both the Moreton Bay Fig trees to the west of the highway as well as the remaining Renfrew Park grounds and garden plantings. However, following extensive investigation of design options, the optimal strategy cannot be realised.

The required footprint for the proposal would necessitate either the removal of the larger eastern fig tree on the western side of the highway, or the smaller of the two figs plus a section of the grounds of Renfrew Park, including the fig located near the south western corner and the current formal entrance posts and gate. Both Aboriginal and non-Aboriginal heritage values would be affected regardless of which alignment option is selected.
It was concluded that an alignment that conserves, at least the larger of, the two Moreton Bay Fig trees on the western side of the highway, and which as a consequence must impact the western portion of the Renfrew Park homestead grounds and plantings, would be a justifiable management solution on the following grounds:

- Strong Aboriginal cultural values are associated with the larger tree on the west side of the highway.
- The continuing integrity of this tree as a healthy and vigorous tree, and as a central axis tree in relation to the homestead.
- The larger of the two fig trees on the western side of the highway has the longer SULE of the two fig trees of the homestead and therefore should be preserved over the smaller of the western trees.
- The combined Aboriginal and non-Aboriginal values of this tree.
- The already compromised nature of the Moreton Bay Fig tree in the south western corner of the Renfrew Park gardens (given the loss of its pair at the former north-west corner of the homestead grounds, and its impacted and vulnerable root system).
- The already compromised nature of the western portion of the homestead grounds, due to previous highway widening and the recent construction of a new vehicle driveway and entrance.
- Renfrew Park is typical of rural domestic houses of the era and locality. They are well represented currently on Kiama Municipal Council’s LEP. The relevance of the curtilage, fronting the highway would be maintained and therefore impacts to the heritage item would not change the significance of the item ie it would retain its local significance on the draft Kiama Heritage Inventory (DKHI) 2007.
- A fig tree of this age and Aboriginal cultural significance is not as common in the locality. Its rarity lies in the cultural activity associated with the tree by Aboriginal people.
- The potential to mitigate the impact to the homestead grounds by re-location of the formal entrance way and remodelling of the front garden and its planting to re-establish symmetry around the central axis.

Strategies for managing the potential impacts on each Aboriginal and non-Aboriginal heritage site or features are detailed in Appendix G and reflected in the recommendations below.

6.5.6 Safeguards and management measures

Aboriginal

- Aboriginal stakeholders would continue to have the opportunity to actively participate in an on-going consultation program regarding the management of Aboriginal cultural heritage within the proposal areas.
- A systematic program of archaeological test excavation would be conducted across all PASAs identified within the study area to determine their archaeological significance prior to the determination of the proposal. A section 87 permit (AHIP) has been obtained from DECCW as a prerequisite to the conduct of this program.
- Where the destruction (including ‘salvage’) of known Aboriginal objects or confirmed archaeological deposits is anticipated as part of the direct impact of proposal, application would be made to DECCW for a section 90 consent (AHIP) to undertake such impact. No impact can occur to Aboriginal objects prior to the receipt of the AHIP, and any impact must be consistent with the provisions of the AHIP.
- RTA protocols would be adopted and followed in the event that proposal involves the unanticipated discovery of Aboriginal objects or suspected human remains.
With regard to the management of mature fig trees within the proposal area:
- Wherever feasible, direct impact to mature fig trees would be avoided.
- The continued and sustainable health of near or adjacent trees would be considered in the detailed design of the upgrade.
- In cases where direct impact to mature fig trees is unavoidable:
  - Wherever feasible, trees with reduced health, condition or vigour are impacted in preference to examples displaying good condition, health and vigour.
  - Establish a management and impact mitigation program in consultation with the AFG. This action is relevant to the anticipated removal of the fig trees at Rose Valley Road.
- Consultation with Aboriginal stakeholder groups would be conducted with regard to all incidences of anticipated impact to mature fig trees.

An appropriate means of commemorating the traditional Aboriginal culture of the country being traversed by the upgrade would be adopted where and as feasible. This may take the form of signage, adopted nomenclature for built structures or wayside stops, the use of motifs in any incorporated artwork, or the erection of commemorative markers and/or monuments. The development, source material, and approval of any such proposal would be the subject of continuing consultation with Aboriginal stakeholders.

Non-Aboriginal

- There are expected to be some impacts to locally significant items of non-Aboriginal heritage as a result of the proposal and an excavation permit would be applied for under section 140 of the Heritage Act.
- Where feasible, direct impact to known sites and features with assessed heritage significance would be avoided, and where not feasible, that impact would be minimised and mitigated.
- Consideration would be given to reducing the extent of the cuts required adjacent to Aorangi (H34) and the dry stone wall (H36), with the objectives of avoiding or reducing the extent of direct impact (including the loss of mature garden plantings at Aorangi), and the width of the required easement and consequential property acquisition.
- The boundary of the upgrade easement would be defined so that land acquisition is minimised in the area of the following sites:
  - H31 (site of Harding tenant farm)
  - H32 (former Toolijooa Public School)
  - H34 (Aorangi)
  - H36 (dry stone wall)
  - H38 (Renfrew Park)
  - H40 (former Omega Public School)
  - H42 (site of original Homeleigh).
Temporary fencing would be erected between the following sites / features and the zone of construction activity, for the duration of construction works. Fencing around trees would include a radius around the stem that includes the canopy. The fenced off areas would be identified as 'no go' areas for vehicles, and exclude materials storage or the conduct of ground surface disturbance:

- H31 (site of Harding tenant farm).
- Trees to be retained along the northern boundary of Aorangi (H34).
- The dry stone wall (H36).
- The portion of the Renfrew Park front enclosure not subject to impact (H38).
- The portion of the Homeleigh archaeological site not subject to impact (H42).

An archival record would be prepared of the following sites prior to the commencement of construction impact:

- The front formal garden of Aorangi (H34) if it is determined that significant plantings would be directly impacted (the recording of non impacted portions of the garden can be at a lesser detail and are required to provide a context for the impacted items).
- The agricultural dry stone wall (H36), if it is determined that the wall would be directly impacted.
- The front grounds and enclosure of Renfrew Park (H38).
- The 1940s highway remnant (H41), consideration would be given to conducting a cross sectional excavation as part of this recording.
- The site of the original Homeleigh homestead (H42).
- The Innisfail driveway entrance (H43).

A program of archaeological test excavation, and where warranted, subsequent archaeological salvage excavation, would be conducted at relevant locations within the area of impact at sites H32 (former Toolijooa Public School), and H42 (site of the original Homeleigh homestead). The scope of excavations at H42 may extend beyond the area of impact, depending on the management objectives of the program and the need to clarify the nature and extent of the site.

With regard to site H37 (site of Omega Stationmasters residence), disturbance to the deposit would be avoided below a depth of around 100 cm. If the area is required for ancillary activities (not associated with substantial ground disturbance), then additional hard stand gravels would be applied to protect any remaining archaeological deposits. In the event that excavations below a depth of 100 cm are anticipated and unavoidable, then an archaeological test excavation would be conducted with approval from Heritage Branch, to ascertain the nature, significance and management requirements of any potentially occurring archaeological deposits.

With regard to the Renfrew Park property (H38), it is recommended that the following actions be undertaken in addition to the archival record outlined above:

- Ensure that the palm tree remains undisturbed and viable.
- Develop and instigate, in consultation with the landowner and a heritage garden specialist, a landscaping plan for the remaining portion of the homestead front enclosure. The objective of the plan would be to integrate the upgrade batter and easement requirements with the redevelopment of the homestead frontage. Subject to owner and Kiama Municipal Council heritage requirements, it is recommended that the plan seek to retain the palm tree, to re-establish the formal and symmetrical garden schema, and to reposition the existing entrance posts and gateway in a new location along the central axis.
- Integrate the retained fig tree on the west side of the highway with any planned, northbound exit, gateway installation for the Gerringong area.
With regard to site H39 (1940s highway remnant north of Renfrew Park), impact to this feature would be minimised where feasible, and adjacent landscaping and other treatments within the easement adjacent to the site would take into account the desirability of maintaining the ability of the public to view the feature either from the road during travel, and/or via a pedestrian path.

With regard to the Innisfail property entrance feature (site H43), and in addition to the archival record outlined above, the following actions would be conducted subject to agreement by stakeholders:
- The feature would be appropriately dismantled.
- Temporarily stored (if necessary).
- Re-installed, and restored to its original form, at a new entrance location along the Innisfail property driveway.

A program of revegetation along the upgrade easement and associated works would be conducted with the aim of mitigating the impact to the cultural values of the immediate and larger surrounding landscape. The program would include the use of both native and exotic species in accordance with the landscape plan. The latter would be representative of those already present in the landscape and be established in the proximity of towns, historical estates or where dictated by the surrounding landscape.

RTA protocols would be adopted and followed in the event that proposal related disturbance involves the unanticipated discovery of non-Aboriginal artefacts (relics) or suspected human remains.

6.6 Traffic assessment

6.6.1 Introduction

A traffic and transportation assessment was prepared for the proposal, which includes a review of existing conditions and a detailed study of future year traffic volumes and an assessment of the Gerringong upgrade carriageway and access performance measures. In addition, the impact of increased travel demand in the locality of Gerringong during and after construction is assessed.

This section includes a summary of the analysis and findings from the detailed traffic assessment. A copy of the complete detailed traffic assessment report is included in Appendix I.

6.6.2 Existing environment

Route description

The Princes Highway is the main road corridor connecting Sydney, Wollongong, the Illawarra and the south coast to the Victorian border along the east coast of NSW. It is an important corridor for the following purposes:

- Commuter route between Sydney, Wollongong and Nowra.
- Local route for residents of surrounding smaller towns in Nowra.
- Major tourist route for key destinations including Gerringong, Berry, Nowra and the NSW South Coast, resulting in high volume peak period traffic on weekends and holiday periods.
- Important freight and bus route, particularly for the south and far south coast where there are no rail services.
The proposal includes upgrading the 7.5 km section of the existing Princes Highway between Mount Pleasant and Toolijooa Road - the Gerringong upgrade as shown in Figure 6.2. Within the study area, the existing highway is primarily one lane in each direction, except for the two lane section on the northbound carriageway from Fern Street to Mount Pleasant. The highway has limited overtaking opportunities, several junctions with local rural roads and many uncontrolled private accesses, and incorporates two access points to the town of Gerringong: one at the northern end of town at Fern Street and one at the southern end at Belinda Street.

The posted speed limit along the section has been recently decreased to 80km/h from 100km/h. This was due to the combination of less than desirable horizontal and vertical alignments between Mount Pleasant and Toolijooa Road, narrow shoulders, poor visibility and a poor safety record has led to this reduction.

The Fern Street intersection with the Princes Highway is the commencement of an alternative route connecting Gerringong to Bomaderry, known locally as the ‘Sandtrack’. Figure 6.2 shows this route which is of a lower classification than the Princes Highway, with the road surface generally of a poorer quality. The ‘Sandtrack’ offers an alternative to the winding, hilly section of Princes Highway between Gerringong and Berry, and therefore many private vehicles take this option to avoid delays behind slow moving heavy vehicles (which are prevented from using the ‘Sandtrack’ by a five tonne load limit). The ‘Sandtrack’ is slightly longer than the highway with a posted speed limit of 90km/h or 100km/h for much of its length.

**Figure 6.2: Study area and existing route options**

Existing traffic volumes

In addition to the permanent RTA traffic count site 07.800 on the Princes Highway north of Rose Valley Road, the RTA commissioned traffic surveys during May and June 2009 to measure current traffic volumes at other key locations on the Princes Highway and adjacent ‘Sandtrack’ route in the study area.
Automatic traffic count (ATC) tubes were located on the Princes Highway south-west of Belinda Street and on the ‘Sandtrack’ to the south of the Belinda Street intersection. A summary of the average peak and daily traffic volumes (seasonally adjusted) are shown in Table 6.4.

Table 6.4: 2009 traffic volumes summary

<table>
<thead>
<tr>
<th>RTA site ID</th>
<th>Location</th>
<th>Source</th>
<th>AM peak (veh/hr)</th>
<th>PM peak (veh/hr)</th>
<th>100th hour (veh/hr)</th>
<th>AADT (veh/day)</th>
<th>% heavy veh</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.800</td>
<td>Princes Highway, north of Rose Valley Road</td>
<td>RTA permanent</td>
<td>1,495</td>
<td>1,798</td>
<td>2,429</td>
<td>20,902</td>
<td>8%</td>
</tr>
<tr>
<td>7.045</td>
<td>Princes Highway, west of Belinda Street</td>
<td>ATC</td>
<td>749</td>
<td>900</td>
<td>1,214</td>
<td>10,447</td>
<td>12%</td>
</tr>
<tr>
<td>7.101</td>
<td>Sandtrack, south of Belinda Street</td>
<td>ATC</td>
<td>620</td>
<td>758</td>
<td>1,010</td>
<td>8,692</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 6.4 shows that the highest daily volume of traffic in the area is on the Princes Highway north of Rose Valley Road with an annual average daily traffic (AADT) of 20,902 vehicles. South of Gerringong, the combined AADT flows on the Princes Highway (west of Belinda Street) and on the ‘Sandtrack’ (south of Belinda Street) are 19,139 vehicles suggesting a net loss of traffic of around 1,800 vehicles to the town of Gerringong. The ‘Sandtrack’ route south of Belinda Street currently accommodates 8,692 vehicles per day, which equates to 45 per cent of the total traffic south of Gerringong. The other 55 per cent of trips currently travel on the Princes Highway.

In addition to AADT, Table 6.4 shows the average AM peak, PM peak and 100th busiest single hour traffic volumes, and the daily proportion of heavy vehicles for each location. As the Princes Highway is in a rural area and a major route for tourism with significant peak period travel demand during school holidays, it is not necessarily appropriate to focus analysis at typical weekday morning and evening peak periods. Therefore, further analysis was carried out to identify the true periods of peak demand and found that these usually occurred on Friday or Sunday evening of a public holiday weekend or during other holiday periods.

Since it is not economical to design to a level of capacity that is required only for a few hours per year, a design hour must be chosen upon which to base design analysis. The design hour is normally chosen between the 30th and 100th busiest hour of the year, with the 100th hour selected to assess carriageway and access operational performance measures for the Gerringong upgrade. As expected, analysis of the RTA permanent traffic data for site 7.800 (north of Rose Valley Road) showed that the 100th hour was considerably higher than traffic flows during the ‘typical’ AM and PM peak periods with the 100th hour representing 11.6 per cent of the AADT compared to 7.2 per cent and 8.6 per cent for the AM and PM peaks respectively.

The 100th hour factor of 11.6 per cent was applied to the 2009 AADT for the other two count locations to synthesise a 100th hour traffic flow for the ‘Sandtrack’ and the Princes Highway south of Gerringong. The resultant traffic volumes are shown in Table 6.4.

Midblock Level of Service

Level of service (LOS) is a measure to determine the operational conditions and efficiency of a roadway or intersection. The definition of LOS generally describes the operating conditions in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and
convenience, and road safety.

There are six levels of service, A to F, with LOS A representing optimum operating conditions (free flow) and LOS F the poorest (forced or breakdown in flow). Common RTA practice suggests that when a roadway falls to LOS D, investigations should be initiated to provide suitable remediation prior to the roadway falling to LOS E or F.

Table 6.5: Midblock level of service (LOS) summary (2009)

<table>
<thead>
<tr>
<th>Location</th>
<th>AM peak hour (veh/hr)</th>
<th>PM peak hour (veh/hr)</th>
<th>100th hour (veh/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flow</td>
<td>LOS</td>
<td>Flow</td>
</tr>
<tr>
<td>Princes Highway, north of Rose Valley Road</td>
<td>1,495 E</td>
<td>1,798 E</td>
<td>2,429 E</td>
</tr>
<tr>
<td>Princes Highway, west of Belinda Street</td>
<td>749 D</td>
<td>900 D</td>
<td>1,214 E</td>
</tr>
</tbody>
</table>

The current midblock LOS on the Princes Highway (north of Rose Valley Road and west of Belinda Street), based on 2009 AM peak, PM peak and 100th hour two-way traffic volumes, is summarised in Table 6.5. The table shows that both highway locations operate at an unacceptable LOS E during 100th hour conditions, which reflects high volume recreational traffic, particularly noticeable in the southbound direction on Friday afternoons, and northbound direction on Sunday afternoons.

Intersection performance

The current LOS and delay at three key intersections has been assessed using SIDRA intersection modelling software. Table 6.6 provides a summary of intersection performance for existing 100th hour traffic volumes.

Table 6.6: 100th peak hour intersection analysis (2009)

<table>
<thead>
<tr>
<th>Intersection / approach</th>
<th>Veh/hr</th>
<th>LOS</th>
<th>DOS</th>
<th>95% Back of queue (m)</th>
<th>Av delay (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princes Highway / Fern Street</td>
<td>607 C</td>
<td>0.842</td>
<td>86</td>
<td>36.3</td>
<td></td>
</tr>
<tr>
<td>Princes Highway north</td>
<td>1,215 A</td>
<td>0.364</td>
<td>0</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>Princes Highway south</td>
<td>683 A</td>
<td>0.379</td>
<td>0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,505</td>
<td>0.843</td>
<td>86</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td>Princes Highway / Belinda Street</td>
<td>216 F</td>
<td>1.351</td>
<td>427</td>
<td>510.8</td>
<td></td>
</tr>
<tr>
<td>Princes Highway north</td>
<td>722 A</td>
<td>0.311</td>
<td>0</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Princes Highway south</td>
<td>590 A</td>
<td>0.293</td>
<td>3</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,528</td>
<td>1.348</td>
<td>427</td>
<td>73.9</td>
<td></td>
</tr>
<tr>
<td>Belinda Street / Fern Street</td>
<td>515 A</td>
<td>0.442</td>
<td>29</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>106 A</td>
<td>0.146</td>
<td>8</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Fern Street north</td>
<td>546 A</td>
<td>0.463</td>
<td>32</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>Belinda Street west</td>
<td>202 A</td>
<td>0.262</td>
<td>15</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,369</td>
<td>0.463</td>
<td>32</td>
<td>9.3</td>
<td></td>
</tr>
</tbody>
</table>
The Princes Highway and Fern Street intersection has an overall average delay of 9.7 seconds per vehicle. Both the approaches from and departure to the Princes Highway experience minimal intersection delay, however the average delay on the Fern Street approach increases to 36.3 seconds, resulting in LOS C.

Table 6.6 also shows the degree of saturation (DOS), which is a ratio of the number of vehicles entering an intersection in the specified 100th busiest hour to the number which could enter if all approaches were fully saturated during this period. Acceptable DOS ratios for priority intersections and roundabouts are <0.85 and ratios greater this value would indicate that the approach is operating over capacity with excessive average delays.

The Princes Highway and Belinda Street intersection is currently over capacity with an overall DOS of 1.348. The Princes Highway itself operates well within capacity through the intersection having a DOS for the major northbound and southbound approaches at 0.311 and 0.293 respectively. The Belinda Street approach pushes the intersection over capacity with a DOS of 1.351. Belinda Street is currently operating at LOS F, meaning a breakdown in traffic flow, with the 95th percentile back of queue extending an estimated 427 m in 100th hour conditions.

The Belinda Street and Fern Street roundabout performs well within capacity at LOS A. This is consistent across all approaches with an overall average delay of 9.3 seconds. The highest average delay per vehicle is recorded on the Belinda Street west approach at only 12.6 seconds. All approaches operate within capacity with the highest DOS being 0.442 on the Fern Street south approach.

Traffic crashes

The 7.5 km section of the Princes Highway between Mount Pleasant and Toolijooa Road has a poor crash record. Between 1 July 2003 and 30 June 2008 a total of 87 crashes were recorded, including five fatalities and 38 injuries. Table 6.7 shows the crash statistics for this period for the specific highway section where they occurred.

<table>
<thead>
<tr>
<th>Section from</th>
<th>Section to</th>
<th>Section length (km)</th>
<th>Total crashes</th>
<th>Fatal crashes</th>
<th>Injury crashes</th>
<th>Tow-away crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount Pleasant</td>
<td>Rose Valley Road</td>
<td>1.6</td>
<td>21</td>
<td>2</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Rose Valley Road</td>
<td>Fern Street</td>
<td>0.8</td>
<td>31</td>
<td>1</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Fern Street</td>
<td>Belinda Street</td>
<td>2.2</td>
<td>23</td>
<td>1</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Belinda Street</td>
<td>Toolijooa Road</td>
<td>2.9</td>
<td>12</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7.5</td>
<td>87</td>
<td>5</td>
<td>38</td>
<td>44</td>
</tr>
</tbody>
</table>

Crash severity indices provide an assessment of road safety based on the type and number of crashes occurring on a route. Fatal, injury and tow-away crashes carry different weightings, with traffic volumes excluded from the calculation. The following formula was used to calculate these indices:

\[
\text{Severity Index} = \frac{([\text{Number of fatal crashes} \times 3.0] + [\text{Number of injury crashes} \times 1.5] + [\text{Number of non-injury crashes}])}{\text{Total number of crashes}}
\]
The average crash severity index along the length of the proposal area is 1.33, with two sections approaching or higher than 1.40. By comparison the severity index across NSW between 2001 and 2005 is 1.23, indicating the Princes Highway currently has a higher than average proportion of fatal and injury crashes in the proposal study area.

6.6.3 Potential impacts

Forecast traffic volumes

The detailed modelling methodology used to forecast traffic volumes for the proposal incorporated the following three key stages, which are described in more detail in the Gerringong upgrade detailed traffic assessment report, included in Appendix I.

- Analysis of 2009 traffic patterns.
- Base and future year TRACKS traffic model development.
- Application of a traffic forecasting spreadsheet model.

Table 6.8 provides a summary of the forecast AADT at key locations for the 2009 base year and the following two design year scenarios:

- 2014 Gerringong upgrade opening year.
- 2034 Gerringong upgrade opening +20 design year.

Table 6.8: Final Gerringong upgrade forecast traffic volumes (key locations)

<table>
<thead>
<tr>
<th>Location</th>
<th>2009 all vehicles</th>
<th>2014 all vehicles</th>
<th>Growth rate p.a. (09 - 14)</th>
<th>2034 all vehicles</th>
<th>Growth rate p.a. (14 - 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princes Highway, north of Rose Valley Road</td>
<td>20,902</td>
<td>24,193</td>
<td>3.1%</td>
<td>37,356</td>
<td>2.7%</td>
</tr>
<tr>
<td>Princes Highway, west of Belinda Street</td>
<td>10,447</td>
<td>12,114</td>
<td>3.2%</td>
<td>24,011</td>
<td>4.9%</td>
</tr>
<tr>
<td>‘Sandtrack’, south of Belinda Street</td>
<td>8,692</td>
<td>9,912</td>
<td>2.8%</td>
<td>11,827</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

Note: Forecast traffic volumes on the ‘Sandtrack’ only include heavy vehicles up to five tonnes due to load limit.

The Gerringong upgrade is programmed to be completed by 2014. During the period 2009 to 2014 it is expected that:

- AADT volumes on the Princes Highway north of Rose Valley Road are expected to have increased by more than 3,000 vehicles; an increase of over 3.0 per cent per annum.
- South of Gerringong, traffic is expected to have increased by 3.2 per cent and 2.8 per cent per annum on the Princes Highway and the ‘Sandtrack’ respectively.
- Traffic is expected to follow current patterns and distributions, with a 55 per cent / 45 per cent split in traffic between the Princes Highway and the ‘Sandtrack’ in 2014.

The potential cumulative impact of the predicted traffic growth of the proposal combined with the planned road network improvements on the Princes Highway south of Gerringong is likely to result in a transfer of traffic from the ‘Sandtrack’ to the Princes Highway. This is due to improved traffic efficiency, road safety and travel time savings on the upgraded Princes Highway.
During the period 2014 to 2034 it is expected that:

- AADT volumes on the Princes Highway north of Rose Valley Road are estimated to increase by 2.7 per cent per annum over the 20 year post construction design period (from 24,193 to 37,356 vehicles per day).
- Further south on the Princes Highway west of Belinda Street, AADT volumes are expected to grow by 4.9 per cent per annum.
- The split between the Princes Highway and the ‘Sandtrack’ traffic is estimated to change from 55 per cent /45 per cent in 2009 to 67 per cent /33 per cent in 2034.

Consequence of no action

Table 6.9 shows the LOS that has been estimated for the existing route should the highway not be upgraded. Projected 100th hour traffic volumes for 2034 would result in congested peak period conditions for the Princes Highway west of Belinda Street and north of Rose Valley Road operating at an unacceptable LOS E and LOS F respectively.

Table 6.9: Midblock level of service (LOS) summary - without upgrade (2034)

<table>
<thead>
<tr>
<th>Location</th>
<th>AM peak hour (veh/hr)</th>
<th>PM peak hour (veh/hr)</th>
<th>100th hour (veh/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flow</td>
<td>LOS</td>
<td>Flow</td>
</tr>
<tr>
<td>Princes Highway, north of Rose Valley Road</td>
<td>2,672</td>
<td>E</td>
<td>3,213</td>
</tr>
<tr>
<td>Princes Highway, west of Belinda Street</td>
<td>1,350</td>
<td>E</td>
<td>1,622</td>
</tr>
</tbody>
</table>

Table 6.10 shows the intersection performance for the 100th hour volumes in 2034 without the proposal. As anticipated the intersection of Princes Highway and Fern Street would operate over capacity with excessive queuing and delays. This is entirely accountable to the Fern Street approach with the Princes Highway north and south approaches recording acceptable DOS ratios of 0.657 and 0.683 respectively. The Fern Street approach is estimated to operate with a queue length of 7,896 m and at LOS F.

The Belinda Street approach at the Princes Highway intersection would operate at LOS F in 2034. The forecast increase for the right turn movement from Belinda Street to the Princes Highway between 2009 and 2034 is not as great as the right turn movement from Fern Street to the Princes Highway. Despite this the DOS for the Belinda Street approach exceeds capacity at 4.667. The SIDRA modelling indicates that both Princes Highway approaches would operate at LOS A.

The overall performance of the Belinda Street and Fern Street intersection is estimated to be LOS B. The forecast overall average delay is 24.2 seconds per vehicle with a DOS of 0.930. This is over capacity and improvement measures would need to be considered at the roundabout with queue lengths for the Fern Street north and Fern Street south approaches forecast to extend 214 m and 143 m, respectively. The Belinda Street approach from the west is predicted to operate at LOS D, with an average delay of 43 seconds.
### Table 6.10: 100th peak hour intersection analysis - without upgrade (2034)

<table>
<thead>
<tr>
<th>Intersection / approach</th>
<th>Veh/h</th>
<th>LOS</th>
<th>DOS</th>
<th>95% Back of queue (m)</th>
<th>Av delay (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princes Highway / Fern Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fern Street</td>
<td>1,070</td>
<td>F</td>
<td>6.176</td>
<td>7,896</td>
<td>8,984</td>
</tr>
<tr>
<td>Princes Highway north</td>
<td>2,171</td>
<td>A</td>
<td>0.657</td>
<td>0</td>
<td>4.7</td>
</tr>
<tr>
<td>Princes Highway south</td>
<td>1,232</td>
<td>A</td>
<td>0.683</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>4,473</td>
<td>-</td>
<td>6.185</td>
<td>7,896</td>
<td>2,151</td>
</tr>
<tr>
<td>Princes Highway / Belinda Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belinda Street</td>
<td>390</td>
<td>F</td>
<td>4.667</td>
<td>2,154</td>
<td>5,072</td>
</tr>
<tr>
<td>Princes Highway north</td>
<td>1,302</td>
<td>A</td>
<td>0.529</td>
<td>0</td>
<td>2.3</td>
</tr>
<tr>
<td>Princes Highway south</td>
<td>1,064</td>
<td>A</td>
<td>0.529</td>
<td>14</td>
<td>2.6</td>
</tr>
<tr>
<td>Total</td>
<td>2,756</td>
<td>-</td>
<td>4.667</td>
<td>2,154</td>
<td>720</td>
</tr>
<tr>
<td>Belinda Street / Fern Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fern Street south</td>
<td>895</td>
<td>B</td>
<td>0.866</td>
<td>143</td>
<td>17</td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>193</td>
<td>C</td>
<td>0.584</td>
<td>46</td>
<td>29</td>
</tr>
<tr>
<td>Fern Street north</td>
<td>962</td>
<td>B</td>
<td>0.930</td>
<td>214</td>
<td>23</td>
</tr>
<tr>
<td>Belinda Street west</td>
<td>364</td>
<td>D</td>
<td>0.853</td>
<td>109</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>2,414</td>
<td>B</td>
<td>0.930</td>
<td>214</td>
<td>24</td>
</tr>
</tbody>
</table>

Travel times on the Princes Highway along the proposed upgrade would increase as the level of congestion increases. Delays would be caused by local traffic conflicting with major through traffic movements at the main Belinda Street and Fern Street intersections. Long delays would also result in economic impacts, especially to freight and tourist traffic travelling either to local areas or long distance regional destinations.

The potential for crashes is likely to increase with increased traffic volumes especially at major intersections along the route, such as Fern Street and Belinda Street in Gerringong.

**Construction impacts**

Construction impacts of the Gerringong upgrade would include an increase in heavy vehicle activity on the Princes Highway and local routes due to on/off road earthworks haulage. Traffic control details are limited at this stage in the proposal due to the uncertainty associated with the ultimate contractor’s work methods. The construction sequencing and any temporary works identified would be based on minimising user delay whilst providing sufficient flexibility for the contractor to efficiently plan the construction of the Gerringong upgrade.

Although it is the RTA’s goal to maintain an 80 km/h construction zone speed where possible, delays for traffic using the Princes Highway would be expected during the construction phase in those periods when the Gerringong upgrade ties in with the existing highway. There would also be delays to local traffic during periods when other minor or private roads are being bridged or tied in with the proposal.
In order to construct the new railway overbridge at Fern Street there would be a need to temporarily close Fern Street for a period of up to 12 months. The traffic impacts would be associated with the temporary loss of the northern access to Gerringong and the resultant redistribution of traffic to the town via the southern access at the Belinda Street interchange, which is proposed to be fully upgraded and operational prior to the closure of Fern Street.

An assessment of the resultant traffic impacts has been undertaken to determine the operational performance of the detour route during the closure of Fern Street. Table 6.11 shows the estimated midblock LOS for the existing Princes Highway carriageway during construction of the Fern Street overbridge. Projected 100th hour traffic volumes would operate in poor traffic flow conditions, with the highway performing at an unacceptable LOS F north of Belinda Street.

<table>
<thead>
<tr>
<th>Location</th>
<th>AM peak hour (veh/hr)</th>
<th>PM peak hour (veh/hr)</th>
<th>100th hour (veh/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Princes Highway, north of Belinda Street</td>
<td>1,715 E</td>
<td>2,061 E</td>
<td>2,781 F</td>
</tr>
</tbody>
</table>

Table 6.11: Midblock level of service (LOS) summary - temporary Fern Street closure (2014)

Table 6.12 provides details of the operating conditions, during the closure of Fern Street in 2014, for the grade-separated interchange at Belinda Street and also the main Fern Street and Belinda Street intersection in Gerringong.

<table>
<thead>
<tr>
<th>Intersection / approach</th>
<th>Veh/h</th>
<th>LOS</th>
<th>DOS</th>
<th>95% back of queue (m)</th>
<th>Av delay (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princes Highway / Belinda Street interchange west ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willowvale Road south</td>
<td>212</td>
<td>D</td>
<td>0.831</td>
<td>53</td>
<td>44.4</td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>863</td>
<td>A</td>
<td>0.490</td>
<td>0</td>
<td>9.1</td>
</tr>
<tr>
<td>Total</td>
<td>1,075</td>
<td>-</td>
<td>0.833</td>
<td>53</td>
<td>16.1</td>
</tr>
<tr>
<td>Princes Highway / Belinda Street interchange east ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>989</td>
<td>A</td>
<td>0.540</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>Princes Highway off ramp north</td>
<td>856</td>
<td>F</td>
<td>1.008</td>
<td>570</td>
<td>72.3</td>
</tr>
<tr>
<td>Belinda Street west</td>
<td>192</td>
<td>A</td>
<td>0.122</td>
<td>13</td>
<td>6.8</td>
</tr>
<tr>
<td>Total</td>
<td>2,037</td>
<td>-</td>
<td>1.009</td>
<td>570</td>
<td>31.7</td>
</tr>
<tr>
<td>Belinda Street / Fern Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fern Street south</td>
<td>571</td>
<td>C</td>
<td>0.902</td>
<td>153</td>
<td>37.8</td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>267</td>
<td>B</td>
<td>0.606</td>
<td>50</td>
<td>25.1</td>
</tr>
<tr>
<td>Fern Street north</td>
<td>541</td>
<td>B</td>
<td>0.798</td>
<td>99</td>
<td>25.2</td>
</tr>
<tr>
<td>Belinda Street west</td>
<td>949</td>
<td>A</td>
<td>0.777</td>
<td>93</td>
<td>10.9</td>
</tr>
<tr>
<td>Total</td>
<td>2,328</td>
<td>B</td>
<td>0.906</td>
<td>153</td>
<td>22.5</td>
</tr>
</tbody>
</table>

At the Princes Highway and Belinda Street interchange, the Belinda Street east approach (from Gerringong) operates well with LOS A and a delay of only 9.1 seconds despite a significant increase in traffic. However, the give-way approach from Willowvale Road south (which includes the northbound off ramp traffic) operates at a LOS D, with average queuing and delays of 53 m and 44.4 seconds respectively. The overall DOS for the intersection is 0.833.
Both Belinda Street approaches at the Princes Highway and Belinda Street interchange east ramps operate at LOS A, with very little queuing or delays. Conversely, the Princes Highway off ramp approach operates at LOS F, with a DOS of 1.008, signifying the junction is over capacity due to the volume of traffic on this approach. The result is lengthy queues in excess of 500 m, and an average delay of 72.3 seconds.

The Belinda Street and Fern Street roundabout operates adequately in this scenario. The lowest LOS is C, for the Fern Street approach from the south, with a DOS of 0.902, queue length of 153 m and average delay 37.8 seconds. All of the other approaches operate at LOS A or B. The intersection operates at an overall LOS B, with an average delay of 22.5 seconds.

**Operational impacts**

*Midblock Level of Service*

Table 6.13 shows the midblock LOS that has been estimated for the two main carriageway sections of the proposal for the AM peak, PM peak and worst case 100th hour peak period scenarios. Projected 100th hour traffic volumes for the 2034 design year would operate in acceptable traffic flow conditions, with the highway performing at an acceptable LOS C north of Rose Valley Road and LOS B west of Belinda Street. The predicted midblock LOS at both highway locations falls within the concept design criteria set out for the proposal, which states that the proposal must perform at LOS C or better for the 100th highest hour.

**Table 6.13: Midblock level of service (LOS) summary (2034)**

<table>
<thead>
<tr>
<th>Location</th>
<th>AM peak hour (veh/hr)</th>
<th>PM peak hour (veh/hr)</th>
<th>100th hour (veh/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princes Highway, north of Rose Valley Road</td>
<td>2,663</td>
<td>3,222</td>
<td>4,341</td>
</tr>
<tr>
<td>Princes Highway, west of Belinda Street</td>
<td>1,723</td>
<td>2,065</td>
<td>2,790</td>
</tr>
</tbody>
</table>

*Interchange performance*

Table 6.14 provides details of the 2034 operating conditions for the two grade-separated interchanges and the Fern Street and Belinda Street intersection in Gerringong.

The table shows that the majority of approach arms on the Princes Highway, Rose Valley and Fern Street interchange west and east ramps would operate at LOS B or better, with only the minor Rose Valley Road east approach performing at LOS C. The average delay for ramps on the western side of the interchange would be 10.4 seconds and 5.1 seconds for ramps on the eastern side. The overall DOS for the interchange is 0.309 for the western side and 0.268 for the eastern side.

Similarly, the majority of approach arms on the southern Princes Highway and Belinda Street interchange would operate at LOS B or better, with only the Willowvale Road south approach performing at LOS C. The average delay for ramps on the western side of the interchange would be 11.4 seconds and 5.9 seconds for ramps on the eastern side. The overall DOS for the interchange is 0.481 for the western side and 0.544 for the eastern side.

The Belinda Street and Fern Street roundabout would operate within capacity at LOS C with an overall average delay at the roundabout of only 21.5 seconds. The highest average delay per vehicle and DOS is recorded on the Fern Street south approach at 30.5 seconds and 0.906 respectively.
### Table 6.14: 100th peak hour intersection analysis (2034)

<table>
<thead>
<tr>
<th>Intersection / approach</th>
<th>Veh/h</th>
<th>LOS</th>
<th>DOS</th>
<th>95% back of queue (m)</th>
<th>Av delay (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princes Highway / Rose Valley / Fern Street interchange west ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rose Valley Road east</td>
<td>509</td>
<td>B</td>
<td>0.309</td>
<td>20</td>
<td>10.6</td>
</tr>
<tr>
<td>Princes Highway on / off ramp</td>
<td>68</td>
<td>A</td>
<td>0.055</td>
<td>3</td>
<td>8.4</td>
</tr>
<tr>
<td>Rose Valley Road west</td>
<td>44</td>
<td>B</td>
<td>0.055</td>
<td>3</td>
<td>10.7</td>
</tr>
<tr>
<td>Total</td>
<td>621</td>
<td>B</td>
<td>0.309</td>
<td>20</td>
<td>10.4</td>
</tr>
<tr>
<td>Princes Highway / Rose Valley / Fern Street interchange east ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fern Street</td>
<td>492</td>
<td>A</td>
<td>0.268</td>
<td>0</td>
<td>8.2</td>
</tr>
<tr>
<td>Princes Highway off ramp</td>
<td>519</td>
<td>A</td>
<td>0.260</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Rose Valley Road east</td>
<td>80</td>
<td>C</td>
<td>0.159</td>
<td>5</td>
<td>16.4</td>
</tr>
<tr>
<td>Total</td>
<td>1,091</td>
<td>-</td>
<td>0.268</td>
<td>5</td>
<td>5.1</td>
</tr>
<tr>
<td>Princes Highway / Belinda Street interchange west ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willowvale Road south</td>
<td>258</td>
<td>C</td>
<td>0.481</td>
<td>26</td>
<td>16.4</td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>542</td>
<td>A</td>
<td>0.303</td>
<td>0</td>
<td>9.0</td>
</tr>
<tr>
<td>Total</td>
<td>800</td>
<td>-</td>
<td>0.481</td>
<td>26</td>
<td>11.4</td>
</tr>
<tr>
<td>Princes Highway / Belinda Street interchange east ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>715</td>
<td>A</td>
<td>0.392</td>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>Princes Highway off ramp north</td>
<td>458</td>
<td>A</td>
<td>0.541</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>Belinda Street west</td>
<td>233</td>
<td>A</td>
<td>0.138</td>
<td>10</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>1,406</td>
<td>-</td>
<td>0.544</td>
<td>40</td>
<td>5.9</td>
</tr>
<tr>
<td>Belinda Street / Fern Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fern Street south</td>
<td>702</td>
<td>C</td>
<td>0.906</td>
<td>171</td>
<td>30.5</td>
</tr>
<tr>
<td>Belinda Street east</td>
<td>353</td>
<td>C</td>
<td>0.643</td>
<td>56</td>
<td>22.3</td>
</tr>
<tr>
<td>Fern Street north</td>
<td>542</td>
<td>B</td>
<td>0.652</td>
<td>61</td>
<td>14.9</td>
</tr>
<tr>
<td>Belinda Street west</td>
<td>576</td>
<td>B</td>
<td>0.690</td>
<td>69</td>
<td>16.2</td>
</tr>
<tr>
<td>Total</td>
<td>2,173</td>
<td>C</td>
<td>0.917</td>
<td>171</td>
<td>21.5</td>
</tr>
</tbody>
</table>

**Travel time analysis**

The 2006 base year TRACKS traffic model has been developed with inputs including traffic volume, travel time and land use and demographic data. Using these inputs the model has been calibrated to ensure an accurate representation of current highway conditions in the proposal study area.

Following the development of a model to represent current traffic conditions, a 2026 future year model has been developed to estimate the effects the proposal would have on future travel times and speeds. The results of this modelling are included in Table 6.15 with the extent of the routes shown in Figure 6.3.
Future year modelling of the proposal shows that upgrading the alignment of the highway (minor shortening the effective length of the route) combined with an increase in posted speeds; create a travel time saving of 1.4 minutes in the northbound direction, and 1.1 minutes in the southbound direction in comparison to current conditions on the Princes Highway. It is estimated that travel times along the ‘Sandtrack’ would remain roughly constant at between 10.0 and 10.5 minutes. This means that travel times on the Princes Highway are estimated to 50 per cent faster than the corresponding ‘Sandtrack’ route.

Traffic crashes

The proposed highway upgrade would be expected to significantly improve road safety conditions along and adjacent to, the Princes Highway corridor. Traffic crash analysis has been undertaken by comparing existing and proposed conditions to determine corresponding crash reduction statistics based on historical data for the five year period between 1 July 2003 and 30 June 2008. The results from the analysis are shown in Table 6.16.
The most effective road safety improvements of the proposal would be the upgrade of major at-grade intersections to interchanges and the inclusion of median safety barriers, preventing opposing direction crashes (100 per cent reduction). Highway improvements would reduce crashes between vehicles travelling in the same direction (-75 per cent), as well as ‘off-path’ crashes (-13 per cent on straights, -42 per cent on curves). It is estimated that total crashes would have been reduced by 69 per cent under the proposed conditions.

Table 6.17 shows that the improved alignment along with the installation of a median safety barrier for the length of the proposal and median closure at all interchanges is expected to result in an annual reduction of around 11 crashes between Mount Pleasant Lookout to Belinda Street, with the potential to eliminate all of the fatal crashes that occurred during this period. The crash rate per vehicle kilometre also experiences a large reduction, falling by 39.3 to 14.3.

Between Belinda Street and Toolijooa Road, road safety improvements are not as dramatic as between Mount Pleasant Lookout and Belinda Street, due to the lower base level of crashes. Total crashes reduce by around 50 per cent, as do tow-away crashes. Casualty crashes are estimated to drop by 20 per cent, while fatal crashes would potentially reduce to zero.
### Table 6.16: Crash statistics: annual average 1 July 2003 - 30 June 2008 (existing and proposed conditions)

<table>
<thead>
<tr>
<th>Crash statistic</th>
<th>Crashes</th>
<th>Crash rate (Total / 100MVKM)</th>
<th>Crash severity index</th>
<th>Crash costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Fatal</td>
<td>Casualty</td>
<td>Tow-away</td>
</tr>
<tr>
<td>Mount Pleasant Lookout to Belinda Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing conditions</td>
<td>15.0</td>
<td>0.8</td>
<td>6.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Proposed conditions</td>
<td>4.0</td>
<td>0.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Change in conditions</td>
<td>-11.0</td>
<td>-0.8</td>
<td>-4.6</td>
<td>-5.6</td>
</tr>
<tr>
<td>Belinda Street to Toolijooa Road</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing conditions</td>
<td>2.4</td>
<td>0.2</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Proposed conditions</td>
<td>1.4</td>
<td>0.0</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Change in conditions</td>
<td>-1.0</td>
<td>-0.2</td>
<td>-0.2</td>
<td>-0.6</td>
</tr>
</tbody>
</table>

Source: AECOM, based on RTA Southern Region Crash Data & RTA Crash Reduction Guide
Table 6.17: Existing and proposed crash statistics based on Highway Safety Improvements (1 July 2003 – 30 June 2008)

<table>
<thead>
<tr>
<th>Section</th>
<th>Scenario</th>
<th>Intersection (adjacent approaches)</th>
<th>Vehicles from opposing directions</th>
<th>Vehicles from same direction</th>
<th>Off-path (on straight)</th>
<th>Off-path (on curve)</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount Pleasant lookout to Rose Valley Road</td>
<td>Existing</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Proposed</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Rose Valley Road to Fern Street, Gerringong.</td>
<td>Existing</td>
<td>24</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Proposed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fern Street to Belinda Street, Gerringong</td>
<td>Existing</td>
<td>10</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Proposed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Belinda Street, Gerringong to Toolijooa Road</td>
<td>Existing</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Proposed</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>Existing</td>
<td>34</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>12</td>
<td>4</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Proposed</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>13</td>
<td>7</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Crash reduction (%)</td>
<td></td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>13%</td>
<td>42%</td>
<td>0%</td>
<td>69%</td>
</tr>
</tbody>
</table>
6.6.4 Safeguards and management measures

Construction

- A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements and procedures to be used when activities or areas of work have a potential impact on existing traffic arrangements. The TMP would be submitted in stages to reflect the progress of work and would:
  - Identify the traffic management requirements during construction.
  - Describe the general approach and procedures to be adopted when producing specific traffic control plans.
  - Ensure the continuous, safe and efficient movement of traffic for both the public and construction workers.
  - Maintain the capacity of local roads.
  - Provide 80 km/h construction zone speed where possible.
  - Minimise delays and disruptions are kept to a minimum.
  - Minimise impacts on existing Princes Highway and local traffic.
  - Provide access to local roads and properties, including the use of temporary turn-around bays.
  - Provide temporary works and traffic signals.
  - Determine the number and width of traffic lanes in operation.
  - Identify traffic barrier requirements and placement.
  - Public transport, pedestrian and bicycle facilities.
  - Include methods for implementing the traffic management plan.
  - Include methods for minimising road user delays.
  - Provide signposting.
  - Road closures, including Fern Street during construction of the new railway overbridge.
  - Construction methods and staging would be designed to minimise road closures, subject to other proposal constraints and ensure that disruption to the existing traffic is maintained within acceptable levels.
  - Traffic diversions or stages would include lane and shoulder closures on either the existing, temporary or new pavements. Road occupancy licences would be obtained for each type of construction work involving closures.
  - Provide traffic management measures during the closure of Fern Street, such as temporary traffic lights, to improve the performance of the off ramp approaches.
  - Ensure the Belinda Street interchange is fully upgraded and operational prior to the closure of Fern Street.

Operation

- Traffic monitoring would be undertaken for the Princes Highway and key local roads in Gerringong including Belinda Street and Fern Street. Traffic volumes would be assessed against those predicted.
6.7 Noise and vibration

A noise and vibration assessment for the proposal was undertaken in February 2010 (refer to Appendix J). The assessment has been carried out in accordance with the NSW DECCW Environmental Criteria for Road Traffic Noise (ECRTN), Interim Construction Noise Guideline (DECC 2009), Assessment of Vibration: A technical guideline (DEC 2006), the RTA’s Environmental Noise Management Manual (RTA 2001) and relevant construction vibration standards. The report includes noise and vibration related to the construction and operation of the proposal, identifies sensitive locations and assesses potential noise and vibration impacts.

6.7.1 Criteria

The proposal is classed as an arterial road and according to the RTA’s Environmental Noise Management Manual (ENMM), the proposal would be considered as a ‘redevelopment’ of an existing arterial road. The noise criteria for the proposal are identified in Table 6.18.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Base goal</th>
<th>Where criteria are already exceeded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redevelopment of an existing freeway / arterial</td>
<td>$L_{Aeq}(15hr)$ 60 dB(A) $L_{Aeq}(9hr)$ 55 dB(A)</td>
<td>In all cases, the proposal should be designed so as to not increase existing noise levels by more than 2 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.</td>
</tr>
</tbody>
</table>

6.7.2 Existing environment

The noise sensitive receivers near the proposal comprise isolated rural houses and the low density urban area of Gerringong in close proximity to the east of the highway.

Noise monitoring was carried out at three locations in or near the study area to measure current traffic noise, ambient and background noise levels. Figure 6.4 shows a map illustrating these locations.
Table 6.19: Noise monitoring locations

<table>
<thead>
<tr>
<th>Monitoring site number</th>
<th>Monitoring site description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Princes Highway, Gerringong. Second storey veranda, 55 m to road and 100 m to rail.</td>
</tr>
<tr>
<td>2</td>
<td>Austral Park Road, Toolijooa. Free field in paddock.</td>
</tr>
<tr>
<td>3</td>
<td>Austral Park Road, Toolijooa. Free field.</td>
</tr>
</tbody>
</table>

It should be noted that loggers 2 and 3 are outside of the Gerringong upgrade study area, however traffic flows on the Princes Highway close to loggers 2 and 3 are representative of flows on the Princes Highway south of Gerringong. Measurements from these logger locations were used to calibrate the traffic noise model.

Noise logging occurred continuously from 8 February 2007 through 19 February 2007. Current noise levels are below the noise criteria for requiring noise mitigation. Table 6.20 presents a summary of the noise levels at each monitoring location.

Table 6.20: Summary of ambient noise measurement results

<table>
<thead>
<tr>
<th>Location</th>
<th>Ambient noise levels</th>
<th>Subjective description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Day</strong> $L_{Aeq(15hr)}$</td>
<td><strong>Night</strong> $L_{Aeq(9hr)}$</td>
</tr>
<tr>
<td>1</td>
<td>56</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>48</td>
<td>46</td>
</tr>
</tbody>
</table>

All extraneous noise events and noise data affected by adverse weather conditions were excluded from the logging results in calibration.
Figure 6.4: Monitoring locations
6.7.3 Potential impacts

Operational noise

Operational noise calculations were conducted using measured and predicted traffic volumes for the existing road configuration and the upgraded road configuration in 2018 (after opening) and in 2028 (opening plus ten years). The noise contours in Figure 6.5 and Figure 6.6 show the day ($L_{Aeq,15hr}$) and night ($L_{Aeq,9hr}$) noise levels at each noise sensitive receiver in 2028, ten years after opening.

During the daytime the ECRTN goal of $L_{Aeq(15hr)}$ 60 dB(A) would be exceeded at 52 residential properties in 2028. During the night-time period, the ECRTN goal of $L_{Aeq(9hr)}$ 55 dB(A) would be exceeded at 97 residences in 2028.

Of the residences that are likely to be exposed to noise levels exceeding the ECRTN goals, 83 exceed the allowance of 2 dB(A) over future existing noise levels, exceed the allowance of 2 dB(A) over the noise goals or, where future existing noise levels already exceed the noise goals, are defined as “Acute”. There are 22 isolated rural dwellings along the Princes Highway where exceedances are predicted. Noise levels at five of these properties exceed the ECRTN goals by more than 10 dB(A), noise levels at nine of these properties exceed the ECRTN goals by 5 dB(A) to 10 dB(A) whilst noise levels at the remainder of the properties exceed the ECRTN goals by up to 5 dB(A).

Within Gerringong there are 62 properties that would be eligible for consideration of mitigation measures where reasonable and feasible (refer to Appendix J). Noise levels at 17 of these properties exceed the ECRTN goals by 5 dB(A) to 10 dB(A), these properties are all located immediately east of the railway line adjacent to the Princes Highway. Noise levels at the remainder of the properties in Gerringong exceed the ECRTN goals by less than 5 dB(A).

Should noise attenuation such as a barrier be considered appropriate and installed as part of the proposal, it may reflect some noise from passing trains to the residential properties immediately to the east of the railway line. However, the increase in railway noise as a result of the potential construction of noise attenuation would be barely perceptible and is considered unlikely to cause criteria exceedances.
Figure 6.5: Day time operational noise in 2028

Figure 6.6: Night time operational noise in 2028
Construction noise

It is anticipated that the proposal would require some works to be undertaken outside the working hours of:

- Monday – Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and Public Holidays: No work.

This would be to minimise disruptions to local businesses, reduce the overall construction time and to provide for special delivery of plant and materials to site.

There would be generally be five phases of work:

1) Site clearance – clearing the land areas adjacent to the existing road.
2) Earthworks – removing soils and creating embankments and landscaping,
3) Road works – removing existing carriageway and constructing new road.
4) Culvert installation – installation of culverts under carriageway.
5) Bridge works – construction of new bridges.

Table 6.21 below presents the total noise levels for each phase of the construction and the associated sound pressure levels.

Table 6.21  Construction noise prediction

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Noise management level</th>
<th>Construction noise phase</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Greatest exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A¹</td>
<td>54</td>
<td>75</td>
<td>65</td>
<td>76</td>
<td>74</td>
<td>78</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>B²</td>
<td>54</td>
<td>69</td>
<td>59</td>
<td>70</td>
<td>68</td>
<td>72</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>C³</td>
<td>54</td>
<td>65</td>
<td>55</td>
<td>67</td>
<td>64</td>
<td>68</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>D⁴</td>
<td>46</td>
<td>79</td>
<td>69</td>
<td>81</td>
<td>78</td>
<td>82</td>
<td></td>
<td>36</td>
</tr>
</tbody>
</table>

1 First row of houses adjacent construction zone – Gerringong township
2 Second row of houses adjacent construction zone – Gerringong township
3 Third row of houses and beyond adjacent construction zone – Gerringong township
4 Various rural farmhouses

The results of the assessment indicate that construction phases 1 to 5 would exceed noise management levels by between 14 dB(A) and 36 dB(A). Construction noise control and management would therefore be implemented for all the catchment areas during all phases of construction.

It is likely that some the use of rock breaking machinery and blasting may be required to excavate material in some areas and this would have a potential noise and vibration impact during construction.
Construction vibration impacts

The closest vibration sensitive receivers are located 25 m to 30 m from the proposed construction works. The noise and vibration assessment found that it is therefore unlikely that any structural damage would be caused by construction vibrations. There may be some vibration perceptible to people within 100 m of vibration intensive equipment, which may cause a short-term annoyance during construction.

6.7.4 Safeguards and management measures

Operational noise

It is reasonable to consider mitigation if the ECRTN goals are exceeded for the design year at residential properties (2028) by:

1) Greater than 2 dB(A) above the future existing noise levels;
2) Greater than 2 dB(A) above the noise goals detailed in the ECRTN; or
3) “Acute” (65 dB(A) $L_{Aeq(15hr)}$ or 60 dB(A) $L_{Aeq(9hr)}$ or above), where future existing noise levels already exceed the noise goals (Section 2.2 Practice Note (iv) in the Environmental Noise Management Manual).

With the exception of Gerringong, the majority of properties that are eligible for consideration of mitigation measures are isolated properties or properties clustered in small groups. Where receivers are in groups of three or less, it would be considered acceptable and cost effective to provide architectural treatments instead of installing roadside barriers.

The following mitigation measures would be considered in the proposal:

- Noise attenuation would be considered during detailed design to reduce road traffic noise levels at the residential properties located immediately to the east of the railway line adjacent to the Princes Highway. The indicative location of noise attenuation is shown in Figure 6.7 possible attenuation could include a noise barrier, or mound, or combination of both, which would be investigated in more detail during detail design.
- In addition to the noise attenuation, architectural treatments would be considered at the detailed design stage for properties where appropriate eg for isolated properties where a noise barrier would not be feasible. Depending on the level of impact, architectural treatments may include provision of fresh air ventilation, sealing of wall vents, upgraded window and door seals and upgraded windows and doors for more heavily impacted residences.
- A low noise road surface such as open graded asphalt or stone mastic asphalt, would be considered as an alternative to architectural treatments for properties within Gerringong and may reduce the size and scale of the noise attenuation required. This option would be subject to a cost benefit analysis during detailed design.

The mitigation measures would be determined in detailed design where reasonable and feasible and in consultation with property owners.
Construction noise

Selection of plant, type of operation, activity duration and time of day would take sensitive receivers into account. The contractor would be required to demonstrate best practicable means and include noise mitigation measures in the construction management plan. These would include, but not be limited to the following:

- Where possible, construction activities would be limited to between 7am and 6pm Monday to Friday and 8am to 1 pm Saturday.
  - Where work is undertaken outside of the standard working hours it would be in accordance with the DECCW Interim Construction Noise Guideline (DECC 2009) and the procedure contained in the RTA’s Environmental Noise Management Manual 2001, “Practice Note vii – Roadworks Outside of Normal Working Hours”.
- Where noise attenuation is identified, it would be constructed early where feasible to maximise the benefits during construction.
- Temporary barriers would be installed for stationary noisy equipment.
- Possible restrictions to construction hours (beyond the above hours) would be considered where noise impacts are increased.
- All plant items would be properly maintained and operated according to manufacturers’ recommendations in such a manner as to avoid causing excessive noise.
All pneumatic tools would be fitted with silencers or mufflers.

Any compressors brought on to site would be silenced or sound reduced models fitted with acoustic enclosures.

Induction and training would be provided to staff and sub-contractors outlining their responsibilities with regard to noise.

Affected property owners would be consulted and informed prior to works being carried out.

Develop a procedure for dealing with and responding to complaints.

Noise monitoring would be undertaken at sensitive locations as agreed with NSW DECCW for any excessive noise or noise complaints being assessed with appropriate action taken.

Appropriate consideration of the use of penetrating cone fracture (PCF) techniques or the use of expansive grouts for rock breakage where blasting is required in close proximity to residents.

Where residential locations are likely to be adversely affected, special construction noise mitigation measures would be applied including:

- Respite periods would be provided for any activities that result in impulsive or tonal noise generation or for residences that are highly noise affected ($\geq 75$ dBA).
- Negotiated agreements would be made with residences that are highly noise affected outside recommended standard hours.
- Timing and duration of noisy construction activities would be considered and opportunities to reduce their noise impact identified.
- Vehicle movements would be minimised outside normal daytime working hours.
- Site access points and roads would be selected away from residences where feasible.
- Noise source controls would be applied to reduce noise from plant and equipment.
- Plant and equipment would be selected based on its acoustic performance.
- All equipment would be operated and maintained in the correct manner (ie engine covers are in place, rattling components are tightened).
- Noisy activities would be combined to reduce their impact and duration where feasible.
- Distances between noisy plant items and sensitive receivers would be offset where possible.
- Equipment would be oriented away from sensitive areas.
- Equipment would be switched off during break times.
- Work compounds, parking areas, equipment and material stockpiles would be placed away from noise sensitive locations (where practical).
- Loading and unloading would be carried out away from sensitive areas where practicable.
- Where possible, portable enclosures would be used around fixed plant producing high noise levels, or operations conducted in close proximity to residences. This may apply to compressors, generators or similar plant items located outside a particular residence for an extended period of time.
- Where variable pitch reversing alarms are fitted to plant, they would be required to be set on the lowest safe level, and where practicable, endeavour to provide drive-through facilities to minimise utilisation of reverse warning devices. The use of broadband reversing alarms is strongly recommended.
Construction vibration

- Where vibration intensive equipment is used at distances up to 100 m from residential properties, prior notification would be given to residents and vibration monitoring would be undertaken. In addition, any properties deemed at risk of vibration damage would be inspected prior to construction commencement.
- Develop a procedure for dealing with and responding to complaints from people experiencing vibration impacts during construction.

6.8 Air quality

An air quality impact assessment was carried out for the proposal.

6.8.1 Existing environment

Motor vehicles emit a number of pollutants that are known to be potentially harmful to human health. These pollutants are carbon monoxide (CO), nitrogen oxides (NOₓ), hydrocarbons (HC, including benzene) and particulate matter. Each of these pollutants has the capacity to adversely affect health if the concentration is too great over a particular exposure period.

The NSW DECCW has historically noted air quality goals 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).

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

The closest DECCW monitoring station was located at Croom Road in Albion Park, approximately 15 km north of Gerringong. This site was decommissioned early in 2005 and a new station was commissioned at Terry Reserve (Albion Park South) in December 2005. Pollutants monitored at these sites were:

- Nitrogen dioxide (NO₂)
- Ozone (O₃)
- Sulphur dioxide (SO₂)
- Particulate matter (PM₁₀) (DEH, 2004)

Carbon monoxide (CO) was recorded at Wollongong.

Existing data recorded at the Croom Road and Terry Reserve monitoring sites over the 10 year period from 1997 to 2007 shows that:

- \( \text{NO}_2 \) concentrations are well below DECCW air quality criteria for both maximum one hour average and annual average.
- \( \text{O}_3 \) concentrations are regularly exceeded for the maximum one hour and four hour air quality goals. These exceedances can be attributed in part to variability in meteorological conditions and often occur in the warmer summer months when sunlight hours are higher. Bushfires can also cause elevated ozone concentrations.
PM$_{10}$ concentrations are on occasions above the 24 hour air quality goal, for example when dust storms occur.

PM$_{10}$ concentrations are well below the average annual DECCW air quality goal except when bushfires occur.

CO concentrations are well under the goals for one hour and eight hour average maximum

Future predicted air quality modelling on existing alignment

In 2007 a modelling study was conducted which investigated air quality impacts due to the existing highway alignment. The results of this modelling show that all the predicted concentrations are well below their respective air quality goals. The nearest residences through the township of Gerringong are about 50 m from the kerb. Levels at this distance due to existing traffic volumes are very low and well below air quality criteria.

6.8.2 Criteria

DECCW specifies ground-level concentration (glc) criteria for criteria pollutants (NSW DEC, 2005), as listed in Table 6.22.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Goal</th>
<th>Averaging period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td>30 mg/m$^3$</td>
<td>1 hour</td>
<td>WHO (2000)</td>
</tr>
<tr>
<td></td>
<td>10 mg/m$^3$</td>
<td>8 hour</td>
<td>NEPC (1998)</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
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<td>1 hour</td>
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</tr>
<tr>
<td></td>
<td>62 μg/m$^3$</td>
<td>Annual</td>
<td>NEPC (1998)</td>
</tr>
<tr>
<td>Particulate matter &lt; 10 μm (PM$_{10}$)</td>
<td>50 μg/m$^3$</td>
<td>24 hour</td>
<td>NEPC (1998)</td>
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<tr>
<td></td>
<td>30 μg/m$^3$</td>
<td>Annual</td>
<td>EPA (1998)</td>
</tr>
</tbody>
</table>

mg/m$^3$ – milligrams per cubic metre
ppm – parts per million
μg/m$^3$ – micrograms per cubic metre

6.8.3 Potential impacts

Operational impacts

Air quality standards and goals refer to pollutant levels which include the proposal and existing sources. The proposal would contribute to existing background pollutant concentrations in the area and the local air quality impacts due to emissions from the proposal have been assessed on this basis.

Two scenarios were assessed to estimate the future air quality impacts from operation of the proposal. The scenarios include:

- Upgraded roadway in 2018.
- Upgraded roadway in 2028.

Air quality impacts are dependent on meteorological conditions, traffic volumes, age and type of vehicles, emissions rates, type and quantity and the receptor location (ie distance from the roadway from 0 m to 50 m).
The air quality assessment estimated CO, NOₓ and PM₁₀ for 2018 and 2028 scenarios at the section of road which passed closest to residences in Gerringong. Results found that:

- **CO and NO₂** one hour and eight hour average concentrations are predicted to be within the relevant DECCW air quality standards for both 2018 and 2028 horizons.
- **CO and NO₂** cumulative one hour and cumulative eight hour average predicted concentrations are unlikely to exceed the DECCW criteria for 2018 and 2028 horizons.
- **PM₁₀** predicted 24 hour average concentrations along the proposed roadway are well below the DECCW criteria for 2018 and 2028. However, PM₁₀ concentration would exceed the 24 hour assessment criteria from time to time as background levels are on occasions already close to or in exceedance of the goal. These measurements can be influenced by regional events such as dust storms or localised events that only affect the area directly near the monitoring site and do not necessarily affect areas further away such as near the proposal.

When the predicted results are compared with results from the existing alignment (see Section 6.8.1 above), it can be seen that levels of CO and NO₂ are estimated to be unchanged or slightly lower for the proposed alignment, at the nearest residences.

In the case of a relatively rural area such as the study area, exceedances of particulate matter are often caused by local dust generating activities and are usually short lived. In these circumstances it is useful to consider the degree to which the proposal on its own contributes to the overall impact against the DECCW criteria.

Currently the median 24 hour average PM₁₀ exceeds the DECCW criteria. Following the completion of the proposal there would be a decrease in PM₁₀ levels to approximately 11 per cent of the DECCW criteria and a further reduction in 2028 to approximately 3.2 per cent.

At the nearest residence, approximately 50 m from the roadway, predicted concentrations comprise a very low 2.4 per cent or less of the air quality goal. It is therefore unlikely that the goal would be exceeded due to the small contribution from the proposal.

**Construction impacts**

Dust would be generated from earthworks associated with the construction of the proposal and the total amount of dust would depend on the silt and moisture content in the soil and the types of activities being carried out. There are a number of safeguards that can be put in place during construction to minimise adverse air quality impacts at sensitive receptors such as residential properties. As such, the impacts have not been specifically modelled.

The equipment to be used on-site would include, but not be limited to, such things as:

- Front end loaders
- Excavation plant
- Back hoes
- Vibrating rollers
- Concrete agitator trucks
- Concrete and asphaltic paving machines
- Water tankers
- Jack hammers
Bulldozers
Graders

The major sources of dust would be bulldozers, excavators and wind erosion of exposed surfaces during earthworks.

### 6.8.4 Safeguards and management measures

The DECCW's Managing Urban Stormwater Soils and Construction, Volume 2D Main Road Construction, 2008 and Landcom's Managing Urban Stormwater, Soils and Construction, Volume 1, Edition 4 contain safeguards to control air pollution. In accordance with DECCW the proposal would include mitigation measures such as:

- Watering of haul roads and sealing of roads where possible.
- Trucks entering and leaving the site would be well maintained in accordance with the manufacturer's specification to comply with all relevant regulations. Fines may be imposed on vehicles that do not comply with smoke emission standards. Truck movement would be controlled on-site and restricted to designated roadways. Truck wheel washes or other dust removal procedures would be installed to minimise transport of dust off-site.
- Modification of construction methods if necessary during periods of high wind.
- Watering / revegetating of stockpiles and exposed areas.

It may be necessary to carry out dust monitoring at sensitive receptors during construction to determine compliance with dust deposition goals currently noted by DECCW.

An air quality management plan (AQMP) for the proposed works would be undertaken as part of an overall environmental management plan (EMP). The general principles of the AQMP are listed below.

- All disturbed areas would be stabilised as soon as practicable to prevent or minimise wind blown dust.
- All unsealed trafficable areas would be kept sufficiently damp during working hours to minimise wind blown or traffic generated dust emissions.
- Water sprays, sprinklers and water carts would be employed if needed to adequately dampen stockpiles, work areas and exposed soils to prevent the emission of dust from the site.
- Stockpiles and handling areas would be maintained in a condition that minimises wind blown or traffic generated dust. Areas that may be inaccessible by water carts would be kept in a condition which minimised wind blown or traffic generated dust using other means.
- All equipment for dust control would be kept in good operating condition. The equipment would be operable at all times with the exception of shutdowns required for maintenance.
- Construction equipment would be properly maintained to ensure exhaust emissions comply with the POEO Act.
- Silt would be removed from behind filter fences and other erosion control structures on a regular basis, so that collected silt did not become a source of dust.
- Any dust, soil or mud deposited on public roads by sub contractors construction activities and vehicle movements would be removed immediately and disposed of appropriately.
6.9 Urban design

An urban design, landscape character and visual impact assessment was undertaken for the proposal (refer Appendix K).

The urban design assessment evaluates the proposal with regard to:

- The proposal urban design objectives, developed prior to commencement.
- The contextual and landscape character units.
- The landscape character and visual impact assessment.

6.9.1 Urban design objectives and principles

The urban design objectives and principles were established and used to develop and assess the concept design in line with the RTA’s overall strategy for urban design of the Princes Highway and at a more detailed local level for the proposal.

The six objectives and design principles that make up the urban and regional design framework for the proposal are outlined in Table 2.3 in relation to the design response for the proposal.

6.9.2 Existing environment

The natural landscape setting of the study area and the greater context of the NSW South Coast is a constant interaction of ocean and beaches, rocky headlands, narrow coastal plains, escarpments and coastal ranges. In contrast to the permanent presence of the ocean, other landscape elements vary greatly in scale and interact in many different but ultimately harmonious combinations. The existing highway offers a rich driving experience that is layered into this landscape.

The study area has been divided into four landscape character units defined by the formation of the landscape, to best describe the proposal and assess the potential impacts. These character units are illustrated in Figure 6.8.
Mount Pleasant

At the northern end of the study area, Mount Pleasant, Saddleback Mountain and Currys Mountain separate Kiama from Gerringong. These mountains have resulted in the Princes Highway being located in close proximity to the coast. The area is covered in a mixture of pasture land with isolated clumps of remnant south coast forest on the lower slopes, before moving into more dense forest on the upper slopes. The escarpment formed by Mount Pleasant, Saddleback and Curry’s Mountain forms both a physical and visual containment to the broader landscape.
Omega Flat and Rose Valley

Rose Valley is a small catchment located below Saddleback and Currys Mountain. The Rose Valley catchment drains into Omega Flat and Werri Lagoon and a SEPP 14. The land is dominated by dairying plots mixed with mature cultural plantings. The patterns of land ownership and land use are evident within this landscape unit and articulated by plantings along property boundaries. Travelling along the section of the Princes Highway that passes over Omega Flat is the first opportunity for motorists to truly engage with the landscape rather than participating as an observer. The northern gateway into the township of Gerringong is situated within this character unit. The open nature of this landscape and its cultural and rural landscape patterns confirm the visual sensitivity of this area as high to moderate.

Gerringong

Gerringong is a small coastal town contained between the existing highway and the Pacific Ocean. The character of the town reflects its rural history and unique coastal location. The landscape of the town is characterised by its strong visual connections to both the coast and Rose Valley. Impressive historical plantings of Norfolk Island Pines line the main east-west axis of Belinda Street.

Despite recent growth, Gerringong retains the character and scale of a coastal village. The rolling topography within the town affords regular and expansive views of the coastline and hinterland. The existing Princes Highway bypasses Gerringong. The highway and adjacent railway line form the western boundary of Gerringong urban development and future growth is planned south of the existing town.

The township has developed and functions based on the two main routes through the town. The junction of Fern Street (running north-south) and Belinda Street (running east-west) forms the commercial centre of town. The proposal maintains the town access points similar to those currently in operation and it is unlikely that the proposed access arrangements would have a major influence on the functioning of the town. Figure 6.9 shows the existing land use and structure of Gerringong.
Crooked River catchment

The Crooked River catchment is an area south of Rose Valley and Gerringong. The upper area of the catchment is mostly pasture land. Below the existing highway and South Coast Railway line there are extensive areas of dairying and a waste water trial treatment plant. The landscape grades from gently undulating in the west to flat in the east. The landscape is only sparsely vegetated with trees, the majority of these being planted around existing dwellings or on the few steep slopes adjacent to the existing highway. The visual sensitivity of this character unit is considered high to moderate due the open nature of the landscape and the strong patterns of pastoral landscape.
6.9.3 Landscape character and visual impact assessment methodology

The methodology for the landscape character and visual impact assessment is based on the RTA’s Environmental Impact Assessment Guidance Note - Guidelines for landscape character and visual impact assessment (RTA, 2009b).

Assessment is carried out on the proposal as a whole, followed by an assessment for each of the four key landscape character units identified above.

A detailed methodology used in assessing landscape character and visual impact for each of the units is contained in Appendix K. The assessment provided in this chapter contains the following summary of the methodology:

The following method was used in assessing landscape character and visual impact for each of the units:

- A detailed description of the proposal.
- Identification of potential impacts from the proposal.
- Assessment of the visibility of the proposal.
- Assessment of the sensitivity to the proposed change.
- Assessment of the magnitude of the proposed change
- Overall assessment of the landscape and visual impact.

Assessment of the overall landscape and visual impact is derived by the combination of the sensitivity and the magnitude to change assessment, based on the following table:

<table>
<thead>
<tr>
<th>Character unit visual impact</th>
<th>Sensitivity</th>
<th>High</th>
<th>High to moderate</th>
<th>Moderate</th>
<th>Moderate to low</th>
<th>Low</th>
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Princes Highway – Gerringong upgrade
Review of Environmental Factors
6.9.4 Assessment of the overall proposal

Proposal description

Key elements of the proposal as they relate to the urban and landscape design are:

- New grade-separated interchange at Rose Valley Road including raising Rose Valley Road and a service road to Fern Street.
- New bridge at Fern Street over the railway line.
- Embankments to lift Fern Street access.
- Cutting through knoll adjacent to Gerringong township.
- Deep cutting near Sims Road adjacent to Gerringong township.
- Large embankment and raising of the highway across Omega Flats.
- New grade-separated interchange at Belinda Street combining a service road to Willowvale Road.
- Large embankment approaching Crooked River.
- Deep cutting past Crooked River.

A requirement for noise attenuation has been identified along a section of the highway upgrade at the northern end of Gerringong (refer Figure 6.7 in Section 6.7.4 for the indicative location).

Further investigations would be undertaken during the detail design phase to determine the most appropriate method of noise attenuation. Possible solutions may include a noise barrier, a vegetated noise mound (or combination of mound and wall), or architectural treatment of individual properties.

The proposed route and the location of the key elements are illustrated in Figure 6.10.
Impacts

The proposal would have a landscape character and visual impact from the following:

- The relative scale of the proposed upgrade this includes both in footprint (width), structure (bridges and overpasses) and in general elevation (flood mitigation).
- The introduction of large fill embankments and cut slopes.
- The amount of infrastructure required for the new town access points.
- The potential introduction of noise attenuation measures to be investigated during detailed design.
- The potential loss of existing roadside vegetation.

Visibility

Based on the open nature of the landscape and the localised topography the proposed upgrade generally all areas that are highly visible. Visibility and viewer sensitivity to the upgrade and modifications by the proposal was analysed from the perspective of assumed viewers. These are expected to be primarily adjacent residents and road users.

Sensitivity to proposed change

Viewer sensitivity of adjacent residents and road users within the area is expected to be medium to high based on:

- The relatively open nature of the landscape which the upgrade passes through.
- The long evolved and well established cultural patterns exhibited within the landscape.

Magnitude of proposed change

The magnitude of change to local residents and road users is expected to be high based on:

- The relatively open nature of the landscape which the upgrade passes through.
- The scale of the intervention required.
- The potential time frames for construction.

Assessment of impact

Based on the overall scale of the proposed intervention and the relative distance that the majority of users would experience these interventions from, the overall impact is rated as high to moderate. **Overall rating - high to moderate.**
6.9.5 Assessment of Mount Pleasant

Figure 6.11: Looking north-east at the descent from Mount Pleasant into Rose Valley along the existing highway

Proposal description

The proposal would include:

- A widening of the road from three lanes to separated dual carriageway.
- New cut batters to southern facing slopes.
- New concrete barriers to the centre median.
- Northbound climbing lane up Mount Pleasant.

Figure 6.12 to Figure 6.14 show different views of the proposal within the catchment.
Figure 6.12: Aerial view looking south-west towards Rose Valley, illustrating proposed cut embankments on the south-east facing slopes

Figure 6.13: Driver's view, heading north to the Kiama Bends illustrating proposed concrete median and cut embankments

Figure 6.14: Driver's view, heading north in the vicinity of the Fern Street bridge
Impacts

Intervention associated with the upgrade that would have a landscape character and visual impact on the Mount Pleasant landscape character unit would include:

- Increased footprint width of the upgrade.
- Increased cut batters to the south and south eastern facing slopes.
- Loss of some vegetation associated with the widening of the corridor.

Visibility

The southern slopes of Mount Pleasant enclose Rose Valley to the north and are clearly visible from the majority of Gerringong and from the residents on the southern side of Rose Valley. For northbound highway users the southern slopes of Mount Pleasant are highly visible all the way from Sims Road through to Rose Valley Road.

Sensitivity to proposed change

The views to Mount Pleasant are chiefly from the town of Gerringong, which is some distance away. Currently the Kiama Bends are the most noticeable element in the viewshed. The increased size of the new cuttings would have an impact but based on the distance away for the majority of people experiencing the Mount Pleasant landscape the sensitivity to change would be moderate.

Magnitude of proposed change

The experience of the Mount Pleasant landscape is broad and the changes are chiefly related to the widening of the road corridor and the increased footprint of the existing cut slope. The magnitude of this change would have a moderate impact.

Assessment of impact

Based on the overall scale of the proposed intervention and the relative distance that the majority of users would experience these interventions from, the overall impact is rated as medium.
6.9.6 Assessment of Omega Flat

Figure 6.15: Looking south over Rose Valley and Omega Flat, the strong grid pattern of the landscape is clearly evident

Proposal description

The proposal would include:

- A new interchange at Rose Valley Road including:
  - A bridge over the highway, the proposed bridge would include throw screens and lighting for safety.
  - North and sound bound on and off ramps.
  - A concrete reinforced earth wall between the highway and the south bound off ramp.
  - A bus pick-up and drop-off facility on Rose Valley Road.

- A new bridge at Fern Street over the South Coast Railway Line, with a total length of 180 m. The proposed bridge would include throw screens and be constructed on concrete piers.

Figure 6.16 to Figure 6.18 show different views of the proposal within the catchment.
Figure 6.16: Aerial view, looking south illustrating the Rose Valley Road bridge and southbound off ramp to Gerringong

Figure 6.17: Drivers view, heading north-east across Omega Flat, illustrating the Fern Street bridge to the east
Impacts

Interventions associated with the upgrade that would have a landscape character and visual impact on the Rose Valley and Omega Flat landscape unit include:

- Increased footprint width at the interchange with the addition of the southbound and northbound entry and exit ramps to access Rose Valley Road.
- New bridge over the highway that is elevated in the landscape and a new visible element.
- The widened road corridor would have impacts to the western edge of Renfrew Park Estate, requiring the removal of some existing vegetation, including a Moreton Bay Fig tree.
- Extensive earthworks including embankments to accommodate new roads and bridges as the proposed interchange is on a small ridge line.
- Impacts to mature Moreton Bay Fig trees on the south western side of the upgrade. The smaller of the two trees would be removed to accommodate the new ramp to exit from the Princes Highway to Rose Valley Road.
- The addition of the two lane bridge over the South Coast Railway Line would be the highest impact within Rose Valley and Omega Flat and would introduce an elevated element into the flat landscape. The likely structure would be visually imposing with an overall length of approximately 180 m.
- Prominence of the elevated embankment across Omega Flat providing 1 in 100 flood immunity.
Visibility

Rose Valley and Omega Flat are generally visible from the north and north-west facing slopes of Gerringong. The existing lookout at Mount Pleasant provides a view over Rose Valley, Gerringong, Seven Mile Beach, Mount Coolangatta and Shoalhaven Heads in the distance. The proposed bridge at Fern Street would introduce a large new element into this significant view. Within Rose Valley itself, there are a small number of residents that view across Rose Valley toward the highway, these views would also be impacted by the introduction of the proposed bridge over the railway line. Figure 6.19 shows the potential view of the proposal from Mount Pleasant looking south to Gerringong.

Figure 6.19: View of the proposal from Mount Pleasant looking south to Gerringong

Sensitivity to proposed change

In the vicinity of Rose Valley Road the road corridor is highly constrained by cultural elements including the significant Moreton Bay Fig trees to the west and the historic Renfrew Estate to the east.

The existing highway crosses the railway at grade and is part of the fabric of the area and the addition of the elevated bridge would have an impact. This would be tempered by the proposed bridge alignment matching the existing road configurations. There are no residences in the immediate area.

To the west the existing highway is generally unseen from Rose Valley. While some distance from the roadway the open nature of the existing landscape would be impacted on by the introduction of new infrastructure into the viewshed. The sensitivity to the proposed change would be high.

Magnitude of proposed change

The impact on existing landscape at Rose Valley Road would be high to moderate. While not a highly visible location, the potential removal of cultural plantings, the introduction of a bridge and introduction of cuttings, would all combine to impact on the existing landscape character and views to and from the highway.

The proposed bridge at Fern Street is approximately 180 m in length. The introduction of this element into a broad, flat and highly visible landscape would have a high magnitude of change.
Assessment of impact

Based on the overall scale of the proposed intervention and the relative distance that the majority of users would experience these interventions from, the overall impact is rated as high to moderate.

6.9.7 Assessment of Gerringong

Figure 6.20: View of Gerringong and its surrounding landscape

Proposal description

The proposal would include:

- New access arrangement at Fern Street with a two lane bridge over the South Coast Rail Line.
- New access arrangement at Belinda Street with four way access movements and a four lane bridge over Belinda Street.
- New cut embankments in the order of six to eight metres in height in the vicinity of Sims Road.

A requirement for noise attenuation has been identified along a section of the highway upgrade at the northern end of Gerringong (refer Figure 6.7 in Section 6.7.4 for the indicative location).

Further investigations would be undertaken during the detail design phase to determine the most appropriate method of noise attenuation. Possible solutions may include a noise barrier, a vegetated noise mound (or combination of mound and wall), or architectural treatment of individual properties.

Figure 6.21 to Figure 6.22 show different views of the proposal within the catchment.
Impacts

Interventions associated with the upgrade that would have a landscape character and visual impact on the Gerringong landscape unit include:

- The introduction of a large bridge into the broad and visible Omega Flat landscape at Fern Street.
- A reconfiguration of the south bound entrance to town.
- Loss of roadside vegetation to the western side of the existing highway north of Sims Road.
The elevation of the proposed highway by up to four metres above the existing level as it traverses the southern area of Omega Flat just north of Gerringong.

An extended section of raised highway associated with an overpass of Belinda Street, large embankment slopes and substantially increased footprint width in this area.

Potential introduction of noise attenuation measures in the vicinity of Gerringong. Key issues that would be considered during detailed design would include:

- The introduction of new large visual elements into the landscape can alter the quality of the landscape in sensitive areas such as the study area around Gerringong.
- Solutions may be limited due the availability of land and optimum location of noise attenuation.
- Noise barriers (and/or mounds) may have a high visual impact upon adjacent residents and stakeholders due to the height of the noise attenuation treatment, level of the property and any particular views available from properties.
- Noise attenuation treatment (barriers and/or mounds) can also have a visual impact when experienced by road users, and may affect the quality of the scenic, rural driving experience.
- Vandalism and graffiti can be a problem on built structures especially when located adjacent to an urban area.

The new access arrangements to Gerringong do not alter the existing hierarchy and functions of the two main streets, Fern Street and Belinda Street.

Visibility

As Gerringong has the majority of aspect facing north and north-east the visibility of the residents to the proposed bridge at Fern Street would be restricted. The bridge would also be approximately 500 m away from the nearest residences in northern Gerringong and Werri Beach. The additional widened footprint of the proposal would be visible to the north from Gerringong.

The Belinda Street interchange is located in close proximity to the industrial estate within Gerringong. With the local terrain, it would only be partially visible for residents of Gerringong generally on the west and south-west facing slopes. To the east, the railway line serves as a buffer and the highway is generally depressed into the landscape in this vicinity.

Sensitivity to proposed change

The changes, while large in scale, would also occur some distance from the township and are likely to be visible to only a few residences. Within the broader landscape context of Gerringong and Rose Valley the existing landscape would have a moderate sensitivity to change.

Magnitude of proposed change

The two proposed access points at Fern Street and Belinda Street are significant in scale and while not impacting the functioning of the internal local road network would introduce large changes in the broader landscape and alter the entrance and exit experiences for the township of Gerringong. The magnitude of the proposed change is high to moderate.
Assessment of impact

Based on the overall scale of the proposed intervention interfacing with the Gerringong landscape unit, the overall impact is rated as high to moderate.

6.9.8 Assessment of Crooked River

Figure 6.23: View looking north-east over the Crooked River

Proposal description

The proposal would include:

- The upgraded highway following the existing alignment through to the end of the proposal at Toolijooa Road.
- West of Gerringong the access ramps would connect with Willowvale Road and Bailey’s Road.
- New bridges to both the highway and associated ramps cross over Crooked River.
- New cut embankments and fill embankments west of Bailey’s Road to allow for the widening of the road.

Figure 6.24 to Figure 6.26 show different views of the proposal within the catchment.
Figure 6.24: Aerial view looking north at the configuration of bridge, underpass and river crossing.

Figure 6.25: Driver view travelling north, illustrating large cutting west of Gerringong. The start of the exit lane for Gerringong can be seen on the right.
Impacts

Interventions associated with the upgrade that would have landscape character and visual impacts to the Crooked River landscape unit include:

- Prominence of the interchange at Belinda Street which starts approximately 800 m to 900 m west of Belinda Street.
- The requirement for a bridge over Crooked River.
- The large cut and fill embankments required as part of the proposal.
- The loss of vegetation due to the road widening.

Visibility

The existing highway travels along a small ridgeline as it moves west. The current configuration is nestled into the terrain. While some distance from the roadway the open nature of the existing landscape would be impacted on by the introduction of new infrastructure into the landscape.

Sensitivity to proposed change

The landscape is very open in this area and potential changes would be highly visible. By utilising the existing highway and existing cuttings some of that impact would be mitigated. The sensitivity to change is moderate.

Magnitude of proposed change

The proposed upgrade follows the alignment of the existing highway in this area. The increased scale of the cuttings and would be integrated with the existing formations to minimise impact. The magnitude to change would be moderate,
Assessment of impact

Based on the overall scale of the proposal within the Crooked River landscape unit, the overall impact is rated as moderate.

6.9.9 Safeguards and management measures

Early planning is the key to achieving an integrated urban design strategy for the proposal, which would ultimately become part of the fabric of the community and landscape in which it is integrated. Development of the concept urban design has been a process of informing and being informed by each of the design team disciplines to ensure a holistic integrated solution which addresses the urban design objectives and associated design principles as discussed in Section 6.9.1.

The safeguards and management measures applied to the proposal would seek to:

- Apply the proposed urban design strategy and concept plan developed for the proposal (refer to Appendix K).
- Reduce the physical impacts of the upgrade works to the minimum required to achieve the proposal objectives.
- Replace at a minimum any tree and or large shrub plantings lost as part of the upgrade works.
- Integrate new vegetation with the existing landscape character by using culturally relevant species.
- Ensure that long-term integration of the upgrade into the existing landscape character is successful by selecting the appropriate footprint, blending the infrastructure with the surrounding landscape.
- Design retaining wall structures, cut embankments and fill slopes and bridges and associated elements in accordance with the urban design strategy (refer to Appendix K).
- Engage adjacent land owners in assessing if early works mitigation (e.g. landscape plantings) can be achieved to help reduce impacts of the upgrade.

Mitigation for design elements

Cut slopes

- Where high strength rock exists, use of the natural rock is the best solution for stabilisation.
- In low strength, highly erodible batters, stabilisation with vegetation in accordance with the landscaping plan to be developed during detailed design is desirable. Plantings are generally possible on slopes with a maximum of 2.5h:1v in circumstances where aspect and ground material permits.
- Consideration would be given to low strength rock being terraced (space permitting) with bench widths of approximately four metres, providing improved areas for planting and vegetation to establish.
Fill slopes

- Fill slopes would be blended into the adjacent contouring of the land by varying the slope range and feather-out to integrate with the existing grade. Slopes would vary between 2h:1v and 5h:1v to allow for best transition of the proposed upgrade into the landscape context. This would be dependent on available space and consultation with adjacent landowners.

- Where possible, cut and fill formations would be achieved with natural transitions, gently rounded out at both the top and bottom. Flattened embankments and less step cuts would be considered to enable improved integration of slopes and batters with the surrounding landscape. Additional land impacted at construction can be returned to former use once established.

- The use of shotcrete would be minimised where possible. If shotcrete is required for stabilisation, it would be applied in accordance with the RTA Shotcrete Guidelines (2005).

Retaining structures

- Retaining walls would be limited in their application and aesthetic to maintain the local and regional rural characteristic. Where retaining walls are required, they would be coordinated with other proposal elements including safety barriers, potential noise attenuation and light poles.

- All retaining wall cladding panels or form work would match the panel size proportions of other infrastructure elements.

- Where practicable retaining walls would provide a minimum of 1.5 m at the base of the wall for screen planting. The footings of the walls would be designed to maximise the area for soil at the base of these walls and integrate a waterproof membrane to prevent leaching and staining to wall face.

Bridge elements

- New bridges would be designed to be simple, clean structures that are fully integrated with the rest of the highway corridor. Minimum deck depths would be used and railing systems should be utilised on the parapets to reduce the visual mass of the structure. The joints in the superstructure would be integrated with the parapet.

- Lighting would be integrated to reinforce the dimensions of the bridge elements.

- Parapet ends would generally extend beyond abutments to ensure that the bridge is connected into its context.

- Where practicable, abutment treatments to either side of the bridge structures would be consistent.

- Bridges would be designed to be simple elements within the landscape and not as gateway or iconic elements. The physical bulk of these large infrastructure items would be reduced in favour of a slim superstructure and parapet detail.

Town entrances and access

- Appropriate cultural plantings and use of local materials would be utilised in developing a gateway that connects the town with this access point.

- A gateway design at Rose Valley interchange would be developed in conjunction with Kiama Municipal Council, the local community and the RTA. The landscape design outcome would be subtle and integrated with the adjacent landscape context and design elements (embankments, retaining walls and bridges).
Signature cultural plantings would be used to provide a visual connection to the landscape patterns within the town. This would include the use of either or both Moreton Bay Fig trees and/ or Norfolk Island pine trees.

Broad scale application of screening planting to the highway corridor would reinforce the upgraded corridor rather than provide an integrated solution. The reinforcement of the traditional cultural planting patterns in the landscape would be more sympathetic with the landscape context and provide an integrated solution for the upgrade.

Prominent local landscape species would be used for revegetation in accordance with the landscaping plan to be developed during detailed design.

The design would conform to the landscape design objectives as outlined in the RTA’s Landscape Guideline (2008).

With the consent of land owners ribbons of planting would extend perpendicular to the highway into the landscape where creek crossings and fence lines are located to reinforce cultural use of the land. Planting would be used to reinforce existing lines of vegetation, e.g. Fern Street Casuarina Avenue and would be developed in accordance with the landscaping plan during detailed design.

To minimise potential visual impacts, a key design objective during detail design would be to develop and design a solution which integrates with the surrounding environment. This would be achieved by applying an integrated design approach, involving all design disciplines to achieve predefined urban design objectives and design principles, and in consultation with identified stakeholders.

6.10 Socio-economic

A socio-economic assessment was undertaken for the Gerringong upgrade. The objective of the assessment is to provide an overview of potential socio-economic impacts associated with the proposal, and where possible identify mitigation measures. Refer to Appendix L for the detailed report.

6.10.1 Existing environment

The socio-economic profile is the town of Gerringong. The profile also examines the characteristics of the Kiama Local Government Area and nearby Gerroa, located two kilometres south of Gerringong.

Gerringong is a small coastal town located midway along the length of the proposal, approximately 130 km south of Sydney. The town is accessed from the Princes Highway at two points, one at the northern end of town at Fern Street and one at the southern end at Belinda Street.

Gerringong's industrial hub is located adjacent to the South Coast Railway Line and consists mainly of light industry. The commercial / business centre is located around Fern Street, Belinda Street and Blackwood Street. In addition to local shops and services, the town includes a number of tourist related activities including boutique hotel accommodation and bed and breakfasts, cafes and restaurants, beach related retail outlets as well as a number of lifestyle and craft related services.
In 2006, Gerringong was home to a population of 3,588 residents with a high proportion of retirees (aged 65 and over) living in the area. The total Gerringong labour force in 2006 was 1,584 and the unemployment rate of 3.6 per cent is below the NSW average unemployment rate of 5.9 per cent. In comparison, Gerroa is a much smaller community, with a population of 475 persons, a total labour force of 216 and unemployment rate of 4.2 per cent in 2006.

Part-time employment in Gerringong is higher than the state average at 36 per cent, likely reflecting high tourist sector employment. The main employment sources include education (14 per cent), retail (11 per cent), health care and social assistance (11 per cent), construction (11 per cent), accommodation and food services (9 per cent), public administration (9 per cent), manufacturing (7 per cent) and professional services (6 per cent). The average weekly income of $421 per individual and $1,198 per family is similar to the NSW average.

Rural localities in the study area predominantly consist of large lot agricultural holdings including dairy farming and vineyards, as well as designated environmental protection areas such as east and west of the existing Fern Street alignment, east of the proposal between Fern Street and Mount Pleasant and in another area at Willow Vale. Many of the farms and dwelling houses on these agricultural land holdings are located close to the highway and have direct access to the highway.

Generally, the topography is more rugged to the west of the highway. In these areas, heavily wooded areas are well established. Views from some of these areas stretch down to the Shoalhaven River and to the ocean. There are also a large number of farms to the west of the highway, some of which are “hobby” and “weekend” farms. The farms are serviced by the access roads adjoining the highway.

Land to the east of the highway is generally flatter, with a high percentage situated on the flood plain. This land is primarily used for dairy farming. One other activity of note is quarrying on Crooked River Road, which according to the operator, Cleary Bros., indirectly employs over 100 persons.

6.10.2 Potential impacts

Given the Princes Highway already exists as a major road transport corridor, and that the proposal generally follows the existing highway alignment, many of the operational, social and economic impacts associated with a road project, such as changes to the socio-economic profile, impacts on local businesses, connectivity and severance, would have already occurred.

Construction Impacts

The proposal is expected to generate construction worker employment during the two year period. Construction worker expenditure during the two year construction period would benefit local services in the vicinity of the highway, such as cafes and takeaways, service stations and potentially some accommodation providers. The expenditure would have flow on effects to other businesses in the area.

The proposal would not create any new severance impacts, however town access would be disrupted during construction. The main community impact is likely to be stress due to uncertainty of the construction process and the impacts this may have on their property and lifestyle.

Residents in the vicinity of the proposal may experience minor disruption to their daily lives due to loss of amenity during the construction phase from noise, visual amenity and air quality (dust) impacts.
The new rail overbridge at Fern Street may have a socio-economic impact during construction. Construction of the rail overbridge would require closure of the existing highway junction access at Fern Street for up to 12 months. Although the junction closure is unlikely to result in additional travel time, drivers would perceive an inconvenience.

A number of businesses (resort, hotel, cafes, ice cream shops, etc) are located on the Fern Street approach to the town centre and the temporary diversion to Gerringong via Belinda Street could result in a temporary loss of passing trade. However, given the proposal would generate construction worker expenditure the businesses are not expected to result in a loss in turnover. Additionally many of these businesses are located on the southern section of Fern Street in the town centre (near Belinda Street) and an effective signposting and traffic management strategy (directing traffic to the centre of town via Belinda Street) would be developed to manage the impacts.

Operational Impacts

During operation, residents in the vicinity of the Gerringong upgrade may experience noise and visual impacts which would require mitigation, as described in the noise and vibration assessment (Appendix J) and the urban and landscape design assessment (Appendix K).

The proposal is not expected to create major community impacts and town access would not be altered during operation.

The removal of the Fern Street level crossing facility following the construction of the rail overbridge would remove exposure to rail / motor vehicle crashes and also remove the need for motorists to stop to allow a train to pass, creating travel time and vehicle operating cost savings. Moreover, removing the level crossing would remove the need for annual maintenance of level crossing controls and equipment. Additionally, costs from periodic upgrades (approximately every eight years) would be eliminated.

The change of access provisions for private properties and some local roads to left turn in and left turn out only, would have the potential to increase journey time for some residents and other road users who currently turn right across the existing highway. However, with improved driver sight distance, the need to give-way to traffic in one direction only and the provision of a two metre sealed shoulder, road safety would be greatly enhanced on the upgraded Princes Highway.

Consultation has identified a need for some more immediate pedestrian/cycle connection to Gerringong as this movement is effectively prevented by the left turn in, left turn out configuration for Sims Road junction with the upgraded highway. A shared cycleway / footpath is proposed to link Sims Road to Gerringong via the Belinda Street interchange, providing a safer route to town.

The proposal would improve journey times and road safety for highway users, particularly due to the rail overbridge on Fern Street, which replaces the level crossing. On the Princes Highway, head-on collisions would be eliminated, and other crashes associated with the existing highway alignment would be greatly reduced. The detailed traffic assessment conducted for the proposal found that fatal crashes on the upgrade could potentially be eliminated altogether, based on the types of crashes in the area which have previously caused fatalities.

Most properties directly affected by the proposal have agricultural uses, specifically dairy pasture owned by members of the Gerringong Dairy Farmers Cooperative. The operation of agricultural and farm lands can be affected if an upgrade passes directly through an agricultural property or if access is reduced. As well as loss of productive land, farmers can incur additional costs in moving or replacing high cost equipment such as milking machines.
There are not expected to be any properties severed by the Gerringong upgrade given strip acquisition would occur at the edge of the existing road reserve. Furthermore, all existing property accesses would be maintained as part of the proposal.

Land acquisition would be required as part of the Gerringong upgrade, with full acquisition of three properties and strip acquisition affecting up to 31 properties. Based on preliminary adjusted road boundaries, the proposal would require approximately 993,400m$^2$ (99.34 ha) of private land.

Of this total, the breakdown between full and partial strip acquisitions is shown below:

- Full acquisitions (three properties) - 743,050m$^2$ (74.305 ha).
- Partial acquisitions (31 properties) - 250,350m$^2$ (25.035 ha).

The majority of the strip acquisitions affect farming / class 2 and class 3 agricultural land, but is generally not considered large enough to significantly alter production and economic viability. The impacts that may be most detrimental are associated with reduced subdivision potential with reduction in some affected lot sizes and rebuilding potential.

### 6.10.3 Mitigation measures

Mitigation measures to address potential negative impacts have been considered for both the construction and operational phases of the proposal.

**During construction:**

- The community would be kept informed by providing regular information and updates such as:
  - Letter box drops, media releases, and/or community updates.
  - An internet site established and maintained for the duration of the proposal.
  - Variable message signs.
  - Targeted consultation with affected individuals or groups including the Gerringong Chamber of Commerce, Kiama Municipal Council and local tourism promoters.

- Information would be provided to the community including:
  - Changes to access and traffic conditions.
  - Details of future works programs.
  - General construction progress.

- Visual, air quality and noise and vibration management plans would be developed prior to construction to manage amenity impacts.

- Traffic impacts would be managed through the preparation of a detailed traffic management plan to include construction staging.

- Construction methods and staging would be designed to minimise road closures, subject to other proposal constraints. Staged construction would be allowed so that disruption to the existing traffic is maintained within acceptable levels.

- Adequate signage would be provided to ensure that drivers are aware of how to access Gerringong town centre and Gerroa during the temporary closure of Fern Street.

- The RTA would continue to consult with the community (Gerringong Chamber of Commerce, Kiama Municipal Council, local tourism promoters and where appropriate other community members) as it determines mitigation measures for the impact of the temporary closure of Fern Street.
Land would be acquired in accordance with the RTA Land Acquisition Policy (and under the terms of the Land Acquisition (Just Terms Compensation) Act 1991).

Property access would be maintained and provided throughout construction and operation. Should temporary or alternative property access be required this would be provided in consultation with the affected landowner(s).

Ancillary services, such as accommodation, catering and office supplies, would be locally sourced where possible and cost effective.

During operation:
A strategy would be developed to provide appropriate signage on the Princes Highway on approach to Gerringong and near to interchanges to identify Gerringong and Gerroa as stopping destinations.

6.11 Land use

6.11.1 Existing environment

From north-east to south-west the study area passes over Omega Flat, past Werri Lagoon, beside the town of Gerringong and terminates at Toolijooa Road in Toolijooa. The pasture land and rural settlement patterns of the study area and the existing highway corridor are defining features. The rural landscape that exists today is highly reflective of agricultural activities that have been occurring since the first half of the nineteenth century.

The largest agricultural influence has come from dairying activities. The agricultural land is a mix of class two (the land is suitable for grazing and cropping and occasional cultivation) and class 3 (the land is suitable for grazing, pasture improvement, and occasional cropping). Dairying activities have defined the general pattern of vegetation clearance, defined rural boundaries by linear cultural plantings, and the distribution of rural houses and farm buildings.

A large number of farms are located to the west of the highway, some of which are “hobby” and “weekend” farms. The farms are serviced by the access roads adjoining the highway. Land to the east of the highway is generally flatter and situated on the flood plain. This land is primarily used for dairy farming.

The rural backdrop is slowly changing and the partial decline in the dairying industry has created a more complex landscape pattern. A wider variety of agricultural activities is resulting in more areas under cultivation.

Kiama Municipal Council’s LEP provides provisions for land use planning within its LGA. Table 6.23 and Figure 6.27 detail the land use zones and corresponding objectives that are applicable to the proposal.
Figure 6.27: Gerringong LEP zoning

The Council of the Municipality of Kiama

THE COUNCIL OF THE MUNICIPALITY OF KIAMA

Mount Pleasant Ridge

ROSE VALLEY

Willow Vale

GERRINGONG

Kiama LEP 1996
Zoning Type
1(a) Rural A
2(a) Residential A
4(c) Extractive Industrial
4(d) Light Industrial
5(a) Special Uses
5(b) Special Uses (Railway)
6(a) Existing Recreation
6(b) Proposed Recreation
7(a) Rural Environmental Protection (Sustainable Wetlands)
7(b) Rural Environmental Protection (Scenic)
7(c) Rural Environmental Protection (Hinterland)
7(d) Rural Environmental Protection (Forsythe Protection)
9(a) Proposed Arterial Road
9(a) Arterial Road
Deferred Matter

LEGEND
- Railway
- Existing Princes Highway
- Eastern Gas Pipeline
- Council Border
- Other Roads
- Study Area
- Council Border
- National Parks
- Wetlands
- Waterbody

GERRINGONG UPGRADE - GERRINGONG LEP ZONING

MAY 2010
60021933

0 0.25 0.5 1
km
<table>
<thead>
<tr>
<th>Zone No. 1(a) – Rural A (agricultural production)</th>
<th>Relationship to the proposal</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurs predominantly throughout the study area</td>
<td>(a) to provide suitable land for agricultural use.</td>
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<td></td>
<td>(b) to protect the agricultural potential of rural land.</td>
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<td></td>
<td>(c) to prevent the fragmentation of rural land, prime crop and pasture potential.</td>
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<td></td>
<td>(d) to enable uses that are compatible with the rural use of the land.</td>
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<tr>
<td></td>
<td>(e) to protect the landscape quality of the rural area.</td>
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<td></td>
<td>(f) to cater for small domestically-based enterprises that do not adversely affect the environment or the amenity of the neighbourhood and its residents.</td>
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<tr>
<td></td>
<td>(g) to ensure that development and land management practices do not have an adverse effect on water catchments, water quality, land surface conditions and important ecosystems such as streams, estuaries and wetlands.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone No. 5(b) – Special Uses (railways)</th>
<th>Relationship to the proposal</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurs to the east of the proposal following the alignment of the South Coast Railway Line</td>
<td>(a) to identify land to be used for railway purposes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) to ensure that development and land management practices do not have an adverse effect on water catchments, water quality, land surface conditions and important ecosystems such as streams, estuaries and wetlands.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone No. 7(b) – Rural Environmental Protection (estuarine wetlands)</th>
<th>Relationship to the proposal</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurs to the east and west of the existing Fern Street alignment in the vicinity of the proposed Fern Street bridge</td>
<td>a) to identify and preserve estuaries and wetlands and allow them to continue to function as a diverse and natural ecosystem.</td>
<td></td>
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<tr>
<td></td>
<td>(b) to prohibit development within the zone that is likely to have a detrimental effect on the biological and physical function of the wetlands.</td>
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<td></td>
<td>(c) to restrict public works to those which provide essential services where no other alternative is available and which would not have a detrimental effect on the habitat or landscape qualities of the wetland or other significant coastal habitat areas.</td>
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<tr>
<td></td>
<td>(d) to prohibit the clearing of land except for the careful control of noxious plants by means not likely to be significantly detrimental to the native ecosystem.</td>
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<tr>
<td></td>
<td>(e) to encourage the enhancement of wetland values by reinstatement of the natural water regime and vegetation.</td>
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<tr>
<td></td>
<td>(f) to provide for changes in sea and related water levels.</td>
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</tbody>
</table>
| Zone No. 7(d) - Rural Environmental Protection (scenic) | Occurs extensively to the east of the proposal between Fern Street and Mount Pleasant and in another area at Willow Vale. | (a) to protect vegetation and land of significant scenic or aesthetic value.  
(b) to preserve, within the land referred to in paragraph (a), significant vegetation stands and promote revegetation programs.  
(c) to preserve dominant land forms which contribute to significant landscapes and form part of an aesthetic environmental feature.  
(d) to provide suitable land for agricultural use.  
(e) to protect the agricultural potential of rural land.  
(f) to prevent the fragmentation of rural land of prime crop and pasture potential.  
(g) to allow on lawfully cleared prime crop and pasture land the continuation of animal grazing and cropping practices associated with the use of land for agriculture.  
(h) to cater for small domestically-based enterprises that do not adversely affect the environment or the amenity of the neighbourhood and its residents.  
(i) to ensure that development and land management practices do not have an adverse effect on water catchments, water quality, land surface conditions and important ecosystems such as streams, estuaries and wetlands. |
| Zone No. 9(a) - Proposed Arterial Road | Occurs immediately adjacent the proposal to the north of the existing alignment at Mount Pleasant. | (a) to provide for the opening of new, and widening of existing, arterial roads as identified on the map.  
(b) to ensure that development and land management practices do not have an adverse effect on water catchments, water quality, land surface conditions and important ecosystems such as streams, estuaries and wetlands. |
Kiama Municipal Council and the Department of Planning are currently reviewing the Illawarra Regional Strategy to determine a southern boundary for development in Gerringong. It is envisaged that further residential development would be west of Elambra Estate. Kiama Municipal Council is currently considering a development application for a SEPP 21 Caravan Park of about 370 cabins at the end of Campbell Street.

6.11.2 Potential impacts

Widening the Princes Highway to the west of the existing alignment means the proposal would extend into adjacent land use zones and potentially impact upon their objectives. The proposal is consistent with the objectives of the proposed arterial road zone given the proposal is widening an arterial road (Princes Highway). There would be no impact to the objectives of the special uses (railway) zone given the proposal would construct an overbridge to span the South Coast Railway Line.

The proposal would result in the loss of up to 99.34 ha of class 2 and class 3 agricultural land (mix of class 2 and class 3) within the rural agricultural land use zone. The proposal would undertake strip acquisition to minimise fragmentation of class 2 and class 3 agricultural land, help protect the agricultural potential and help protect the landscape quality of the rural area. Maintaining access to rural land holdings would enable the proposal to be compatible with the rural agricultural zone. Through the implementation of the safeguards from Table 7.1 the proposal would be generally consistent with this zone.

The proposal is generally consistent with the objectives of rural protection (wetlands) zone given the design parameters and drainage structures would allow estuaries and wetlands to continue to function as a natural ecosystem. The Princes Highway would provide an essential service, especially in times of flood. Additionally the design parameters and the implementation of the safeguards means the proposal would not have a detrimental affect on natural ecosystems, water quality and land surface conditions.

The proposal would not have an impact on potential residential development located west of Elambra Estate given its outside of the study area.

6.11.3 Safeguards

- All acquisition would be undertaken in accordance with the Land Acquisition (Just Terms Compensation) Act, 1991 and RTA’s Land Acquisition Policy. The Act guarantees that, if and when the land is acquired by the RTA under the Act, the amount of compensation would not be less than the market value (assessed under the Act), unaffected by the proposal.
6.12 Waste

6.12.1 Waste management strategies

In following the resource management hierarchy principles embodied in the *Waste Avoidance and 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 Act are as follows:

1) Avoid unnecessary resource consumption as a priority.
2) Avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling and energy recovery).
3) 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 8.2.

6.12.2 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 proposal.
- **Excavated material** - The proposal would utilise as much site-generated material as possible. Excavated material is not expected to be a major waste stream and a cut / fill balance would be achieved where possible. Where a cut / fill balance cannot be achieved excess material would be reused within the proposal where practicable. Possible reuse may include revegetation and landscaping works or possible stockpiling for use on other roads projects.
- **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 or during packaging.
- **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.
6.12.3 Safeguards and management measures

A resource and waste management plan (RWMP) would be prepared in accordance with RTA QA Specifications and the RTA’s Waste Minimisation & Management Guidelines, 1998 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 ‘avoid’ ‘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.

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.
- Green waste that could not be re-used during revegetation works would be transported to an appropriate waste depot for recycling. Non-weed species would be mulched for on-site reuse wherever possible, in preference to transportation off-site.
- Any noxious weeds identified would be disposed of in accordance with the requirements of the Illawarra District Noxious Weeds Authority (IDNWA) for the disposal of noxious weeds.
- Any disposal of non-recyclable waste would be in accordance with the EPBC Act and DECCW’s Waste Classification Guidelines: Part 1 Classifying Waste (DECCW 2009).
- 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 licences and approvals would be obtained from DECCW 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.
- 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 where practicable.
- 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, if not connected to town sewer, be regularly emptied and serviced by the contractor providing them.
Putrescibles 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.

The works site would be left tidy and rubbish free on completion of the proposal.

Management of acid sulphate soils would be in accordance with the acid sulphate soils management plan and the RTAs Guideline for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA 2005).

6.13 Greenhouse gas emissions and sustainability management measures

6.13.1 Background

One of the objects of the EP&A Act is to encourage ecologically sustainable development (ESD). The Environmental Planning and Assessment Regulation 2000 (Regulation) provides the principles of ESD that must be considered when justifying the carrying out of a development or activity. The principles of ESD are discussed in detail in Section 8.2.

Consideration of ESD and general sustainability management measures through the early development stages of the proposal would help to ensure that the objectives of the EP&A Act are met.

An ESD workshop was held in December 2007, which facilitated the further development of some of the findings of the preliminary environmental investigations.

At the workshop it was decided that further detailed assessment of sustainability and climate change impacts should be undertaken to address the recent and continuing increase in scientific knowledge and public awareness of sustainability and climate change impacts. The Sustainability Factors, Climate Change and Economic Appraisal Report (ESD Report) presents the findings of the work conducted after the ESD workshop. This report is publically available on the project website. The purpose of the study was to provide information on greenhouse gas emissions, climate change vulnerability and the economic impacts from climate change and emissions production to feed into the value management process and the selection of a preferred option.

The study included:

- Assessment of the impacts of climate change, greenhouse gas (GHG) emissions, greenfield land consumption and peak oil to the proposal.
- Determination of which of the potential adaption measures for climate change, greenhouse gas emission and peak oil would provide value for money.
- Recommendations for sustainable construction techniques for the proposal.

Reducing GHG emissions is a major public concern and transport is a substantial contributor to GHG emissions in Australia. GHG emissions would be generated during the construction and operation of the proposal.
GHG emissions are categorised into three different scopes (either scope 1, 2 or 3) in accordance with the Intergovernmental Panel on Climate Change (IPCC) and Australian Government GHG accounting / classification systems. The emissions from the proposal associated with each scope are outlined in Table 6.24.

**Table 6.24: Emissions from the proposal per scope**

<table>
<thead>
<tr>
<th>Scope 1 - direct emissions</th>
<th>Scope 2 - indirect emissions</th>
<th>Scope 3 - upstream indirect emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions generated directly by the proposal</td>
<td>Emissions generated outside of the proposal's boundaries to provide energy to the proposal</td>
<td>Upstream emissions due to third party supply chains that are in direct relation to the proposal (e.g. extraction, production and transport of purchased materials and waste disposal off-site)</td>
</tr>
<tr>
<td>• The use of fuel by construction plant / equipment on-site.</td>
<td>• The use of electricity on-site, purchased from the grid.</td>
<td>• The use of construction materials.</td>
</tr>
<tr>
<td>• The vegetation permanently cleared.</td>
<td></td>
<td>• The use of fuel for the transportation of construction / waste materials to/from the site.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The use of electricity on-site, purchased from the grid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The use of fuel by construction plant / equipment on-site.</td>
</tr>
</tbody>
</table>

6.13.2 Existing environment

Base case emissions

The base-case scenario (no upgrade) is used as a point of comparison to determine whether greater or fewer emissions would occur as a result of the proposal. Under the base case scenario, there are no emissions associated with construction. Operations emissions include those associated with maintenance, repair and vehicles using the road. Under the base case scenario, operations emissions are estimated to be in the order of 17,153 tonnes of CO₂-e per year.

6.13.3 Potential impacts

Construction and operation of the proposal would result in the emission of greenhouse gases.

Impacts from construction emissions

GHG emissions associated with construction of the proposal were calculated using SimaPro. The construction of the proposal would generate approximately 58,342 tonnes of CO₂-e. The results as shown in Figure 6.28 display that the majority of GHG emissions are indirect upstream emissions (Scope 3 emissions) associated with the use of construction materials, including transporting the materials to the site and the use of construction plant. Figure 6.29 shows that concrete contributes the largest amount (37 per cent) to the GHG emissions, followed by asphalt (29.5 per cent).
Impacts from operations emissions

Operations emissions for the proposal were modelled on a 2013 base year by calculating the emissions from fuel consumption of light vehicles (LV), heavy vehicles (HV) and predicted traffic volumes on the upgraded road.

The annual operations emissions of the proposal are estimated at 17,826 tonnes of CO$_2$-e, compared with 17,153 tonnes of CO$_2$-e per year if the road is not upgraded. As seen in Table 6.25 this represents a deficit in emissions savings of 673 tonnes per year.
Table 6.25: Annual operations emissions

<table>
<thead>
<tr>
<th></th>
<th>Base case (no upgrade)</th>
<th>Upgrade</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuel (kL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV</td>
<td>4,530</td>
<td>4,599</td>
<td>-69</td>
</tr>
<tr>
<td>HV</td>
<td>2,361</td>
<td>2,550</td>
<td>-189</td>
</tr>
<tr>
<td><strong>Emissions (t CO₂e)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV</td>
<td>10,783</td>
<td>10,947</td>
<td>-164</td>
</tr>
<tr>
<td>HV</td>
<td>6,370</td>
<td>6,879</td>
<td>-509</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17,153</td>
<td>17,826</td>
<td>-673</td>
</tr>
</tbody>
</table>

Although there is expected to be a slight increase in emissions, these are minimised as a result of the addition of lanes and changes in horizontal and vertical alignment which enables more consistent speed as well as reduced acceleration up slopes and stop-start driving.

The proposal would increase GHG emissions compared to that from traffic on the existing highway due to the effects of higher travel speeds on fuel consumption. However, without the proposal the existing highway is likely to become heavily congested which would also increase GHG emissions over time.

6.13.4 Safeguards and management measures

Emission reduction opportunities

*Operations*

Reductions in operational emissions are achieved by developing an optimal design, in particular through vertical and horizontal alignments and reduction of stop start driving, and are cumulative over the design life of the proposal.

- Innovative technologies would be considered for integration into the design to power traffic management systems or lighting (eg photovoltaic panels where appropriate).

*Construction*

GHG emissions can be reduced in the construction phase of the proposal by setting goals, managing planned objectives and implementing sustainable construction techniques.

- Consideration would be given to the procurement process and the preferential selection of materials with higher recycled content (eg recycled aggregate in concrete) and lower embodied energy. The whole life cycle of materials would be considered including extraction, manufacture, transport to site, related waste and tipping.
- Materials would also be selected based on availability of local resources in order to minimise the energy requirements over the life of these materials.
- The construction fleet would be comprised of vehicles and construction plant / equipment with high fuel efficiency and low GHG intensive fuel such as biofuels (eg biodiesel, ethanol). Construction plant / equipment would be maintained to reduce energy efficiency losses associated with damaged / unmaintained equipment.
- Green site offices would be installed, considering passive design strategies such as orientation, natural ventilation and user-operative environments (eg shading and operable windows) to reduce energy loads. Purchase of green power would be considered for proposal related activities.
6.13.5 General sustainability management measures

The following measures would be incorporated into the proposal and help to ensure that the objectives of the EPA&A Act to amongst other things, encourage ecologically sustainable development, are met.

General sustainability management measures

- A conservational approach would be taken to water management including:
  - Consideration of the use of recycled water during construction, sourced from the Gerroa Treated Effluent Irrigation Scheme.
  - Use of dust suppressor additives to reduce evaporation and attract more dust particles to save water.
  - Water harvesting from construction sites.
  - Bio-swales to treat runoff.
  - Sediment basins.
  - Spill containment at appropriate locations.
  - Appropriate infrastructure and culvert design.
- Recycling programs would be implemented in site offices and for construction waste.
- The RTA would hold a sustainability workshop with the design and construction teams in the early detailed design stages to identify proposal-specific opportunities for emission reduction, resource conservation and sustainability initiatives (through technologies and innovation).

6.14 Climate change

6.14.1 Existing environment

Climate change refers to future changes in climate that are driven by an increase in heat from the sun, retained in the earth's atmosphere. There is presently a general consensus amongst climate experts that climate change is occurring (IPCC 2007).

The impacts of climate change on the proposal were assessed using contemporary climate change research conducted by IPCC, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Bureau of Meteorology (BOM), AustRoads, and other climate change experts sourced from peer reviewed journals and published reports.

Climate models prepared by CSIRO and BOM predict that the future climate on the south coast of NSW, including the study area, would have:

- Lower average rainfall.
- More intense extreme rainfall events.
- Higher sea level and storm surge events.
- Higher average temperatures.
- More frequent occurrence of extreme temperatures.
- More frequent extreme fire danger days.
Climate change adaptation for road infrastructure is a relatively new field of study. Few specific studies have been published in the past on infrastructure projects and most of these provide qualitative approaches but no quantification of costs or adaptation measures.

6.14.2 Potential impacts

Design impacts

Road infrastructure is generally designed for a life up to 100 years although specific elements would have different design lives. In Australia, the urbanisation of more coastal and regional areas leads to the development of road infrastructure, such as the proposal, in zones that are potentially the most vulnerable to effects of climate change. During the 20th Century the utilisation of the coast has increased significantly and human-induced pressures are exacerbating the impacts of climate change in these areas (Nichols et al. 2007).

Climate change could potentially affect the proposed upgrade through changed average conditions and extreme events resulting in the following impacts:

- Damage to bridges and a requirement to upgrade bridges to meet current RTA design standards for intense design rainfall events.
- Degradation of concrete caused by carbonation when poorly cured or when cover is insufficient.
- Unacceptable build up of flood water upstream of the road in more intense design rainfall events and a requirement to upgrade drainage infrastructure to prevent this occurring.
- Damage to footings from changes in chemical composition of dryer soil, or movement due to more extremes in wet and dry conditions.
- Landslides or damage to natural or engineered slopes.
- Increased frequency of road or lane closure due to infrastructure damage, flooding and bush fires.
- Compounding effects on flooding from sea level rise.
- Accelerated degradation of bituminous pavements and road formation (road substructure).

The proposal would serve an important ‘essential services’ function in the event of any catastrophic weather or other event affecting the communities it serves. It is therefore important that the road is designed and maintained with resilience to be able to withstand extreme weather events. This would provide continued access for other essential services for communities that may be adversely affected by extreme weather events, sea level rise or other emergencies.

Economic impacts

Climate change impacts, such as increased frequency and duration of rainfall and storms, sea level rise, changes in water content of soils and changes in wind speed\(^1\), can result in road and lane closure from flooding, accelerated but gradual degradation of infrastructure, or damage to infrastructure from extreme events.

\(^1\) http://www.coag.gov.au/meetings/130407/docs/national_climate_change_adaption_framework.pdf
The base case scenario for the economic impact study considers the effects of future predicted climatic events on the road, built to current RTA standards with no adaptation measures implemented. As there is a great deal of uncertainty associated with climate change impacts, the probability of an event occurring was used to calculate the expected costs of climate change, assuming no adaptation measures are adopted. If the cost for repairs and maintenance under a changed climate regime are greater than the costs for designing the upgrade to withstand future conditions, then considering adaptation in design is worthwhile.

Climate change adaptation involves planning to reduce vulnerability to climate change and associated consequences. The vulnerability of industry, settlements and society to climate change mainly relates to extreme weather events rather than to gradual climate change (Wilbanks et al. 2007). Low-lying areas would be exposed to increasing risks, including erosion over the coming decades due to climate change and sea level rise (Nichols et al. 2007).

Vulnerability to climate change is generally greater in high-risk locations such as coastal and riverine areas (Wilbanks et al. 2007). Nichols et al (2007) recommend that adaptation measures should be indispensable for coastal roads in the medium and long terms since sea level rise is considered unavoidable on those time scales due to the significant inertia of the climatic systems. While the proposal is not defined as a ‘coastal’ road, adaptation would be considered due to its proximity to the coast as it would be affected by climatic changes within the area and is an important service route when nearby coastal towns such as Gerringong are affected by extreme events.

The economic analysis highlighted the following in relation to the proposal:

- A substantial impact from climate change is caused by the requirement to upgrade drainage infrastructure to prevent unacceptable build up of flood water upstream of the road in the more intense design rainfall events.
- It is worthwhile adapting the design of drainage infrastructure (i.e. culverts) for projected future more intense design rainfall events in the highway at the construction stage; however, it is not worthwhile adapting the design of bridges for projected future design rainfall intensity at the construction stage and regular bridge maintenance or repairs is a more cost effective climate change adaptation strategy.
- Expenditure required to adapt the pavement does not provide value for money and regular pavement maintenance is a more cost effective climate change adaptation strategy.

Damage to infrastructure, including that identified in Table 6.26 is likely to increase the frequency of road or lane closure.

Road closure would be required where bridges are damaged or roads are severely flooded or damaged making them impassable by traffic. Road closure has an economic impact, particularly on non-discretionary (essential) trips due to the additional travel time required to detour, the additional travel time costs; and additional vehicle operating costs.

Lane closure on the other hand, would be required during less severe flooding or road damage and would have economic impacts due to lower speeds on the existing route, which increases journey time and changes vehicle operating costs.
6.14.3 Safeguards and management measures – climate change adaptation

Adaptation strategies can be expected to fall into one of four categories, namely a change in:

- *Selection* of materials for infrastructure exposed to changed climatic conditions, based on the desired life expectancy of the infrastructure and maintenance regime.
- *Design* standards of particular components of infrastructure allowing for changes in the range of expected extreme events as well as accelerated degradation of materials and structures.
- *Maintenance* regimes over time to accommodate acceleration in the degradation of materials and structures.
- *Technologies* where an existing technology may not be able to deliver the required standard of performance or service under changed climatic conditions (Holper et al., 2007).

It is often argued that adaptation costs for vulnerable coasts are much less than the cost of inaction (Nichols *et al.* 2007). Where the cost for implementing adaptation measures in the design is less than the cost of repair and maintenance resulting from climate change, early adaptation is worthwhile.

The economic analysis for the proposal highlighted that it is worthwhile upgrading drainage infrastructure to withstand future predicted conditions but that expenditure required to adapt pavements and bridges for the proposal would not provide value for money compared with expenditure on more frequent maintenance and repairs.

The adaptation measures for the proposal are outlined in Table 6.26,
<table>
<thead>
<tr>
<th>Impact</th>
<th>Climate change variables</th>
<th>Impact</th>
<th>Recommendations</th>
</tr>
</thead>
</table>
| Materials - concrete | - Frequency and temperature of extremely hot days.  
- Increase in atmospheric carbon dioxide concentration. | - Accelerated degradation. | - Upgrade structural expansion joints. |
| Materials - protective coatings | - Frequency and temperature of extremely hot days. | - Accelerated degradation. | - Review specifications for protective coatings and update them if necessary so that they can meet the changed conditions. |
| Bituminous surface and road pavement | - Frequency and temperature of extremely hot days.  
- Increased intensity of solar radiation. | - Dryer climate would reduce the amount of moisture available to degrade road pavement, but higher cycling of pavement temperatures caused by extreme heat would increase cracking and opportunities for ingress of moisture.  
- Increased high temperatures and solar radiation would make binder compounds more brittle and increase the rate of degradation. | - Increased maintenance regimes would be considered where appropriate to maintain bridges and bituminous pavement and formation. |
| Landslides | - Extreme rainfall. | - No major threat | - Lay back soil layers at tops of cuttings where feasible. |
| Bridges | - Extreme rainfall.  
- Extreme wind-speed.  
- Average maximum temperature and extreme daily temperatures. | - Bridges would have to be upgraded to meet RTA design standards in more intense 100 year ARI events under future climate change.  
- All bridges are at risk from higher velocity extreme wind events induced by climate change. | - Design bridge to meet RTA design standards for future 100 year ARI rainfall events*.  
- Remove clay material or use piles to access deeper and more suitable material. |
<table>
<thead>
<tr>
<th>Impact</th>
<th>Climate change variables</th>
<th>Impact</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridges</td>
<td></td>
<td>Bridges are also vulnerable to contraction of the ground around footings due to drying caused by the predicted higher average temperatures, which may destabilise footings. (This is only likely to impact bridges founded in clay soils).</td>
<td></td>
</tr>
<tr>
<td>Drainage infrastructure</td>
<td>Extreme rainfall.</td>
<td>The capacity of road drainage infrastructure would have to be upgraded to prevent overtopping of the road during flooding caused by the more intense 100 year ARI design rainfall events in the future climate scenario.</td>
<td>Upgrade drainage infrastructure*.</td>
</tr>
</tbody>
</table>

* Subject to a value for money assessment.
6.15 Operational hazards and risks

6.15.1 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:

- General operational traffic accidents associated with road travel involving single and multiple vehicles, pedestrians and cyclists.
- 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. Those hazards and risks associated with construction would be managed through implementing the mitigation measures outlined in Section 7.

6.15.2 Potential impacts

The proposal is not expected to generate any additional hazards and risks beyond those associated with a normal road infrastructure 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.

Higher travel speeds

The improved alignment and geometry of the proposal would have 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.

Interaction between pedestrians, cyclists and vehicles

There would be minor potential for interaction between pedestrians, cyclists and vehicles on the proposal. However, the proposal would be designed to incorporate all appropriate safety measures to Australian Standards to minimise potential risk and the level of interaction would be similar to the existing highway.

Pollution

There would be a potential for vehicular generated pollutants including hydrocarbons, combustion derivatives, lubricants, petroleum, rubber and heavy metals to enter the road drainage network and runoff into adjacent waterways. However, the level of pollution generated by the proposal is not expected to be greater than that generated on the existing highway.

The potential risk of pollution caused by accidental spills would be minimised by the incorporation of appropriate water quality treatment measures within its drainage network including sediment and spill control basins. Furthermore, the improved alignment and geometry of the proposal would increase driver safety and potential for additional hazards and risks are expected to be low.
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.

6.15.3 Safeguards and management measures

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 substantial 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.

6.16 Cumulative environmental effects

6.16.1 Potential impacts

The proposal is part of ongoing improvements in safety and efficiency for the Princes Highway. It is anticipated that in the near future the RTA would carry out further upgrade works of the Princes Highway south of the current proposal, to Bomaderry.

The upgrade of the Princes Highway forms part of the RTA’s broader strategy of providing four lanes between Sydney and Jervis Bay Road, which includes the North Kiama Bypass; Oak Flats to Dunmore; South Nowra and the future bypass of Albion Park Rail. With the recent opening of the Oak Flats to Dunmore upgrade, the section of highway from south of Mount Pleasant to Bomaderry will remain the only two lane section of the Princes Highway between Sydney and Nowra.

The issues for those future sections of work are likely to include vegetation removal; fauna impacts; large scale earthworks and associated sediment and erosion control and water quality issues; impacts to Aboriginal heritage areas and non-Aboriginal heritage items; visual amenity, noise and other social and community issues and loss of productive class 2 and class 3 agricultural land through full and partial acquisition. Cumulative impacts for those future sections of work are likely to be moderate.

There are no known construction projects currently or proposed to be undertaken by Kiama Municipal Council within the vicinity of the proposal. However council are currently considering a development application to construct a caravan and tourist park comprising 365 sites at the south end of Gerringong.

Positive cumulative benefits of the proposal would include:

- A safe, sustainable and efficient road transport system:
  - Significant road safety improvements, resulting in an estimated 69 per cent reduction in crashes.
  - High standard road network conditions to meet future challenges facing the operation and performance of the Princes Highway corridor.
  - Sufficient road network capacity and the provision of future widening, to support population growth and demographic change on the south coast, in addition to regional and local economic development.
  - Increased travel time efficiencies and fewer delays as a result of crashes and ensuing maintenance activities.
- Improved access and reduced travel times which would have the effect of increasing visitation to the region and support local tourism developments such as a caravan park development application currently under consideration by Kiama Municipal Council.
- Supports the social functioning of the community, providing a structure around which the built environment can be enhanced.
  
  • Provision of safe grade-separated interchanges providing for all movements access to Gerringong at both the northern and southern ends of town.
  • Provision of 1 in 100 flood free access where feasible to Gerringong at the Belinda Street interchange.
  • Creation of up to 2,990 jobs over the two year construction period.
  • Provision of a rail overbridge on Fern Street spanning the South Coast Railway Line, which has been identified as number 20 in the New South Wales Government's top 300 priority list for safety treatment of level crossings.

Negative cumulative impacts of the proposal would include:

  • Reduction in the visual amenity of the Princes Highway during construction.
  • Loss of up to 99,340m² (99.34 ha) of agricultural (mix of class 2 and class 3) and rural residential land through full and partial acquisitions.
  • Generation of approximately 58,342 tonnes of CO₂-e during construction.
  • Impacts to some heritage items, including some items of Aboriginal cultural value and some impact to non-Aboriginal heritage items.
  • Introduction of large scale and/or raised infrastructure elements in a relatively flat landscape that would alter the visual amenity, including bridges, interchanges, raised carriageways and potentially noise walls.

6.16.2 Safeguards and management measures

Safeguards detailed in Section 7 of this REF would be implemented to mitigate the cumulative impacts of the proposal.

6.17 Summary of beneficial effects

The beneficial effects associated with the construction of the proposal would include:

  • Improvements in road safety to reduce road accidents on the Princes Highway between Mount Pleasant and Toolijooa Road including:
    - Barriers in road medians
    - Provision of four-way, grade-separated interchanges at both the northern and southern ends of Gerringong and the removal of right hand turns (eg at Fern Street crossing)
  • Maintenance of existing travel patterns through Gerringong with the provision of access point at both ends of the town.
  • Provision of an additional fourth southbound access to the Princes Highway at the northern end of town.
  • Improved travel time through optimised grades and reduction of stop-start driving
- Improved efficiency of the Princes Highway by providing capacity for current and projected traffic growth and the provision of future widening.
- Long-term emission reduction through operational efficiencies.
- Improved flood immunity for the highway to meet the 1 in 100 year event particularly across Omega Flat and provision of 1 in 100 flood immune access where feasible to Gerringong via Belinda Street interchange.

6.18 Summary of adverse effects

The proposal would result in some adverse effects, which would include:

- Temporary increases in noise and dust emissions during construction.
- Short-term disruption to traffic flows during construction.
- Increased heavy vehicle movements during construction.
- Potential for sedimentation of local waterways as a result of construction activities.
- Loss of up to 99,3400 m² (99.34 ha) class 2 and class 3 agricultural and rural residential land.
- Impacts to some Aboriginal and non-Aboriginal heritage items.
- Potential short-term impact on traffic flows through Gerringong with the closure of Fern Street during construction of the Rose Valley Road interchange.
- Adverse visual impacts associated with the introduction of large scale and/or raised infrastructure elements in a relatively flat landscape.

The majority of adverse effects would be of a temporary nature only, and the impacts would be managed during the construction period in accordance with the CEMP.