7.2 Impacts on channel structure - receiving environments

Director-General's requirements	Where addressed
Impacts on Channel Structure – Receiving environments: the Environmental Assessment must include a geomorphic assessment of channel structure for all receiving waterways.	Section 7.2
The assessment must consider potential increase in the frequency and intensity of storm events and increased runoff from paved surfaces to determine potential impacts on the structural integrity of receiving environments.	Section 7.2.2
The assessment should also consider the potential impacts of flow concentration due to all proposed (and existing) drainage structures with respect to the above.	Section 7.2.2
The scope of assessment is to include all ephemeral drainage lines likely to receive increased or concentrated runoff from the development in addition to Glenugie Creek, the main receiving waterway, for the length of the proposed development (CH4415 – CH8500).	Section 7.2.2

7.2.1 Existing environment

Receiving waterways and drainage network

The project area drains to Glenugie Creek including a number of minor unnamed creeks and tributary streams within the Glenugie Creek catchment. The Glenugie Creek catchment drains to the Clarence River.

Glenugie Creek and the unnamed tributaries that drain the project area include intermittent and ephemeral waterways with generally small catchments that flow in response to rainfall. The waterways in the southern part of the study area have particularly steep headwaters due to the presence of Glenugie Peak. There are nine waterways marked on the Pillar Valley (9538-3N) topographic map that cross the existing Pacific Highway in the project area, all of which drain in an easterly direction. The southern most and largest of these waterways is Glenugie Creek. Semi-permanent pools occur on Glenugie Creek and a number of the larger ephemeral creeks in the project area.

To determine the characteristics of the existing environment and the potential impacts of the project, field inspections were undertaken over two field trips of two days (13 - 14 May and 27 – 28 July 2009). A total of 87 sites were inspected, covering the area between chainage 4415 and chainage 8500 (as per the DGRs) plus additional sites to the north and south. Glenugie Creek was inspected from a point approximately 1.5 km upstream of the existing highway to a point approximately 3.8 km below it. The other eight ephemeral creeks were inspected from a point approximately 250 m upstream of the existing highway (above the point at which runoff from the proposed highway would enter the creeks), to their junction with Glenugie Creek.

During the field inspections, those channel instability features (eg headcuts and bank erosion) that occurred below the point at which runoff from the development would enter each creek were noted and their locations were recorded. The purpose of this was to assess the potential of each feature to worsen as a result of the project and the corresponding increase in runoff from paved surfaces.

At a selected number of sites, full condition assessments were carried out in accordance with the *State of the Rivers* protocol (described later).

Figures 7-2-1a-c show the location of field inspection sites. The risk ratings shown on the map are discussed later in this chapter.

Geomorphic (structural) condition of waterways

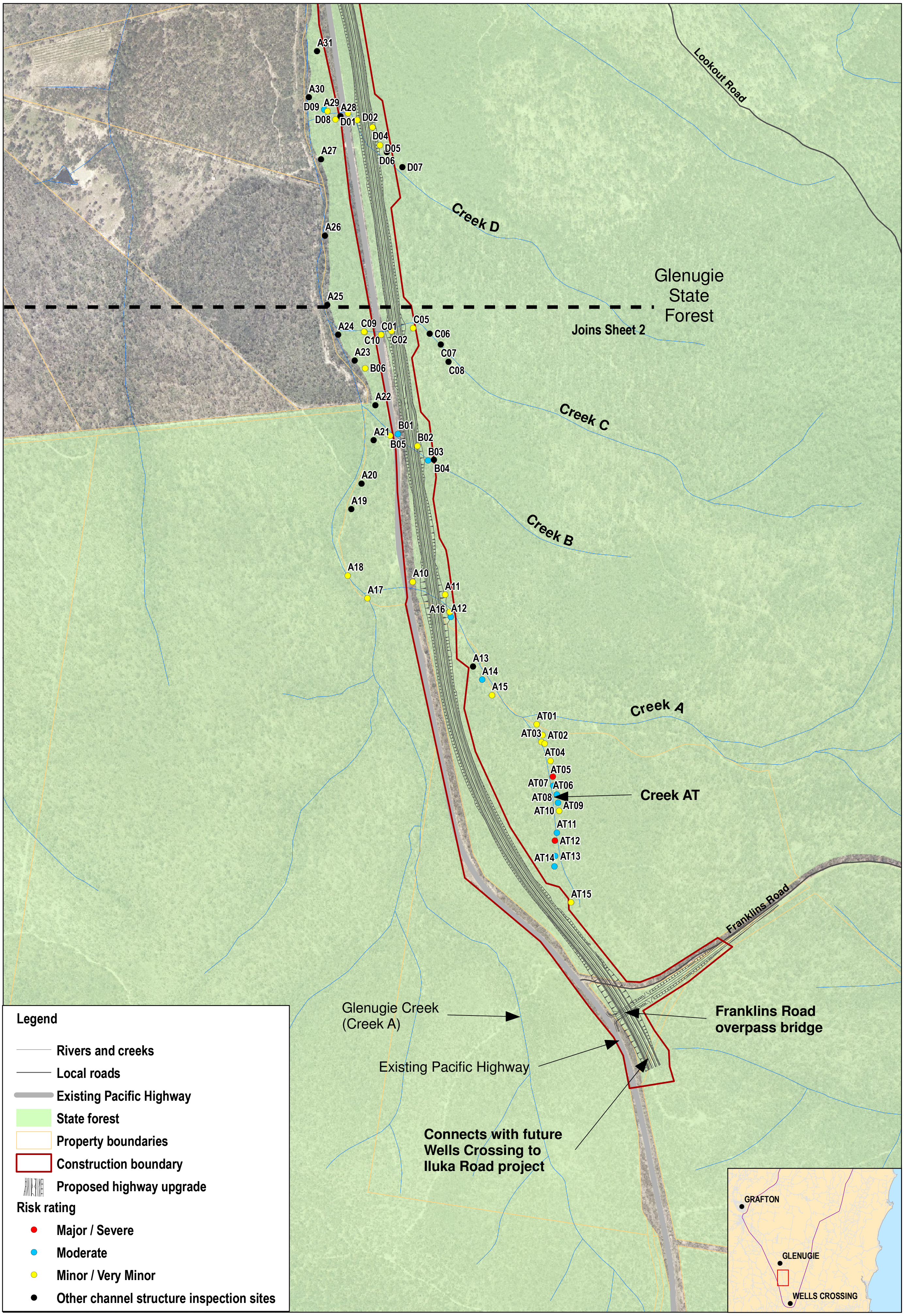
Context

The geomorphic (structural) condition of the waterways in the study area is subject to sharp flow peaks resulting from storm events. For example, Bureau of Meteorology rainfall records indicate that a major rainfall event occurred in Grafton in February 2009, including an event exceeding the one in 100-year average occurrence interval event for the 3-hour storm (IEAust 1998). The observations made during the field surveys are presented in the following sections.

Creeks upstream of existing highway

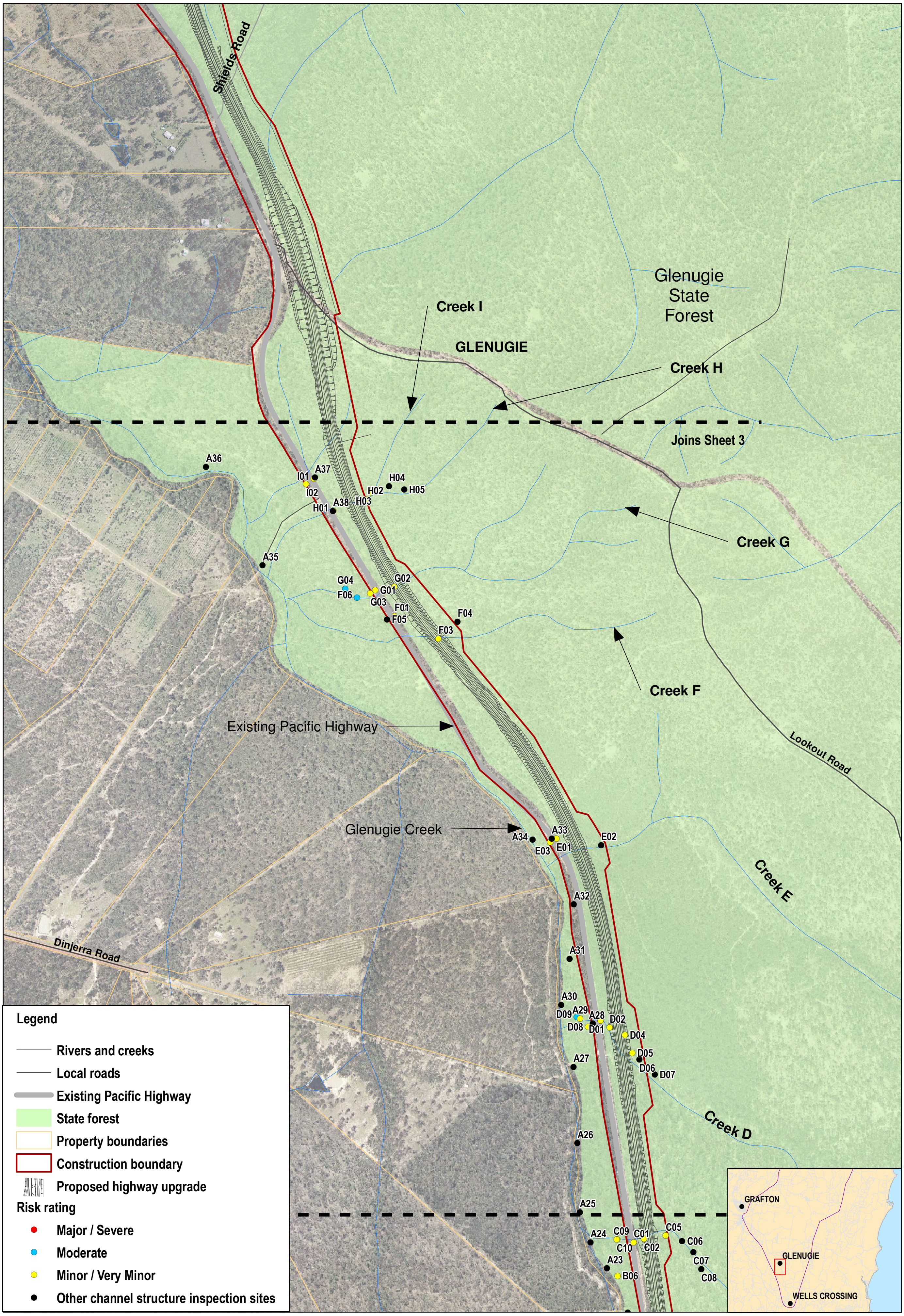
At the time of the field surveys, the creeks upstream of the highway were eroding both vertically (bed) and laterally (banks). Bed deepening was evident at a number of sites, often taking the form of headcuts (eroding 'steps' in the channel bed that migrate in an upstream direction during flows). Occasional bedrock outcropping of mudstone/sandstone restricted the extent of bed deepening, although scour of bank toes and consequent bank failure was evident at a number of locations. Soil erosion, slumping and gullying were occurring along the tributary creeks and floodplain flow paths. Erosion of bank tops was also occurring at the points where the overland flow entered the creeks. Sediment deposition (mainly sand and fine gravel) was evident at a number of sites, particularly in the lower reaches of the ephemeral creeks on the upstream side of the existing highway. Erosion and headcutting within these sand deposits was noted at several sites, a process referred to as 'cut-and fill'.

There were logs and fallen trees within the creeklines at a number of locations, which is likely to have been caused by bank collapse. Minor debris jams were also present at some locations, which could lead to further eddying and scour during high flows. The catchments of the creeks upstream of the existing highway were generally well-vegetated. Although no soil tests were conducted, erodible and dispersive soils are likely to occur in the project area.



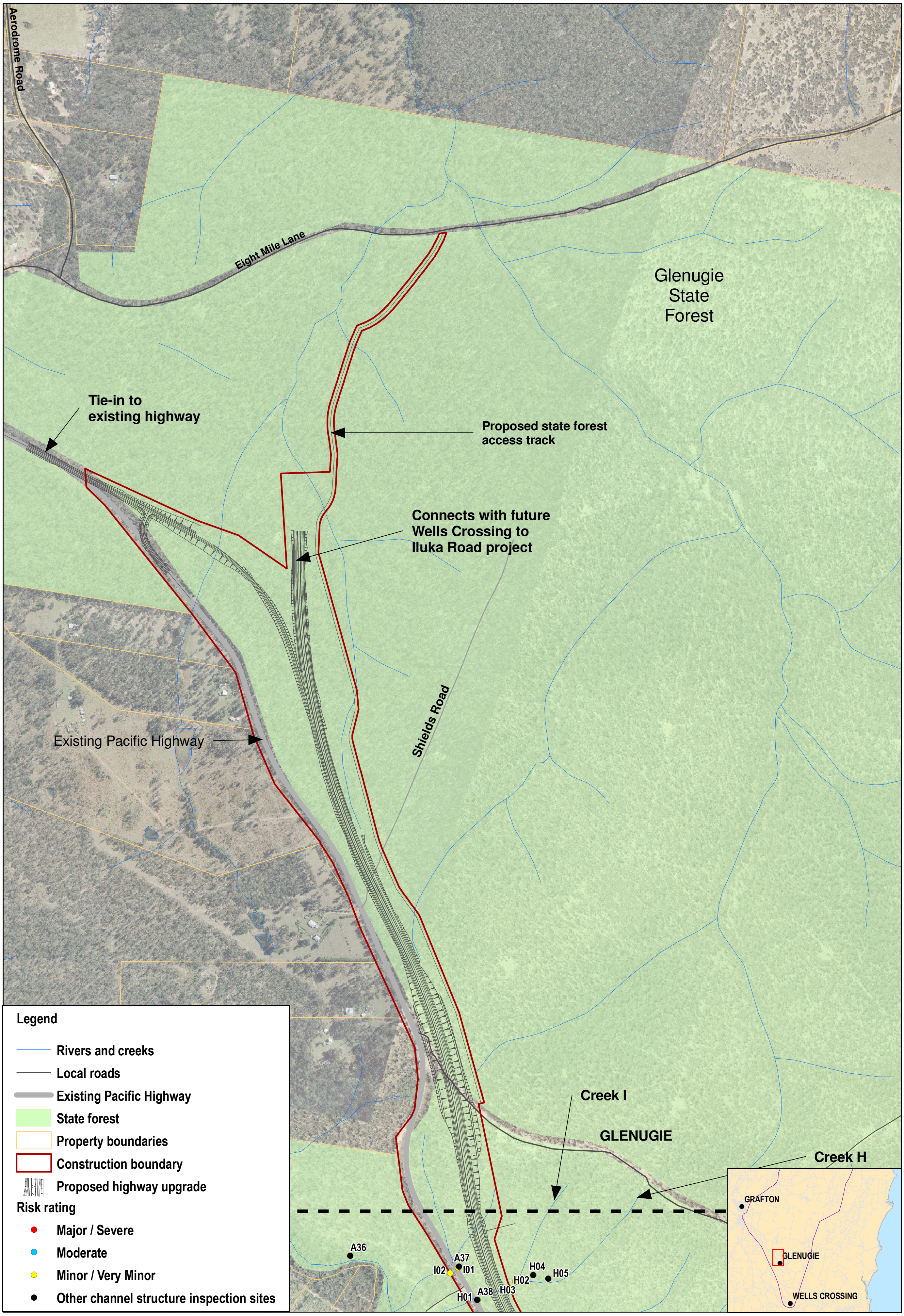
Data Sources
Streetworks, LPI 2008
Aerial: 2007

Figure 7-2-1a: Locations of field sites and channel instability risk scores - Sheet 1



Data Sources
Streetworks, LPI 2008
Aerial: 2007

Figure 7-2-1b: Locations of field sites and channel instability risk scores - Sheet 2



Data Sources
Streetworks, LPI 2008
Aerial: 2007

Figure 7-2-1c: Locations of field sites and channel instability risk scores - Sheet 3

0 500
A4 1:15,000 Metres

The condition of the creeks in the vicinity of the road crossing culverts was generally moderately stable. There was evidence of sediment deposition and backup of floodwaters on the upstream sides of culverts, and scour and degradation on the downstream sides.

Glenugie Creek upstream of existing highway

Glenugie Creek is the largest waterway in the study area with a catchment area (upstream of the existing highway) of 2.07 km^2 (SKM hydraulic data). Upstream of the existing highway, the characteristics of Glenugie Creek were similar to those of the creeks described above. These characteristics included:

- A generally incised channel with headcuts.
- Bank erosion (toe scour and larger mass failures).
- Floodplain erosion and drainage channel erosion, including floodplain headcuts.
- Ponding and channel deposition at the culvert approach zones.
- Intermittent deposition of sand and gravel on the channel bed.
- Large woody debris and organic matter in the channel.
- A number of trees on undermined bank tops that were on the point of falling into the channel.
- Intermittent bed and bank rock outcropping, predominantly sandstone and mudstone.

Examples of these features are presented in **Figure 7-2-2**.

Figure 7-2-2 Existing condition of Glenugie Creek upstream of existing highway

Mudstone outcrop and sediment deposits
site A11

Bedrock outcrop
site A12

Bank erosion and overhanging tree
site A12

Bank mass failure
site A10

Flood debris line above bank top
site A10

Rocks aligned by high stream power
site A12

Creeks downstream of existing highway

Culvert exit points on creeks downstream of the existing highway were affected by local scouring. At site B01, erosion identified on the left bank was likely to have been caused by the combined effect of culvert exit flow and the entry of overland flow from the road table drains, which would cause turbulence, eddying and scour. No scour protection was present at any of the culvert outflow or stormwater entry points inspected.

Bed and bank scour extended for variable distances downstream from the culvert outflows. In the lower reaches of tributary creeks, near the confluence with Glenugie Creek, bed and bank conditions tended to be more stable, although several minor headcuts were noted.

Although scour was noted throughout the ephemeral creeks, scour in the southern part of the study area tended to be slightly more frequent than that found in the north. This could possibly reflect the larger size of the southern catchments draining Glenugie Peak. The condition and characteristics of the creeks downstream of the existing highway are shown in **Figure 7-2-3**.

- **Figure 7-2-3 Existing condition of the creeks downstream of the existing highway**

	
Culvert outflow at site A28	Downstream culvert outflow at site A28
	
Scour due to stormwater and culvert outflows at site B05	Lower reach of tributary near site A24

Glenugie Creek downstream of existing highway

The reaches of Glenugie Creek downstream of the existing highway were generally structurally stable. Bed scour and bank erosion was generally limited to the first 100 m or so downstream of culvert exits, with the remainder of Glenugie Creek being largely an extended pool section with a generally stable bed, and stable, well-vegetated banks. This stability can be attributed to the gentle land slope and dense vegetation, which combine to produce relatively slow (non-scouring) flows.

There was occasional bed/bank rock outcropping and timber debris in the channel. There were also a small number of four-wheel drive crossings, including a single lane bridge. Overall, the channel downstream of the existing highway was in better structural condition than the reaches upstream and provided higher quality ecological habitat.

The condition of Glenugie Creek downstream of the highway at the time of the field survey is shown in **Figure 7-2-4**.

- **Figure 7-2-4 Existing condition of Glenugie Creek downstream of the existing highway**

Bank erosion about 250 m downstream from the road culvert a site A18

Good structural stability and high habitat value near site A24

4WD track crossing creek at site A20

Glenugie Creek at downstream end of study area at site A34

Assessment of Channel Structure
As previously described, each occurrence of channel instability was recorded and its location logged. Each recorded feature was assigned a risk rating as described below. This was not a formal risk assessment procedure, but the risk score was based upon professional judgement with reference to its potential to worsen and affect channel structure (and infrastructure) as a result of the development and increased runoff. The risk categories were:

- Risk category 1 - very minor. Channel features typically < 0.25 m of vertical/lateral extent. Localised and very limited effect on channel structure likely. Minor threat to nearby infrastructure.
- Risk category 2 - minor. Typically < 0.5 m. Unlikely to cause significant widening and/or deepening. Minor effects only at a local scale and only minimal effects on channel structure.
- Risk category 3 - moderate. 0.5 – 1.0 m. Likely to cause transient bed widening and/or deepening but with associated minor to moderate affects on overall channel structure at a wider scale. Minor to moderate threat to nearby infrastructure possible.
- Risk category 4 - major. 1.0 – 2.0 m. Likely to cause transient bed widening and/or deepening with possible undermining of banktop vegetation causing inputs of timber debris. A notable effect on channel structure may occur. May affect sediment and debris load with possible moderate effect on nearby local infrastructure (eg blocking of culverts) and increased sediment delivery to Glenugie Creek.
- Risk category 5 - severe. Typically > 2.0 m. Likely to cause significant change to channel structure, with concomitant increase to sediment load and timber debris. Likely to impact upstream and downstream nearby infrastructure.

The results of this assessment are presented in **Table 7-2-1** and **Figures 7-2-1a-c**.

▪ **Table 7-2-1 Summary of channel instability features**

Site code	**Easting**	**Northing**	**Description**	**Risk category**
Creek A (Glenugie Creek) Reach notes. Upstream generally degraded (incised) with numerous bed and bank erosion/deposition features. Perched tributary inflows. Downstream reach generally stable.				
A10	504331	6698710	Minor scour and erosion at culvert approach	2
A11	504429	6698671	Headcut and perched overland flow entry point	2
A12	504447	6698604	Bank erosion	3
A14	504542	6698413	Headcutting and bank erosion	3
A15	504572	6698366	General bank erosion and bed cut/fill	2
A16	504444	6698619	General bank erosion and bed cut/fill	2
A17	504193	6698660	Headcut	1
A18	504133	6698729	Bank erosion	1

Site code	Easting	Northing	Description	Risk category
A29	504072	6700140	Headcut	2
Creek AT (Glenugie Creek tributary) Reach notes. Incising and eroding system with frequent headcuts and instances of bank erosion. Active headward extension of creek network delivering sediment downstream.				
AT01	504708	6698277	Perched tributary junction	2
AT02	504726	6698244	Headcut	1
AT03	504722	6698224	Headcut	2
AT04	504732	6698219	Headcut	1
AT05	504750	6698167	Headcut	2
AT06	504757	6698119	Headcut	4
AT07	504758	6698091	Headcut	3
AT08	504769	6698064	Series of minor headcuts	3
AT09	504773	6698039	Headcut	3
AT10	504776	6698015	Headcut	1
AT11	504769	6697948	Headcut and upstream bank erosion	3
AT12	504763	6697924	Headcut	5
AT13	504764	6697877	Two minor headcuts	3
AT14	504762	6697846	Headcut	3
AT15	504812	6697736	Headcut (upstream extent of channels)	2
Ephemeral Creek B Reach notes. Degraded creek, mostly bed degradation with several headcuts. Mostly stable downstream of highway.				
B01	504286	6699160	Headcut	3
B02	504345	6699123	Series of minor headcuts	2
B03	504377	6699079	Headcut upstream of rock bar	3
B05	504262	6699155	Bank scour d/s existing highway	2
B06	504186	6699359	Headcut	1
Ephemeral Creek C Reach notes. Generally minor incision with minor to moderate bank erosion. Mostly stable downstream of highway.				
C01	504235	6699461	Headcut	2
C02	504266	6699472	Series of minor headcuts	2
C05	504332	6699481	Headcut	2
C09	504185	6699469	Local scour d/s existing highway	2
C10	504183	6699470	Headcut	1
Ephemeral Creek D Reach notes. Generally degraded and incised creek both upstream and downstream of existing highway, with active bed and bank erosion. Higher rate of sediment delivery to Glenugie Creek compared with other ephemeral creeks.				
D01	504134	6700134	Bed and bank erosion at culvert entry	1
D02	504162	6700113	Headcut – general deepening and widening	2

Site code	Easting	Northing	Description	Risk category
D04	504208	6700091	Floodplain headcut – fresh erosion	2
D05	504231	6700036	Floodplain headcut	2
D08	504096	6700115	Local scour around culvert d/s highway	2
D09	504062	6700145	Headcut	3
Ephemeral Creek E Reach notes. Moderately stable with few significant erosion/deposition features although locally scoured to bedrock in places. Extended pools downstream of highway.				
E01	504000	6700687	Minor erosion at culvert entry	1
E03	503981	6700676	Local scour around culvert d/s highway	2
Ephemeral Creek F Reach notes. Upstream reach characterised by extensive sediment deposits and numerous minor headcuts incising into this deposit. Larger headcuts observed in reach downstream of highway.				
F01	503508	6701363	Minor scour at culvert entry	1
F03	503641	6701294	Series of minor headcuts	2
F05	503485	6701353	Very minor scour/deposition around culvert.	1
F06	503394	6701419	Headcut near highway	3
Ephemeral Creek G Reach notes. Upstream reach characterised by in-channel gravelly-sand deposits with generally minor headcutting.				
G01	503449	6701442	Minor local scour around culvert entry	1
G02	503507	6701452	Headcut	1
G03	503434	6701432	Local scour/bank erosion around culvert exit	2
G04	503358	6701446	Headcut	3
Ephemeral Creek H Reach notes. Upstream reach generally incising through bed sediment deposits. A major gully feature and instance of bank erosion noted but upstream of proposed highway. Minor scour downstream highway and drainage to Glenugie Creek appears to be captured by 4WD track.				
H01	503322	6701683	Minor erosion at culvert entry	1
H02	503426	6701718	Bank erosion	1
H03	503437	6701739	Headcut and bank erosion	2
Ephemeral Creek I Reach notes. Indistinct drainage line				
I01	503263	6701780	Minor scour at culvert entry	1
I02	503239	6701764	Scour below culvert exit apron	2

State of the Rivers Assessment

A *State of the Rivers* assessment was conducted at six of the field survey sites (**Figures 7-2-1a-c**). The *State of the Rivers* method is a recognised Australian protocol for stream condition assessment, providing a 'snapshot' of the physical condition of streams relative to their presumed natural condition. The method evaluates stream condition in terms of a number of parameters, including:

- Overall disturbance rating.
- Overall bank instability.
- Bank susceptibility to erosion.
- Overall bed stability rating.

The *overall disturbance rating* records the extent of disturbance of land adjacent to the creek on a scale of decreasing severity from Extreme to Very Low. The *overall bank instability* and the bank *susceptibility to erosion* records information about the condition of the banks and sensitivity to future erosion on a scale of decreasing risk from High to Minimal. The *overall bed stability* rating records information about factors affecting the stability of the creek bed. The score categories for this parameter are Severe Erosion, Moderate Erosion, Bed Stable, Moderate Aggradation and Severe Aggradation.

The results of the State of the Rivers assessment are presented in **Table 7-2-2** and are consistent with the results of other field observations. Specifically, the results indicate that while there is widespread erosion and headcutting along the unnamed creeks and tributaries, Glenugie Creek, particularly downstream of the existing highway, was generally in good structural condition.

The erosion and headward extension of the drainage network upstream of the existing highway indicates that the landscape is generally erodible and sensitive to disturbance. The results of the field study indicate that the majority of the existing erosion and head cutting is unlikely to have resulted from the construction and operation of the existing highway. Rather, the ongoing erosion of the creek network is most likely a result of runoff from the upstream catchment during intense storm events.

Table 7-2-2 Summary of State of the Rivers scores

Creek name	Site number	Chainage	Overall disturbance rating	Overall bank instability	Bank susceptibility to erosion	Overall bed stability rating
Upstream of highway						
Glenugie Creek	A15	3900	Low	Moderate	High	Moderate erosion
Glenugie Creek	A16	4200	Low	Moderate	High	Moderate erosion
Downstream of highway						
Glenugie Creek	A19	4800	Low	Low	Moderate	Stable
Creek D	30	5900	Moderate	High	High	Severe erosion
Glenugie Creek	A34	6500	Low	Low	Moderate	Stable
Glenugie Creek	A36	7900	Low	Low	Moderate	Stable

7.2.2 Potential impacts of the project

This section examines the potential for increased runoff from paved surfaces, the potential for flow concentration and the potential impacts associated with the predicted increase in the intensity and frequency of storm events. The corresponding potential for impacts on water quality and aquatic ecology are detailed in Section 7.1.2.

Potential for increased runoff from paved surfaces

Additional runoff will be generated from the impervious surfaces of the new highway section. At present, runoff from the road surface is shed laterally into table drains that run alongside the road before being discharged into drainage lines downstream of highway culverts and Glenugie Creek.

Peak runoff from impervious road surfaces will be generated from short storm events of high intensity, while peak runoff from the larger pervious catchment will result from storms of longer duration and lower average intensity. Runoff from paved areas would generally reach the stream network first, followed by a secondary peak from the slower catchment runoff. Estimated peak discharges for the existing environment and the operating project were computed for Glenugie Creek using the Rational Method for eastern New South Wales (IEAust 1998). The results of this assessment are presented in **Table 7-2-3** and show an increase in peak discharge from paved surfaces as a result of the project. The culverts constructed as part of the project will be selected and sized during the detailed design phase to accommodate these flows.

Table 7-2-3 Predicted runoff from the existing highway and operating project

Average recurrence interval (ARI) event	Peak discharge from existing highway for storm duration of 6 minutes (L/s)	Peak runoff from operating project for storm duration of 6 minutes (L/s)	Peak discharge from Glenugie Creek catchment at peak of road runoff for 6 minute storm (L/s)	Peak discharge from Glenugie Creek catchment upstream of existing highway for a critical storm duration of 1 hour (L/s)
1	127	380	148	6,700
2	160	479	225	10,300
5	197	590	314	14,350
10	218	654	378	17,400
100	316	947	669	30,500

Note: These figures are based on the following assumptions: a) A critical storm duration of six minutes for paved areas for both the existing case and the operating project; b) A critical storm duration of one hour for Glenugie Creek upstream of the highway; c) A representative table-drain length of 500 m; d) A constant runoff coefficient of 0.95 for paved surfaces (both existing and operating project); e) A three-fold increase in paved surface area as a result of the highway upgrade.

Potential for flow concentration

Impacts of project construction

The potential impacts of project construction are as follows:

- Sediment plumes in creeks during storm events.
- Scour of flow paths due to uncontrolled runoff from construction areas.

- Deposition of sediments on upstream and downstream sides of culverts.
- Bed and bank scour, on downstream sides of culverts or within any disturbed areas of the channel, including temporary stream crossings.
- Sediment deposition from construction sediments in Glenugie Creek.
- Intersection of dispersible soils causing accelerated erosion.

The likelihood of these impacts occurring will largely depend on:

- Rainfall events during construction.
- Design, implementation and maintenance of erosion and sediment controls.
- Project staging.

Impacts of project operation

The following impacts may occur during project operation as a result of flow concentration:

- Creek scour downstream from culverts (existing and proposed) due to culvert outflows and entry of road drainage.
- Turbulence and scour on upstream sides of culverts due to entry of road drainage.
- Upstream progressing headcuts upstream of highway in channel and on floodplain (new or existing).
- Upstream progressing headcuts between the existing and new highway in channel.
- Upstream progressing headcuts downstream of highway in channel (new or existing).
- Ongoing deposition of sediment in Glenugie Creek.
- Mobilisation of in-channel sediment deposits and organic debris between the existing and new highway due to increased runoff, with the potential to affect drainage structures and deliver sediment to Glenugie Creek.
- Increased upstream flood afflux from increased head loss through extended culverts.
- Inappropriate management of dispersible soils causing piping and failure of drainage structures.
- Accelerated erosion due to climate change and failure of drainage structure/scour protection due to under-design.

As the project is located upstream of the existing highway there is potential for flow concentration to increase through drainage culverts under the existing highway. The potential impacts of flow concentration on existing culverts and drainage structures may include:

- Bed and bank scour immediately downstream of the culverts and continuing for distances in the order of tens of metres, (culvert runout zones) particularly in steeper catchments.
- Sediment deposition from scoured bed and banks in the culvert runout zones.

- Bank scour due to the uncontrolled entry of overland flow from road table drains on both upstream and downstream sides.

The above-listed potential impacts are typical of all road projects and can be readily managed through drainage design and the implementation of standard stormwater runoff and erosion and sediment controls.

Potential for increase in frequency and intensity of storm events
Predicted changes in the frequency and intensity of storm events due to climate change are described in CSIRO (2007a, 2007b). The effect of climate variability is likely to be relevant in the long-term post-construction operational phase but unlikely to be relevant during the short period of construction. Despite some uncertainty in the results of the various climate models that have been used, it is generally accepted that, for the study area, there will be an increase in daily precipitation intensity and the number of dry days. Results from CSIRO (2007b) indicate that:

- Increases in annual average rainfall of up to seven per cent and 20 per cent may be expected by 2030 and 2070 respectively.
- Increases in extreme rainfall event totals (defined as the 40-year one day rainfall) of up to five per cent and 10 per cent may be expected by 2030 and 2070 respectively.

While CSIRO (2007b) predicts an increase in rain storm intensity and extreme events, it does not indicate the magnitude of this increase for specific critical storm durations applicable to the project study. Nevertheless, it is likely that any substantial increase in the intensity of short-term storm events would increase the risk of local scour at culverts and drainage entry points.

Based on the information presented in **Figures 7-2-1a-c** and **Table 7-2-1**, areas of key focus for headcuts and bank erosion should include:

- Glenugie Creek (Reach A and AT between Franklins Road and the existing highway crossing).
- Creek B upstream and downstream of the existing highway.
- Creek D upstream and downstream of the existing highway.
- Creek F downstream of the existing highway.
- Creek G downstream of the existing highway.

Creeks D and G upstream of the existing highway contain more in-channel sediment compared with other ephemeral creeks, which may be mobilised under conditions of increased runoff from additional paved surfaces.

7.2.3 Impact mitigation and management measures

The measures listed below would be implemented to minimise impacts on channel structure and receiving environments.

- Drainage structures for the project would be designed to accommodate the increase in flow from paved surfaces and future climate change predictions. The selection, sizing and design of culverts would be finalised during detailed design.

- To prevent mobilisation of headcuts, appropriate bed/bank protection and energy dissipation measures would be applied to areas downstream of culverts, any identified points of instability between the new and existing highway, and any unstable areas immediately upstream of the new highway that may be influenced by its construction and operation.
- Standard erosion and sediment controls and stormwater management measures, consistent with the Blue Books (Landcom 2004 and DECC 2008), would be implemented during construction to minimise the risk of impacts on receiving environments both upstream and downstream. Attention would be given to the potential occurrence of dispersible soils and corresponding management requirements.
- In the design of drainage structures and stormwater controls for construction, particular attention will be given to overland flow conveyance and overland flow entry points to Glenugie Creek and tributary creeks.
- A 'factor of safety' in the design of hydraulic structures and erosion protection measures would be implemented to address the potential risks associated with climate change.

7.3 Operational traffic and transport implications

Director General's requirements	Where addressed
Operational Traffic and Transport Implications – the Environmental Assessment must include an assessment of the operational impacts of the project on ...	Section 7.3.2
the surrounding road network	Section 7.3.2 - Impacts on the local road network and
safety implications for the Pacific Highway and relevant local roads, and	Section 7.3.2 - Impacts on road safety
impacts on local property access	Section 7.3.2 - Impacts on property access

7.3.1 Existing environment

Existing highway

Carriageway configuration

The section of the existing Pacific Highway to be upgraded is a two-lane single carriageway road with occasional overtaking lanes. The road has a posted speed limit of 100 km/h and is typified by poor horizontal and vertical geometry, narrow shoulders, and traffic hazards close to the roadway. Many crashes occur on sections with substandard curves. These factors combine to produce unacceptable road conditions.

Traffic usage

The average annual daily traffic (AADT) volume on the Glenugie section of the Pacific Highway is currently 8,200 vehicles per day based on traffic counts undertaken by the RTA in May 2009. The average daily volume comprises 6,300 (77 per cent) light vehicles and 1,900 (23 per cent) heavy vehicles.

The majority of traffic on the Pacific Highway at Glenugie passes through the area without stopping. There are a small number of local trips accessing Shields Road and Franklins Road. The derivation of local traffic volumes and calculations of the impact of the upgrade on the existing highway are based on the RTA's *Guide to Traffic Generating Developments Version 2.2,* which recommends a trip generation rate of nine vehicle trips per day for low density residential dwellings. Based on this assumption, the amount of local traffic has been calculated and the results shown in **Table 7-3-1**. The peak hour is from 15:00 – 16:00 in the afternoon and has approximately 652 vehicles, 53 per cent of which are southbound and 47 per cent northbound.

The DPI Forests NSW has advised that logging traffic accessing Glenugie State Forest is about four trucks per day.

- **Table 7-3-1 Trip generation for access points from Pacific Highway**

Connecting road	Number of dwellings	Daily trips generated
Franklins Road	7	63
Shields Road - Logging activities	0	4
Direct access to highway (west side)	6	54
Total	**13**	**117**

Based on the results, less than two per cent of traffic travelling on the existing highway in the Glenugie area is local traffic and forestry industry generated activity.

Pedestrians, cyclists and public transport

Public transport in the Glenugie area is limited. Two companies provide long-distance coach services through the area:

- Greyhound / McCaffertys operate four services daily in each direction between Sydney and Brisbane.
- Premier Motor Service operates three services daily in each direction between Sydney and Brisbane.

Neither of the above-listed services stops within the Glenugie area.

Ryans provides two local bus services on weekdays from Grafton to Coffs Harbour via Woolgoolga and from Coffs Harbour to Grafton via Woolgoolga. These bus services operate on a hail and ride basis and have different schedules for school holidays and school days. Ryans also operate the school buses for the Glenugie area and have a designated school stop at Franklins Road.

The proposed Coastal Cycleway runs along the Pacific Highway through the Glenugie area from Halfway Creek to Grafton.

There is no pedestrian use of the Glenugie section of the Pacific Highway.

Forecast traffic generation

The *Mid North Coast Regional Strategy* (DoP 2009) does not identify any regionally significant farmland, proposed urban areas or proposed employment lands within the project area. From historical data and land use studies, annual traffic growth on the Pacific Highway is estimated to be 2.9 per cent per annum. The estimated future traffic volume on the Pacific Highway is detailed in **Table 7-3-2**. The traffic forecasts have been estimated for 2012 as this is the assumed year of opening and 2022 giving a 10 year forecast from opening to ensure the Pacific Highway operates at an acceptable level of service in the long term.

Table 7-3-2 Forecast traffic volumes for the Pacific Highway at Glenugie

Year	Pacific Highway AADT (vehicles per day)
2009	8,200
2012	8,900
2022	11,500

Traffic capacity

The Pacific Highway at Glenugie has a capacity of one lane in each direction, with overtaking lanes in some sections.

The Level of Service (LoS) of a section of road varies from A (good) to F (poor), depending on the number of lanes, traffic volume and the frequency of intersections and junctions. The LoS on the Pacific Highway in the Glenugie section is currently operating at Level of Service 'D'. The Pacific Highway without the proposed upgrade through the Glenugie section will continue to operate at level of service 'D' in the future to 2022 unless highway upgrades are implemented.

Existing road safety issues

The section of the highway to be upgraded has a poor crash record. Between July 2003 and June 2008 there were 30 crashes which comprised:

- Two fatal crashes.
- 11 injury crashes.
- 17 non-casualty crashes.

The 30 crashes on the existing highway resulted in two fatalities and nineteen injuries. The crash rate for the Glenugie section of the existing highway is therefore 27 per 100 million vehicle kilometres travelled (MVKT), which is above the target crash rate of 15 per 100 MVKT. The fatality rate is 1.8 per 100 MVKT which is also above the 0.7 per 100 MVKT in the NSW State Plan.

Six of these crashes have occurred on the carriageway south of Shields Road, where the existing road consists of substandard curves. The northbound overtaking lane in this section of the existing highway has experienced numerous incidents involving heavy vehicles. A trucking company has issued a Safety Notice to its drivers highlighting this area as a potential safety risk.

Local road network

There are two local, unsealed access roads connecting with the existing highway, namely Shields Road and Franklins Road. Franklins Road provides access to seven dwellings and forestry activities. Shields Road provides access to forestry activities. Lookout Road, which runs off Shields Road, provides access to Mount Elaine but does not have direct access to the highway.

Dinjera Road provides access to the rural residential area to the north-west of the proposed upgrade. This road does not have direct access to the highway within the project area.

Eight Mile Lane enters the Pacific Highway just to the north of its tie- in point with the project. This road also provides access to Glenugie State Forest and private properties.

Property access

Six properties have direct access to the western side of the existing highway. This section of the existing highway would be retained as a local access road for both the motorway style upgrade and the likely initial staging.

The seven properties on the east side of the upgrade section access the highway via Franklins Road and Shields Road. Glenugie State Forest is accessed via Shields Road and Franklins Road.

7.3.2 Potential operational traffic and transport impacts

Impacts on Pacific Highway traffic and transport

The project will result in significant travel efficiency benefits for the existing road network. The traffic assessment has shown that an average of 8,800 and 11,300 vehicles daily would utilise the proposed highway upgrade in 2012 and 2022 respectively. Based on these forecast traffic volumes the Pacific Highway would operate as follows:

- No upgrade - LoS ‘D’ in 2012 and 2022.
- Project in place - LoS ‘A’ in 2012 and 2022.

The road network would operate more efficiently and with fewer delays than it does currently. The upgrade would improve travel times marginally for cars, freight and public transport generally, with more significant benefits realised during peak holiday travel periods.

The existing highway would be retained as a local access road and the proposed Coastal Cycleway would not be impacted by the project. Additionally, continuous bicycle access is provided for the full length of the project along the shoulder of the upgraded highway. An alternate cycle route would be available along the existing Pacific Highway. The project would also result in a safer cycling environment along the existing pacific highway in comparison to the existing situation.

No long distance bus services have scheduled stops within the project area. Local bus services would be able to use the existing highway. The existing school bus stop at the Franklins Road intersection would not be affected.

Impacts on the local road network

The impacts of the project on local traffic patterns would be limited, as the proposed upgrade is located in an area with few intersections and direct property accesses. For the motorway style upgrade, local access would be maintained by retaining the existing Pacific Highway. About 140 vehicles per day would use the existing highway as a local access road in 2012 and 2022 respectively.

The existing access at Franklins Road would be removed and replaced with a grade-separated access across the new highway to the existing highway. Access to Shields Road would be closed and forestry vehicles would use the new unsealed access road running from Eight Mile Lane to Lookout Road, which is to be constructed as part of the project.

For the likely initial staging, local access will be maintained by retaining the existing Pacific Highway and access to the upgrade at the newly constructed intersection at the northern end of the project. An at-grade intersection would be provided at Franklins Road. Access to Shields Road would be closed. Forestry vehicles would be able to access Lookout Road and Glenugie State Forest via the proposed unsealed access road from Eight Mile Lane.

Impacts on property access

The impacts of the project on property accesses would be minimal, with the maintenance of the existing highway as a local service road, providing access to both the local area and the upgraded highway.

Impacts on road safety

As described in Section 7.3.1, the section of the Pacific Highway to be upgraded has a poor crash record. The implementation of the full motorway style upgrade would result in a reduction in the crash rate to 15 crashes per 100 MVKT, and 0.4 fatalities per 100 MVKT. For the likely initial staging, the accident rate would be reduced to 21 per 100 MVKT and 1.1 fatalities per 100 MVKT.

Both the full motorway style upgrade and the likely initial staging would have a positive impact on road safety. Both the full motorway style upgrade and the likely initial staging would address the existing safety issues on the northbound carriageway south of Shields Road where there have been numerous incidents involving heavy vehicles (see Section 7.3.1). The safety of local road intersections and property accesses will be improved.

7.3.3 Operational traffic and transport impact mitigation and management measures

Operational impact mitigation and management measures include:

- Improved at-grade access to the highway upgrade at Franklins Road and the existing highway south of Eight Mile Lane for the likely initial staging option. For the full motorway style upgrade, a bridge across the upgrade connecting to the existing highway would be provided at Franklins Road.
- Retention of the existing Pacific Highway alignment as a local access and service road on the western side of the upgrade and provision of a service road on the eastern side of the upgrade would maintain full access on either side of the proposed new alignment.
- Modifications to local roads where they are intersected by the new road alignment to maintain the function of the local and State Forest road networks and in servicing land use on either side of the route.

7.4 Operational noise impacts

Director General's requirements	Where addressed
Operational Noise Impacts – the Environmental Assessment must include an assessment of the noise impacts of the project during operation, consistent with the guidance provided in Environmental Criteria for Road Traffic Noise (EPA, 1999).	Section 7.4.2
The assessment must include specific consideration of impacts to sensitive receivers (schools, hospitals, aged care facilities) and sensitive structures, as relevant.	Section 7.4.2

An assessment of the operational noise impacts has been undertaken and is detailed below. This is supported by the Noise and Vibration Assessment Working Paper, which is attached as Appendix F. As part of the investigation of noise impacts, the tasks undertaken included:

- Identifying existing sensitive receivers.
- Determining appropriate noise criteria for sensitive receivers in accordance with the Environmental Criteria for Road Traffic Noise (ECRTN) (EPA 1999).
- Determining existing road traffic noise levels by conducting noise modelling and noise monitoring.
- Predicting the road traffic noise levels (operational noise) expected to result from the project and comparing these to the relevant noise criteria.
- Recommending appropriate controls for any operational noise impacts.

7.4.1 Existing environment

Sensitive receivers

Eight residences have been identified as potential noise sensitive receivers for the project. These residences are about 15 km south of Grafton in a rural/rural residential community. They were selected for assessment based on their proximity to both the existing and the proposed new alignment and their potential to experience changes in road traffic noise. The selection of individual residences has been undertaken using aerial photography and where possible visual identification during the monitoring survey. **Figure 7.4.1** shows the location of the sensitive receivers in relation to the construction corridor and the noise monitoring site. The project does not affect any other sensitive receivers, such as schools, hospitals, aged care facilities or sensitive structures.

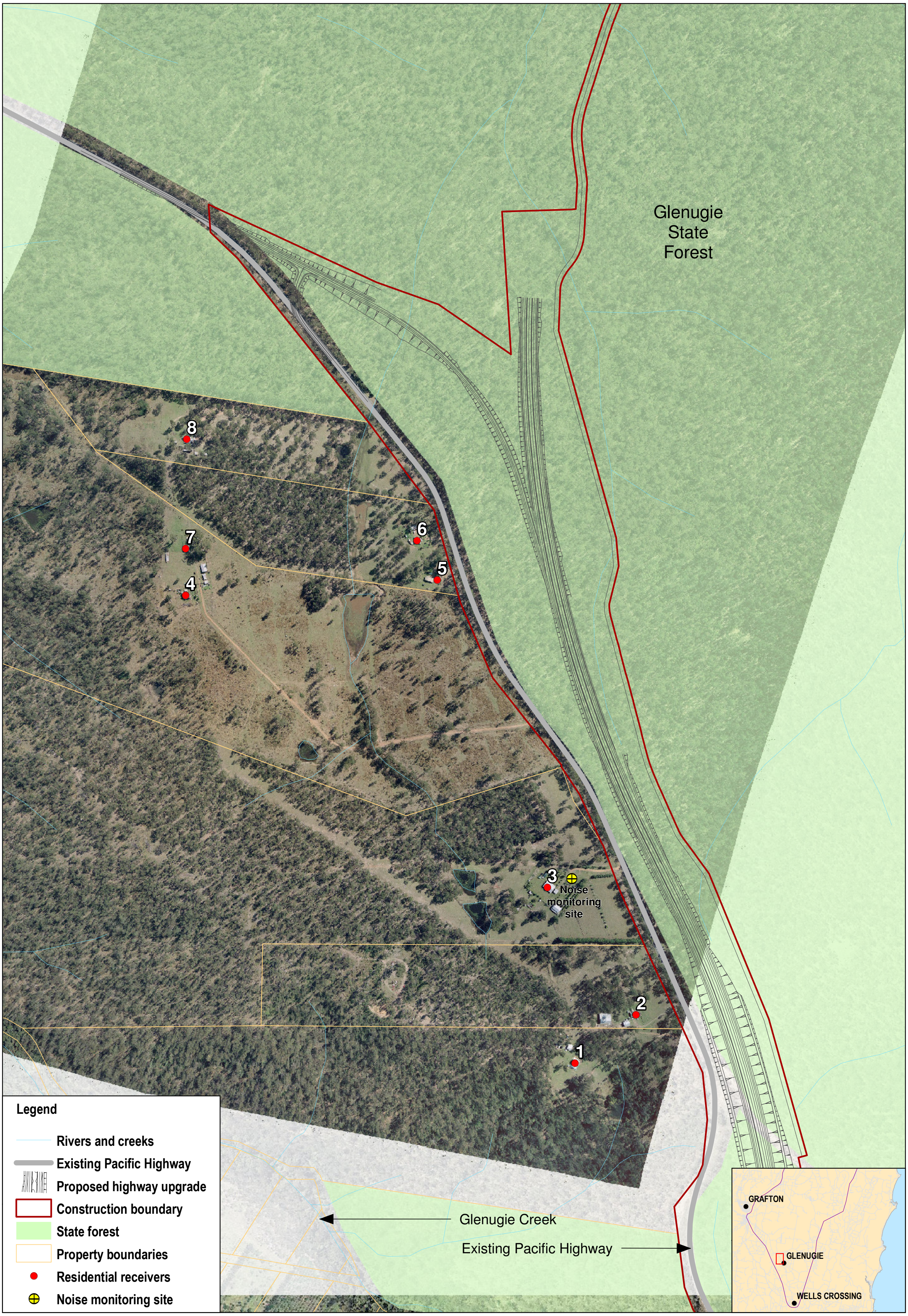
Existing background noise levels

To assist in the assessment of potential impacts for road projects, noise levels are measured at key locations along the existing highway. This monitoring data provides information on the current traffic noise levels, which is used to calibrate a road traffic noise model.

Noise monitoring for the project was conducted over one week, between 11 and 18 May 2009, at a representative residential location about 100 m from the existing highway. The monitoring site was chosen as a good location to confirm existing background noise levels. Considerations included line of sight to the existing highway and proximity to receivers

When measuring noise levels, the use of statistical descriptors is necessary to understand and describe how variations in the noise environment occur over any given period. For road traffic noise these descriptors are further classified for daytime (7am – 10pm) and night time (10pm – 7am) periods. For environmental noise, the assessment period for night time is the same however, day time is further split into day and evening as follows day time (7am – 6pm) and evening (6pm – 10pm). Common descriptors used in this noise assessment are defined as follows:

- LA10 – the noise level exceeded for 10 per cent of the measurement interval, this is commonly referred to as the average-maximum level.
- LA90 – the noise level exceeded for 90 per cent of the measurement interval. This is commonly referred to as the background noise level.
- LAeq – the noise level having the same energy as the time varying noise level over the 15 minute interval. For traffic noise this descriptor is classified as LAeq 15 Hr and LAeq 9 Hr for day and night time noise levels respectively and is often referred to as the ambient noise level.
- LAmax – the maximum noise level measured at a given location over the measurement interval.
- RBL – The Rating Background Level (RBL) is the overall single-figure background level, which is the 10th percentile of the LA90 values for each of the day, evening and night time periods over the whole monitoring period.



Data Sources
Streetworks, LPI 2008
Aerial: 2007

Figure 7-4-1: Locations of sensitive receivers and the noise monitoring site

0 250
A4 1:10,000 Metres

The statistical noise indices were calculated from the monitored data, and include both road traffic noise and environmental noise parameters. The road traffic parameters are used to provide information on existing traffic noise levels for the noise modelling and the environmental noise statistics are used for the setting of construction noise criteria. The $L_{A10,18\ hour}$ and $L_{Aeq,15\ hour}$ and $L_{Aeq,9\ hour}$ road traffic noise indices and the L_{Amax} descriptors were calculated on a daily basis for these monitoring locations and are summarised as the median of the combined daily results. Because the L_{A10} and L_{Aeq} indices are not directly interchangeable, a correction factor is required to convert the modelled L_{A10} values to the L_{Aeq} criterion base. In this case, the difference between the $L_{A10,18\ hour}$ and $L_{Aeq,15\ hour}$ results is used to determine the correction factor that is applied to the results of the Calculation of Road Traffic Noise (CoRTN) noise modelling.

The daily traffic noise profile for the monitoring location is summarised in **Table 7-4-1**. Observations of noise influences during the site surveys identified road traffic noise on the existing highway as being the dominant noise source. Similarly, the ambient night time noise environment is dominated by road traffic.

- **Table 7-4-1 Summary of traffic noise monitoring descriptors**

Monitoring date	$L_{A10\ 18\ hour}$	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} Day	L_{Amax} Night	Difference L_{A10} - L_{Aeq}
11 May 09 – 18 May 09	61 dB(A)	58 dB(A)	57 dB(A)	68 dB(A)	68 dB(A)	3 dB(A)

Environmental noise parameters for the monitoring location are presented in **Table 7-4-2**. The maximum noise level recorded is noted as the L_{Amax}. The ambient L_{Aeq} noise level and the rating background level (RBL) are also presented for each monitoring period.

- **Table 7-4-2 Summary of unattended environmental noise monitoring descriptors**

Location	Day			Evening			Night		
	L_{Amax}*	L_{Aeq}*	RBL†	L_{Amax}*	L_{Aeq}*	RBL†	L_{Amax}*	L_{Aeq}*	RBL†
Location 1	67 dB(A)	56 dB(A)	44 dB(A)	69 dB(A)	59 dB(A)	41 dB(A)	68 dB(A)	57 dB(A)	33 dB(A)

*Note * L_{AMax} and L_{Aeq} – 50th Percentile; † L_{A90} 10th Percentile*

In **Table 7-4-2**, the L_{Amax} and L_{Aeq} values have been reported as median values for each of the periods. These values are not used in the assessment of construction noise, however, they provide a reference to the existing environment when determining the potential level of impact expected from the construction of the project. The RBL monitoring data provide the basis for setting noise goals for the construction activity based on the appropriate construction noise guidelines.

7.4.2 Potential noise impacts of project operation

Road traffic noise criteria

The noise criteria identified for the project are in accordance with the DECC *Environmental Road Traffic Noise Criteria* (ECRTN) guideline (EPA 1999). The appropriate noise goals for the project are listed in **Table 7-4-3**. The assessment methodology and application of the noise criteria are taken from the RTA's *Environmental Noise Management Manual* (ENMM) (RTA 2001).

▪ **Table 7-4-3 Road traffic noise base criteria**

Road category	Day time levels	Night time levels
Redevelopment of an existing freeway	$L_{Aeq\ (15hour)}$ 60 dB (A)	$L_{Aeq\ (9hour)}$ 55 dB (A)

Modelling of traffic noise impacts

Traffic noise at each identified receiver has been predicted for the project using the Calculation of Road Traffic Noise (CoRTN) method applied through the SoundPLAN noise modelling program. The CoRTN method predicts the $L_{A10,\ 18\ hour}$ and the $L_{A10,\ 1\ hour}$ noise levels at a receiver location based on the parameters listed in **Table 7-4-4**.

▪ **Table 7-4-4 Summary of modelling inputs**

Input variable	Data
Traffic numbers and mix	Traffic numbers forecast for the years 2012 and 2022 (see **Section 7-3**)
Ground topography	Obtained from aerial photogrammetry, 1 m increments
Gradient of roadway	Taken from a 3D model of the design alignment
Air and ground absorption	Ground absorption assumed 100% soft ground
Height of receivers	1.5 m above ground terrain
The acoustic properties of the road pavement surfaces	Tyned asphaltic concrete assumed for the whole alignment having a relative correction of +2.5 dB(A) compared to Dense Grade Asphalt
Traffic speed	110 km/h throughout the project
Attenuation due to building structures	Building structures have not been included in the noise model due to the rural residential nature of the investigation area
Facade Reflection	+2.5 dB (A)
L_{A10} to L_{Aeq} conversion	3 dB (A) from L_{A10} to L_{Aeq} (See **Table 7-4-1**)

The assessment of noise impacts considers four different traffic flow scenarios:

- The current year 2009, which considers the current road network and traffic conditions in assessing the level of existing impact at noise sensitive receiver locations. This scenario is also used to validate the noise model to provide an indication of the level of accuracy of the noise model based on known parameters.
- The future existing year, which considers traffic flows for a year

equivalent to the year of opening of the project, but with no change to the existing road infrastructure (the "do nothing" option). This is 2012 for the purposes of modelling.

- The project opening year (2012), which considers the proposed new road design and future traffic flows, incorporating normal growth, at the time of the project opening.
- The design year, which considers the proposed new road design and future traffic flows incorporating normal growth expected over a period of 10 years after the opening of the road project. The design year for the Glenugie upgrade is 2022.

Table 7-4-5 presents a summary of the traffic flows used in each of the above modelling scenarios showing the total traffic numbers for day and night time for each direction. These data are used in the modelling of traffic noise impacts and are based on the average flows over the whole year. The traffic numbers used in the modelling represent the Annual Average Daily Traffic (AADT) flows and are calculated from SCATS data, RTA permanent counting stations and actual site measurements from tube counts.

- **Table 7-4-5 Summary of road traffic data inputs for noise modelling**

Assessment period	Direction	Future existing year 2012	Project year of opening 2012	Design year 2022
		Volume	Volume	Volume
Day time (7am – 10pm)	South bound	3977	3914	5044
Night time (10pm – 7am)	South bound	526	518	661
Day time (7am – 10pm)	North bound	3779	3718	4795
Night time (10pm – 7am)	North bound	623	613	781

Validation of the noise model

To ensure the validity of the design year predictions, a noise model for the existing road traffic flows was developed. The modelled output was compared to the measured noise levels that were recorded during the noise surveys along the existing road alignment. The predicted road traffic noise levels for the current year from the validation model indicate a variation of within 1 dB(A) of the measured value, which is within the tolerance of predictive accuracy that is required by the RTA for a model validation.

Potential operational noise impacts

The assessment of the potential noise impacts of project operation was calculated for the receivers adjacent to the existing highway for each scenario and compared to the relevant noise criteria at each location. For the modelling scenario, contributions from the existing alignment were not included in the prediction of noise emissions from the proposed carriageway. **Table 7-4-6** presents the results of the modelled traffic scenarios for the future existing and new road, design year outcomes.

- **Table 7-4-6 Modelled road traffic noise levels**

Receiver number	Distance from construction (m)	Traffic noise levels						Base criteria		Are target levels exceeded? Y/N	
		Future existing (year 2012)		Project opening (year 2012)		Design year (year 2022)					
		L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)
1	300	60	57	55	52	57	53	60	55	N	N
2	150	63	60	57	53	58	55	60	55	N	N
3	200	59	57	56	53	58	54	60	55	N	N
4	700	65	63	57	53	58	55	60	55	N	N
5	210	66	64	57	54	59	55	60	55	N	N
6	220	55	53	54	50	55	52	60	55	N	N
7	670	56	53	55	51	56	53	60	55	N	N
8	420	57	55	57	53	58	55	60	55	N	N

Normal traffic growth from the year of opening (2012) to the design year (2022) is expected to generate an increase of approximately 1.5 dB(A) in noise levels. For all residences, this increase in noise due to traffic growth over the period is offset to varying degrees by the realignment of the highway. However, day time noise levels for the receivers in the north (locations 6, 7 and 8) show either no change or only a marginal increase, with a decrease in night time traffic noise. These residences experience a smaller attenuation of noise levels due to the relatively minor relocation of the alignment, where it rejoins the existing highway in the north.

For the design year, the modelling indicates that all residences would fall below the project specific noise level criterion. On this basis, there is no requirement for mitigation of operational noise levels resulting from the project. When the same years of operation are compared (base case and project in place), all of the modelled receivers are predicted to experience a reduction in the existing noise levels, including maximum noise levels generated by heavy vehicles.

7.4.3 Impact mitigation and management measures

The road alignment of the project is the same distance or further away from sensitive noise receivers as the existing highway. No impact mitigation or management measures are required for operational noise. Monitoring 12 months after completion of construction will indicate the need for any noise mitigation and management measures. These measures would then be implemented if feasible and reasonable.

7.5 Aboriginal heritage impacts

Director-General's requirements	Where addressed
Aboriginal Cultural Heritage – the Environmental Assessment must include an assessment of the potential Aboriginal cultural heritage impacts of the project, including	Section 7.5.2
- an assessment of objects, places of significance, natural and landscape values of the corridor and surrounding area	Section 7.5.1
- taking into account the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, July 2005).	Section 7.5.1

7.5.1 Existing environment

Geology and topography

The project occurs within an extensive area of lowland foothills situated on the western fall of the coastal ranges. These foothills form a distinct and undulating topography located between the high gradient slopes of the range and the low-lying floodplains of the Clarence River valley. This topography has formed from sandstones, siltstones and claystones of the Grafton Formation. The low to moderate slope gradients and moderate drainage course density that characterise this landscape are a direct reflection of the weathering of this substrate. A further consequence is that rock shelters and extensive sandstone rock platforms are absent or very rare.

A local exception to the moderate gradients is Glenugie Peak (also known as Mount Elaine). Glenugie Peak forms a prominent conical and symmetrical, but flat topped, peak of resistant basalt and reaches an elevation of 316 m Australian Height Datum. The peak, including its lower margins, are outside the project area. Glenugie Peak is situated on the watershed between the Coldstream River to the east, and Glenugie Creek to the west. Both catchments drain to the northwest and enter a network of now partially drained wetland basins on the floor of the Clarence River valley. The upstream extent of the plain is situated approximately five kilometres to the north of the preferred route. This is also the edge of the foothills.

The southern end of the project study area is situated in the upper Glenugie Creek catchment. The project traverses the western fall of the Glenugie Creek valley, crossing a series of low spurlines separated by tributary creeks. Like the existing highway, the project runs parallel to, and within about 250 m of the eastern bank of Glenugie Creek for about 3.5 km. This section of Glenugie Creek has a limited catchment and the creek is unlikely to provide a permanent source of freshwater. The creek banks merge with the surrounding bedrock slopes and there is no significant development of a flat valley floor. Substantial Quaternary valley floor sediments only become evident in the Glenugie Creek valley around the confluence with Sawpit Creek, two kilometres downstream of the project area.

The project crosses a low and broad ridgeline at Lookout Road, which forms the watershed between Glenugie Creek and Pheasant Creek (one of the lower catchment tributaries of Glenugie Creek). The project then traverses the upper reaches of the Pheasant Creek catchment until terminating in the area of Eight Mile Lane.

Vegetation in the project area consists predominantly of dry sclerophyll forest dominated by spotted gum and ironbark species. Small areas of mixed floodplain forest association occur near Glenugie Creek and its tributaries.

In summary, the project predominantly traverses upper catchment spurs and gullies of the lowland foothills situated between the coastal ranges to the east and the floor of the Clarence valley to the north and north-west. Glenugie Peak lies about one kilometre to the east of the project. The landscape traversed by the project is typified by bedrock based slopes and crests. Substantial or significant deposits of Quaternary aged valley floor deposits do not occur within the project landscape. The pre-European resources of the project area landscape would have been characterised by intermittent fresh water sources and predominantly dry sclerophyll forests.

Cultural values

Traditional and tribal boundaries

Two major tribal groups, the Gumbainggar and the Yaygir, occur in the Wells Crossing to Iluka Road study area. Tindale (1940) places a Kumbainggiri (Gumbainggar) tribe in the area from the headwaters of the Nymboida River across the range to Urunga, Coffs Harbour, Bellingen, Glenreagh and Grafton.

The boundary between this group and the Yaygir (Jiegera) to the east is difficult to establish. While Tindale (1974) places the Yaygir downstream from Grafton from the south bank of the Clarence west to Cowper and south to Wooli, Heron (1991), after oral research, placed the boundary from Corindi Beach north to Black Rocks and taking in Ulmarra in the west. These areas are bounded to the north by the Badjelong (Bandjalong) and to the south by the Dangaddi tribal groups.

Aboriginal consultation

The project falls within the area of interest of four local Aboriginal community organisations:

- Grafton-Ngerrie Local Aboriginal Land Council (LALC).
- Yaegl Native Title Group.
- Yarrawarra Aboriginal Corporation (including the Garby Elders).
- Burra:way Wa:jad Traditional Owners group.

Aboriginal consultation during the development of the Wells Crossing to Iluka Road preferred route and concept design was undertaken in accordance with the DECC *Interim Community Consultation Requirements for Applicants* (DECC 2005a), the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005) and the then RTA *Draft Procedures for Aboriginal Cultural Heritage Consultation and Investigation*. Registered Aboriginal stakeholders including representatives from each of the above organisations attended an Aboriginal focus group (AFG) meeting on 6 September 2007 to discuss, among other things, the proposed methodology for the Aboriginal cultural heritage assessment. That methodology included details of the survey methodology and Aboriginal participation in the survey. The September 2007 meeting was the fifth such meeting held with local Aboriginal community representatives since May 2005 to discuss various aspects of the proposed upgrade of the highway between Wells Crossing and Iluka Road.

Following the September 2007 AFG, registered Aboriginal stakeholders were provided with a copy of the proposed methodology and were requested to provide comment on it, and to nominate a site investigation officer from their group to participate in the field survey of the preferred route. During late October and early November 2007, each of the above organisations responded to this request. The Grafton-Ngerrie and Yaegl LALCs, and the Yarrawarra Aboriginal Corporation each nominated a site investigation officer. The Yaegl Native Title Group and the Burra:way Wa:jad Traditional Owners group did not nominate a site officer or participate in the survey.

Arrangements were then made with respective organisations to have nominated field survey participants available for fieldwork. In this regard, the LALC representatives operated within their LALC boundaries, and the Yarrawarra Aboriginal Corporation (Garby Elders) operated in the southern section of the preferred route, generally south of Tucabia.

The Birrigan Gargle LALC (situated immediately to the east of the study area) was not involved in field investigations, however it has been involved in project consultation for some years, including attendance at AFG meetings and discussions of Aboriginal heritage sites and areas of significance during the development of options for the Wells Crossing to Iluka Road upgrade.

An investigation report was reviewed and discussed at an AFG meeting held on 17 September 2008 and participants endorsed and agreed to the public release of the Concept Design Cultural Heritage Working Paper (RTA 2009a). That public document did not contain precise location details of sensitive Aboriginal sites or areas within the project precincts.

On 2 June 2009, the seventh AFG meeting was held to:

- Advise that the Glenugie section of the Wells Crossing to Iluka Pacific Highway upgrade was progressing to construction ahead of the remainder of the upgrade.
- Discuss the findings of previous heritage investigations, as reported in the *Wells Crossing to Iluka Road Concept Design Report Cultural Heritage Working Paper* (RTA 2009d).
- Advise that the findings of previous investigations were suitable for the environmental assessment of the Glenugie upgrade.
- Discuss the next steps of the project and Aboriginal participation in construction.

All registered Aboriginal stakeholders were invited to attend the meeting.

Representatives from the following organisations attended:

- Grafton-Ngerrie LALC.
- Yaegl LALCs.
- Yaegl Native Title Claimants Group.
- Garby Elders.

Places of cultural significance

The local Aboriginal community has identified two areas of Aboriginal cultural significance in the vicinity of the Glenugie upgrade project. These are Glenugie Peak and Pillar Valley. These locations were identified through both documented stories (such as Gumbaynggir Language & Cultural Group 1992) and community consultation undertaken as part of the Wells Crossing to Iluka Road route selection process. Neither of these locations is close to the corridor for the Glenugie upgrade.

As part of the planning for the Wells Crossing to Iluka Road upgrade, a meeting was held at Franklins Road on 1 March 2006 with representatives of the Garby Elders to discuss the significance of Glenugie Peak. The meeting was attended by several representatives of the Garby Elders, and representatives of the RTA, Navin Officer Heritage Consultants and SKM.

At that meeting the Garby Elders advised the following in relation to the potential impacts of route options for the Wells Crossing to Iluka Road upgrade on Glenugie Peak:

- The Peak itself is the focus of significance. The areas around the Peak are not significant, but Aboriginal people would have passed through these areas.
- Waterholes and wetlands around Coldstream River east of the Peak (and well beyond the Glenugie upgrade) may contain sites (camps, scatters, etc.) but the Elders know no significant sites in that area.

In summary, the results of the cultural heritage assessment undertaken for the project indicate that there would be no impacts on cultural heritage

Archaeological values

Previous archaeological studies in the project area

In 1993, an archaeological assessment of areas within the Grafton Forestry Management Area was conducted by Hall and Lomax (1993). This investigation was the first to attempt a systematic regional overview by employing a predictively based and quantified extrapolation of survey results. Despite locating only open artefact scatters during survey, the study established a set of land-system based models for Aboriginal site location and distribution patterns within the Grafton region.

The study achieved an overall site detection rate of one artefact occurrence per 1.8 km of survey transect. The density within the escarpment range foothills was considerably lower at one artefact occurrence per 2.3 km and markedly higher in the lowland hills at one artefact occurrence per 0.1 km.

However, artefact density was significantly lower on the lowland hills with an average of 1.0 artefact per 100 m^2 compared to 3.0 artefacts per 100 m^2 in the escarpment range foothills (Hall and Lomax 1993). It was concluded that relatively few sites were detected within the lowland hills because sites are more dispersed and not as strongly focused on drainage and ridge lines than for rangelands (Hall and Lomax 1993). Two open camp sites (artefact scatters) were identified during the study. These sites occur outside of the project area.

When considering the effect of geology on site contents it was found that there was a relative lack of artefacts in sandstone country, but relative abundance in argillite dominated geologies. This was interpreted to be a direct reflection of the availability of suitable rock types for tool manufacture from each landform suite (Hall and Lomax 1993).

Previously identified sites across the region

A search of the NSW DECC AHIMS (May 2009), a register of Aboriginal heritage sites and information, returned 64 site recordings within a 30 km area centred on Glenugie Peak, an area which encompassed the whole of the project study area. This search identified 64 site recordings. Of those 64 recordings:

- None are located in the current project corridor.
- Two open camp sites occur over a kilometre away to the east of the project.
- The remaining sites consist of open camp sites, rock shelters with art and/or deposits, burials, ceremonial and mythological sites, stone arrangements, scarred trees and a quarry.

The distribution of previously recorded sites across the area of the AHIMS search reveals a number of patterns:

- Most recordings occur in the south-western (lower left) portion of the search area (at least 10 km away from the project).
- Many recordings appear to be situated along linear traverses.
- Very few recordings occur north and east of the existing highway.

These patterns are a consequence of visibility constraints, past recording interests, and the conduct of systematic surveys as part of environmental assessments, that is:

- The concentration of recordings in the south-western portion of the search area corresponds to the distribution of the Kangaroo Creek Sandstone, a resistant rock type that forms rock platforms, overhangs and shelters.
- A large proportion of the south-western recordings are rock shelters and this reflects:
  - The incidence of rock overhangs.
  - The interests of past recorders in sites such as rock shelters containing archaeological deposit and/or rock art.

  - The visual obtrusiveness of such sites.
- A series of linear development projects, such as transmission lines, water pipelines, and highway upgrades have been conducted across the southern and south-western portions of the search area. Archaeological surveys conducted as part of the environmental assessments for these projects have resulted in recordings (mostly open camp sites) which are situated within the linear footprint of those projects.
- The near absence of recordings to the north and west of the current highway is likely to be a result of both a relative absence of past archaeological survey and the unobtrusive nature of Aboriginal sites across these landforms. Land use practices in this area, which are characterised by forestry, agricultural and conservation, have not required impact assessments involving systematic archaeological survey over large areas. Aboriginal sites across this area are likely to be visually unobtrusive, such as open contexts of surface and subsurface stone artefact distributions. Such sites are unlikely to be recorded outside of systematic archaeological survey programs.

In summary, the pattern of previously recorded sites across the region provides little information about the likely nature of the archaeological record within the area of the project. This is due to limitations in previous archaeological survey coverage, and a past emphasis on sites in sandstone based landscapes.

Predictive statement regarding Aboriginal sites in the project area

As part of the route selection study for the Wells Crossing to Iluka Road Pacific Highway upgrade, a broad scale desktop predictive model of Aboriginal archaeological sites was drafted (RTA 2009a). That model incorporated the results of a number of regionally focused studies including more distant assessments conducted in comparable landscapes (Byrne 1985, Hall and Lomax 1993, Navin and Officer 1990, Officer and Navin 1994, Navin Officer ARM 1996, and Rich 1989a and b). According to this initial schema, the Glenugie project occurred within an area with predicted moderate to low sensitivity over most of its alignment, and traversed a narrow band of predicted high to moderate sensitivity when in close proximity to Glenugie Creek.

Following a comprehensive surface archaeological survey within the corridor of the preferred alignment (RTA 2009a), data from on-ground observation have been combined with previously drafted predictions to refine fine scale predictive statements appropriate to both the lowland foothills landscape in general, and in particular, the Wells Crossing to Iluka Road upgrade study area.

Lowland Foothills

Although few sites have been identified in this zone, Hall and Lomax (1993:27) postulated that sites could be expected to occur in this land system in large numbers. They noted that the fewer artefacts located in the lowland foothills may be due to the absence of lithic sources suitable for stone tool manufacture (Hall and Lomax (1993:65).

Predictive statements regarding site types and locations include:

- The most likely site types are open camp sites of varying size and density, indicated by surface and/or subsurface distributions of stone artefacts.
- Aboriginal scarred trees may occur wherever old growth trees survive, but are likely to be rare in areas which have been subject to repeated cycles of forestry harvesting and/or wildfire.
- Sites may not include visible surface artefacts where situated on aggrading landforms, such as valley floor alluvium.
- Sites will tend to occur in proximity to permanent freshwater sources, on locally elevated and well drained ground.
- Larger campsites will occur on the lower slopes and low spurline crests near substantial creeks and resource-rich swamps.
- Open sites are likely to be found on locally elevated ground in and around the periphery of the floodplain.
- Surface artefact scatters are rarely detected on the immediate banks of creeks and rivers.
- Relatively sparse and small sites will occur in more gently undulating terrain not associated with swamps (Hall and Lomax 1993:27-28).
- Smaller transitory camps may be present on the crests of ridges and spurs in broken and undulating terrain.
- The distribution of sites will tend to be more diffuse, and overall site density will tend to be lower than for comparable landforms within entrenched and steep sided valleys.

The Glenugie upgrade study area

With regard to the generalised statements for the lowland foothills division, the area of the project falls outside of landforms with significant potential. The project:

- Traverses, and passes in close proximity to, intermittent and non-permanent water sources only.
- Does not traverse or occur close to swamp basins, the Clarence floodplain or valley floor.
- Does not traverse any substantial areas of Quaternary valley floor sediments or aggrading landforms with clear potential for subsurface archaeological deposits.
- Would impose a minimal impact to major spurs or ridgelines where small transitory open camp sites could be expected. Watershed ridgelines are traversed only in the vicinity of Franklins Road in the south, and between Lookout and Shields Roads in the north. Each of these locations has been impacted previously by light rail operation, forestry tracks and associated harvesting operations.
- Accidental artefact discard (background scatter) is likely to occur on most landforms. This may be encountered within the project area. This is a risk for all projects.

Based on the relative absence of small scale landform divisions with archaeological sensitivity, it can be concluded that the archaeological potential of the project area is low.

Archaeological survey results

No Aboriginal sites, places, objects or potential archaeological deposits (PADs) were identified in the Glenugie upgrade study area during the 2008 field investigations.

7.5.2 Potential impacts of the project

The potential impacts of the project on Aboriginal cultural heritage have been assessed in accordance with the relevant guidelines for Part 3A projects, in particular the *Draft Guidelines For Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005). **Table 7-5-1** identifies how these guidelines have been addressed in the environmental assessment. The potential impacts of the project are discussed in the following sections.

Table 7-5-1 Cultural heritage impact assessment guidelines checklist

Steps in the assessment process[1]	Where addressed in the environmental assessment
Step 1 Preliminary assessment	Volume 2, Appendix E – Working Paper: cultural heritage - Section 1.1 pps 1-4, Section 2 pps 6-10, Section 3 pps 11-14 and 16, Section 7 p.35, Section 9 p. 41, Appendix 1 pps 47-52, Appendix 2 pps 53-55, and Appendix 3 pps 53-58. Volume 1, Section 7.5.1.
Step 2 Information requirements	Volume 2, Appendix E – Working Paper: cultural heritage - Section 4 pps 17-19, Section 5 pps 20-29 and Appendix 3 pps 53-58. Volume 1, Section 7.5.1.
Step 3 Integration of information and identification of heritage values	Volume 2, Appendix E – Working Paper: cultural heritage - Section 2 pps 6-10, Section 3 pps 11-14 and 16, Section 5 pps 20-30, Section 7 p.35, Section 9 p. 41, Appendix 1 pps 47-52, Appendix 2 pps 53-55 and Appendix 3 pps 53-58. Volume 1, Section 7.5.1 and Section 7.5.2.
Step 4 Information regarding the proposed development	Volume 2, Appendix E – Working Paper: cultural heritage - Section 3.3 p. 16, Section 5.3 p. 22, Section 5.4 pps 22-24, Section 7.1 p. 35, Section 9.1 p. 41, and Section 10.1 p. 43. Volume 1, Section 7.5.2.
Step 5 Integration of assessment with proposed development	Volume 2, Appendix E – Working Paper: cultural heritage - Section 3.3 p. 16, Section 5.3 p. 22, Section 5.4 pps 22-24, Section 7.1 p. 35, Section 9.1 p. 41 and Section 10.1 p. 43. Volume 1, Section 7.5.2.
Step 6 Management strategy for Aboriginal heritage	Volume 2, Appendix E – Working Paper: cultural heritage - Section 3.3 p. 16, Section 5.3 p. 22, Section 5.4 pps 22-24, Section 7.1 p. 35, Section 9.1 p. 41, and Section 10.1 p. 43. Volume 1, Section 7.5.3.

1. DEC (2005).

Impacts on cultural values

No sites, places or objects of Aboriginal cultural value have been identified within the project study area.

Impacts on archaeological values

No Aboriginal sites, places, objects or potential archaeological deposits (PADs) were identified within the project study area. Based on the low predicted archaeological potential of the project study area, this result is considered to be a reliable indication of the actual Aboriginal archaeological resource present within the project footprint.

7.5.3 Impact mitigation and management measures

Construction

As no Aboriginal sites, places, objects or potential archaeological deposits (PADs) were identified along the length of the project corridor; there are no recommended management actions with regard to known sites or PADs. Protocols to deal with unexpected finds of previously unidentified Aboriginal Objects or suspected human remains would be developed and implemented. A cultural heritage component would be included in an induction program conducted for all construction and in-field personnel.

Operation

There are no Aboriginal cultural heritage operational constraints or on-going management requirements.

7.6 General construction impacts

Director General's requirements	Where addressed
General Construction Impacts – the Environmental Assessment must consider the potential impacts associated with the construction of the project, and present a management framework for construction works to ensure that impacts are mitigated, monitored and managed.	Section 7.6.1 (Construction noise), Section 7.6.2 (Construction traffic), Section 7.6.3 (Erosion, sedimentation, water quality and riparian management issues) and Section 7.6.4 (Management framework).

7.6.1 Construction noise and vibration

Director General's requirements	Where addressed
The Environmental Assessment must include consideration of, and a management framework for: • construction noise and vibration, including a considered approach to scheduling construction works having regard to	Section 7.6.1 and Section 7.6.4.
– the nature of construction activities (including transport, blasting and tonal or impulsive noise-generating works),	Section 7.6.1 - Potential impacts of project construction.

Director General’s requirements	Where addressed
– the intensity and duration of noise and vibration impacts,	Section 7.6.1 - Potential impacts of project construction.
– the nature, sensitivity and impact to potentially-affected human receivers and structures,	Section 7.6.1 - Potential impacts of project construction.
– the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and	Section 7.6.1 - Potential impacts of project construction.
– other factors that may influence the timing and duration of construction activities (such as traffic or spoil management).	Section 7.6.1 - Potential impacts of project construction.
The Environmental Assessment must also present a strategy for monitoring and mitigating construction noise and vibration, with a particular focus placed on those activities identified as having the greatest potential for adverse noise or vibration impacts, and a broader, more generic approach developed for lower-risk activities;	Section 7.6.1 - Construction impact mitigation and management measures and Section 7.6.4.

Existing environment

The existing noise environment is described in Section 7.4.1 and Appendix F. There are eight residential properties located about 15 km south of Grafton that have been considered as potential sensitive noise receivers due to their proximity to both the existing highway and the project.

To identify existing background noise levels, monitoring was conducted over a one week period in May 2009. A single monitoring location was selected and was designed to provide a representative indication of the noise levels experienced at the above-mentioned eight residential properties. Considerations in site selection included the line of sight to the existing highway and proximity to residential receivers. The location of the noise monitoring site is shown in **Figure 7-4-1**. The existing noise environment at this location is dominated by road traffic.

The Department of Environment and Climate Change (DECC) provides guidance for assessing construction noise impacts. In general, the noise level at sensitive receiver locations and the corresponding need for noise impact mitigation measures is influenced by the timing and duration of the noise emissions and the emergence of the noise above existing background levels. An estimate of the noise levels to be generated by construction activities and the potential level of impact is used to identify the requirements for noise mitigation and management measures. The noise objectives for the project are presented in **Table 7-6-1** and have been determined from the measured background noise levels and DECC construction noise objectives**.**

■ **Table 7-6-1 Project noise objectives**

Receiver distance to upgraded road centreline (m)	Rating background level (dB(A))	Noise objective (dB(A))
700-150	44	49

Potential impacts of project construction

Potential construction activities

Although a detailed program of construction has not yet been determined, the project is likely to include the activities identified in **Table 7-6-2**. The noise impacts of these activities have been considered and assessed.

■ **Table 7-6-2 Anticipated construction activities**

Activity	Description
Clearing and grubbing	Felling of trees and shrubs as well as removal of manmade structures; removing stumps, roots and general vegetation.
Earthworks	Bulk earthworks including topsoil stripping, cut and fill, excavation of culverts and sedimentation basins, construction of batters and landscaping.
Bridgeworks[1]	Casting and formwork, piling, concrete pouring, pre-cast element installation and demolition as required
Paving and asphalting	Application of road surface pavement to road base slab including pouring of concrete base and sub-base, supplication of sprayed bitumen seals; laying of asphalt, finishing open drains and installation of road furniture and medians.
Concrete or asphalt batching	A temporary concrete or asphalt batching plant (or both) is likely to be required. This will involve deliveries of aggregate and cement/fly ash as well as generate significant truck movements for concrete delivery.
Blasting	While not expected to be required, blasting may become necessary at the cutting at Lookout Road if hard rock is encountered during excavation.
Site compound and workshop	An administrative and maintenance area will be required.
Deliveries	Deliveries to site may include heavy machinery, construction materials and other consumables.

1. A bridge across the upgrade would be required at Franklins Road for the motorway style upgrade. No bridges would be required for the likely initial staging.

Proposed construction work hours

Construction will normally be limited to the following hours:

- Between 6am and 6pm Monday to Friday.
- Between 7am and 4pm Saturday.

There will be no works on Sundays or public holidays except:

g) Works that do not cause construction noise to be audible at any sensitive receivers.

h) For the delivery of materials required outside these hours by the Police or other authorities for safety reasons.

i) Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

j) Any other work as agreed through negotiations between the RTA and potentially affected sensitive receivers. Any such agreement must be recorded in writing and a copy kept on site for the duration of the works.

k) Where the work is identified in the Construction Noise and Vibration Management Plan (CNVMP) and approved as part of the Construction Environmental Management Plan.

l) As agreed by the DECC.

Local residents and the DECC must be informed of the timing and duration of work approved under items (d) and (e) at least 48 hours before that work commences.

Hours of work would be addressed in the CNVMP for the project. The CNVMP would be finalised in consultation with the Department of Planning and DECC.

Predicted construction noise impacts for typical construction activities

The noise levels likely to be experienced at identified sensitive receiver locations are dependent upon the type of construction equipment used and the proximity of the receivers to the noise source. Intervening factors such as topography and meteorology will also have an influence on noise levels experienced. The likely construction equipment to be used for the project is identified in Chapter 4 and in the Noise and Vibration Assessment Working Paper (Appendix F). Based on the sound power levels associated with this equipment, the sound pressure levels likely to be experienced at increasing distances from the noise sources have been predicted (**Figure 7-6-1**).

▪ **Figure 7-6-1 Estimated reduction of construction noise with distance from source**

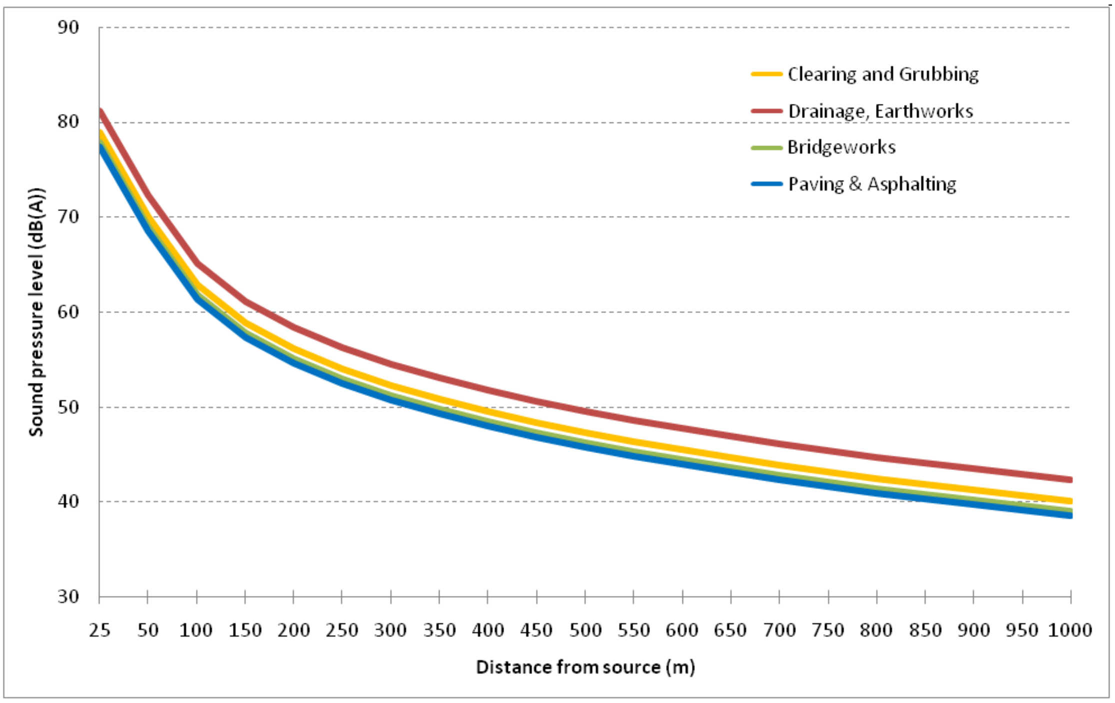


Table 7-6-3 contains predicted noise levels at sensitive receiver locations that would result from the anticipated construction activities and facilities, together with the amount of exceedance of the construction noise goal of 49 dB(A) (refer to **Table 7-6-1**). These predicted noise levels are conservative and do not take into account additional noise attenuation from ground absorption and topography. The predicted construction noise levels indicate that the construction noise goals would be exceeded at all sensitive receiver locations, except receiver numbers 4 and 7.

▪ **Table 7-6-3 Predicted noise levels resulting from construction**

Receiver number[2]	Distance to construction (m)	Construction noise levels (dB(A))[1]			
		Clearing and grubbing	Drainage and earthworks	Bridgeworks	Paving and asphalting
1	300	52 (3)	55 (6)	51 (2)	51 (2)
2	150	59 (10)	61 (12)	58 (9)	57 (8)
3	200	56 (7)	58 (9)	55 (6)	55 (6)
4	700	44 (0)	46 (0)	43 (0)	42 (0)
5	210	56 (7)	58 (9)	55 (6)	55 (6)
6	220	57 (8)	59 (10)	56 (7)	56 (7)
7	670	44 (0)	46 (0)	43 (0)	42 (0)
8	420	49 (0)	51 (2)	48 (0)	48 (0)

1. Numbers in brackets indicate amount of exceedence of the construction noise goal of 49 dB(A).
2. Refer to **Figure 7-4-1** for locations.

Potential noise impacts of batching plants

Batching requirements for the project have not yet been determined. It is expected that either a concrete or asphalt batching plant (or both) would be required for producing paving material and may be located at or adjacent to the road construction corridor. Since the location of the batching plant site is not known at this stage, appropriate criteria cannot be determined in this assessment. As a guide, presuming a rural/residential setting, a planning noise level of approximately L_{Aeq} 50 dB(A) would be anticipated during the day, based on the *Industrial Noise Policy* (EPA 2000). The criterion for night time noise levels would be lower, consistent with existing background noise levels.

Table 7-6-4 summarises some of the potentially dominant noise sources at an operational batching plant. For the purpose of this assessment, a concrete batching plant has been used to predict the potential noise impact on sensitive receivers. The predicted impacts from a concrete plant should be representative of those from an asphalt batching plant. The actual batching facility selected would require further assessment during detailed design.

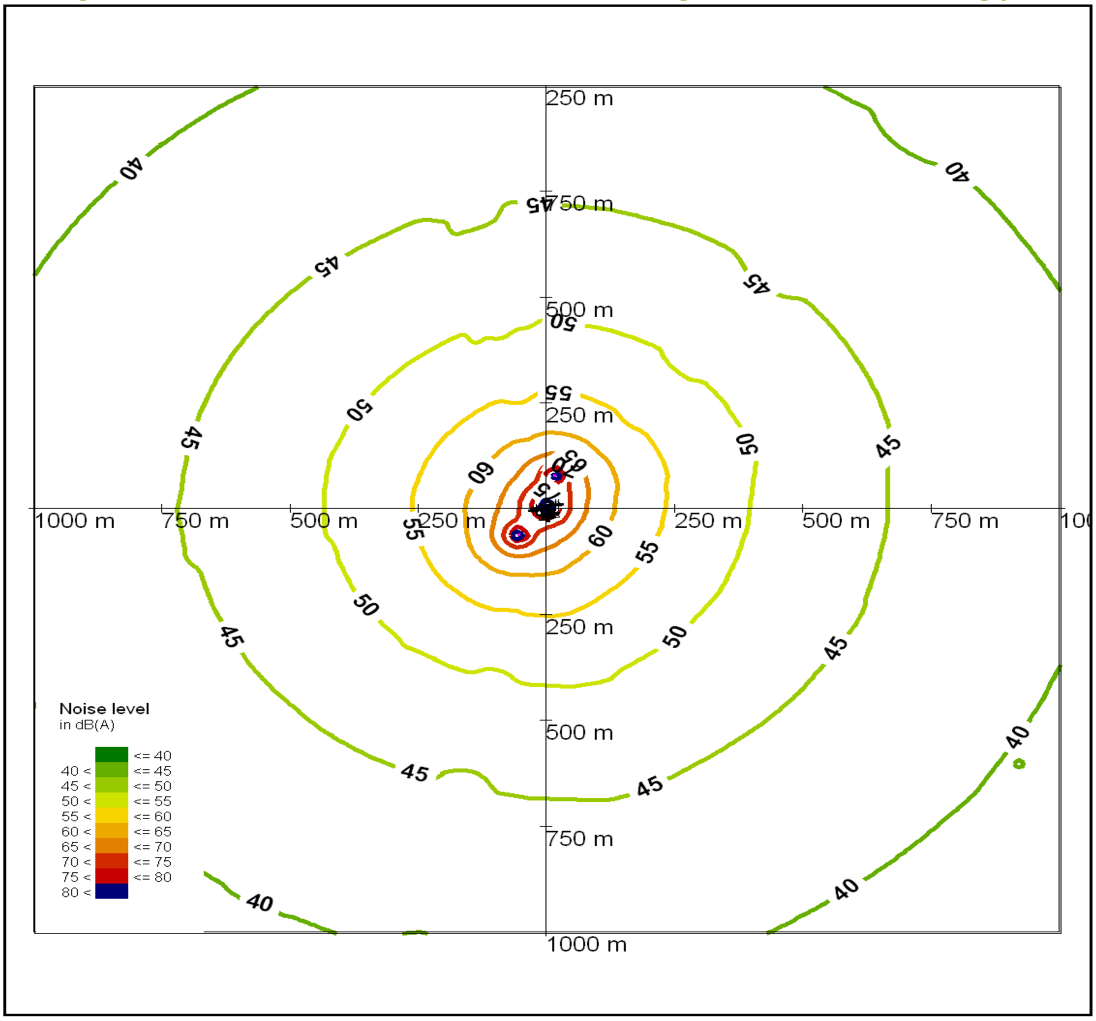
- **Table 7-6-4 Potential noise sources at an operational batching plant**

Noise source	Process description
Aggregate loading	A front end loader used to load aggregate and sand from the stockpiles into the hoppers.
Aggregate hopper gates	The aggregate may be loaded onto the conveyors via gates which are controlled by compressed-air power rams, which generate a significant air release each time gates are opened.
Aggregate conveyor	The aggregate is loaded to the mixing drum via a conveyor. The conveyor is driven by an electric motor and runs on rollers, which may squeal if not properly lubricated.
Dust extraction fan	Externally mounted fans for controlling dust in cement and fly-ash silo.
Vibratory aggregate hopper cleaner	May be associated with the aggregate hopper and activates each batch to ensure all product has been loaded - emits a mid-frequency hum.
Mixing drum	Rotation by hydraulic or electric drive.
Truck movements	Trucks are a significant noise source for a batching plant, with a high number of movements and rapid turnaround time. Other truck movements include aggregate and cement deliveries at a lower frequency of movement.
Compressor	Used to operate gates, externally mounted.
Generator	Where the site is not connected to 3-phase power a generator would be required to power the plant. Even with power, a generator would be installed for emergency use.
Cement loading	Cement is pneumatically loaded to the silo using a blower on the silo.
Reverse beepers	Trucks are typically required to reverse into the loading bay.

The noise contours from the SoundPLAN model are presented in **Figure 7-6-2** and indicate the following approximate noise levels with increasing distance from the plant:

- 55dB(A) at a distance of 250 m from the plant.
- 48 dB(A) at a distance of 500 m from the plant.
- 41 dB(A) at a distance of one kilometre from the plant.

▪ **Figure 7-6-2 Predicted noise levels with increasing distance from batching plant.**



Potential noise impacts of blasting

Blasting activities produce ground-borne vibration and air blast overpressure, both of which can cause discomfort and at higher vibration levels, potential damage to property. Chapter 154 of *the Environmental noise control manual* (EPA 1994) provides guidance on times of day, airblast overpressure noise level and ground vibration peak particle velocity limits for operations which involve the repeated use of explosives, such as quarrying and bulk earthworks. Blasting operations are recommended to be confined to the periods Mondays to Saturdays, 9 am to 3 pm and blasting outside these times should be approved only where blasting during the recommended times in is impractical. Blasting at night should be avoided unless absolutely necessary.

Table 7-6-5 shows the limiting over-pressure and ground vibration levels during blasting at the nearest sensitive receiver.

- **Table 7-6-5 Limiting criteria for the control of blasting impact at residences**

Blast Over Pressure Level, dB (linear)*	Ground Vibration, Peak Particle Velocity (mm/sec)**
115	5

* Any exceedance above a blast over pressure of 115dB (linear) should be limited to not more than 5% of the total number of blasts. On these infrequent occasions a maximum limit of 120dB (linear) should not be exceeded at any time over a 12 month period.
** Ground vibrations above 5 mm/sec should also be limited to not more than 5% of the total number of blasts. On these infrequent occasions a maximum limit of 10 mm/sec should not be exceeded at any time over a 12 month period.

In the absence of specific blasting information and seismic details of the site, **Table 7-6-6** provides guidance for estimating the likely minimum distance from blasting that may be required to meet the over-pressure and vibration criteria described above for a range of maximum instantaneous charge (MIC) values. The distances are estimates and should only be referred to for guidance. It is evident that the degree of impact is strongly dependent on the size of the blast and that a greater separation distance is required to comply with the over-pressure limit than the vibration limit.

- **Table 7-6-6 Minimum distances to comply with blasting vibration and over-pressure limits for various MIC values**

Maximum instantaneous charge (MIC)	Minimum distance limits (metres)	
	Vibration	Over pressure
5	70	290
10	100	350
20	140	430
50	220	560
100	300	670
200	430	750

Potential noise impacts associated with site compound and deliveries

During establishment of the site, anticipated activities include clearing and grading and the installation of pre-fabricated portable site offices and a maintenance workshop area. Noise associated with these activities would be limited in duration. Plant used would include mobile machinery (eg scrapers, graders compactors and mobile cranes) and stationary plant (eg generators and compressors). Vibration sources are not likely to be significant and would be rapidly attenuated with distance.

Operation of the site compound/s would be required to support construction activities. The predominant noise source would be vehicle movements (eg staff transport and delivery of construction supplies). It has been assumed that the location of the construction compounds would be near transport facilities for delivery and access reasons and therefore the additional vehicle movements are not likely to present a significant noise or vibration impact on sensitive receivers. The use of hand tools during vehicle maintenance may result in audible noise at sensitive receivers. This noise would not be significantly different from that generated by existing rural land uses.

Vibration during construction

Table 7-6-7 summarises the anticipated level of vibration for each stage of construction. Activities such as compaction, rolling and ripping would be the dominant sources of vibration.

- **Table 7-6-7 Summary of anticipated vibration levels for construction activities**

Activity	Component tasks	Vibration guidance
Clearing and grubbing	Clearing of vegetation, trunk and root removal, processing of timber waste	In general, the activities carried out during this stage of works generate low levels of vibration and areas close to residences are generally already cleared. Vibration impact unlikely.
Earthworks	Bulldozers ripping	1 mm/s to 2 mm/s at distances of approximately 5 m. At distances greater than 20 m, vibration is usually below 0.2 mm/s.
	Compactors	20 mm/s at distances of approximately 5 m, 2 mm/s at distances of 15 m. At distances greater than 30m, vibration is usually below 0.3mm/s.
	Vibratory rollers	Up to 1.5 mm/s at distances of 25 m. Higher levels could occur at closer distances, however, no damage would be expected for any building at distances greater than approximately 12 m (for a medium to heavy roller).
	Truck traffic (on normal smooth road)	0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 – 20 m from a roadway. Very large surface irregularities can cause levels up to five to ten times higher.
Bridgeworks[1]	Impact piling	The typical levels of ground vibration from pile driving range from 1 mm/s to 3 mm/s at distances of 25 m to 50 m, depending on ground conditions and the energy of the pile driving hammer.
Paving and asphalting operations	Paver, concrete cutter	None of the construction plant used during paving and asphalting will be major sources of ground vibration.

1. A bridge across the upgrade would be required at Franklins Road for the motorway style upgrade. No bridges would be required for the likely initial staging.

While most of the works will not be within 100 m of residential locations, vibration levels generated by construction plant have been estimated at various distances and expected vibration impacts are shown in **Table 7-6-8**. These results indicate that vibration generated by construction activities is unlikely to impact sensitive receivers and is therefore unlikely to be an issue for the project.

Table 7-6-8 Potential vibration impacts

Approximate distance	Comment on potential vibration impact
Earthworks	
50 – 100 m	Reduction in human comfort as a result of ripping is possible. Structural damage unlikely.
100m+	Low probability of reduction in human comfort for all activities
Bridgeworks	
50 -100 m	Reduction in human comfort as a result of piling is possible. Structural damage unlikely.
100 m+	Low probability of reduction in human comfort from piling activities

Construction impact mitigation and management measures

The proposed construction noise impact mitigation and management measures are listed below.

- Potentially affected sensitive receivers are to be given adequate prior notice of the construction program, kept informed throughout the construction period, and provided with a name and contact number for construction noise information and complaints. A specific notification procedure would be developed for any blasting activities. Any noise complaints will be dealt with through a standard complaints management procedure identified in the community consultation plan.
- Construction will be confined to approved construction hours.
- Construction noise and vibration will be minimised as far as practical through the implementation of all feasible and reasonable impact mitigation and management measures. These would include:
  - Use of noise source controls such as residential class mufflers to reduce noise from plant and equipment where practical.
  - Ensuring that plant and equipment are well maintained,
- Construction staff training will cover noise mitigation techniques.

Construction noise levels experienced at sensitive receivers will be monitored to assess the need for additional impact mitigation measures. This monitoring will be undertaken at all sensitive receiver locations where construction noise goals are likely to be exceeded. Where potential or actual exceedences of noise goals are identified, all additional feasible and reasonable best practice noise management measures will be considered and investigated. Additional measures that may be applied where feasible, reasonable and likely to be effective include:

- Use of portable, temporary screens for mitigation of a specific noise source.
- Use of respite periods for noisy activities.
- Modifying work activities.
- Negotiating temporary arrangements with affected residents.

The construction noise impact mitigation and management measures identified above are to be incorporated into the Construction Environmental Management Plan prepared for the project.

7.6.2 Construction traffic

Director General's requirements	Where addressed
The Environmental Assessment must include consideration of, and a management framework for: • construction traffic including a considered approach to route identification and scheduling of transport movements, having regard to	Section 7.6.2 - Potential impacts of project construction. Section 7.6.2 - and Construction impact mitigation and management measures. Section 7.6.4 and Appendix G.
– alternatives to road transport, the number,	Section 7-6-2 - Potential impacts of project construction.
– frequency and size of construction related vehicles (both passenger, commercial and heavy vehicles),	Section 7-6-2 - Potential impacts of project construction.
– the nature of existing traffic on construction access routes (with consideration of peak traffic times and sensitive road users, including emergency vehicles and buses),	Section 7.6.2 - Existing environment.
– the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project, and	Section 7.6.2 - Potential impacts of project construction.
– how construction traffic impacts will be managed to minimise any potential for cumulative traffic impacts.	Section 7.6.2 - Construction impact mitigation and management measures
The Environmental Assessment must also present a strategy for monitoring and mitigating traffic impacts, with a particular focus placed on those activities identified as having the greatest potential for adverse traffic flow, capacity or safety implications, and a broader, more generic approach developed for day-to-day traffic management; and	Section 7.6.2 - Construction impact mitigation and management measures. Section 7.6.4 and Appendix G.

Existing environment

The existing traffic and transport conditions are detailed in Section 7.3.1. Key features of the existing environment are as follows:

- The section of the Pacific Highway to be upgraded is a two-lane single carriageway road with occasional overtaking lanes and a posted speed limit of 100 km/h.
- The average annual daily traffic (AADT) volume on the Glenugie section of the Pacific Highway has been estimated at 8,200 vehicles per day based on RTA traffic counts in May 2009. This total volume is made up of 6,300 (77 per cent) light vehicles and 1,900 (23 per cent) heavy vehicles.

- The majority of traffic on the Pacific Highway at Glenugie passes through the area without stopping.
- Two bus companies (Greyhound/McCaffertys and Premier Motor Service) provide long-distance coach services through the area. Neither stops within the Glenugie area.
- Ryans bus services provide two local services on weekdays between Grafton and Coffs Harbour, operating on a hail and ride basis. Ryans bus service also operates the school buses for the Glenugie area and have a designated school stop at Franklins Road.
- The section of the highway to be upgraded has a high incidence of vehicle accidents, which can be attributed largely to deficiencies in the current road standard, including substandard curves, narrow road shoulders and traffic hazards in close proximity to the carriageway.
- There are currently two local access roads connecting with the existing highway, namely Shields Road and Franklins Road. Both roads are unsealed and provide access to private properties (Franklins Road) and Glenugie State Forest (Franklins Road and Shields Road).

Potential impacts of project construction

Potential construction site access

Possible construction vehicle access to the work site could include use of:

- The existing highway.
- The carriageway under construction.
- Bypass areas within the approved corridor.
- Local roads including Eight Mile Lane and Franklins Road.

Construction site access would be designed to minimise impacts on *Eucalyptus tetrapleura* and would be confirmed during the detailed design phase.

Increase in traffic volumes

A short to medium term increase in traffic volumes is expected during the construction period as a result of the movement of construction vehicles in and around the work site and the haulage of materials and fill to and from the work site. It is estimated that up to 100,000 cubic metres of pavement and various materials would need to be imported over the two year construction period. While it is anticipated that the majority of construction movements occurring within the site will be able to be undertaken away from traffic, there will be the need for construction traffic to interact with public vehicles at Franklins Road and Eight Mile Lane.

The number of construction personnel would change during the course of construction. A maximum workforce of 230 people is anticipated on site at any one time, including 70-80 employees based in offices in the main compound site. Experience on previous Pacific Highway projects is that many staff carpool to the construction site. On average, 120 light vehicles are expected to be driven to site each day. These vehicles would be parked at the main site compound and other ancillary facilities. Some of these vehicles would be driven to and from Grafton, Woolgoolga, and Coffs Harbour.

Based on likely numbers of construction vehicles, an estimate has been made of the number of vehicle trips per day on the public road network (for the purpose of this calculation, a trip is defined as an 'in' or ''out' movement, so a delivery would be counted as two trips):

- Staff vehicles – 240 trips per day.
- Delivery of equipment – 20 trips per day.
- Delivery of materials – 40 trips per day.
- Construction movements outside of site boundary – 50 trips per day.

Based on the above, construction activities are expected to generate about 240 light vehicles and 110 heavy vehicle trips per day on public roads.

If required, asphalt wearing course is likely to be imported from Coffs Harbour, with vehicles accessing the site from the south.

Preliminary sources of quarry material are listed in **Table 7-6-9**.

Table 7-6-9 Potential sources of quarry material

Quarry	Location	Proposed haulage route
Duncan's Pit	Gwydir Highway, 30 km west of Grafton	Gwydir Highway, Pacific Highway, approaching the site from the north.
Jones / Thorleys Pit (Pillar Valley)	Off Franklins Road, Glenugie	Franklins Road, Pacific Highway, approaching from the south/east.
McLennons Pit	Old Glen Innes Road, Chanbigne	Gwydir Highway, Pacific Highway, approaching the site from the north.
Woolgoolga Quarry	Morgans Road, Woolgoolga	Morgans Road, Pacific Highway, approaching from the south/east.

Glenugie Peak (Mount Elaine) is an important area to the Aboriginal community and is not a potential source of material for the project. Glenugie peak currently has statutory protection as a flora reserve under Section s25A of the *Forestry Act* 1916.

Deliveries and staff arrivals would be timed so as to occur outside of peak periods along the Pacific Highway to minimise the impacts of construction traffic on the operation of the highway.

Where possible and feasible, machinery and materials required to be delivered over long distances would be transported to Coffs Harbour or Grafton by rail and hauled to site by road transport. All other goods would be transported by road.

Disruption to traffic flow

Disruptions to traffic flow, including general traffic, heavy vehicles and buses, would generally be confined to the tie-in points between the project and the existing highway and to the gated access points to the project. Work that may be required on the existing highway for the likely initial staging would be carried out under traffic.

Potential impacts on road safety

Potential impacts on road safety would be confined to the areas where works may interact with in-use roads. These areas are the tie-in points between the project and the existing highway and the gated access points discussed in the previous section. As the majority of works are anticipated to occur away from traffic, the impact of the works on road safety would be minimal.

Construction impact mitigation and management measures

The construction works would be undertaken in accordance with the RTA's *Traffic Control at Worksites Manual* (2003) and *AS1742.3 Manual of Uniform Traffic Control Devices* (2009). In accordance with these requirements:

- Strict road safety measures including speed limits would be implemented and enforced.
- Relevant Road Occupancy Licences would be obtained, as required.
- Any necessary road closures would be supervised and maintained at all times, with appropriate alternate routes put in place where required.
- Parking for construction workers would be within the site compounds and would not affect the normal operations of nearby roads or construction activities.
- Construction-generated traffic would be carefully managed to maximise deliveries of materials outside of peak traffic hours and to source local suppliers and services wherever practicable.
- Car sharing would be encouraged.
- A community involvement plan and regular updates on traffic management arrangements for local and long distance traffic would be implemented as part of the construction package. As part of this, advance notification would be given to impacted property owners and occupants on project schedules, construction works and access arrangements.
- Pre-construction road dilapidation reports would be prepared for all roads likely to be used by construction traffic prior to and on completion of works. Any damage found to be resulting from construction, except for normal wear and tear, would be repaired at the RTA's expense, unless otherwise agreed with the local roads authority.
- Property and local road access would be maintained for the duration of the construction. Temporary access requirements (if necessary and feasible) would be assessed in consultation with affected land holders.
- At the locations where the new alignment deviates from the existing highway, crosses the existing highway or any local roads, traffic management measures would be in place to facilitate access through or past the work areas.
- Traffic delays would be managed under the Pacific Highway Road User Delay Management strategy for managing the impact of delay.

7.6.3 Erosion, sedimentation, water quality and riparian management issues

Director General's requirements	Where addressed
The Environmental Assessment must include consideration of, and a management framework for: • erosion, sedimentation, water quality and riparian management issues for works in and around watercourse crossings.	Section 7.6.3 (Potential impacts of project construction) Section 7.6.4 and Appendix G.
The Environmental Assessment must specifically consider how construction of the project at watercourse crossings will be undertaken and managed to minimise the potential for impacts on riparian vegetation, fish passage and water quality in the watercourse for the duration of construction works.	Section 7.6.3 (Potential impacts of project construction) Section 7.6.4 and Appendix G.

Existing environment

Soils, erosion and sedimentation

The project is underlain by the Grafton Formation, which comprises residual soils and weathered rock. The residual soils comprise sandy and silty clays of medium to high plasticity and a very stiff to hard consistency. The soils are typically two to three metres deep, although they have been found to be up to 15 m deep in some areas. Dispersible soils may occur in the project area and may lead to erosion problems.

Acid sulphate soils are soils that contain iron sulphides, which can lead to the generation of sulphuric acid when oxidised or exposed. There is no known occurrence of actual or potential acid sulphate soils in the study area. Acid sulphate soil testing was undertaken as part of the route development for the Wells Crossing to Iluka Road upgrade and no acid sulphate soils were identified. The soils derived from the Grafton Formation rocks are considered to have a low likelihood of acid sulphate occurrence.

There are no known occurrences of contaminated land within the study area.

Groundwater

Geotechnical investigations undertaken at the proposed Lookout Road cutting location indicate that the water table is about 13.5 m below the natural ground surface. The Lookout Road cutting would be about 14 m deep and is the deepest cutting proposed for the project.

Water quality

The project area drains to Glenugie Creek and a number of its unnamed tributaries. Glenugie Creek is a tributary of the Clarence River. The receiving waters in the project area are ephemeral streams that fall within the lowland river classification of the ANZECC/ARMCANZ (2000) water quality guidelines.

To provide baseline water quality data for the project, targeted water quality sampling of Glenugie Creek was undertaken at six sites (**Figure 7-6-3**) from 12 to 14 May 2009. The resulting water quality data are provided in **Table 7-6-10**. Every effort was made to select two sites situated upstream of the project area, however all tributaries upstream of Glenugie Creek were dry at the time of sampling.

The results of sampling indicate that the creeks in the study area have poor to moderate water quality, with consistently low dissolved oxygen levels and high turbidity. Samples collected during dry weather indicate that water quality fails to meet ANZECC/ARMCANZ (2000) guidelines for Protection of Lowland River Aquatic Ecosystems (**Table 7-6-10**). Heavy rainfall appears to flush the system, resulting in improved water quality, with all measured parameters meeting the ANZECC/ARMCANZ guidelines during wet weather.

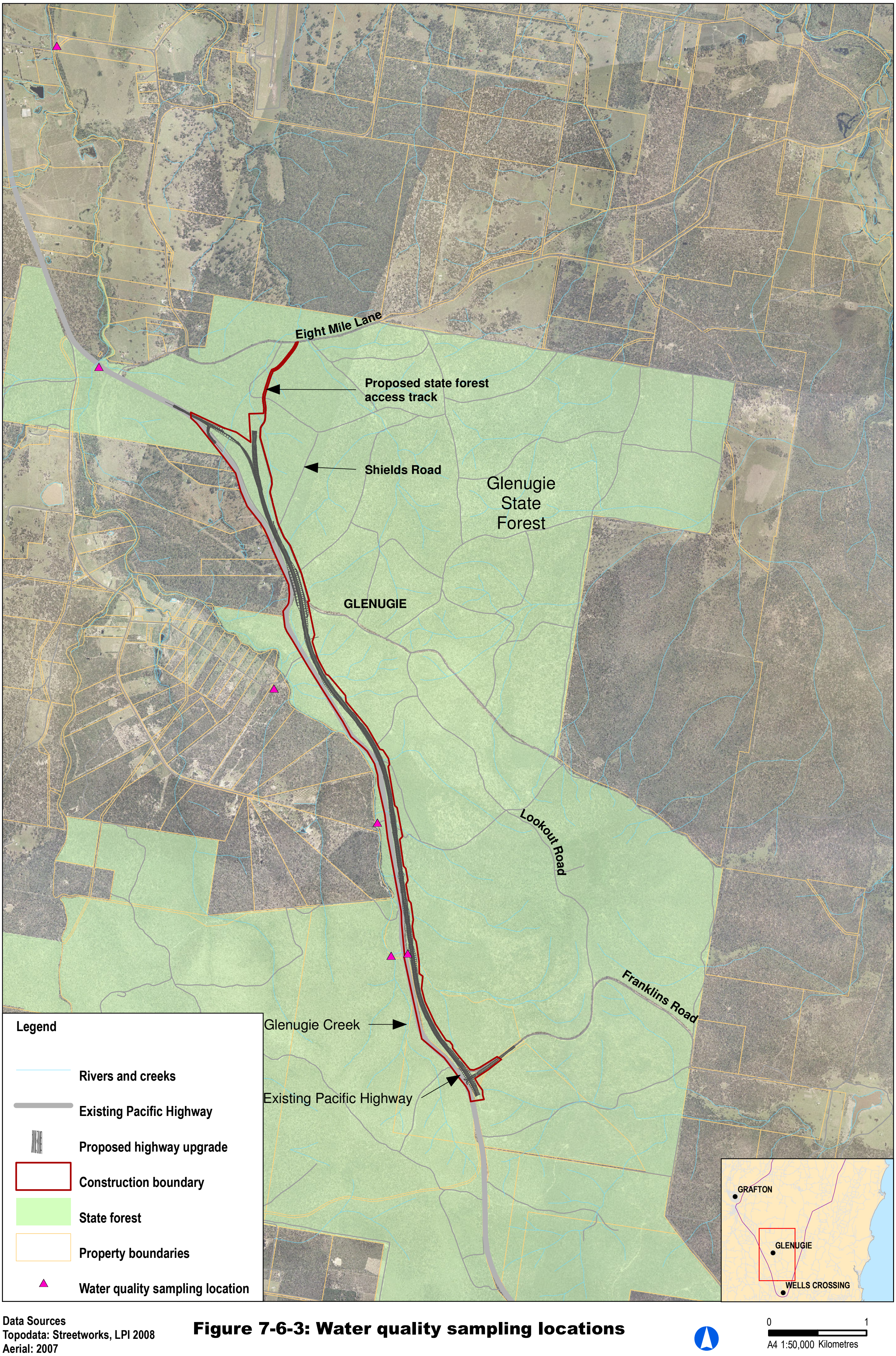
Riparian zone

Glenugie Creek has moderately sloping banks stabilised by native vegetation. It has intermittent flow, with sandstone rockbars separating pools. Riparian vegetation communities in the vicinity of the project include *Subtropical Coastal Floodplain Forest*, which is listed as an endangered ecological community under the NSW *Threatened Species Conservation Act* 1995 and is important for fauna movement and refuge. This community is found in areas that flood intermittently and have sandy alluvial soils. These areas include some of the tributary drainage lines of Glenugie Creek that extend into the project footprint and areas surrounding Glenugie Creek on the western side of the existing highway.

There are no SEPP 14 wetlands in the immediate vicinity of the project.

Fish passage

The waterways within and downstream of the project area, including Glenugie Creek and its tributaries, flow intermittently and consist primarily of shallow disconnected pools. These areas provide Class 2 and 3 (moderate to minimal) fish habitat as classified by Fairfull and Witheridge (2003). A Class 2 waterway is typically a permanent or intermittent waterway with clearly defined banks and semi-permanent to permanent pools, which is considered to provide ‘moderate’ potential for fish habitat. A Class 3 waterway is a minor waterway that typically has intermittent flow, providing potential but limited refuge, breeding or feeding areas for some aquatic fauna. Opportunities for fish passage within the waterways of the study area occur during periods when the creeks are flowing, primarily in response to rainfall.



Data Sources
Topodata: Streetworks, LPI 2008
Aerial: 2007

Figure 7-6-3: Water quality sampling locations

- **Table 7-6-10 Mean dry weather water quality 12 to 14 May 2009**

Site	Depth	pH	Electrical Conductivity (µS/cm)	Electrical Conductivity (mS/cm)	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	Salinity	Oxidation Reduction Potential
1	0.3	7.4	308.7	0.4	14.9	**45.9**	4.7	**44.8**	0.4	427
2	0.3	7.8	272.3	0.4	14.0	**51.9**	4.5	**43.1**	0.4	345
3	0.3	7.6	587.3	0.4	14.4	**115.9**	3.1	**30.8**	0.2	351
3.5	0.1	7.9	209.7	0.3	15.5	**81.6**	5.1	**50.5**	0.2	318
4	0.3	7.7	195.3	0.3	13.8	**32.0**	5.6	**54.2**	0.1	329.0
4.5	0.2	8.3	267.3	0.4	14.0	**79.3**	6.9	**65.9**	0.4	326.3

* Text in bold indicates an exceedance of the ANZECC/ARMCANZ (2000) guidelines.

Potential impacts of project construction

Soils, erosion and sedimentation

Construction activities will result in soil disturbance, leaving soil vulnerable to wind and water erosion. If not effectively managed, erosion of soils could lead to transport of sediment into nearby riparian areas and waterways. Additional potential impacts include scouring of flow paths as a result of uncontrolled runoff from construction areas, deposition of eroded sediments on upstream and downstream sides of culverts, and bed and bank scour on downstream sides of culverts. Dispersible soils may occur in the project area and may exacerbate erosion risks if they are not identified and managed. Cuts are required to achieve the current highway design and may create areas of local instability that require specific slope protection measures during construction. These potential impacts are typical of all road projects and can be readily managed with standard erosion and sediment control measures.

The project is not expected to affect any areas containing actual or potential acid sulphate soils. Furthermore, as the project area is unlikely to contain contaminated material, the project is unlikely to result in disturbance and migration of contaminants. There is potential for contamination to occur during construction as a result of accidental spills of potentially harmful materials, including asphalt, cement, fuels, hydraulic fluids and other chemicals. Appropriate management measures would be implemented to minimise the risks of this occurring as far as practical.

Groundwater

Groundwater seepage may be encountered during excavation. Adverse impacts on groundwater systems (including groundwater resources and groundwater dependent ecosystems) are not expected. The project does not impact any licenced groundwater boreholes.

Water quality

The waterways in the project area, including Glenugie Creek and its tributaries, are susceptible to adverse water quality impacts because they already exceed or are close to established limits for ecosystem protection for many water quality parameters. Construction of the project may impact the physical and chemical properties of surrounding creeks as follows:

- Soil erosion from the construction site may lead to off-site transport of eroded sediments and pollutants, increasing turbidity and sediment loads in receiving waterways and resulting in deposition of sediments on stream beds.
- Accidental spills or leaks of oil, grease, fuel or other materials or chemicals may enter nearby waterways.
- Construction of the new roadway and waterway crossings may lead to changes in surface drainage, including changes in flow direction, volume and intensity, leading to physical and chemical changes in surfaces waters.
- In-stream structures are required for major waterway crossings, including the northern Glenugie Creek crossing. The installation of these structures would create the potential for surface water quality impacts through the removal of in-stream and stream bank vegetation and disturbance of existing in-stream sediments.

Measures to reduce the potential for soil erosion, adverse effects on drainage and accidental spills would need to be incorporated into design and construction. Site-specific measures would be required at waterway crossings and culverts.

Riparian zone

Impacts on riparian vegetation would occur directly as a result of clearing within the road footprint at proposed culverts. Indirect impacts could also occur as a result of changes to local hydrological regimes and edge effects, such as possible shading of proximal vegetation and weed invasion. Clearing of native vegetation communities adjacent to Glenugie Creek is likely to impact the endangered ecological community *Sub-tropical Coastal Floodplain Forest*, either directly or indirectly.

Construction activities may result in a temporary disturbance and degradation of the riparian vegetation near the crossing of Glenugie Creek and other unnamed streams in addition to the temporary disturbance of fauna species in the vicinity of the works for which the riparian vegetation provides refuge and a corridor. The riparian zone provides potential habitat for a range of State and Commonwealth listed threatened fauna species, including the Grey-headed Flying-Fox (*Pteropus poliocephalus*), Rufous Bettong (*Aepyprymnus rufescens*), Brush-tailed Phascogale (*Phascogale tapoatafa*) and Little Bentwing-Bat (*Miniopterus australis*). Impacts on aquatic and terrestrial ecosystems are detailed in Section 7.1.

Fish passage

The project would traverse Glenugie Creek and several unnamed, intermittent watercourses, which provide habitat for fish and other aquatic organisms. Potential impacts on aquatic habitats include pollution of waterways, change to the hydrological regime, removal of in-stream woody debris and disruption of fish passage. Impacts on aquatic ecology are detailed in Section 7.1.2 and Appendix D.

Construction impact mitigation and management measures

Erosion and sediment control

Erosion and sediment controls would be installed to control polluted runoff from disturbed areas of the construction site. Erosion and sediment controls would consist of localised control measures such as sediment fences, check dams, straw bales, and sediment traps, as well as end of line controls such as sediment basins. ‘Clean’ runoff from areas unaffected by the project would be diverted around the construction areas and sediment basins using temporary diversion drains located upstream of the project site.

Localised erosion and sediment controls would be adequate for relatively smaller and flatter disturbed areas where the erosion hazard would be low. Sediment basins will be required for larger disturbed areas with potential for substantial soil loss and for disturbed areas immediately upstream of sensitive receiving waters that require increased environmental protection. Temporary drains would be installed at the downstream end of disturbed areas to convey sediment laden runoff to the sediment basins.

Temporary sediment basins would be located within the project construction area boundary. These basins would be used to provide for temporary storage of runoff from all cut batters and associated berms and benches. Indicative locations of the temporary sediment basins within the project construction corridor are shown in **Figure 4-1a-c**. Following completion of construction, a number of these sediment basins would be converted to permanent spill basins to provide for ongoing protection of waterways during road operation.

The proposed sediment basins have been initially sized in accordance with *Managing Urban Stormwater: Soils and Construction*, Volume 1, 4th edition (Landcom 2004) and *Managing Urban Stormwater: Soils and Construction, Volume 2D - Main Road Construction* (DECC 2008). A sediment basin is considered to be the “end of line” control. Details of the additional erosion and sediment controls on site will be provided at the detailed design stage and include:

- Diversion of external ‘clean’ runoff around the construction area to reduce mixing of ‘clean’ and ‘dirty’ runoff and reduce the size of the required sediment basins.
- Diversion of all ‘dirty’ runoff to the proposed sediment basins.
- Installation of barrier fences to delineate the extent of site that can be disturbed.
- Installation of sediment fences and straw bales to trap sediments.
- Installation of sediment traps and check dams, where required,

especially in smaller catchments where a sediment basin has not been proposed.

- Stockpiling and reuse of all topsoil.
- Rehabilitation of disturbed are as quickly as possible.

Further management measures include:

- Any vegetation to be cleared for the project would be mulched on-site and used in the revegetation and stabilisation of the site.
- Revegetation would be undertaken with native endemic species.
- All fuels and chemicals would be bunded and stored in approved storage containers.
- Disturbed soil would be covered and protected with vegetation, mulch or erosion-resistant material.
- Buffer zones of dense vegetation would be established along watercourses.

Water quality management

The key to minimising water quality impacts lies in ensuring that the detailed design adequately addresses water quality issues. For the treatment of stormwater and road runoff the following measures are proposed:

- Existing drainage lines have been identified in the design and construction drawings and will be protected using appropriate measures such as sediment barriers, grassed areas, swale drains, and buffer strips, as detailed above for erosion and sediment control.
- Sediment basins have been designed for the construction phase of the project in accordance with *Managing Urban Stormwater, Soils and Construction*, Volume 1, 4th edition (Landcom 2004) and *Managing Urban Stormwater: Soils and Construction*, Volume 2D - Main Road Construction (DECC 2008) to allow adequate storage for the 80th percentile 5-day rainfall depth.
- A bunded and impermeable wash area with collection and treatment systems would be installed for washing plant and equipment. The material captured through the treatment process would be pumped out at regular intervals or after rainfall and appropriately disposed of.
- All equipment would be maintained in good working order to avoid leakage or spillage of oil, fuel or other contaminants.

Riparian zone management

Impacts on riparian habitats adjoining the road footprint would be limited by minimising the construction footprint at all proposed culverts, installing run-off storage structures, minimising erosion and through post-construction site revegetation using locally indigenous riparian species.

Fish passage

All bridges and culverts at waterway crossings have been designed conservatively and meet the requirements for ‘Class 1 – Major Fish Habitat’ as classified by Fairfull and Witheridge (2003). Specific impact mitigation measures for aquatic ecology are provided in Section 7.1.3 and include measures for soil erosion and sediment control, relocation of in-stream woody debris, and construction of fish friendly waterway crossings.

7.6.4 Construction management framework

A Framework Construction Environmental Management Plan (Framework CEMP) has been prepared to specify the actions and environmental controls required during construction of the project. The Framework CEMP:

- Establishes the environmental performance objectives and targets for each construction issue.
- Details the relevant legislative requirements and other policies, guidelines and standards relevant to the project.
- Identifies and assesses the potential environmental risks.
- Establishes the responsibilities and requirements of the project team and sub-contractors.
- Outlines environmental monitoring, inspections and auditing required during construction.

The Framework CEMP is attached in Appendix G.