ELLA BAY
Far North Queensland

Ella Bay Integrated Resort Proposal

SEIS Submission Response

Volume Four

Ella Bay Road Design and Environmental Management Report



Executive Summary

This report is a road and environment design document with a primary aim of providing information for approvals under the EPBC Act and Wet Tropics Management Authority (WTMA) permit for Satori Resorts Ella Bay Pty Ltd for the action *Ella Bay Integrated Resort Development Proposal (EPBC 2005/2159)*. The report provides the design and key environmental values for the proposed upgrade of Ella Bay Road from Flying Fish Point to Ella Bay.

It is based on work completed for the EIS, and Supplementary EIS and subsequent studies contained in the SEIS Submission Response. The report summarises all relevant design and environmental advice and sets out the design criteria

Ella Bay Road upgrade is required to provide suitable level of access for the Ella Bay Integrated Resort Development. Ella Bay Road is a long established gravel road which services the Seahaven Prawn Farm, visitors to Ella Bay National Park and access to Ella Bay property with a length of approximately 4km.

The road winds through World Heritage Area Zone C around Heath Point Headland and is under the control of Wet Tropics Management Authority for construction and management approvals of the World Heritage Area (WHA) section.

This report provides detailed road and environmental design covering road alignment, cross-section, clearing envelope, storm water treatment, fauna and flora mitigation and monitoring, and operational management and monitoring.

Road concept and staging

The road implementation differs from that proposed in the EIS & SEIS; Stage 1 of Ella Bay Road upgrade will be completed at the start of the Ella Bay Development and Stage 2 Flying Fish Point Bypass will be initiated once a trigger point of 1,000 vehicles per day has been reached.

The road alignment chosen in the SEIS; Option D has been retained and further refined. The Multi Criteria Analysis presented in the SEIS selection of options has been reviewed and confirmed as the most appropriate option. The road traffic generation has been revised and confirmed within 10% of that presented in the EIS & SEIS. The reports are attached in the Appendix 2 & 3 of this report respectively.

Stage 1 comprises a 4000 metre upgrade of the existing Ella Bay Road from Ruby Street in Flying Fish Point to the entry of Ella Bay Development. The road will be required to carry up to 1,000 vehicles per day prior to the commitment of stage 2. The road will be constructed to the full width as part of Stage 1 works.

Stage 2 will comprise a new 880m road that bypasses Flying Fish Point to the west, Stage 2 will include construction of a roundabout and approaches on Bay Road to direct Ella Bay traffic north behind Flying Fish Point through a new tunnel, and connection to the existing Ella Bay Road alignment to the north of Ruby Street. The road will then follow the existing alignment to Ella Bay.

The critical event of evacuation has been taken into account with the elevation of the road to a minimum of 5m AHD of which is approximately 2.5m above the 100 year ARI, Global Warming inundation levels.

Environmental Significance and Potential Impact to WHA

The Ella Bay Road study area is considered to be of National Significance for nature conservation. It supports a high diversity of terrestrial flora and fauna of conservation significance as well as important populations of Southern Cassowary (*Casuarius casuarius* *johnsonii),* the Common Mist Frog *(Litoria rheocola)* and potentially the Torrent Tree Frog (*Litoria nannotis*), and Australian Lacelid (*Nyctimystes dayi)*.

The potential unmitigated impacts of the proposed access road and the effectiveness of mitigation measures on the site have been assessed. Extensive mitigation measures have been proposed to minimise this impact on fauna especially the cassowary. The complete set of these mitigation measures have not been trialled previously with cassowaries although the methodology is commonly used with other fauna. The proponent has initiated a number of studies and trials of elements of the mitigation: Cassowary fence and escape gate trials and surveys of cassowary usage of underpasses.

The mitigation will also include fauna underpasses (culverts with fauna furniture) for smaller animals (macropods, amphibians, understorey and ground dwelling fauna) in order to minimise the barrier effects. Frog-exclusion fencing will be included within 25m of streams to reduce possible road mortality.

The Ella Bay Road passes through Ella Bay National Park and World Heritage Area through the Heath Point headland which provides magnificent views of the coast line and to Ella Bay. The scenic values of the Wet Tropics Queensland and Great Barrier Reef World Heritage Areas will be showcased with the road upgrade.

A Visual Landscape Analysis has concluded that the visual impact of the road widening and upgrade of the road, with incorporated visual impact mitigation measures, is unlikely to adversely affect the scenic values of the World Heritage Areas and in most cases the visual amenity will be improved through dust suppression and endemic revegetation strategies.

The conclusion of the multi criteria assessment is that providing the design and mitigation strategies that are described in this report are implemented the proposed road upgrade will not have a net adverse impact on the integrity of the World Heritage Area.

Road Design and Design Criteria

Ella Bay Road will be designed to reduce the impact of edge effect on the rainforest by minimising clearing and retaining mature trees where possible. The road will be revegetated to seal the edge of the rainforest and prevent weed incursion.

The road is expected to convey a maximum design daily two way traffic of 4,138 v/d with an annual average daily traffic (AADT) of 3,134 v/d. The maximum design hourly two way traffic is 350 v/h.

The roadwidth chosen for the recommended speed of 60km/h is a sealed pavement width of 10.0m comprising 2 x 3.5m lanes with a 1.5m delineated sealed shoulder each side. This is based on Austroads single carriageway road widths where narrower lanes or shoulders are suggested based on:

- The preservation of flora and existing edge sealing forms stringent controls preventing wider lanes;
- The road speed is restricted to 60km/hr;
- There will be little truck traffic except for servicing the resorts; and
- The lane width is consistent with other roads in the World Heritage Areas.

Localised widening of both the laneway and shoulder will be required where horizontal curves are less than 119m radius.

The 1.5m wide shoulder is suitable for use as a bikeway and will be delineated to provide a bicycle lane in both directions. Extensive traffic calming comprising delineated roadside shoulders, cassowary signage, transverse line markings, chicanes and raised speed platforms will be used to reduce the operational speed. The bike lane and traffic calming will be used to support the “change of focus” as people enter the Ella Bay area.

Localised “pull off” lanes of 2.5m total sealed shoulder will be provided for service vehicles and for discretionary stopping of cars. The road widening will be located near mitigation features for servicing and monitoring e.g. fauna bridge, fauna culverts and escape gates.

Preliminary design investigation has established that stopping sight distances, and manoeuvre sight distances will be compromised in some locations requiring reshaping of embankments with minor additional clearing and revegetation with low height species.

A noise study has determined that the predicted peak hourly noise levels of Ella Bay Road will be more than 7dB(A) less (quieter) than the current Kuranda Range Road at 10m from the centre of the lane. At 33.5m it is predicted to be equivalent to the peak hourly noise level for the Kuranda Range Road at 100m.

Hydrology, Catchment Integrity and Water Quality

The road cross-section has been designed with a 3% one-way fall towards the east so that upstream flows emanating from heavily vegetated rainforest will be able to bypass contamination from road runoff by transport in table drains to culverts on the western side of the road. On the eastern side, the road runoff will be treated for gross and fine particulates removal with sensitive areas incorporating bioretention swales for treating soluble toxins from first flush road runoff.

Table drains will be lined with vegetation and geo-fabric or concrete in steeper areas to prevent erosion. The culverts along Ella Bay Road will be changed from concrete pipe culverts and replaced with concrete box culverts and riprap discharge apron will be provided to prevent erosion.

There will be three bridges along Ella Bay Road including a dedicated fauna underpass over a small drainage line. Where Ella Bay Road crosses two creeks, bridges will be constructed instead of culverts to provide cassowary fauna underpasses. The bridges have been sized for cassowary use and will far exceed the hydrological flow requirements.

Visual Values

Ella Bay Road has significant visual values along the majority of the road from Flying Fish Point to Ella Bay and encompassing the WHA of Heath Point. The alignment of Ella Bay road is located adjacent to and passes through the Wet Tropics WHA within a sensitive visual catchment which exhibits moderate to high levels of visual sensitivity.

A landscape integration strategy has been prepared to provide safe travel for the public between Ella Bay and Flying Fish Point whilst retaining the natural visual sensitivity and catchment values. This vision will be achieved by incorporating the following objectives into road design methodology:

- Retain the corridor effect created by dense vegetation;
- Retain existing mature trees, in particular trees with canopy connectivity;
- Relocate where possible Endangered, Vulnerable or Rare (EVR) flora within clearing envelope;
- Remove existing weed infestations of batters, drains and shoulders and revegetate with frangible edge closure vegetation;
- Influence the natural surrounds with a comprehensive revegetation strategy;
- Include water sensitive design coupled with revegetation to improve roadside aesthetics and assist in weed control;
- Discrete shadecloth fencing to reduce the potential mortality of the Southern Cassowary;
- Stabilisation of embankments using vegetated gabions;
- Protect the existing rainforest and woodland from edge effects; and
- Promote this 4km stretch of road as a tourist drive in conjunction with Cassowary Coast Regional Council and WTMA.

Fauna Sensitive Road Design

The fauna sensitive road design of Ella Bay Road has been based on fence and funnel mitigation strategies which provide safe connectivity and prevent fauna access to the road and direct fauna to crossings. The mitigation strategies cover the endangered cassowary, marsupials including macropods and amphibious species including endangered stream dwelling frogs.

A specific cassowary underpass (Bridge 1) will provide habitat connectivity to the reserve at Flying Fish Point; and additionally two cassowary underpasses (Bridge 2 and 3) at the creeks in Little Cove will allow cassowaries and other fauna to freely move under the road. The design of the bridges will be based on the observations of North Hull and Wongaling bridges where cassowaries have been reported to cross. A road tunnel Stage 2 – Flying Fish Point Bypass will allow fauna free movement and connectivity above the road.

The fence and funnel strategy will comprise a shadecloth cassowary fence (1.8m high) and escape gates. The fence will be located 3m to 12m within the vegetation parallel to the road alignment and within the road reserve functioning as a visual barrier and as a soft exclusion barrier. The fence will not be installed where the road edge and surrounding slopes are greater than 1:1 or where the embankment is vertically greater than 1.5m e.g. gabions walls. Other barriers such as guard rails and noise fences, where installed, will provide an exclusion function where the above conditions are still met.

The proponent has designed and developed a tensioned shadecloth fence and a one way escape gate. The shade cloth fence was trialled utilising a shear clip arrangement developed to withstand branch strike and facilitate dropping the fence to the ground as a management procedure in the event of cyclone warning. The escape gate was trialled at the Johnstone River Crocodile Park, Queensland with two adult male cassowaries which had been reared in captivity. The cassowaries used the escape gate to access their food for over a month and continued to use the gate preferentially during a number of trials even when an alternative access point was provided.

Four fauna culverts for smaller fauna; macropods, amphibians, understorey and ground dwelling fauna will be installed along the road in strategic locations. The small fauna culverts will be designed with elevated dry fauna ledges for safe passage of fauna during wet periods.

A fence and funnel strategy will also be used for stream dwelling frogs. The frog fence will exclude frogs from the road and direct frogs to the fauna culverts and bridges. The target species is the endangered stream dwelling frogs likely to occur in the streams crossing the road. The style of frog fence was chosen based on the Tugun bypass design.

Flora Sensitive Road Design

The aim of the clearing design of Ella Bay Road upgrade is to fully utilise the existing cleared road alignment wherever possible, to save mature trees and maintain canopy connectivity and only selectively clear to widen the road and to improve the road-side drainage to meet current standards. However in some cases the saving of mature trees has increased the area required for clearing as the road alignment has been moved to avoid these trees. Additionally the canopy connectivity of Ella Bay Road was significantly damaged by Cyclone Larry (2006) and more recently by Cyclone Yasi (2011) with the high shear winds breaking many of the canopy crowns and the large branches that formed the canopy cover, particularly on the edge of the road.

Mature trees have been protected where possible to provide canopy shading with over 20 trees requiring guard rail protection because of their proximity to the road. To achieve this level of tree retention the road alignment has been modified to specifically avoid the trees and road safety mitigation added where the alignment has remained too close to the tree.

Revegetation will take place as each stage or partial stage of works is completed. A detailed plant species selection for revegetation has been undertaken. This was based on selecting endemic plants that suit the criteria for the roadside vegetation; blend with the surrounding vegetation and complement the natural surroundings; and seal the edge of the forest to reduce the potential of edge effects. Plant selection will also be required to meet road safety criteria where the species do not inhibit sight distances and are frangible. Only in limited cases external species will be used where the roadside criteria does not match the Regional Ecosystem such as the table drains and vegetated swales.

The majority of weeds are restricted to the disturbed roadside margins to a distance of 2 to 3 metres and are unable to effectively compete in the shaded areas of the rainforest. The management of existing and imported weeds will be critical pre, during and post construction of the road and is a key part of the Weed Environmental Management Sub-plan.

Construction Methodology

The construction methodology will be to focus on environmental controls and plan of high risk civil works to fit within the dry season constraint.

Stage 1 construction Flying Fish Point to Ella Bay is scheduled to commence and be completed within a one year period, with major earthworks being conducted from May till December to coincide with the dry season. The construction schedule is complex in that the works are impeded by lack of articulated vehicle access past Heath Point and the narrow work footprint. Interruptions and change of construction focus will be made depending on fauna spotter reports of any EVR fauna that is breeding. The use of offsite prefabricated components will be maximised to reduce heavy through traffic and traffic disruption to local residents. This will reduce construction time, and material storage at construction locations.

Stage 2 construction of the Flying Fish Point bypass and tunnel is scheduled to be conducted over a two dry season periods due to the lengthy construction requirement of the cut and fill tunnel. The option of boring the tunnel, if feasible, may reduce the construction duration.

Traffic Management Plans

The objective of the traffic management plan is to:

- Minimise disturbance and inconvenience for residents of Coconuts and Flying Fish Point through the Local Area Traffic Management Plan (LATM);
- Minimise workforce traffic movements through Coconuts and Flying Fish Point;
- Manage traffic during construction; and
- Communicate the plan to residents and workforce.

The road design concept of minimising clearing and environmental footprint of temporary and permanent works will require the majority of the road to be constructed under traffic. A sidetrack will be required for construction of Bridges 1 and 2.

Temporary closures of Ella Bay Road will be unavoidable, but it is proposed to maintain the existing minimum single lane movement during the majority of construction. This will be delivered through use of traffic signals in conjunction with a single lane bypassing the specific area/s of construction. The cutting works past Heath Point park will require more extended closure of the road. This portion of the road services the Ella Bay Properties and visitors to the WHA.

Operational Management and Monitoring

Operational management of Ella Bay Road will comprise maintenance of the road assets; maintenance of the environmental mitigation measures; and monitoring of the mitigation. The road assets will be maintained by the Cassowary Coast Regional Council (CCRC) under agreement with the Proponent and subject to conditions of WTMA permit for World Heritage Areas. The environmental mitigation measures will be maintained by the Proponent and subsequently the Body Corporate under a Corridor Management Plan. Monitoring of impacts and wildlife movements will be managed by the Proponent. The monitoring will be performed by researchers, consultants and Ella Bay staff depending on the task and criticality of the monitoring.

The desired outcome is for maintenance and ongoing operation of the road to have no disturbance of surrounding natural or rehabilitating areas.

Changes from previous reports

The road alignment and design have been improved from the EIS and SEIS with regards to both vehicle safety and to environmental needs. The changes from the EIS and SEIS for the road design are:

- The road will be constructed to the final design width and environmental mitigation in stage 1;
- Stage 2 will be implemented once the road traffic exceeds 1,000 v/d;
- The road way will have the same nominal width of 2 x 3.5m lanes as the SEIS;
- The road shoulder has been increased from 1m in the SEIS to 2 x 1.5m;
- The overall road width will be 10m but will have localised lane and shoulder widening at horizontal corners of less than 119m radius;
- The tunnel for Stage 2 has been realigned so that the tunnel faces north and minimises both the visibility from the Great Barrier Reef Marine Park and the noise to Flying Fish Point;
- A preliminary road safety audit has been conducted and the road modified accordingly to ensure vehicle safety;
- A noise assessment has concluded that the road noise of Ella Bay Road at 33.5m will be equivalent to the road noise of the current Kuranda Range Road conditions at 100m;
- The Multi Criteria Analysis presented in the SEIS has been revised and the alignment of Option D has been retained and refined further; and
- The road demographics have been revised resulting in some minor changes to that presented in the EIS & SEIS.

The changes from the EIS and SEIS for environmental mitigation are:

- The cassowary fence design has been modified to 1.8m high;
- The cassowary fence and cassowary escape gate have both been successfully trialled;
- The cassowary fence location has been detailed in linear position and approximate location within the vegetation;
- The cassowary underpass has been modified to match bridges where cassowaries have been observed to using as underpasses;
- A frog fence will be installed for 25 m each side of ephemeral and permanent streams;
- Four fauna culverts with “furniture” have been designed and included;
- Trees greater in diameter than 300mm have been surveyed and significant mature trees identified for Stage 1; and
- The clearing envelope for stage 1 has been detailed and has specifically avoided clearing mature trees wherever possible.

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1. Introduction

Ella Bay Road is a long established gravel road of approximately 4km which services the Seahaven prawn farm, visitors to Ella Bay National Park / WTWHA and access to Ella Bay property.. The road is a single lane road with little edge clearing and generally varies from 6m to 10m width with an extended verge of 1 to 3m.The road narrows as it winds around very tight corners of the Heath Point headland varying to between 4m to 8m width with clearing extending between 0.5m to 1m on each side.

The current road alignment was first formed in the early 1900's when Ella Bay was a one of three major banana producing properties in Northern Australia, (Brisbane Courier, 1903) and mention of a request to initially survey the road was made in 1912 (Brisbane Courier, 1912). The road has relatively low traffic numbers of up to 150 vehicles per day with no access to articulated vehicles due to the tight radius and narrow alignment of the headland section. The road speed is signposted with at 40km/hr from the exit of the Flying Fish Point community. The road surface is dirt consisting of introduced gravels and road base with natural rock surface around the Heath Point cutting. The road suffers from poor surface drainage and erodes and potholes frequently during the wet season. The road is maintained by Cassowary Coast Regional Council with grading and compaction of road base occurring 3-5 times per year.

The road winds through World Heritage Area Zone C around Heath Point Headland and is under the control of Wet Tropics Management Authority for construction and management approvals of this section.

The road side vegetation is wind damaged vine forest with limited canopy connectivity. The canopy connectivity around the woodland Heath Point Headland that had recovered from Cyclone Larry (2006) has been further damaged by Cyclone Yasi (2011). The roadside trees have suffered recent major damage from these cyclones resulting in the canopy crown or upper canopy being badly damaged. This has led to the introduction of weed infestations along the clearing adjacent to the road after Cyclone Larry and has been exasperated by Cyclone Yasi. A number of endangered floral species are present along the roadside verge.

The road is frequented and traversed by cassowaries in a number of locations crossing to isolated rainforest and coastal vegetation.

The proposed road upgrade is to widen and bitumen seal the road and provide a bypass of the Flying Fish Point community. The proposed environmental solutions detailed within are key to this road design.

2. Structure and Purpose of this Report

This report is a road and environment design document with a primary aim of providing information for approvals under the EPBC Act and WTMA permit. The report is for the following stakeholders:

- Australian Government Department of Sustainability, Environment, Water, Population and Communities;
- Wet Tropics Management Authority;
- Department of Infrastructure and Planning; and
- Cassowary Coast Regional Council.

The proponent in this report is Satori Resorts Ella Bay Pty Ltd for *Ella Bay Integrated Resort Development Proposal (EPBC 2005/2159)* (Ella Bay Development).

Control of the Road Development and Maintenance

Ella Bay Road construction will be completed by the Proponent and handed over to the Cassowary Coast Regional Council.

Maintenance of Ella Bay Road will be performed by Cassowary Coast Regional Council. The council would be responsible for maintenance and repair activities in the road reserve in the same manner that applies to all other new roads created as a normal consequence of development activities.

The Proponent and there after the body corporate will retain responsibility for maintenance and monitoring of Ella Bay Road fauna and flora mitigation measures as outlined in the Corridor Management Plan and Fauna, Flora, and Aquatic Monitoring Chapter 12.

Relationship to Previous Reports and Studies

This report details the preliminary design of the proposed widening and upgrade of Ella Bay Road. The previous reports were:

- Ella Bay Integrated Resort Proposal Environmental Impact Statement
- Appendix A6.5 Infrastructure Requirements; and
- Ella Bay Integrated Resort Proposal supplementary Environmental Impact Statement
- Appendix A2.6 Supplementary EIS – Access Road Strategy.

The road differs from the EIS & SEIS in this report as Stage 1 of Ella Bay Road upgrade will be completed at the start of the Ella Bay Development and Stage 2 Flying Fish Point Bypass will be initiated once a trigger point of 1,000 vehicles per day has been reached.

The chosen alignment of Option D has been retained and further refined. The Multi Criteria Analysis and Road Demographics have been reviewed and have changed from that presented in the EIS & SEIS. The reports are attached in the Appendix 2 & 3 of this report respectively.

Guides and Manuals

In the preparation of this report a number of manuals and guidelines were referenced:

- Roads in the Wet Tropics;
- Roads in Rainforest, Best Practice Guidelines for Design, Planning and Management;
- Roads in Rainforest, Science Behind the Guidelines;
- Road Project Environmental Processes Manual;
- Fauna Sensitive Road Design Volumes 1 and 2;
- Road Landscape Manual;
- Road Drainage Design Manual;
- FNQROC Development Manual Design guideline;
- Road Planning and Design Manual;

- Austroads Guide to Road Design Part 1, Part 2, Rural Road Design, Road Runoff: Environmental impacts and Management Options, Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure;
- Water Sensitive Road Design - Design Options For Improving Stormwater Quality Of Road Runoff; and
- Road Maintenance Code of Practice for the Wet Tropics World Heritage Area.

Additionally a number of technical reports were important in formulating the design considerations:

- Cardwell Range Upgrade – Preliminary Design Reports;
- Kuranda Range Upgrade EMP and Research Reports;
- Wongaling Corridors Fauna Crossings; and
- Report of the Independent Review of the Proposed Upgrade of the New England Highway: Hampton to Geham.

Research

Unique research was performed for this report in the design and trialling of a cassowary "fence and funnel" fencing and the design and trialling of a cassowary one way escape gate. A report on this research is attached in the Volume 6 of the Ella Bay Submission Response as 6.1i Cassowary Gate Trial 2009 Ella Bay, and 6.1j Cassowary Fence Trial 2010 Ella Bay and a summary in Chapter 7 Fauna Sensitive Road Design of this report.

Best Practice

The road has been designed to Context Sensitive Design principles (DTMR, 2010b). The goal has been to use best practice design, taking design elements from various sources; however the trade-off between the environment and design for vehicle safety has led to compromise. In particular the issue of vehicle safety and clearing distances versus canopy connectivity and clearing of old established trees is one that is not adequately addressed in the manuals and guidelines. A Road Safety Audit has been performed on this report and road design and is attached in Appendix 4 of this report.

Design and Drawings

Drawings for this report and further drawings detailing the road and features are presented in Volume Seven of the Ella Bay Submission Response.

3. Road Concept and Staging

Ella Bay Road will be a 4790 metre long road constructed from Bay Road to the south west of Flying Fish Point to the Ella Bay Development in the north. Ella Bay Road will be required to safely convey residents, visitors and employees of the Ella Bay Development. Ella Bay Road (Figure 3:1 and Figure 3:2) will consist of 2 stages.

Stage 1 comprises a 4000 metre upgrade of the existing Ella Bay Road from Ruby Street in Flying Fish Point to the entry of Ella Bay Development. The road will be required to carry up to 1,000 vehicles per day prior to the commitment of Stage 2. The road will be constructed to the full width with environmental mitigation as part of Stage 1 works. The Ella Bay Road Stage 1 works is detailed in three sections:

- **Section 1 - Prawn Farm**: 1040m upgrade to the existing Ella Bay Road alignment. This is a flat section from Ruby St to unsurveyed road on Council controlled road reserve and will include a road bridge as a cassowary fauna underpass;
- **Section 2 - World Heritage Area**: 1560m upgrade to the existing Ella Bay Road alignment as it runs through World Heritage Area Zone C. (Due to boundary differences the length of road in Ella Bay National Park is 1080m) This is a winding section of the Ella Bay Road around the Heath Point headland inside the WHA ; and
- **Section 3 – Ella Bay**:

  a. 360m upgrade to the existing Ella Bay Road alignment as it exits Heath Point WHA. This is an undulating section within Council Esplanade.
  b. 700m of new alignment in a road easement of the freehold land at Little Cove. This is a relatively flat section of road which crosses two creeks and will incorporate two bridges with fauna underpass design.
  c. 340m improvement of an existing section within Council Esplanade leading onto the Ella Bay allotment.

Stage 2 will comprise a new 880m road that bypasses Flying Fish Point to the west. Stage 2 will include construction of a roundabout and approaches on Bay Road to direct Ella Bay traffic north behind Flying Fish Point through a new tunnel; and connection to the existing Ella Bay Road alignment to the north of Ruby Street. The road will then follow the existing alignment to Ella Bay. The Ella Bay Road Stage 2 works comprises:

- A new intersection at Bay Road and Alice street;
- 350m of new road on an existing road easement. This is a rising section of road on Alice Street;
- 440m of new road on Unallocated State land (USL). This section of road passes through a saddle of the Graham-Seymour Range above Flying Fish Point via a tunnel and fauna overpass through the lowest point of the ridge;
- 90m of new road on Ella Bay Road joining to Stage 1; and
- A shared pedestrian/bikeway from Heath Point Park to Ella Bay parallel to the Stage 1 road alignment around Heath Point.

Ella Bay Road will be designed to reduce the impact of edge effect on the rainforest by minimising clearing and retaining mature trees where possible. The road will be revegetated to seal the edge of the rainforest and prevent weed incursion.

Ella Bay Road will incorporate fauna mitigation measures based on environmentally sensitive road engineering and design. The road will utilise a directional fencing strategy to direct cassowaries and other fauna to specific fauna underpasses. The road will be fenced on both sides of the road in areas accessible to cassowaries, except where the terrain at the side of the road is too steep or the embankments are greater than 1.5m in height. Three bridges will provide safe fauna habitat connectivity under the road; one of the bridges will be a purpose built fauna underpass bridge, whereas the other two bridges will incorporate fauna underpass design together with the creek crossing. Other fauna mitigation measures including frog fencing, four small fauna underpasses, and traffic calming devices will be included. In Stage 2 a fauna overpass will be provided over the road tunnel through the Seymour range west of Flying Fish Point.

Figure 3:1 Ella Bay Road Alignment Dwg. EBR1CE-PD01 (part 1).

Figure 3:2 Ella Bay Road Alignment Dwg. EBR1CE-PD01 (part 2).

Road Tenure

Ella Bay Road will traverse through a number of different tenures and will require approvals from each authority. The tenures are shown in Figure 3:3.

The tenures are;

- Cassowary Coast Regional Council (CCRC) road reserve and council controlled land;
- Unsurveyed State Land;
- World Heritage Area (WHA) Zone C; and
- Ella Bay National Park and World Heritage Area Zone C.

WHA Zone C is designated as a buffer zone comprising disturbed and minimally managed areas associated with existing community infrastructure and leisure uses.

The WTWHA and the Ella Bay National Park do not share the same border along Ella Bay Road. Ella Bay Road crosses through the boundary of WTWHA opposite the Seahaven Prawn Farm whereas the boundary of Ella Bay National Park is near Heath Point. It is only at this point that Ella Bay road is on both WTWHA and Ella Bay National Park tenure.

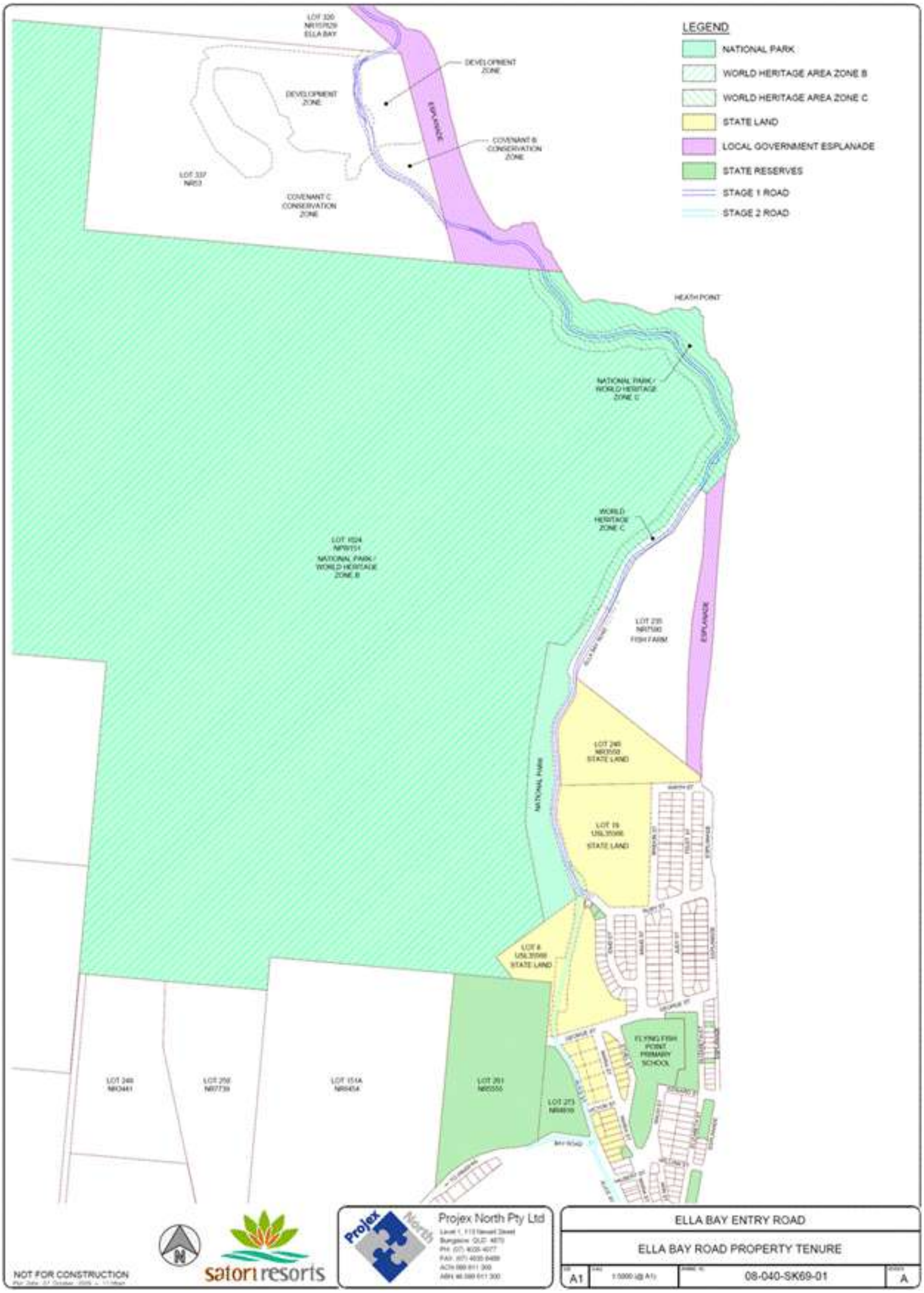

Figure 3:3 Tenure of Ella Bay Road.

4. Environmental Significance and Potential Impact to WHA

The Ella Bay Road study area is considered to be of National Significance for nature conservation. It supports a high diversity of flora and terrestrial fauna of conservation significance including important populations of Southern Cassowary (*Casuarius casuarius johnsonii),* the Common Mist Frog *(Litoria rheocola)* and potentially the Torrent Tree Frog (*Litoria nannotis*), and Australian Lacelid (*Nyctimystes dayi)*.

The potential unmitigated impacts of the proposed access road and the effectiveness of mitigation measures on the site have been assessed. An unmitigated road would be expected to have local impacts onsite; furthermore the populations of Southern Cassowary would be affected at regional and national levels due to an endangered genetic pool. This is primarily associated with road mortality and the resulting genetic sink for these regionally significant populations and legislative significant species. Permanent fragmentation of populations would increase the risk of isolated subpopulations becoming extinct.

Extensive mitigation measures have been proposed to minimise this impact on the cassowary. The complete set of these mitigation measures have not been trialled previously for cassowaries. Various reports and studies have discussed and analysed the concepts together with a number of partial trials (Volume 6.1i Cassowary Gate Trial, 6.1j Cassowary Fence Trial) and (Goosem et al., 2010a). Significant experience with other fauna (koala, deer and moose) suggests that the measures should be successful in directing cassowaries to utilise the fauna underpass and overpass to provide forest connectivity and minimise road mortality.

Extensive slope analysis research and monitoring has determined fencing will be erected along both sides of the road except where the terrain at the side of the road is too steep or vertical embankments are greater than 1.5m in height (refer to drawing EBR1CEPD08). Specialised large fauna underpasses (bridges) and an overpass (road tunnel) will be constructed for the safe movement of all fauna. Small fauna underpasses (culverts) for smaller animals (macropods, amphibians, understorey and ground dwelling fauna) have been provided in order to minimise the barrier effects resulting from the proposed road. Revegetation of the cleared construction envelope along the length of the alignment is designed to direct fauna into the all-weather underpasses. Frog-exclusion fencing will be included within 25m of streams to reduce possible road mortality.

Also marginally affected by the road would be state and regionally significant vegetation communities, regionally significant plant species and internationally important migratory bird species.

WHA Environmental significance

The WHA is managed by Wet Tropics Management Authority (WTMA) who administers road development within the WHA. WTMA together with Queensland Department of Main Roads (DMR) have produced a manual for road construction within the WHA titled Roads in the Wet Tropics,

The goal of the manual is to:

> *"Improve the performance and management of road corridors within the wet tropics region by using current information and the latest technology in such a way that takes into account the costs and benefits to the environment, community and economy."*
>
> (DMR, 1998), pO-1)

The design of Ella Bay Road has primarily been based on this manual with a number of modifications which have evolved through the design process literature study, stakeholder interaction, and design and environmental consultants.

Summary of Values and Impact.

Ella Bay Road traverses approximately 1560m through the Wet Tropics World Heritage Area and is adjacent to the Great Barrier Reef Marine Park. Environmental protection of this ecologically sensitive area is a high priority.

The area traverses the Heath Point headland which provides magnificent views of the coast line and to Ella Bay. It is recommended that the scenic values be emphasised and showcased by the provision of a viewing section and vehicle amenity.

Ella Bay Road will be visible from the Great Barrier Reef Marine Park at two locations. The proposed scenic amenity area will be formed by a cut to the embankment to increase the radius of the road at Heath Point Headland. This cut will be visible from the water. It is proposed to vegetate the embankment to reduce the visibility. Additionally the existing Heath Point park and road are currently visible from the Great Barrier Reef Marine Park and will remain visible due to the proximity to the beach. The road will be elevated with a gabion rock wall and vegetated such that it will provide a similar appearance to the existing Heath Point Headland.

The proposed upgrade will impact on one endangered fauna species, the Southern Cassowary and extensive mitigation is proposed consisting of a combination of fencing, one-way escape gates, and a cassowary and fauna underpass. The proposed upgrade may impact on one species of endangered frog species and mitigation is proposed in the form of two fauna underpasses featuring wet and dry passages. A frog fence will be used for 25m either side of streams.

A small section of critically endangered Littoral Rainforest located adjacent to the road near Heath Point Headland will not be cleared or damaged.

There are major weed infestations along the cleared area on both sides of the road. Weed control is proposed to be undertaken prior to construction. The bare post-constructed surfaces will be revegetated or mulched to reduce the opportunity for weed infestation.

WHA Visual & Aesthetic Values

The Ella Bay Road passes through Ella Bay National Park and World Heritage Area through the Heath Point headland which provides magnificent views of the coast line and to Ella Bay.

Consultation with the Wet Tropics Management Authority has established that the scenic values and outward views of World Heritage Areas from the access road are an important consideration. A viewing section will be included for vehicle amenity and to emphasize the scenic values of the Wet Tropics Queensland and Great Barrier Reef World Heritage Areas. It will offer a significant opportunity to showcase the World Heritage Values of the Ella Bay region (see Figure 4:1, Figure 4:2).

Figure 4:1 View from the access road highlighting the scenic values of the World Heritage Area.

The Ella Bay Road area is in Scenic Management Area 20 (High Priority 2) described as "High Scenic Significance". Under WTMA (1992), for Scenic Management Areas rated 'High Priority 2', the Scenic Quality Objective is to restrict future alterations to those developments that are not visually apparent.

A Visual Landscape Analysis (VLA) (Appendix 1:) has been prepared to assess the visual impact of the road widening and upgrade. The VLA report concludes that the proposed road, with incorporated visual impact mitigation measures, is unlikely to adversely affect the scenic values of the World Heritage Areas and in most cases the visual amenity will be improved through dust suppression and endemic revegetation strategies.

Figure 4:2 Photograph of the existing Ella Bay dirt road around Heath Point.

The road from Flying Fish Point to the World Heritage Area is an existing, flat road section and there will be minimal visual impact arising as a result of the proposed road improvements. This section requires widening of the existing road however the majority of this will be within the existing road clearing resulting in limited native vegetation clearing. The design emphasis has been to maintain mature trees with canopy closure where possible. The major visual impact will be from the fauna mitigation measures including the approaches and bridge sections of the fauna underpass and the cassowary directional fencing. The fauna underpass gabions will not be visible from the road and will not be vegetated. Vegetation of a suitable height will be grown close to the gabion walls. The cassowary fence will weave through existing road reserve vegetation, mostly non-visible however in places the fence will be adjacent to the road where there are entrances, escape gates, small culverts and a bridge. The route of the road has been selected to ensure that design will have a minimum of vegetation clearing. In addition, the proposed bitumen road surface is likely to have less visual impact than the current dirt surface (see Figure 4:4 and Appendix 1)

This section of the road will not be visible from any of the WHA public accessible area including the GBRWHA.

The World Heritage Area section of the road of approximately 1560m extends from the flat road alongside the Seahaven Prawn Farm to the park area at the base of Heath Point and around the Heath Point Headland. The road upgrade will involve road widening and some elevation change. The visual amenity impact is considered to be low.

The road at the Heath Point park will be increased in elevation and the road will be visible from the Great Barrier Reef World Heritage Area. The road will be increased in elevation from 2.4m AHD to 5.0m AHD to maintain an all-weather road not subject to cyclone inundation. The road will be elevated with a gabion rock wall and revegetated such that it will provide a similar appearance to the existing Heath Point Headland.

The proposed road design will involve the increase in radius of two strategic corners on the headland by cutting into the headland, with an increase in the embankment height from a nominal 4m to a maximum height of 8m. Gabion retaining walls will be used where required to reduce the extent of road widening and clearing. The gabions will allow trees and other vegetation to grow through a mesh structural system (see Figure 9:12) and provide considerable visual improvements to the existing untreated, earth embankments. The design concept is to where possible widen the road on the western side of the roadway to maintain the existing vegetation on the eastern side to screen the road and cuttings.

The existing dirt road has limited visibility when viewed from the reef lagoon (see Figure 4:3).

Figure 4:3 View of the existing access road from highlighting its limited visibility. Vegetated retaining walls and other associated mitigation measures will minimise the visual impacts from the reef lagoon.

The sealing of the existing dirt road with bitumen and the removal of weeds from verges will be a significant enhancement to scenic values along the road alignment (refer to Figure 4:4). The area of clearing required for the road alignment in the World Heritage Area has been minimised to 0.66 hectares and a total of 0.69 hectares will be revegetated including the weed infested verges (refer to Table 9:5).

This road section will not be visible from any of the WTWHA public accessible points except from the Great Barrier Reef World Heritage Area.

Flying Fish Point Bypass

The Stage 2 bypass is outside of the WHA boundary. The visual impact of this section will be mitigated through the use of vegetated retaining walls and verges, and a ‘cut and cover’ tunnel (refer to Figure 4:6, Figure 4:7 and Figure 8:10). The ‘cut and cover’ tunnel involves tunnel construction followed by revegetation of the area above the tunnel. Initially there will be some loss of visual amenity until such time as the revegetation has developed. The portal of the tunnel has been realigned in the latest revision so that the tunnel faces north and will minimise the visibility from the Great Barrier Reef World Heritage Area including headlight wash; and will minimise noise to Flying Fish Point residents. After plantings are established the visual impact of this section is considered to be minimal.

Figure 4:4 The existing Ella Bay dirt road with weed infested verges.

Figure 4:5 View from Ella Bay looking back towards the World Heritage Area.

Figure 4:6 Photograph indicating the approximate location of the 'cut and cover' tunnel.

Figure 4:7 View of 'cut and cover' portal from reef lagoon.

Cultural Heritage

The diversity of topography and the resources that Ella Bay provides are of significant cultural importance to the Bagirbarra people. The Bagirbarra are recognised as the Traditional Owners of the Ella Bay area. A Heads of Agreement has been signed to establish the Ella Bay Bagirbarra Development Trust to establish a cultural economy and assist with sustainability of the Bagirbarra cultural heritage.

The Ella Bay Cultural Heritage Management plan has been prepared;

- To acknowledge and protect the cultural significance, values and meanings of Indigenous places and objects for past, present and future generations;
- To undertake the recommendations made as a result of consultation with the Bagirbarra and the Ella Bay Development Cultural Heritage Assessment conducted in June 2007;
- To document the actions and procedures to be performed during the initial land-clearing and sub-surface disturbance phases of the proposed development, to ensure that all culturally significant places and objects are identified, protected and managed according to current cultural heritage legislation requirements; and

- To establish a framework for the employment of Indigenous Cultural Heritage Monitors, to ensure that monitoring is conducted appropriately.

A specific Cultural Heritage assessment has not been prepared for the road as the road for Stage 1 is on an existing road alignment. A cultural assessment has been prepared for the Little Cove property and the Ella Bay Development. A culturally significant site has been identified at the entrance to the Ella Bay property boundary (CH 3740) adjacent to the proposed road construction. This site is recognised by the Bagirbarra people as a “women’s business” site and Bagirbarra men are restricted from the site.

The road design will provide for a buffer zone around the site; however the existing road in this area has been heavily eroded by the sea and has close beach incursion limiting the available area to widen the buffer zone or an alternative route. The buffer zone will be fenced to limit access and cultural viewing literature will be provided on the pathway adjacent. The beach area on the eastern side of the rock also features grinding holes which will require protection during construction.

These features subject to Bagirbarra approval may be incorporated in to heritage/tourist literature with signage.

Historic and Non Indigenous Heritage.

Pre first contact, the Ella Bay area was inhabited by the Bagirbarra clan one of the Mamu-speaking clan groups of the Innisfail region (Pentecost 2007).

It is believed that the first non-indigenous persons to walk along the alignment of Ella Bay Road were the survivors of the ship wreck Maria in 1872 (Maiden, 2000). This was quickly followed by the start of settlement within the ten years.

In 1883 the Ella Bay property was shown on a registered survey along with several streets within Musgrave (now Flying Fish Point) including up to the location of the current Prawn Farm (Surveyor Generals Office Brisbane, 1883), refer to Figure 4:8.

There are numerous newspaper reports from the early 1900’s of Ella Bay being one the major banana growing areas in Queensland. (Brisbane Courier 1903, Sydney Morning Herald 1906, Rockhampton Morning Bulletin 1903) The newspaper articles report that the land was leased to Chinese farmers and there were over 100 men working the site, that 500 acres had been cleared for bananas and there was a 340ft long jetty built in 1902 to load steamers with bananas to Brisbane. There was mention of a request for an initial survey of Ella Bay Road in 1912 (Brisbane Courier, 1912) and a note of a bridge (tender for bridge, Cairns Post 1917).

No non-indigenous artefacts have been found however many exotic species of trees are located along the road route indicating former use. The trees are located just to the north of the WHA along the Esplanade and within Ella Bay property.

Figure 4:8 Surveyor Generals Office Brisbane 1883 (NG1 Sheet 6) with approximate location of Ella Bay Road Upgrade shown in red.

Weeds, Pathogens and Feral Animals

Road clearings and road works provide movement corridors for introduced weeds and pathogens. Disturbance along the roadside margin of the rainforest has enabled weed infestation along Ella Bay Road in places with exotic species dominated by *Rubus alceifolius* combined to achieve up to 40% Foliage Projective Cover. (3D, 2009b)

While there is disturbance along the existing road alignment and an established weed corridor, the land outside the corridor is in a mostly natural state. From (3D, 2009a, p. 2)

> *"The roadsides support an abundance of exotic lianes dominated by bramble (Rubus alceifolius) exotic shrubs and herbs such as devils fig (Solanum torvum) and snake weed (Stachytarpheta cayennensis). Exotic grasses such as giant panic (Megathyrsus maximum var. maximum) and carpet grass (Axonopus ficifolius) are also prominent. ...*
>
> *...Weeds characteristic of the forest margin include Ageratum conyzioides, Axonopus ficifolius, Cleome trifolia, Crassocephalum crepidioides, Cyperus brevicaule, Hyptis capitata, Lantana camara, Mimosa pudica, Passiflora edulis, Rubus alceifolius, Scoparia dulcis, Solanum torvum, and Synedrella nodiflora".*

The most common and potentially invasive weeds will require continual management to reduce to a negligible impact. Canopy closure which has been destroyed by Cyclone Larry and Yasi will take a number of years to re-establish and shade out the exotic competition.

The forest dieback disease *Phytophthora cinnamomi* occurs through the Wet Tropics. While Ella Bay Road has favourable physical conditions that suit the possible existence; in particular the wet areas that have impeded drainage, feral pigs (Goosem, et al, 2010b) and the previous movement of cattle and farming equipment, recent studies have found that there is a strong correlation between altitude and the impact of dieback, with all reported cases in the Wet

Tropics occurring in high elevations in granite soils (WTMA, 2004) and it is highly unlikely that this disease will be viable on the lowlands.

The amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) occurs throughout the Wet Tropics and has devastated frog populations causing declines or disappearance of populations of eight species. All devastations have been above 400m and it is thought while present at lower altitudes the sensitivity of the fungus to temperature precludes damage. Chytrid fungus has been identified to be present at Ella Bay through extensive sampling and in neighbouring areas within 20km (Alford, 2010) (Woodhams & Alford, 2005) (Hodgkison & Hero, 2003). Alford has concluded that given that the fungus is already on the site that no quarantine measures should be instituted, however that if frogs are handled that proper hygiene measures be undertaken to ensure that the fungus is not spread amongst individuals.

Feral animals are present in the WHA with pigs (*Sus scrofa*), cane toads (*Bufo marinus*) and domestic dogs and cats the most common. Dogs and cats will be banned on the construction site. Trapping of feral pigs has been ongoing for two years and will be continued.

Assessment of Impact

The Wet Tropics of Queensland, more commonly known as the Wet Tropics World Heritage Area (WTWHA) was inscribed on the World Heritage List in recognition of its outstanding natural universal values (DEW 2007):

- as an outstanding example representing the major stages in the earth's evolutionary history,
- as an outstanding example representing significant ongoing ecological and biological processes,
- as an example of superlative natural phenomena, and
- containing important and significant habitats for in situ conservation of biological diversity.

The Wet Tropics World Heritage property comprises a long narrow strip along the north eastern coast of tropical rainforest. This small remnant of Gondwanan forest has been fragmented further since European settlement. Significant areas have been cleared for agriculture and urban development, particularly along the coast and on the tablelands (DEWHA 2007).

Impacts from this type of external fragmentation can include: restricting the movement of species between habitat fragments; altering historic natural patterns of gene flow among populations; reducing the ability of a populations to adapt and change; reducing seed and pollen dispersal; and impacts on the long term preservation of evolutionary diversity. In addition, species found in 'Island' habitats are more susceptible to extinction (WTMA 2004a).

The protection of existing vegetation which supports connectivity between habitats is of the utmost importance and rehabilitation in suitable areas is recommended where feasible. Although rehabilitation is central to the community efforts for restoring biodiversity, it is more cost effective to maintain the existing vegetation and connectivity than it is to undertake detailed rehabilitation of an area. It is equally as important to maintain and/or rehabilitate areas outside of World Heritage Areas to establish landscape linkages for wildlife and vegetation (WTMA 2004a).

The key World Heritage value that applies to Ella Bay Road is integrity which is defined as the

'……extent to which the world heritage values:

- Are in their natural ecological, physical or aesthetic condition, and
- Are capable of sustaining themselves in the long term.'

WTMP Schedule 3

The mitigation measures developed for Ella Bay Road are aimed at:

- Minimisation of clearing and fragmentation of habitat through alignment optimisation;
- Maintenance of connectivity for arboreal, terrestrial and aquatic ecosystems;

- Reduction of road kill and enhanced fauna connectivity;
- Avoidance of loss of diversity including floristic, faunal (including aquatic and marine; and
- Improving visual values.

Proposed Mitigation Methods

The mitigation methods are extensive and detailed within Chapter 6 *Hydrology, Catchment Integrity and Water* Quality , Chapter 7 *Visual Values*, Chapter 8 *Fauna Sensitive Road Design*, and Chapter 9 *Flora Sensitive Road Design* of this report. The assessment of impact has been made utilising this mitigation.

Assessment of Impact to WHA post Mitigation.

The following tables 4.1 to 4.6 assess the impact against different criteria.

Table 4.1	Qualitative *Assessment of Impacts on WHA Integrity* is an assessment against a set of indicators of integrity and relative performance of the proposed project and the existing road developed for the Kuranda Range Road Upgrade project. This assessment has been updated from the SEIS.
Table 4.2	Environmental Risk Assessment. The list of recommendations has been developed from the SEIS Fauna and Flora Assessment and is updated in this report.
Table 4.3	Wet Tropics Management Permit Conditions. The table analyses the Wet Topics Management Plan against road design and mitigation measures. This assessment has been updated from the SEIS.
Table 4.4	S60(a)(ii) Impact on Current Users of Ella Bay Road. This table is a subset of Table 4.3 and analyses the impact and whether the upgrade is beneficial to current road users.
Table 4.5	Summary of Compliance with Guideline 3. This table is a subset of Table 4.3 and lists the progress of consultation with Aboriginal Groups.
Table 4.6	Summary of Compliance with Guideline 6. This table is a subset of Table 4.3 and lists the progress of consultation with Community Groups.

The conclusion of the multi criteria assessment is that providing the design and mitigation strategies that are described in this report are implemented the proposed road upgrade will not have a net adverse impact on the integrity of the World Heritage Area.

Qualitative Assessment of Impacts on WHA Integrity

Indicator	Comment
(A) Ecological Process	
Canopy connectivity – length of connectivity greater than 10m in height	Will be reduced as road clearing width (disturbed area) will increase from approximately 10m to 12m including drains etc. for surface formation and up to 15m where cuttings are involved. Saving of mature trees will make a large contribution to retaining canopy at less than 12m. The road currently has very little connectivity. Revegetation will replace the current weed margin with a similar net effect to preconstruction tree width
Surface connectivity for cassowaries and macropods – length of connectivity with no barriers greater than 1 m in height or less than 3m under bridge s/culverts	Will be significantly enhanced by the "cassowary friendly" bridges underpasses. Associated fencing (or natural barriers such as steep slopes and cuttings) will reduce the risk of road kill.
Surface connectivity for small animals – length of connectivity with no barriers greater than 1m in height	As above, and specific small fauna underpasses have been included in four (4) locations.
Aquatic connectivity – the number of creek and gully crossings with retention of significant natural features such as natural streambed conditions	Will be significantly enhanced by bridges at the two important creeks at CH 3000 and 3250. The bridges are designed to protect riparian and aquatic values and maintain water quality. Bridge 2 will replace 2 x 600mm culverts.
Area of clearing	Little additional clearing (existing road clearing – 1.95 ha; new road clearing – 0.66 ha extra). All existing clearing to be incorporated in the upgrade.
Length of edge	Slight reduction in length of impacted edge due to proposed fauna friendly bridge and one new creek crossings.
Penetration of edge effects from the road clearing	Increase in edge effects due to the higher traffic and wider opening. To be mitigated by weed control and revegetation.
(B) Physical Condition	
Slope Disturbance – metres of landform disturbance in terms of cut and fill	There will be over 2000m^2 of vegetated retaining walls within the World Heritage Area. Whilst the construction of these increases slope disturbance initially, it will ensure that the cuttings are more stable in the long term.
Catchment integrity – % of runoff within a catchment sourced from the road	No catchment modifications are proposed (i.e. existing drainage patterns will remain). Road runoff strategy designed to protect water quality.
(C) Aesthetic Condition	
Visual dominance and scenic alteration including views of the road from coastal areas	Visual amenity (especially when viewed from ships at sea) will initially be reduced and any remaining impact will lessen as the proposed revegetation of the retaining walls becomes established.

Indicator	Comment
	Visual impacts are proposed to be managed by the revegetation of cuttings, embankments, and retaining walls in accordance with the Revegetation Strategy.
Presentation of World Heritage Values	Presentation will be improved via the sealing of the road, the control of weeds, and the opportunities for additional viewing areas (Heath Point Vista). Proposed fauna bridges will add to scenic values and interest, especially cassowary awareness as the bridges will be visible elements of the cassowary management strategy (e.g. fence and funnel, escape gates and signage).

Table 4.1 Qualitative Assessment of Impacts on WHA Integrity

Environmental Risk Assessment

Environmental Risk Assessment (update of the SEIS BAAM Fauna and Flora Assessment)		
Vegetation Management Act 1999		
1	The identified Regional Ecosystems mapping prepared for this assessment by 3D Environmental has been based on intensive ground-truthing. A request for a mapping amendment should be made to the Queensland Herbarium.	The VMA mapping request has been submitted to DERM.
Wet Tropics Management Plan 1998		
2	An application for a permit under the Wet Tropics Management Plan 1998 must be lodged with the Wet Tropics Management Authority to conduct works in land designated as Zone C and in the near vicinity (i.e. less than 50m) of land designated as Zone B of the WTMP.	Noted and included as Table 4:3 *Wet Tropics Permit Conditions Assessment against World Heritage* Management Plan (as amended 2009)
3	The proponent to enter into discussions with the QPWS regarding the potential for the proposed road alignment to generate increased visitors to Ella Bay National Park and to determine any need for additional infrastructure to protect the environment from increased visitor numbers.	Noted
Land Protection (Pest Stock Route Management Act 2002)		
4	A Weed and Pest Management Plan is prepared for the construction and operational phases of the development. Control measures for Pond Apple and other weed species present (in particular Hymenache, Sicklepod and Lantana) should be incorporated into the Weed Management Plan for both the construction and operational phases of the project. Issue identification, actions, responsibilities and monitoring procedures are to be incorporated into the Plan. The Plan should be in accordance with the Johnstone Shire Pest Management Plan 2004 and in consultation with other relevant agencies including the WTMA and QPWS.	Completed Refer to Volume 3 of Ella Bay Submission Response 3.8 *Weed Management Sub-plan* submitted to CCRC.
General Flora Recommendations:		
5	Clearing works should be restricted to the proposed impact area.	The detail road drawings (EBR1CE-DD(01-22) and Ch. 9 Flora Sensitive Design show the clearing envelope.

	Environmental Risk Assessment (update of the SEIS BAAM Fauna and Flora Assessment)	
6	A detailed flora survey of the proposed road alignment and impact area should be undertaken prior to any construction works to determine the presence of any significant flora that may require specific strategies for management and/or impact mitigation.	Completed Refer to Volume 6.2a, of Ella Bay Submission Response.
7	A Vegetation Management Plan should be developed to include construction, revegetation, rehabilitation, treatment of listed significant flora and maintenance stages of the proposed road works. No species attractive to the Southern Cassowary should be included in the vegetation works.	Refer to Ch. 9 *Flora Sensitive Road Design* and Appendix 5 *Revegetation Planting List*
General Fauna Recommendations		
8	Fauna spotters required for all vegetation clearing and works in waterways: Fauna spotters should work ahead of clearing to identify the presence of individuals within the road alignment, and clearing should not occur until such time as the individuals are moved. Fallen logs, branches and other suitable sheltering debris should be removed from the clearing corridor by hand (or using machinery where required) and carefully placed in adjacent habitat ahead of clearing activities. Caves and rocky outcrops within the road alignment should be checked for nesting birds prior to clearing activities. Where nesting birds (i.e. Macleay's Fig Parrot) are found, these areas should be avoided until after the end of the breeding season (October to April). The road alignment should be checked for the presence of camps (i.e. for the Spectacled Flying Fox) prior to clearing activities, and these areas should be avoided, with a 100m buffer established between the camp/s and the proposed road. If camps are present, road construction should not occur within the birthing season (September to December). Direct searches by fauna spotters through leaf litter immediately prior to clearing may allow for the relocation of some individuals (i.e. reptiles, particularly *Coeranoscincus frontalis*) Streams should be checked for tadpoles and adults of *Nyctimystes dayi* Australian Lacelid, and those found relocated prior to clearing or construction activities at these locations. This species will need to be excluded from the road surface.	Refer to Ch. 9 *Flora Sensitive Road Design* and Volume 3 Environmental Management Plans and specific sub-plans
9	Clearing and construction activities should not be carried out in close proximity to beach areas (i.e north of Heath Point) during breeding season (September to November) if Beach Stonecurlew *(Esacus neglectus)* nesting reported	Refer to Ch. 8 Fauna Sensitive Road Design
10	The road alignment should avoid habitat for the Torrent Treefrog (*Litoria nannotis*) where they occur	While habitat occurs – no species has been identified in surveys. Continue to survey
11	Prior to any works commencing, a detailed fauna assessment is required to be undertaken along the preferred road alignment to identify the presence of significant species and/or specific habitat features to be avoided or managed during construction.	Completed Refer to Volume 6.3a of Ella Bay Submission Response.
12	It is recommended, in areas where there is no canopy connection over the roadway, that rope bridges are fixed between trees on either side of the gap to further accommodate the passage of arboreal fauna. The number of rope bridges required would need to be determined following completion of the proposed works	Areas where connectivity canopy has been reduced will be investigated for arboreal fauna. No arboreal fauna was identified in survey
13	Benchmark studies and on-going monitoring and management of	Refer to *Ch. 12*

Environmental Risk Assessment (update of the SEIS BAAM Fauna and Flora Assessment)		
	waterway health are required at these locations, particularly during times of high rainfall, to ensure that the creek banks are stable and that roadworks do not initiate erosion	*Operational Management and Monitoring* and Volume 6.4g of Ella Bay Submission Response.
14	The frog species *Nyctimystes dayi* – which is not restricted to waterways and their surrounds, will need to be excluded from the road surface. Specific investigations would be required to determine a fencing type capable of excluding *Nyctimystes dayi*.	Refer to Ch. 8 *Fauna Sensitive Road Design*
15	The proposed overpass (i.e. located at cut and cover tunnel) and underpass structures (i.e. located at creek crossings) will need to be monitored for their effectiveness and providing safe crossing opportunities for the range of fauna species present.	Refer to Ch. 12 *Operational Management and Monitoring*
16	It is recommended that the canopy cover be maintained where possible along the preferred road alignment. On-going monitoring and maintenance to minimise edge effects is required for areas along the preferred alignment where the canopy cover cannot be maintained along the road.	Refer to Ch. 9 *Flora Sensitive Road Design* and Appendix 1 Visual Landscape Assessment.
17	It is recommended that disturbed areas along the roadside be rehabilitated using rainforest species as part of the Vegetation Management Plan. Seed stock should be of local provenance.	Refer to Ch. 9 *Flora Sensitive Road Design* and Appendix 5 Revegetation planting List.
18	To determine if these pest fish species are present it will be necessary to survey the fish populations in creeks along the road alignment and monitor species composition during and following road construction.	Fish pest species present and reported to DEEDI. Refer to Ch. 12 *Operational Management and Monitoring*
19	Community awareness is also an important measure in the prevention of introduction of these species to waterways. The residents within the proposed integrated resort development and existing residents in the township of Flying Fish Point should be included in an awareness program that could be coordinated with local government.	Refer to Ch. *12 Operational Management and Monitoring*
General Recommendations For The Proposed Roadworks		
20	It is recommended that "quite asphalt (e.g. Stone Mastic Asphalt is used in road construction) and that some level of noise control be incorporated into the fauna fencing design to reduce potential noise effects. Noise modelling would be required to formulate the most suitable fencing design.	This recommendation was not adopted. Refer to Ch5 *Road Design and Design Criteria* and Appendix 6 Noise Report
21	All upgrade works should be undertaken with reference to the best practice guidelines as presented in Queensland Department of Main Roads: Roads in the Wet Tropics: Planning, Design, Construction, Maintenance and Operation Best Practice Manual (2000)".	Refer to Ch. 2 *Structure and Purpose of this Report*
22	Ensure that road speeds are maintained at no greater than 50km/hr.	The road speed limit has been set at 60km/hr. Refer to Ch5 *Road Design and Design Criteria*
23	A Fire Management Plan to be prepared that calculates appropriate setbacks for development from the adjacent vegetation. The buffer distances can then be negotiated with NRW based on the findings of the study. The Fire Management Plan should also be relevant to the	This recommendation is not relevant to the road setback

Environmental Risk Assessment (update of the SEIS BAAM Fauna and Flora Assessment)		
	operational phase of the development, and include guidelines for land managers.	
24	An Environmental Code of Conduct is prepared for construction workers to ensure that responsibilities for vegetation protection, fire management and weed management are clear and that National Park regulations are understood. The Environmental Code of Conduct should be incorporated into the induction of any site workers, and should be the subject of community information sessions.	Refer to Ch. 10 *Construction Methodology*
25	A Stormwater and Sedimentation Management Plan will be prepared for the proposed road works to protect the integrity of the receiving environments.	This plan will form part of the Erosion and Sediment Control for road construction
26	A Surface Water and Groundwater Quality Management Plan is prepared for the operational phase of the project. Water quality standards must be set to protect native terrestrial and aquatic flora, including regular monitoring of receiving waters to detect levels of chemicals and sediment entering natural waterways, and planned responses to adverse results.	Refer to Ch. 12 *Operational Management and Monitoring*
27	Development design to incorporate recommendations by (Moore, 2007).	Refer to Ch. 8 *Fauna Sensitive Road Design*
28	All soil and other materials to be used for rehabilitation or landscaping purposes (both by the developer during construction and on private property during operation) to be restricted to materials certified as free of pathogens and weeds.	Refer to Ch. 10 *Construction Methodology* Certification is not practical and not practiced by WTMA.
29	A Fencing Strategy is required that meets the needs of the project to separate fauna and vehicles and to funnel fauna to safe crossing points. It is also recommended that the fence be designed to act as a noise barrier to reduce impacts to adjacent habitat.	Refer to Ch. 8 *Fauna Sensitive Road Design* Refer to Ch, 8 *Road Noise.* and Appendix 6 Road Noise. Fence as noise barrier is not required nor practical.

Table 4.2 Environmental Risk Assessment

Wet Tropics Permit Conditions Assessment against World Heritage Management Plan (as amended 2009)

Section	Comment	Reference
s10-21	no Zone A land will be affected	
s13-15	The existing road alignment and proposed upgrade run adjacent to Zone B. Zone B is 31m at the closest point from the construction work impacts and 38m from the roadway lane. Noise and light may enter zone B.	Ch5 *Road Design and Design Criteria* Ch.5 *Lighting* and Ch. 8 *Road Noise*.
s16-18	The existing road alignment and proposed upgrade run within the World Heritage Area Zone C – this allows roadworks and visitor facilities subject to a permit.	EIS & SEIS and this chapter.
s19-21	Zone D land is not in the vicinity. Infrastructure such as visitor facilities at Heath Point park and the lookout should be accommodated within the Zone C land.	Ch. 5 *Vista Points.*
s34	In the context of the WTMP permit, "the activity" is the provision of access to the Ella Bay Integrated Resort and in particular upgrading the section of the Ella Bay Road that passes through the World Heritage Area.	Refer to this report.
s56(1) & (2)	Most important consideration 'likely impact of the proposed activity on the area's integrity" Providing that the recommended mitigation works are implemented effectively, there will be little adverse impact in integrity. The impact to Zone B is limited to noise and light which will be minimal.	SEIS A2.6 Access Road Strategy, and this report. Refer to Ch. 5 Road Design and Design Criteria *Lighting* & Ch. 8 *Road Noise.*
s57	It is considered that the environmental analysis and expert opinion that has been described in the reports has adequately addressed the scale of likely impacts. While most of the impacts likely to occur with the construction and operation of Ella Bay Road have been minimised, the beneficial and some of the adverse impacts will persist. The fauna, flora and hydrological mitigation, monitoring and environmental management strategies described in the reports aims to ensure the maximum reversibility of adverse impacts and avoidance of potentially serious impacts.	EIS, SEIS, Ella Bay Road Design and Environmental Management Report.
s58 (1)	There are no prudent and feasible alternatives to the preferred solution Many alternatives were considered through the evolution of the Access Road through the EIS and SEIS. It is concluded that the upgrade of the existing road is the only one that is both prudent and feasible.	SEIS A2.6 Access Road Strategy Sec 6.3 and Appendix 2 *Revision to Multi Criteria Analysis*.
s58 (2)(a)	Alternative sites were ruled out in the EIS process. The existing road alignment is the only feasible option.	SEIS A2.6 Access Road Strategy Sec 6.3
s58 (2)(b)	The proposed site is the existing Road alignment. There does not appear to be any land use that is competing with the road (other than the existing road and conservation) and, should the project not proceed, it is highly unlikely that any alternative use will arise.	SEIS A2.6 Access Road Strategy Sec 6.3
s58 (2)(c)	All other road access alternatives were found to be not prudent on the basis of unacceptable impact on the integrity of the	SEIS A2.6 Access Road Strategy Sec

Section	Comment	Reference
	World Heritage Area and other areas. This report increases the level of prudence without sacrificing feasibility.	6.3 and this report.
s58 (2)(d) 1	Not carrying out the activity (i.e. not upgrading the access road link) would not be feasible as the existing road would not meet transport efficiency criterion for the access	SEIS A2.6 Access Road Strategy Sec 6.3 and this report.
s58 (2)(d) 2	It is not feasible to postpone the upgrading of the Access Road.	SEIS A2.6 Access Road Strategy Sec 6.3
s59(3)(a) i	With the proposed road design and Water, Fauna and Flora mitigation strategies, and Offset measures, it is considered that the listed species are not under serious threat and risk has been minimised. The Offset measures will likely improve the cassowary connectivity for national benefits.	EIS, SEIS this report, additional flora and fauna reports and surveys in Vol. 6 of the Ella Bay Submission Response.
s59(3)(a) ii	No serious loss of habitat will occur (only 0.66 Ha of new clearing and utilisation of 1.95 ha of existing clearing). 0.69 Ha of existing and new clearing will be revegetated.	SEIS and this report Ch. 7
s59(3)(a) iii	No additional impacts are expected.	
s59(3)(a) iv	Overall, it is expected that ecological processes will improve. This assumes that all recommended mitigation and management is undertaken and that this is effective	SEIS and this report Ch. 6,7,8, 9 and 10.
s59(3)(b)	The proposed activity is the upgrade and operation of a road. There are unlikely to be other activities proposed in that area of WHA. The only identifiable activity at present is the visitor park at Heath Point, which will be upgraded and revegetated. The only adjoining neighbour along the road is the Seahaven Prawn Farm. Impacts from that activity will be mitigated with the Water, Fauna and Flora mitigation strategies. The cumulative impacts would be restricted to the proposed activity.	Refer - Volume 1 MNES report and this report.
s59(3)(c)	The visual amenity will be impacted during construction and until revegetation screens the earthworks and fauna mitigation. The revegetation will improve the visual amenity by control of weeds and sealing of the forest edge. The new road will provide new opportunities for presentation (for drivers of vehicles and pedestrians and cyclists) and is expected to become a high quality scenic drive.	This report Chapter 4 and Appendix 1 *Visual Landscape Assessment.*
s59(4)	The proposed activity includes extensive actions to prevent, minimise and mitigate adverse impacts. The area will be rehabilitated and monitored during and after the activity. This will be facilitated by a suite of management and mitigations strategies.	SEIS and this report Ch. 5,6,7,8
S60(a)(i)	All relevant Aboriginal people have been consulted. The Bagirbarra clan have been recognised as the traditional owners and a Heads of Agreement has been signed.	Refer to post SEIS report - Volume 1 MNES report and Bagirbarra HoA
S60(a)(ii)	All current users will benefit with the exception of beach users seeking seclusion for whom the degree of isolation will be reduced.	Refer to ***Table 4:4 S60(a)(ii) Impact on Current Users of Ella Bay Road***

Section	Comment	Reference
S60(b)	As an adjunct to the main project (the Ella Bay Integrated Resort), the Ella Bay Road upgrade is required.	
S60(c)	No loss is expected in the community's ability to continue to participate in the management, protection, presentation, enjoyment and ecologically sustainable use of the area. Access will be improved.	
s60(d) 1	Key social concerns (conflicts with local traffic in the Flying Fish Point town area, and the environmental impacts of the upgrade) have been addressed and mitigated	SEIS and this report
s60(d) 2	Economic impact will be beneficial	EIS Vol.2
s61(1)	The traffic capacity will be limited by the fixed number of dwellings of the Ella Bay Development. The carrying capacity of the road has been designed accordingly and will not be required to be further upgraded. The usage of the park and Vista Point will not exceed normal capacity.	Refer to this report Chapter 5 and Appendix 4 Revision to Road Usage Demographics for Ella Bay Road
s62 Guideline 1	Minor and inconsequential impact. The guideline has been used in preparing the EIS, SEIS and this report.	EIS, SEIS this report
s62 Guideline 3	The Bagirbarra clan have been identified, and consulted.	Refer ***Table 4:5 Summary of Compliance with Guideline 3***
s62 Guideline 6	The Local Community have not been consulted with the alignment design report. This would be done with WTMA direction. Consultation was incorporated in the EIS and SEIS.	Refer ***Table 4:6 Summary of Compliance with Guideline 6***
s62 Guideline 9	Road Maintenance Code of Practice. This guideline has been used in preparing this report.	
s65(1)	It is considered that the construction and operation of the Ella Bay Road upgrade will involve a minimal loss of integrity, which will be ameliorated by the mitigation measures. There is no prudent and feasible alternative. Reference s58.	SEIS and this report Ch. 6,7,8
s65(2)	The design confines road works to land already cleared or otherwise degraded, to the greatest possible extent. Clearing has been minimised to meet safety requirements.	SEIS and this report Ch. 7 and 9.
s65(3)a	Canopy clearing will be minimal. Every effort has been made to retain mature trees within road safety constraints. The road is a service to a future community. Canopy connectivity is addressed as part of the detailed Flora mitigation strategy. Rope bridges will be evaluated and installed if required after road construction.	SEIS and this report Ch. 7 and 9.
s65(3)b	The Road Corridor Management plan will reduce the impact of other activities. There are unlikely to be other activities proposed in that area of WHA. Cumulative impacts will be offset by the Offset Policy	Refer to post SEIS report – Vol 1 MNES report and Vol 5 Offsets Policy.

Table 4.3 Wet Tropics Management Permit Conditions.

Impact on Current Road Users	Change In Amenity	NET CHANGE ✓=beneficial ×=adverse ~=no change
Road users – cars	▪ Improved flow, safety, reliability, speed. ▪ Improved views of adjacent forests and coastal plain	✓ ✓
Road users – trucks	▪ Improved flow, safety, reliability, speed. ▪ Reduced dust generation, in particular to the Seahaven Prawn Farm.	✓ ✓
Road users – cyclists	▪ 1.5m shoulder provided.	✓
Road users – pedestrians	▪ Pedestrian will be required to use the road shoulder. Very few numbers.	✓
All users – views	▪ Lookout opportunities to be enhanced. ▪ Views from the road generally improved	✓ ✓
Beach users	▪ Degree of isolation will be reduced. ▪ Quality of access will be improved	× ✓

Table 4.4 S60(a)(ii) Impact on Current Users of Ella Bay Road.

Guideline 3 Consultation with Aboriginal People	EIS	SEIS	Submission Response
Identification of relevant Aboriginal people	✓	✓	✓
Provision of sufficient information to the community	✓	✓	✓
Aboriginal community awareness of permit application	N/A	N/A	✓
Aboriginal community understanding of the location, nature and extent of the proposed activity	✓	✓	✓
Undertaking of joint site inspections	✓	✓	✓
Consultation on the final alignment	N/A	✓	✓

Table 4.5 Summary of Compliance with Guideline 3.

Guideline 6 Consultation with Community	EIS	SEIS	Submission Response
Identification of community sectors	✓	✓	✓
Notification of community	✓	✓	✓*
Provision of sufficient information to the community	✓	✓	✓*
Community/stakeholder awareness of permit application	N/A	N/A	Not yet*
Community understanding of the location, nature and extent of the proposed activity	✓	✓	✓*
Consultation on the final alignment	N/A	✓	Not yet*

Table 4.6 Summary of Compliance with Guideline 6.
***Additional consultation to be undertaken as part of permit process.**

5. Road Design and Design Criteria

This chapter provides the design criteria for the technical road design. The design is for a rural sub-arterial road which complies with the constraints of the environment and the requirements of the Ella Bay Development. The road design acknowledges the priority of the World Heritage Area and the constraints of the traffic through WHA Zone C. Detail drawings of the road can be found in Volume 7 of the Ella Bay Submission Response.

Physical Environment and Climate Constraints

The Ella Bay Road area is subject to among the highest rainfall events and cyclonic weather in Australia. The rainfall events feature intense rain and rainfall duration. The details of climate and stormwater management are provided in Chapter 6 *Hydrology, Catchment Integrity and Water* Quality.

The proximity of Ella Bay Road to the coast and that; the road is the only entry into Ella Bay Development requires cognisance of the sea levels, storm surge and cyclonic wave run-up impact on inundation levels and local coastal flooding. The proposed alignment solution is to raise the level of the road to a minimum 5mAHD which is approximately 2m above the predicted 100year Global Warming sea rise impacts.

Route Selection and Alternative options

The road alignment has been reviewed in the EIS, SEIS and in Appendix 2: *Revision to Multi Criteria Analysis of Ella Bay Road Options* (MCA). The road will be constructed in two stages with the first stage following the existing alignment of Ella Bay Road as proposed in Option D (SEIS). The preferred option; Option D(2) in the MCA (Appendix 2:) will require revocation of a small area of Ella Bay National Park (140m²) as the road reserve will traverse though a corner.

Traffic Volumes and Development Traffic Generation

The road usage demographics for Ella Bay Road traffic are provided in Appendix 3: *Revision to Road Usage Demographics for Ella Bay Road*.

Maximum design daily two way traffic	4,138 v/d
Annual Average Daily Traffic	3,134 v/d
Maximum design hourly two way traffic	350 v/h
The maximum design traffic mix	95%/2.5%/2.5% (car, medium truck, heavy truck)

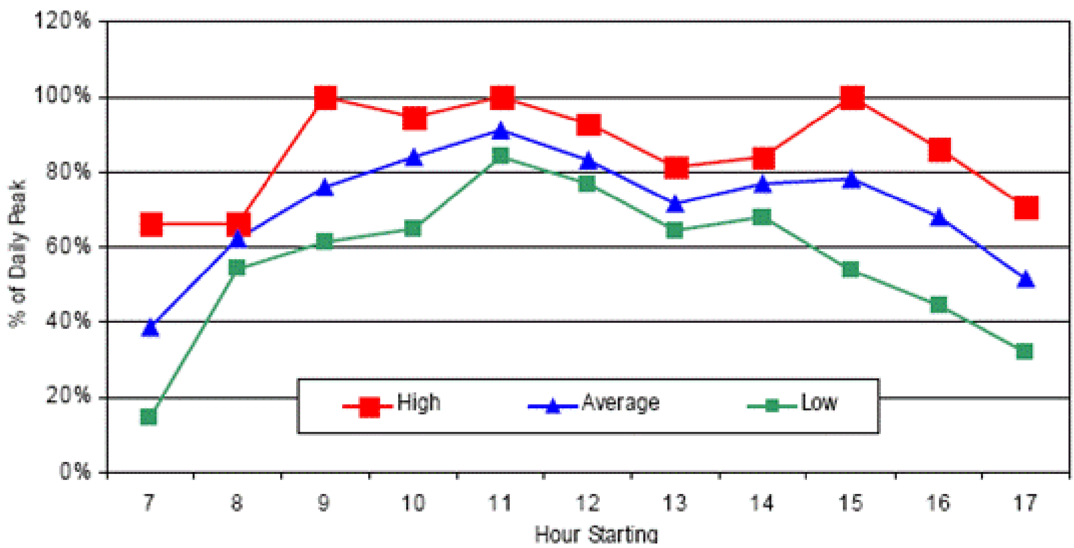

Figure 5:1 Estimated Hourly Trip Generation Profile. EIS Vol A6.5

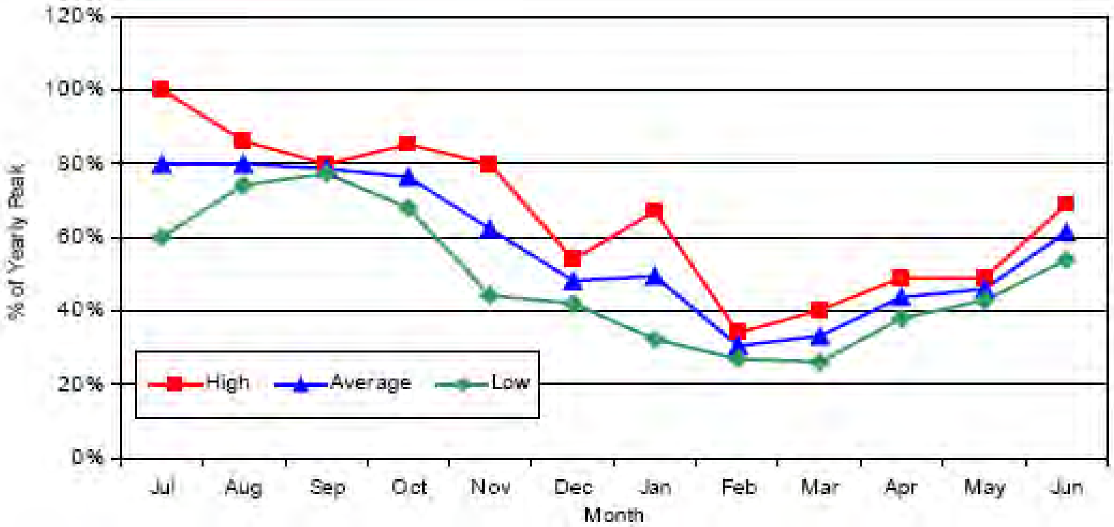

Figure 5:2 Estimated Monthly Trip Generation Profile. EIS Vol A6.5

The traffic volume is expected to fluctuate extensively both by hour of the day and seasonally.

Transport Efficiency and Level of Service Types of Vehicles

The design Level of Service will be LOS B which will be the expectation of drivers for a rural road. It is expected that this level will reduce to LOS C at the Ella Bay entrance where the road alignment has tighter corners and reduced road speed during the highest usage periods.

Factors contributing to the high LOS are:

- Lack of intersections;
- The continuous operating road speed (except for two corners); and
- The low truck ratio and restriction on B doubles;

Road Concept Design

The current practice for road design to minimise cassowary mortality is to have an unfenced road with wide cleared mown verges allowing clear vision and utilising traffic calming such as speed humps to reduce road speed locally. This design has been developed based on adaptation of the existing road conditions and has been relatively unsuccessful based on statistics from the Mission Beach area which show that 62% of reported cassowary deaths in the past 20 years have been from motor vehicle strike (Chenoweth, 2008).

Ella Bay road has adopted an integrated mitigation method based on Goosem (Goosem M. , Fragmentation Impacts Caused by Roads through Rainforests, 2007) and included elements of best practise fauna mitigation. The base design for the road is that the road width will be minimised to ensure canopy connectivity, minimise the clearing of trees and also provide the secondary benefits of maintaining the rainforest experience of the area.

The primary mitigation measure to minimise cassowary and small fauna mortality is to use directional fencing along the road where required and provide habitat connectivity by fauna underpasses and an overpass.

The road design concept is to use a combination of sign posted lower speed and traffic calming to reduce the traffic speed and design for a low operational speed.

Figure 5:3 Figure from (Goosem 2007) illustrates an integrated mitigation method adopted on Ella Bay Road.

Roadwidth

The preferred environmental design is to minimise the road width and clearing to ensure the least disturbance and edge effects. This design is not consistent with Austroads, and DMR road design guidelines where extensive clearing and site distances for fauna and accident avoidance are recommended. The standards and guidelines have been written from a road users' perspective and strive for the highest level of service and do not promote speed reduction and the use of lower speed limits to reduce fauna mortality. The recommended single carriageway widths from (Austroads, 2003a) *Rural Road Design: A Guide to the Geometric Design of Rural Roads* for an AADT of 3,134 v/d results in a total road width of 12m (2x3.5m plus 2.5)) of which 1.0m is unsealed shoulder for a speed of 100km/hr.

Element	Design AADT				
	1-150	150-500	500-1,000	1,000-3,000	>3,000
Traffic Lanes	3.5 (1 x 3.5)	6.2 (2 x 3.1)	6.2-7.0 (2 x 3.1/3.5)	7.0 (2 x 3.5)	7.0 (2 x 3.5)
Total Shoulder	2.0	1.5	1.5	2.0	2.5
Shoulder Seal	0.5	0.5	0.5	1.0	1.5

Table 5.1 Single Carriageway Road Widths (Austroads, 2003a).

However this roadwidth is further qualified in the text which follows the table.

"*Narrower lanes (suggest down to 3.0m – Ref. 18) should be considered where any of the following apply:*

- *The road reserve or existing development form stringent controls preventing wider lanes;*
- *The road is in a low speed environment; or*
- *There is little or no truck traffic.*

...........This lane width framework should be supplemented by the consideration of local practice and experience."

The nominal roadwidth chosen for the recommended speed of 60km/hr (refer to Design Speed in this chapter) is 2 x 3.5m lanes with a 1.5m sealed shoulder each side. This provides a total sealed pavement width of 10.0m. (Refer to road width recommendations Appendix 4 *Road Safety Audit of Ella Bay Road).*

The minimum roadwidth will be 2 x 3.5m lanes with a 1.2m sealed shoulder each side. This provides a total sealed pavement width of 9.4m. The minimum width sealed shoulder will only be used where the saving of a mature tree is required and a localised narrowing or chicaning of the bikepath is required and guardrailing of the tree will be used for safety. The minimum shoulder width is consistent with the minimum width for bikeways.

The roadwidth will be increased around curves as required for semi-trailer movements and vehicle separation.

- Where the road geometry is straight and with radii greater than 120m; the lane widths will be 1.5m wide with 1.5m sealed shoulders;
- Where the horizontal geometry incorporates radii between 80m and 119m the lane widths will be 3.50m plus 2.0m wide sealed shoulders
- Where the horizontal geometry incorporates radii between 60m and 79m the lane widths of 3.70m wide and 2.3m wide sealed shoulders
- Where the horizontal geometry incorporates radii less than 59m the lane widths will be not less than 3.70m wide and 2.3m wide sealed shoulders, but will also be individually designed using the proprietary design program "V-PATH" which provides a conservative estimation of the swept path of the design vehicle.

The narrower shoulder seal of 1.5m versus 2.5m in table 5.1 is justified on the basis that:

- The preservation of flora and existing edge sealing forms stringent controls preventing wider lanes;
- The road speed is restricted to 60km/hr; and
- There is little truck traffic except for servicing the resorts.

The roadwidth is common with tourist roads in the WHA which have become iconic because of the closeness of the rainforest and cathedral appearance of the canopy. Many of these roads have higher speeds and a further reduced width with a greater number of bends. Similar roads are:

- Cape Tribulation Road – Ferry through to Cow Bay – particularly the Alexandra Range section; width of seal; proximity of trees to the road; lesser sight lines; green line marking; cassowary impact mitigation – rumble strips; identified crossing points; signage; slower speeds than design;
- Lake Eacham Road – southern and northern access road;
- Kuranda village entry road – the photo in the Roads in the Wet Tropics and Roads in the Rainforest;
- Palmerston Hwy from East Palmerston (Mamu Tree Top Walk) to Mungalli in the west; and
- Tully Mission Beach Rd from Maria Creeks to Mission Beach.

The roadwidth will not be suitable for B doubles and access will be restricted. The pavement width will require curve widening as noted above to allow semi-trailer movements.

Localised road widening or "pull off" lanes of 2.5m total sealed shoulder will be provided for service vehicles and for discretionary stopping of cars. The road widening will be local to service areas e.g. fauna bridge, fauna culverts and escape gates and will have sufficient length to provide for two parked cars (i.e. one car broken down and one pulled over).

The shoulder will serve a number of functions:

- Road Calming;
- Cassowary warning;
- Bicycle lane; and
- Pull off lane at widening.

The 1.5m wide shoulder is suitable for use as a bikeway (DTMR, 2010b) and will be delineated to provide a bicycle lane in both directions. Pavement marking and signs will give the bike lane legal status, and cyclists will be required to use these lanes unless it is impractical.

The bike lane and traffic calming will be used to support the "change of focus" as people enter the Ella Bay area. The width has been selected to provide an expectation of a narrow road and encourage motorists to reduce their speed.

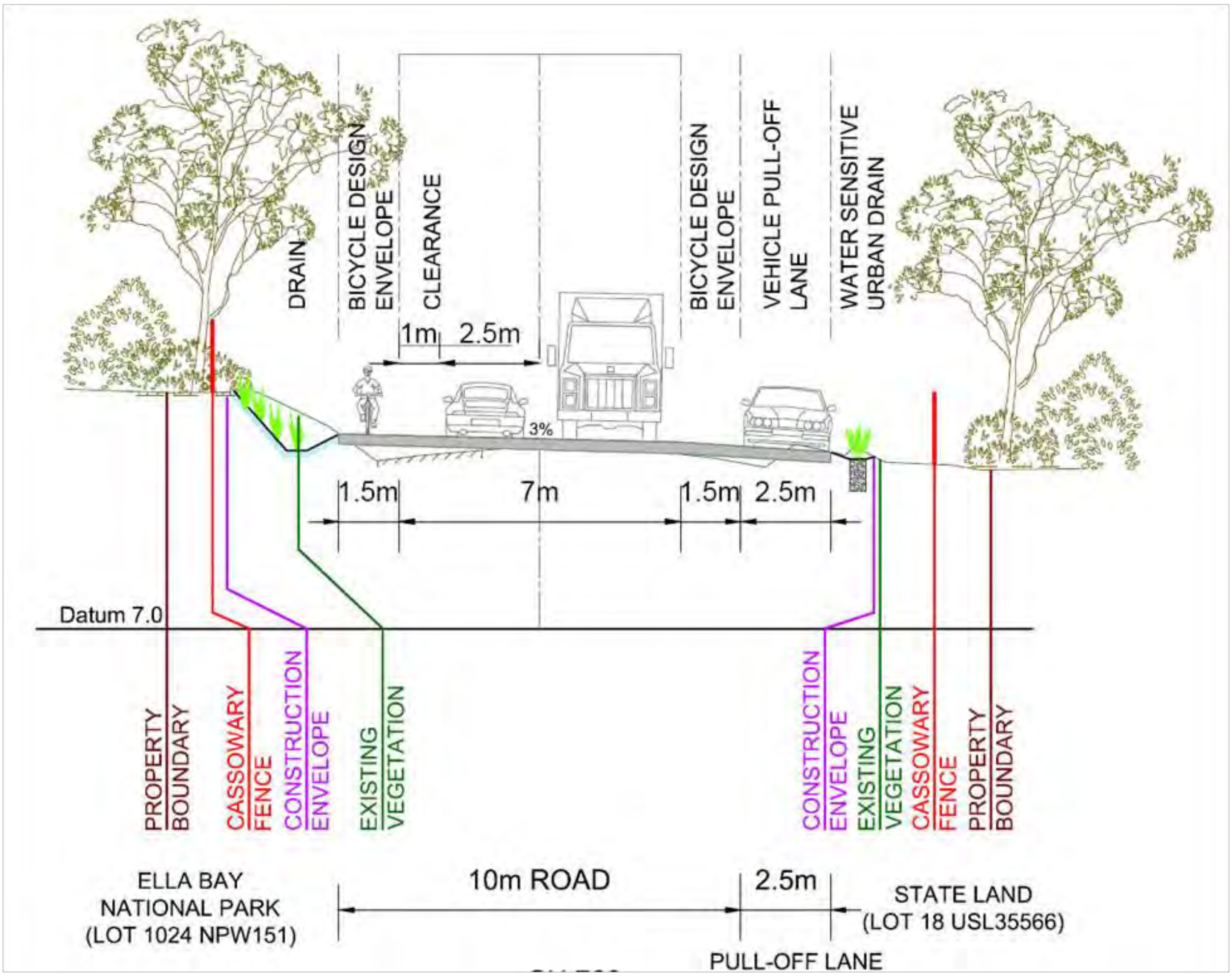

Figure 5:4 Traffic Lane width (from DMR RPDM 2009).

Crossfall and Superelevation

The road has been designed with single cross-fall to separate the non-contaminated runoff from the rainforest and that of the road. The cross-fall will be a minimum of 3% and flow west to east, except where required for superelevation of corners. Horizontal curves which are less than 150m radius will be superelevated to a maximum of 6% (Austroads, 2003a). Horizontal curves less than 600m radius with adverse slope (-3%) will be investigated for safety in detailed design.

The rainforest runoff will be collected into drains on the western side. The road surface runoff will flow to the east. Where superelevation is required the drainage for that localised area will drain to the western side of the road. The treatment of the drainage is discussed in 6 *Hydrology, Catchment Integrity and Water* Quality.

Design Speed

The speed limit will be 60km/h along Ella Bay Road except where designated for horizontal curves which are less than 60m radius and at Little Cove area where the road will be signposted at 40km/h through to Ella Bay.

Road design is generally from a road users' perspective where the goal is to design to the highest level of service and the highest road speed. The posted speed is typically as fast as the conditions allow to 100km/hr for rural roads. In this case the goal is to restrict the speed to a level which:

- Minimises the risk of fauna mortality;
- Minimises the clearing envelope; and
- Allows the visitor to appreciate the road and views.

The operational road speed of a rural road is governed by the number and tightness of the horizontal curves, sight distance and surface quality. The section of road from Flying Fish Point to Heath Point will have a high speed level with an operating speed of up to 100km/hr, which is greater than the desired speed and will require constraining methods to ensure compliance. To reduce the operating speed limit to the posted speed limit in particular on the section to Heath Point will require a number of different forms of traffic calming.

The section of road from Heath Point to Little Cove will have a low speed level due to the many curves with radii less than 150m. The operating speed will generally vary from 50km/h to 70km/h. The alignment would be expected to produce a high degree of driver alertness, so those lower speeds are both expected and acceptable.

The section of road from Little Cove to Ella Bay will have a lower speed level due to the curves with tighter radii less than 70m and restricted sight distance. The operating speed will generally vary from 30km/h to 50km/h. The alignment will feature split lanes and also produce a high degree of driver alertness.

Traffic Calming

Traffic calming will be used to reduce the operational speed in particular between Flying Fish Point and Heath Point Park where the road alignment comprises long radius horizontal curves and is gently undulating and the design speed will exceed the posted speed limit.

Typically in the Wet Tropics the roadside is cleared to increase sight distance to minimise the risk of cassowary mortality (refer to Figure 5:6). Ella Bay Road will be fenced to prevent interaction with cassowaries (refer to Chapter 7) however at entrances and at other locations there is the possibility that cassowaries may enter onto the road and an overall speed reduction is desirable. Traffic calming and the inherent natural picturesque rainforest and ocean views will suitably reduce the speed of visitors and first time users, however the major problem with traffic calming is that regular drivers become complacent and ignore psychological non-intrusive markings and painted narrowings (Gorrill, 2008). The following calming methods will be used and will comprise both physical and psychological traffic calming (Fildes & Jarvis, 1994) (Kennedy, 2005) :

- The roadside shoulder will be designated as a bike lane;
- The roadside shoulder will be delineated and coloured in key places to narrow the road appearance;
- The roadside Signage will warn the driver of the possibility for cassowaries on the road at the fence entrances and near cassowary escape gates;
- The roadway will have transverse line markings at entrances to the cassowary fences (from Flying fish Point and from Ella Bay) which will increase in frequency towards the entrance and rumble strips to alert drivers (and fauna) (refer to Figure 5:5);
- The road shoulder will feature herringbone markings and surface roughening at strategic points (Ella Bay Road from Flying fish Point and from Ella Bay) and adjacent to cassowary fence entrances and cassowary escape gates (refer to Figure 5:5);
- Roadside appearance- the limited clearing and canopy connectivity along the alignment will retain the cathedral appearance of the rainforest, providing a closed-in appearance;
- The roadside vegetation will narrow in areas where mature trees have been retained and guard rail has been placed in front of the trees, with the vegetation providing a natural visual chicane;

- The roadway will feature chicanes and raised humps/platforms in strategic locations to reinforce the reduction in speed. Locations and numbers will be determined at detailed design ;
- The road at Little Cove will have split lanes to minimise the clearing and will be signposted as 40km/hr; and
- Vista Points – The park (CH1635) and the Vista (CH 2070) will provide drivers the opportunity to stop and relax at the beach and/or overlook Heath Point and north east over the Great Barrier Reef Marine Park.

Figure 5:5 Bar markings at known Cassowary Crossings Tully – Mission Beach Road.

Figure 5:6 Extensive road side clearing and speed limits introduced at known Cassowary Crossings.

Road Geometry

The road design parameters have been determined by utilisation of the existing road alignment and realignment where necessary to improve horizontal and vertical curves. The following desired design criteria will be applied and exceptions investigated and mitigated.

Traffic lanes (60km/hr) minimum	2 x 3.5m lanes
Shoulder/Bikeway nominal	1.5m sealed
Shoulder/Bikeway minimum (guard fence protected trees only)	1.2m sealed
Traffic lanes (60km/hr) 119m<radius>80m	2 x 3.5m lanes 2.0m sealed shoulder
Traffic lanes (60km/hr) 79m<radius>60m	2 x 3.7m lanes 2.3m sealed shoulder
Traffic lanes (60km/hr) radius<60m min.	2 x 3.7m lanes 2.3m sealed shoulder individual design
Localised shoulder widening for service vehicles	2.5m sealed shoulder
Localised shoulder widening length	15m with 5m approach
Shared Pedestrian/Bikeway Stage 2 (one side remote)	2.0m
Split lane traffic lane (no bike lane) minimum	3.5m lane
Split lane shoulder (no bike lane) minimum	1.0m + 0.5m sealed
Minimum Horizontal curve radii (60km/hr) (Headland)	70m
Minimum Horizontal curve radii adverse slope -3% (60km/hr)	600m
Minimum stopping sight distance (60km/hr) (level road)	63m
Minimum manoeuvre sight distance (60km/hr)	60m
Minimum clear zone distance	3m.
Superelevation of curves greater then 60m radii	3%
Superelevation of curves less then 60m radii	6%
Maximum grade	12%
Minimum radius of Vertical curve for sight distance (60km/hr)	900m
Flood protection minimum road elevation	5mAHD

Sight Distances

Preliminary design investigation has established that stopping sight distances, and manoeuvre sight distances will be compromised in a number of locations requiring reshaping of embankments with minor additional clearing and revegetation with low height species. In two locations mature trees marked to be retained will compromise sight distance and will require further evaluation with alternative solutions during detailed design, e.g. traffic calming or warnings.

The cassowary fence alignment has the potential to impact on sight distances at entrances and at fauna culverts where the fence is closer than 5m from the road. Each of these occurrences will require specific evaluation.

Two curves between Flying fish Point and the entrance to Little Cove will require reduced speed advisory signage of 40km/hr. The curve at the vista point park will require a localised reduction in speed to improve safety of vehicles entering and leaving the park. The curve at CH. 2400 will have a reduced speed advisory sign as the corner radius is less than the operational speed.

Clear Zone Widths

The nominal clear zone width has been determined at 60km/hr to be 3m on flat ground from the horizontal distance of the edge of the traffic lane (Austroads, 2003a). As noted, it is not always possible to remove or relocate hazards within the clear zone. In the case of mature trees that have been specifically retained for visual and environmental reasons the trees will be made "forgiving" by providing guard fence as a frangible crumple zone.

In the case of culverts in particular fauna culverts the culverts will be extended past the clear zone where feasible.

Barrier Fencing

Barrier fencing will be provided where there is a significant risk to the road user. The methodology for selection of barrier fencing location will be in accordance with the Department of Main Roads *Planning and Design Manual* Severity Index during detail design.

The choice of style of barrier fencing has not been selected. The tight radii corners and steep embankment may preclude the use of flexible barriers such as Brifen wire rope.

Vista Points

There are two sites that will provide sufficient off road parking to introduce visitors to the World Heritage Areas and provide an opportunity to showcase the vistas and educate the casual visitor to the environment and heritage of the area:

- Heath Point Park; and
- Heath Point Headland Vista

The areas will be designed in conjunction with WTMA to showcase the WHA.

Heath Point Park

The Heath Point Park is an existing park which has a small mown section, covered picnic tables, and tracks which provide access to the beach and along the dunal vegetation. The dirt access track also enables undesirable access of vehicles to the beach dunal areas. The park is adjacent to an EPBC critically endangered area of remnant littoral rainforest (RE 7.2.5a) on the southern approach. (Mesophyll to notophyll vine forest of *Syzygium forte* subsp. forte on sands of beach origin) The community is heavily fragmented with remnant patches interspersed with extensive areas of non-remnant vegetation.

The road elevation in this area will be increased to 5mAHD which is an increase in elevation of between 1-1.5m. The road and car park will be built up using vertical gabions with compacted fill. The gabion appearance will be screened with salt tolerant endemic shrubs and vines. The elevated road and carpark will prevent further vehicular access to the beach.

The Heath Point Park will comprise a car parking area for 9 carparks including 2 disabled wide access parks. Access into the park for north bound vehicles will be provided by a turning lane (localised widening of the road width) to accommodate vehicles propped to turn right into the carpark. The parks will be direct nose in parks with sufficient manoeuvring space for reverse redirection onto the road. The pedestrian access from the carpark to the beach will be via a timber ramp.

Facilities at the park will be upgraded to:

- Provide covered weather shelters facilities using recycled materials which harmonise with the local landscape;
- The facilities will include fauna proof rubbish bins;
- Provide graffiti proof interpretative signage of the local fauna, flora, indigenous and pioneering history that blends in with the surrounding areas;
- Revegetating and enhancing the endangered adjoining RE; and
- Install low wattage self-contained LED solar downlights set into the pavement to delineate the access ramp for safety.

Current usage of the park is typically for longer periods with frequent overnight stays. The result is a major litter problem and flora vandalisation, in particular from multi day camping of itinerant groups. The prevention of vehicle access to the dunes will impede the long stay camps, and prospectively reduce litter. The increased traffic frequency with the carpark adjacent to the road will increase the exposure and detract from campers seeking overnight stays.

Heath Point Headland Vista Point.

The vista point at Heath Point Headland is an occasional stopping point for visitors. The view is obscured by guinea grass and weeds. The area below the edge of the road is littered with domestic rubbish and plant cuttings and appears to be stepped from earlier road alignments.

The realignment of the curve will create a cleared area on the outside of the corner suitable for an access lane and car parking. The car park will comprise a lane with parallel parking for 4 vehicles. Access into the vista for north bound vehicles will be provided by a turning lane (localised widening of the road width) to accommodate vehicles propped to turn right into the vista park. The facilities at the vista will comprise:

- Seating and shelter using recycled materials which harmonise with the local landscape;
- Graffiti proof interpretative signage of the local fauna, flora, visual directions, and indigenous history that blends in with the surrounding areas; and
- Selective pruning to expose the view, weed control and revegetating with shrubs of the local woodlands;

The proximity to the road and the change in usage will deter vandalism and dumping of rubbish.

Intersections

There will be no intersections along Ella Bay Road to Ella Bay Development. The only entry points will be from Seahaven Prawn Farm and the two vista points. The Seahaven Prawn Farm entrance will be regraded to the new road level.

Noise

The impact of traffic noise was not addressed in the EIS or SEIS as, the low road speed, low traffic numbers and the distance to dwellings placed the road below the legislative noise threshold. Noise impacts to fauna are addressed in Chapter 8 *Fauna Sensitive Road Design*.

The Environmental Protection Policy (EPP (Noise)) is identified in terms of “planning levels” criteria. The planning levels for a public road are assessed 1m in front of the most exposed part of an affected noise sensitive place and the relevant level for the road design is 60dB(A), assessed as the highest 1 hour equivalent continuous A-weighted sound pressure level between10.00 pm and 6.00am [Leq (1hour];

The hourly noise level for Ella Bay Road is predicted to be less than 60dB(A) (Leq (1hour) at 10m from the centre of the lane. One residence is at 12m from the road and that house is sited at the intersection of Ruby St and Ella Bay Road. A noise attenuation fence will be installed extending 100m to the south along the increase in grade to minimise impact of the noise of vehicles climbing the grade of the Stage 2 Flying Fish Point Bypass.

Pavement, Linemarking and signage

The pavement will be designed for a nominal 20 year life for a sub-arterial rural road with the following parameters:

Design Loading	1x10^6 ESAs
Pavement type:	DGA dense graded asphalt.
Surface Treatment:	45mm DG14
Minimum Pavement Thickness:	300mm
Minimum Base Course:	80 CBR
Minimum Sub-base Course:	60 CBR

Sub-pavement drainage will be provided where the road is in cut or there are known seepage or springs and the base course will be cement modified.

Linemarking and Signs

Linemarking and signage are to be implemented as per AS1742-1991 and requirements of Queensland Main Roads. Linemarking to delineate the bikeway shoulder may use audio tactile line marking to reduce traffic drift.

In addition to standard signage, Specific signage will be implemented for the following:

- Cassowary warning signs;
- Cassowary education and conservation signs;
- Local speed advisory signs for low radii corners;
- Special signage for the Flying Fish Point Bypass tunnel to warn motorists of the confined tunnel environment;
- Boundaries of Ella Bay National Park and World Heritage Area; and
- Vista points and visitor information.

Road Edge guide posts will be installed along the road as per Queensland DTMR - Manual of Uniform Traffic Control Devices (2010).

Services

Fibre optic cable will be run within the road alignment under the bikeway shoulder. The fibre optic pit will be 600mm deep and a minimum of 150mm wide. The trench will run under the shoulder with pits located in pull-off bays. The pits will be “8” type (2 lids, 1270 mm long, 460 mm wide, 843 mm deep).

Geotechnical

Only a preliminary review of geotechnical conditions has been undertaken (Golder, 2007). Review of the 1998 Queensland Department of Mines and Energy Innisfail geology map indicates that the Seymour Range, is underlain by the Barnard Metamorphics.

The conceptual geological route categorisation is:

CH 0000 to 1700 Alluvium. It is likely that this section will comprise interbedded beds of loose sand and soft to firm organic clays. This section of road is relatively level. Works to upgrade and/or widen this section of road should require minimal cut/fill earthworks or other disturbance of the existing relatively shallow slopes. No specific geotechnical engineering design is considered necessary for this section of road.

CH1700 to 2600 Colluvial and weathered Meta-Sediments. This section of the road is the weathered headland of the Heath Point. The weathered rock and meta-sediments feature typically foliation (60º-80º to North West) and jointing (60º-80º). Slumping is characteristic of the colluvium.

CH 2600 to 4000 Alluvium. This section of the road comprises alluvium and extremely weathered meta-sediments with residual soils. Works to upgrade and/or widen this section of road should require minimal cut/fill earthworks.

The majority of cuttings in CH 1700 to 2600, and some cuttings in the other terrain units will be in jointed rock with inclined bedding and overlying colluvium.

- Recommended cut slope and fill batters for weathered rock considered valid for upgrading of Ella Bay Road, i.e. unsupported cut batters up to 3m high:

  Firm the stiff soils and fill material: 1:2 (v:h)
  Weathered rock 1:1 (v:h);
- Engineering design to provide long term stability for the road is likely to require to use of slope stabilisation measures such as soil nails/passive dowels in conjunction with protective mesh and or use of retaining structures; and
- Unsupported fill batters up to about 3m high at 1:1 (v:h) and keyed into underlying weathered rock can be achieved in fill comprising the weathered rock at the site. Overfilling prior to trimming to the design profile should be adopted. Soil nails/passive dowels and/or retaining walls (i.e. gabions) could also be installed to support higher or steeper fill profiles.

The recommendation for cut slopes and fill batters will require slope stabilisation with soil nails/passive dowels and/or retaining walls (Gabions). Further detailed geotechnical investigation will be required to define the method most suitable for low height batters and cuts. For cuts and fills greater than 2m Gabions and rock fall stabilisation will be used.

Given the high local rainfall extensive drainage solutions within the cut and fill will be used to prevent pore water pressure build-up and resulting slips.

Cut and Fill

Extensive cuts will be required within the weathered rock of the Heath Point Headland. It is proposed to place a mobile crusher within the rock cutting at CH 2070 to supply controlled subgrade and engineered fill. Ripped rock produced along the full extent of the cut from CH 1760 to 2700 would be short haul trucked to the mobile crusher. The quantity of cut is expected to produce about 3,000m³.

Embankment Details

The embankments and cutting details will vary depending on location and function.

CH 0000 to 1700 Flying Fish Point to Heath Point Park

This section will require a table drain on the Western side of the road alignment and the extent of clearing of this section the road is due to the cut batters of the drain. The western side of the road elevates to the Seymour Range and the steepness of this slope affects the area of clearing envelope. The drain details are: (Refer to Figure 5:7)

- The cross section of the drain will be nominally 0.5m² ;

- The batter slopes of natural earth embankments on the western side of the road will be 1 vertical to 2 horizontal adjacent to the road (1:2 (v:h));
- The batter slopes of natural earth embankments on the eastern side of the road will be 1 vertical to 4 horizontal adjacent to the road (1:4 (v:h));
- The batter slope of natural earth embankments will be a maximum of 1 vertical to 1 horizontal where the table drain batters to natural ground (1:1 (v:h)). The embankments will be steeper where the geotechnical properties permit in particular where doing so will reduce clearing or aid in preservation of a mature tree; and
- In some areas stabilisation will be required to increase the batter slope to minimise tree clearing and save mature trees.

Batters adjacent to the road will be revegetated with endemic species suitable for growing adjacent to roads. Refer to Chapter 9 *Flora Sensitive Road Design* for details.

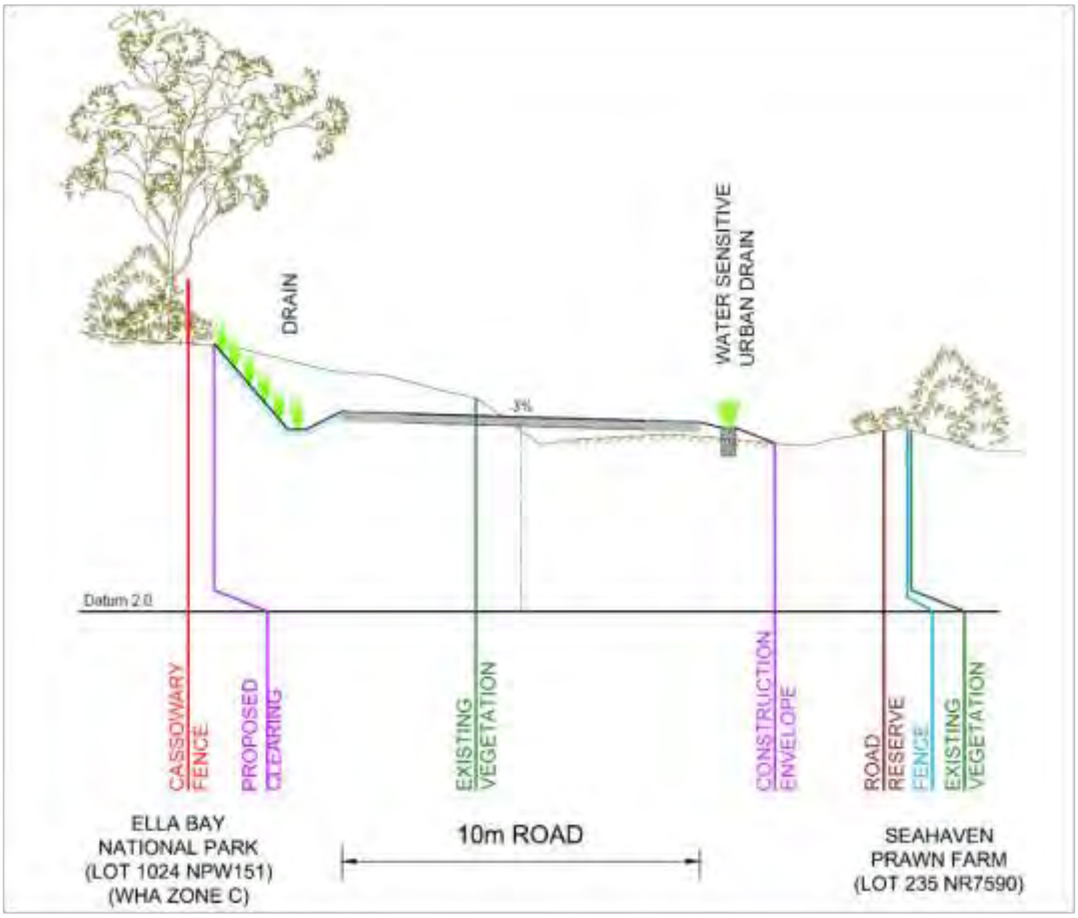

Figure 5:7 Typical Batter slopes near Prawn Farm.

CH 1700 to 2600 Heath Point Park to North of WHA.

This section will require extensive cuts into the western bank and filled embankments on the eastern side. The cut embankments will be in colluvial material and weathered rock. Refer to section *Geotechnical* this chapter.

The embankments and cuttings around the Heath Point Headland afford the greatest opportunity for alternative design to minimise clearing. The use of gabions will reduce the extent of clearing. The gabions will be vegetated (refer to Chapter 8) to soften the appearance and provide improved visual amenity (Refer to Figure 5:8).

Other stabilisation techniques which are less visually intrusive will be investigated during detail design following geotechnical investigation such as soil nails and passive dowels, and rock fall netting.

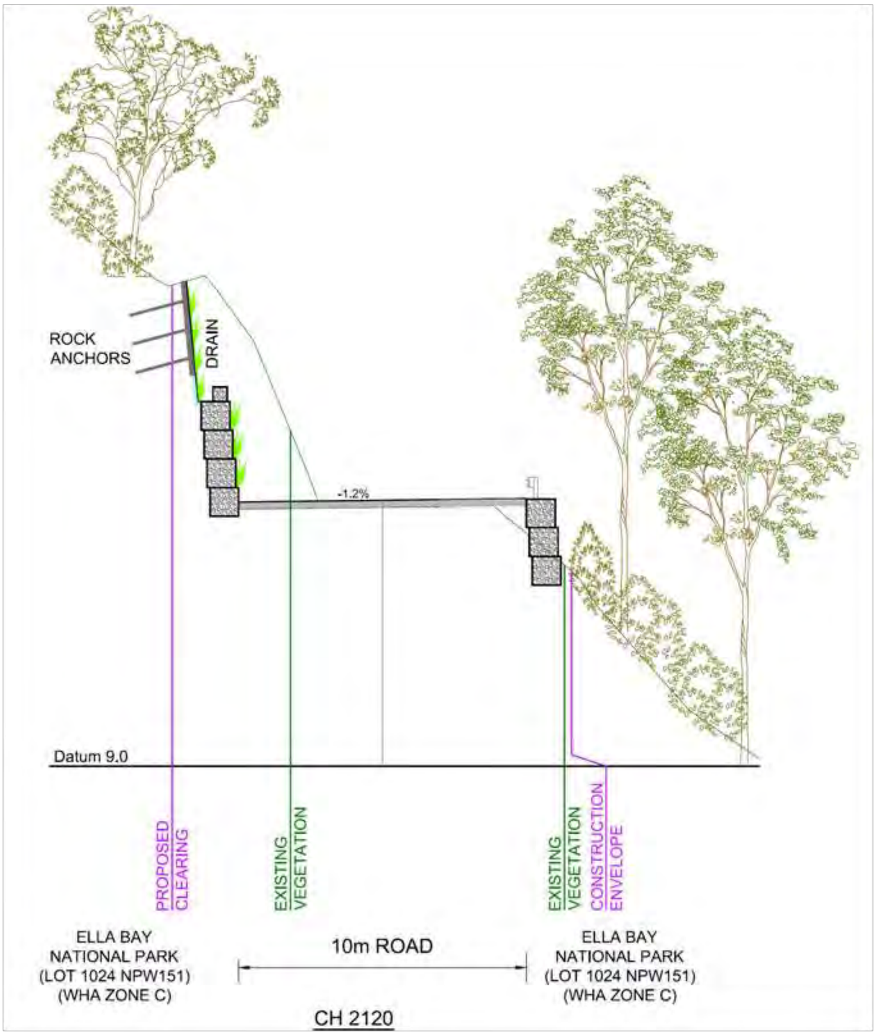

Figure 5:8 Vegetated Gabion embankment at Heath point

CH 2600 to 4000 North of WHA to Ella Bay

This section of road will be similar to the Flying Fish Point to Heath Point Park section and the batter treatment will be the same.

Lighting

Lighting will not be required on Stage 1 of Ella Bay Road. Limited safety lighting will be used at the Heath Point Park and Heath Point Headland Vista.

Lighting will be restricted to the Bay Road Roundabout and the tunnel in the Stage 2 Flying Fish Point Bypass. The Stage 2 Bay Road Roundabout will be lit in accordance with Australian Standard for Road Lighting AS 1158 – 1997 Category V5.

Lighting of the tunnel and approach zones will require special consideration for both day and night time. The tunnel lighting will require detail design to operate without producing light pollution in to the local environment. The aim of the tunnel lighting will be to allow motorists to enter, travel through and leave the tunnel with the same degree of confidence (and at the same travel speed) as on adjacent sections of open road. Light sensors located above the entrance portals to each tunnel will be used to register the external illuminance level and the internal lighting adjusted to similar levels.

Reflectors will be used to delineate the roadside and the centreline where required as per requirements of AS 1158.

Revegetation methods discussed in Chapter 9 *Flora Sensitive Road Design* will aim to decrease the effects of headlights from the alignment into densely vegetated areas.

Road Safety Audit

A road safety audit will be performed on the road design during the detail design phase of the road. A preliminary road safety audit has been completed on the road design by RSA (Appendix 4). The result of the preliminary road safety audit was that the road required widening from the minimalist approach that has been taken to conserve flora and minimise clearing of mature trees. The initial design road design was based on exemptions to the design table road widths based on the design speed being 60km/hr. These changes are now reflected in this report.

Design for construction

The construction of the road will require high levels of management of the environment and the following techniques will be used to aid the environmental outcome:

- Offsite manufacture and filling of gabions, with delivery and placement on a just in time basis, speeding up the process and removing site based stockpiles;
- The use of offsite marshalling compounds to streamline delivery to site;
- Detailed scheduling of cut and fill to minimise stockpiling and external transport movements. This utilises the onsite rock for engineered fill; and
- Precast concrete bridge beams;

6. Hydrology, Catchment Integrity and Water Quality

Water sensitive road design will be implemented to remove pollutants from the road surface storm water runoff prior to discharge. The design will cater for gross and fine particulates, and within sensitive areas will also incorporate methods for treating soluble toxins. The rural nature of the road, intense wet season and minimised clearing width are challenges to the water sensitive design. The overall goal will be to bypass the upstream flows emanating from heavily vegetated rainforest by separating these flows from the road runoff and only treating the first flush road runoff.

A further consideration is to enhance fauna linkage under the road through the culverts and where feasible only discharge runoff utilizing existing eastern drainage paths flowing into the GBRWHA.

Current catchment hydrology

The storm water catchment to Heath Point features 11 sub-catchments that are predominately short length drainage paths of relatively small areas of less than 8 ha which flow from the Seymour Range (refer to Figure 6.5 and 6.6 The local gullies are relatively steep ranging in grade from 20% to 70% and have a flow length of less than 500m. Around Heath point to Little Cove there are a further 8 sub catchments of similar size with the exception of the ephemeral stream of Heath Point (culvert 16) which has a larger catchment of 20 ha within the WHA although it is still relatively short at 600m. The two permanent streams that are crossed within Little Cove and will fauna underpasses (bridge 2 & 3) have larger catchments of 80 ha and 55 ha respectively and are to 1.5km long. The natural ephemeral drainage paths experience high flows during the wet season and are relatively dry during the remainder of the year.

Existing Erosion Potential

Reduction in sediment and pollutants is a significant issue for the existing road alignment due to the surrounding Ella Bay and Great Barrier Reef WHAs. Current physical conditions are:

- Unsealed drains (Figure 6:1) and cracked culverts showing through base course (Figure 6:2);
- Flooding both north and south of Heath Point during intense rainfall events;
- No treatment of road runoff (refer to Figure 6:3 and Figure 6:4);
- Undersized concrete pipe (RCP) culverts; and
- Presence of gross pollutants.

The storm water runoff from the WHA flows down the slope of the Seymour Range and collects into ephemeral watercourses and discharges either directly into culverts or runs along a short length of table drain into the pipe culvert to transfer under the road. This storm water runoff from upstream of the road having emanated from the rainforest and would be considered pristine.

There is no existing treatment of road runoff. The primary sources of sediment and areas of erosion are the table drains and the unsealed road itself. Runoff from the unsealed road generates high loads of sediment and suspended solids which combine on the discharge side of the culvert with the cleaner WHA flows (Refer to Figure 6:3). This occurs around the steeper areas of Heath Point even where there is a base of weathered rock under the road. The high sediment load in the creeks is pushed downstream sufficient to smother the base of stream beds with 20 to 30mm of fine silt only 30 metres from the GBRMWHA (Refer to Figure 6:4). Once the road degrades to an unacceptable point, CCRC repairs the road by grading more gravel into the erosion points and the cycle continues.

Receiving Waters

The receiving waters for the various subcatchments of the Ella Bay Road upgrade are directly and indirectly the GBRMP. The creeks and drainage lines discharge into the General Use Zone under the GBRMP Zoning Plan of 2003. The waters are designated a No Shipping area. The closest Habitat Protection Zone is The Peaks rock outcrop which is approximately 2km offshore.

Figure 6:1 Existing Western drain opposite Seahaven Prawn Farm. Gully erosion is indicative along the whole alignment.

Figure 6:2 Existing culverts at Heath Point. Indicative of approximately one-third of the original RCPs.

Figure 6:3 Unsealed road runoff above and below an existing culvert (headwall visible on left).

Figure 6:4 Sedimentation 20-30mm at Culvert 16. is 30m east of GBRWHA.

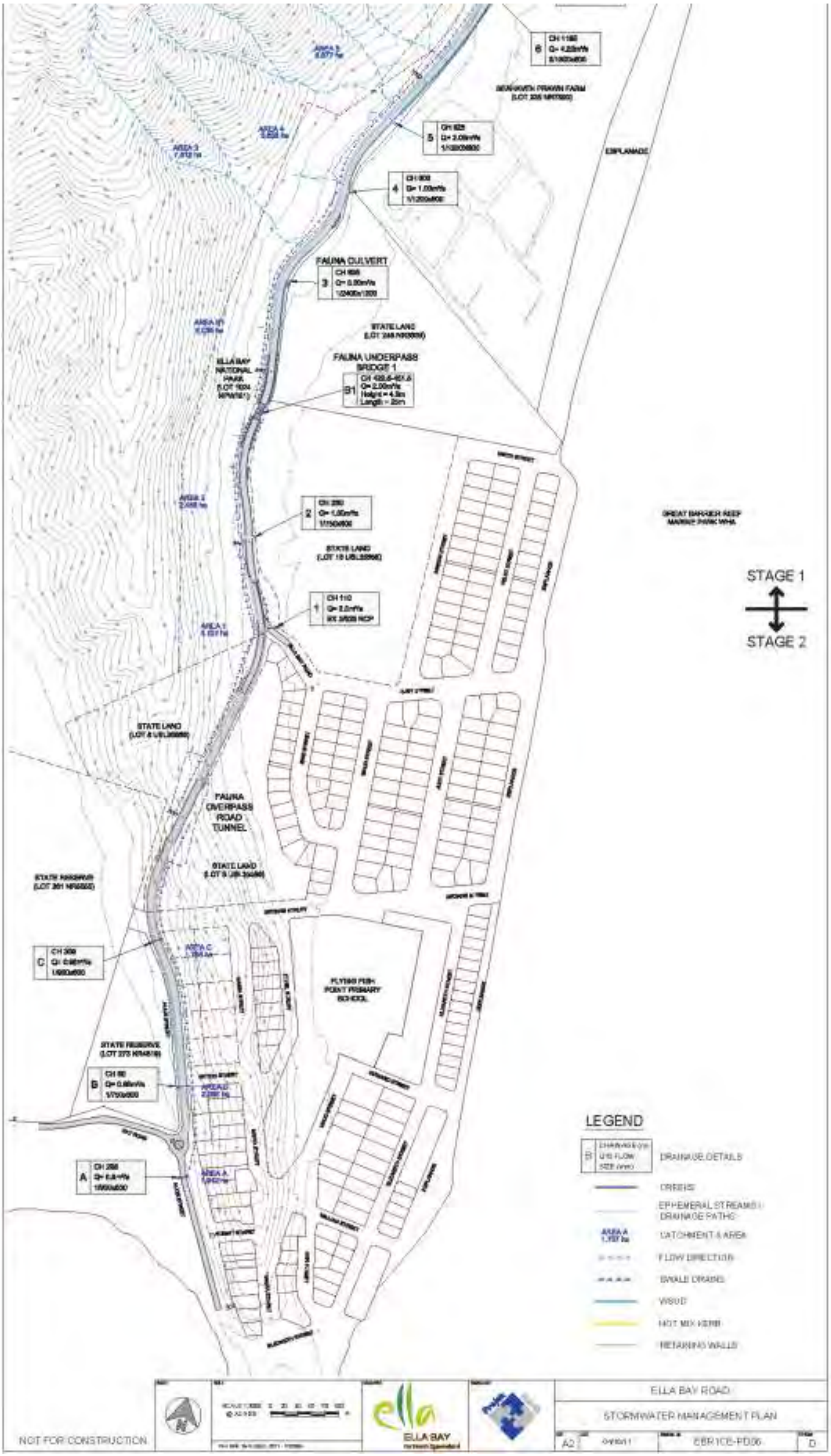

Figure 6:5 Stormwater Management Plan Drawing EBR1CE-PD06 (part 1 of 2)

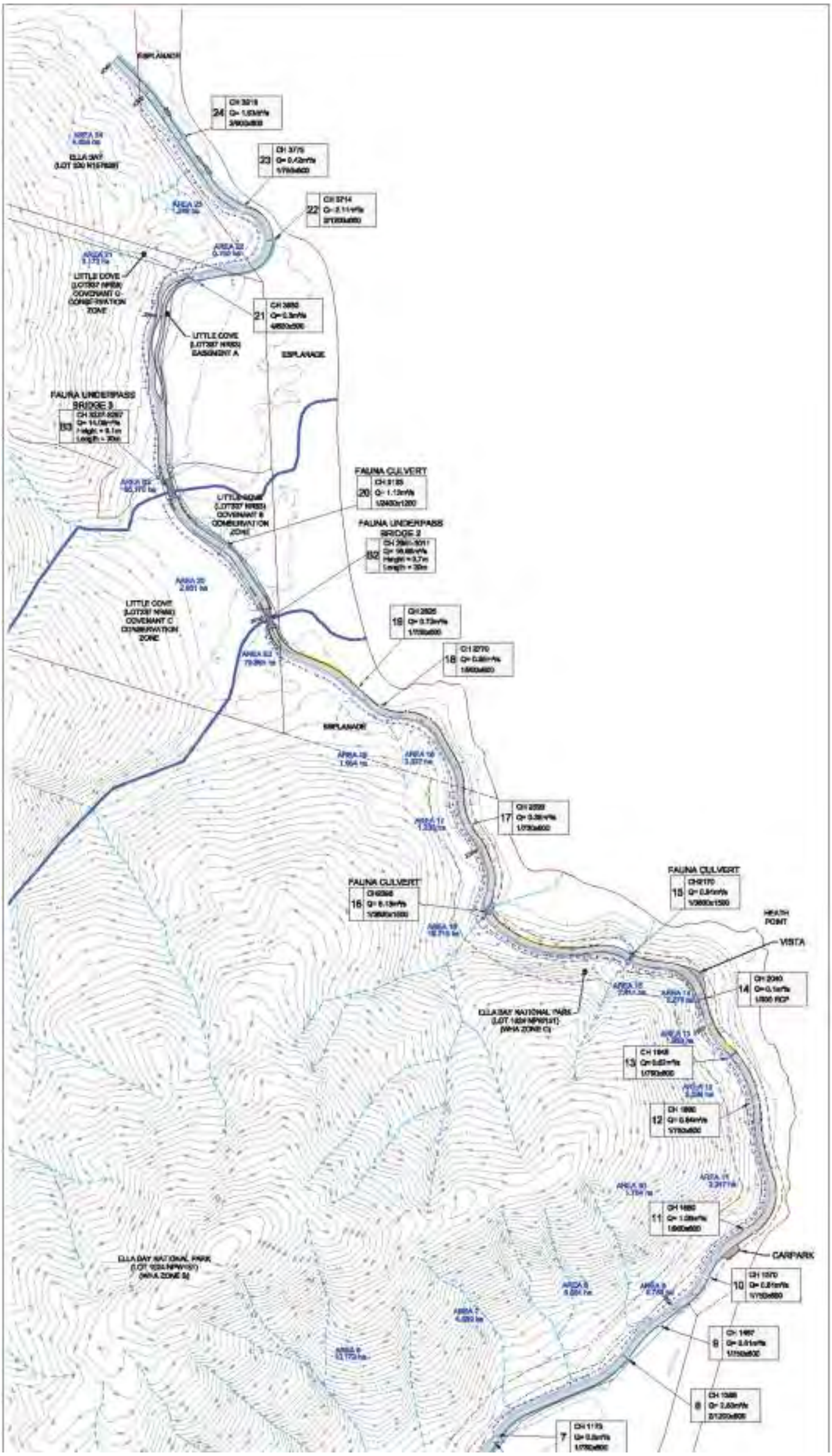

Figure 6:6 Stormwater Management Plan Drawing EBR1CE-PD06 (part 2 of 2)

Western drainage

The runoff from the rainforest will be collected in table drains and transported to culverts. The aim will be to catch gross pollutants and transfer runoff without mixing with roadside contamination. In areas where superelevation is required this will not be possible but for the majority of the road length the in situ water quality will remain intact. The different topographical areas will require different roadside drainage structures. Refer to drawing EBR1CE-PD07 for flow design and catchment details.

CH 0000 to CH 1700 Flying Fish Point to Heath Point Park

This section of road is slightly undulating with low drain slopes. The table drains will be covered with geotextile (jute) material to reduce weed germination and embankment erosion, then vegetated. The invert of drain will be designed for the relevant flows with the base treatment dictated by the slope where:

- 0.5-2.5% gradient, will be geotextile with vegetation, with rock check structures to slow flows on long gradients >50m;
- >2.5% gradient will be geotextile with vegetation slopes and a concrete invert channel, with rock check structures to slow flows on long gradients >50m; and
- Rock retaining structures around the root balls of protected mature trees forming the western wall of the table drain.

Refer to Chapter 9 *Flora Sensitive Road Design* for plant selection in the drain and on the embankments.

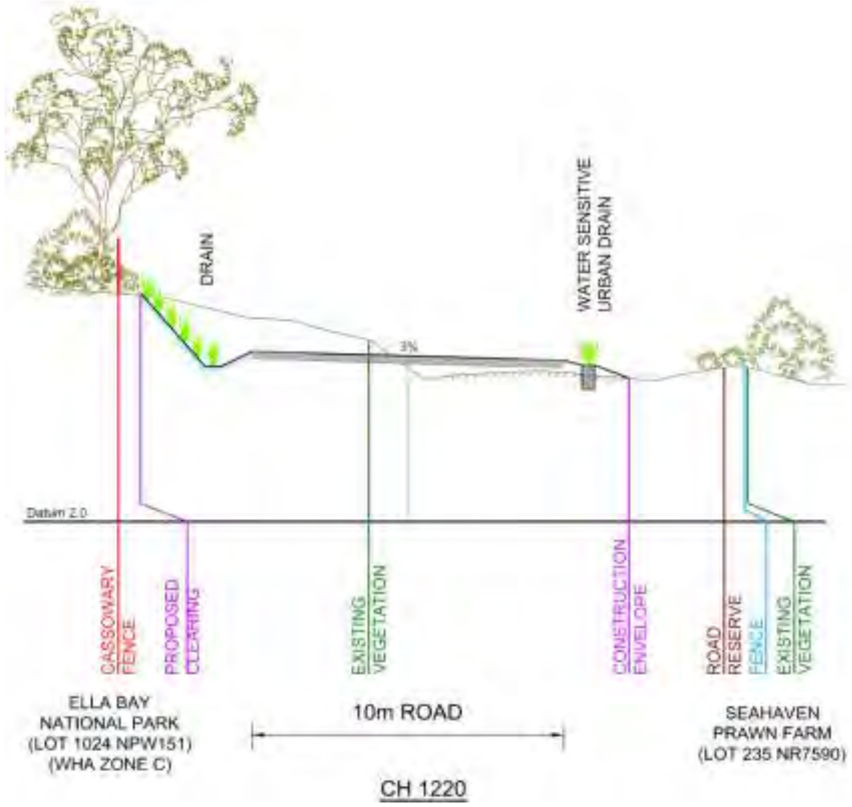

Figure 6:7 Typical western drain cross section Flying Fish Point to Heath Point Park.

CH 1700 to 2600 Heath Point Park to North of WHA.

The Heath Point Section possesses the steepest gradients of the alignment and for the full length of this section the road will require widening through cuttings of the western embankment and stabilisation of natural batters using gabions and/or soil nails. The road will be paved to the edge of the embankments and slope to the east except for specific corners where superelevation is required for safety. The gabions will allow low volume infiltration from the edge seal with the road.

The type of drain structure will be dictated by the embankment type.

- Natural batters will have a concrete invert (or rock lined) cutoff drain above the top of the batter flowing to a drop structure and culvert;
- Gabion structures will utilize the top gabion as a lined drain flowing to a drop structure and culvert. Refer to Figure 6:8 which shows the cross-section designed to minimize the area of disturbance to the west of the drain; and
- Superelevated corners where the storm water flows to the West of the road, will have grating on the paved shoulder bikeway to drain the water to a culvert (CH 2040) or a hotmix spoon drain on the inside of the corner (CH 2700, and others).

The vegetated gabions will allow infiltration of the storm water for plant survival (refer to Chapter 9 for description of the vegetated gabions).

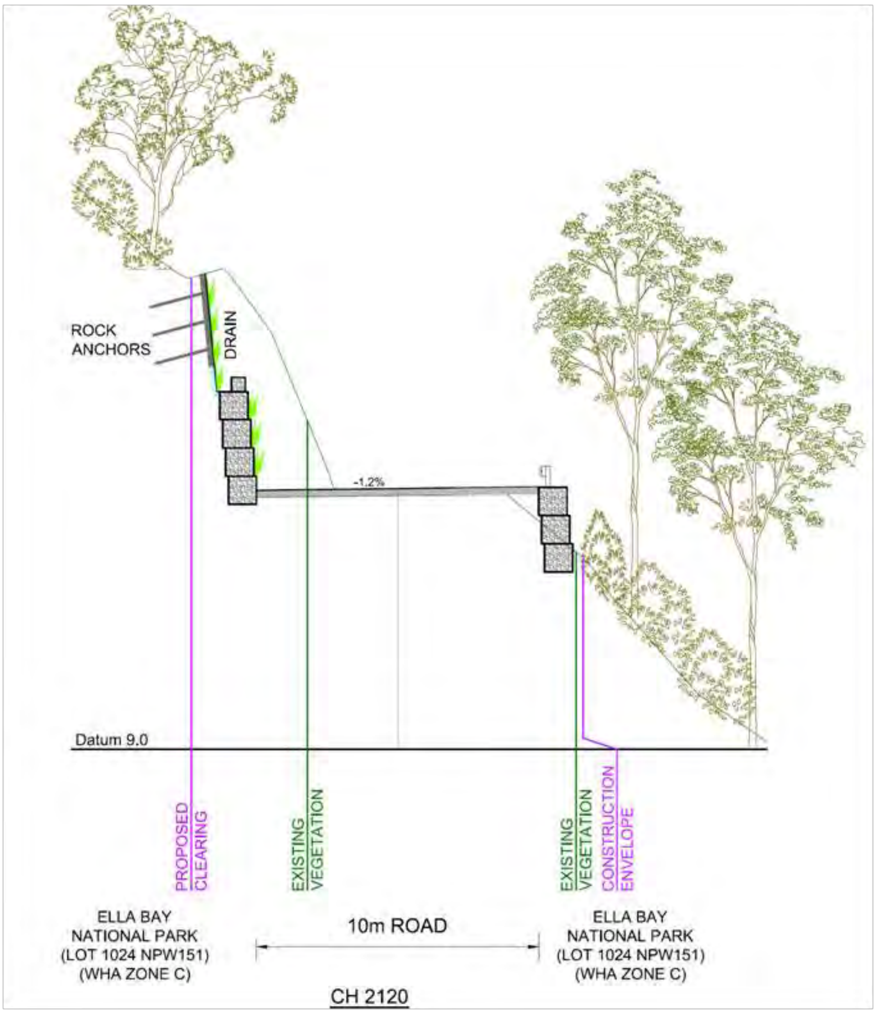

Figure 6:8 Typical western drain for gabion structures at Heath Point. (this section of road is superelevated for safety).

CH 2600 to 4000 North of WHA to Ella Bay

This section of the road is moderately undulating and will require erosion protection in the table drain for a large proportion of the road. The initial section from CH 2600 will require cutoff drains above the embankment similar to the WHA section of the road.

The type of drain structure will be dictated by the embankment type and gradient.

For the embankment cutoff drains:

- Natural batters will have a concrete invert (or rock lined) cutoff drain above the top of the batter flowing to a drop structure and culvert;
- Gabion structures will utilize the top gabion as a lined drain flowing to a drop structure and culvert. Refer to Figure 6.8, which shows the cross-section designed to minimize the area of disturbance to the west of the drain;

For the Table drains

- 0.5-2.5% gradient, will be geotextile with vegetation, with rock check structures to slow flows on long gradients >50m;
- 2.5%- 5.0% gradient, will be geotextile with vegetation slopes and a concrete invert channel, with rock check structures to slow flows on long gradients >50m; and
- >5.0% gradient, and for runs>200m. Rock lined drain walls and inverts.

Culverts

All the culverts along Ella Bay Road will be changed from concrete pipe culverts and replaced with concrete box culverts. Details of culvert locations and size are provided in Table 6.1.

The hydrological design criteria is to:

- Redesign the culverts to cope with the intense rainfall events to prevent afflux and water flowing across the road. (refer to Figure 6:9). On average culverts are situated every 150m to control afflux (refer to Table 6.1);
- Culverts to drain and not hold water or sediment;
- Treat every culvert and bridge as a fauna crossing, with different culverts sized for small fauna, macropods and Cassowaries; and
- Only use culverts where the drainage lines and streams are ephemeral and do not have aquatic fauna.

Figure 6:9 Inadequate drainage causing unnecessary erosion along the current alignment

The culvert locations will be in most cases at the same location as the RCP culvert and discharge into an existing drainage line on the eastern side. The discharge from the culvert will be slowed and spread by rock riprap.

Where significant large mature trees or rocks have split the drainage alignment, additional culverts have been placed to redirect flows (Culverts 7, 9). Where the road climbs over Health Point, additional culverts (Culverts 13 and 18) have been located to improve hydrological flows

The area surrounding the entrance and discharge of the culverts will be revegetated to enhance the fauna passage through the culvert; this is detailed in Chapter 9.

The specialised fauna culverts and bridges have been hydrologically overdesigned and fauna mitigation aspects are detailed in Chapter 8.

Culvert/Bridge ID	Chainage (m)	Amount / Dimensions (W x H)mm
A (Stage 2)	0298 (existing Alice Street)	1 / 900 x 600
B (Stage 2)	0088	1 / 750 x 600
C (Stage 2)	0309	1 / 900 x 600
1 (Stage 2)	0110 (existing Ella Bay Road)	1 / 900 x 600
2	0250	1 / 750 x 600
Bridge 1 Fauna Underpass	0426 – 0451	15m x 4m
3 Fauna culvert	0635	1 / 2400 x 1200
4	0800	1 / 1200 x 600
5	0925	1 / 1200 x 600
6	1165	2 / 1800 x 600
7	1173	1 / 750 x 600
8	1398	2 / 1200 x 600
9	1467	1 / 750 x 600
10	1570	1 / 750 x 600
11	1660	1 / 900 x 600
12	1860	1 / 750 x 600
13	1945	1 / 750 x 600
14	2040	1 / 300 RCP
15 Fauna culvert	2170	1 / 3600 x 1500
16 Fauna culvert	2398	1 / 3600 x 1500
17	2539	1 / 750 x 600
18	2770	1 / 900 x 600
19	2825	1 / 750 x 600
Bridge 2 Fauna Underpass	2981 – 3011	30m x 3.7m
20 Fauna culvert	3123	1 / 2400 x 1200
Bridge 3 Fauna Underpass	3227 – 3257	30m x 5.1m
21	3580	4 / 600 x 300
22	3714	2 / 1200 x 600
23	3775	1 / 750 x 600
24	3918	2 / 900 x 600

Table 6.1 Drainage structures located at Ella Bay Road.

Gross Pollutant Traps

Gross pollutants will be transferred with the storm water through the culverts. In most cases given the rainforest source of the storm water the gross pollutants will be predominantly leaves and twigs with a small amount of litter. Due to the high concentration of leaves and twigs the litter removal rate will be extremely low and sighting of a suitably sized GPT will not be viable within the constraints of the restricted clearing envelope. GPTs will only be installed on the western flows between Flying Fish Point and Heath Point Park and including Heath Point Headland Vista.

The GPT will collect +5mm material with a trash rack or proprietary non blocking GPT which allows overflow in high flow conditions. Where the majority of the flow is from an ephemeral drainage line which effectively discharges directly into the culvert the GPT will be placed in the low flow sections of the table drain.

At Heath Point carpark and Heath Point Headland Vista Side Entry Pollution Traps (SEPT) will be used. These have screens to collect +5mm material in a removable basket. The drainage in these areas will collect only from the road and carpark storm flows and the basket will collect cigarette butts, fine plastic and bottle tops with limited leaves and twigs.

Bridges

There will be three bridges along Ella Bay Road, with one a dedicated fauna underpass over a small drainage line and where Ella Bay Road crosses two creeks, bridges will be constructed instead of culverts to provide cassowary fauna underpasses. The bridges have been sized for cassowary use and will far exceed the hydrological flow requirements.

Bridge 1 CH 0425 - 0450 - (EBR1CE-DD03)

Bridge 1 will be a dedicated fauna bridge. The bridge will provide drainage for a small storm based drainage flow which will be contained in an open rock channel. The area surrounding the channel and the base of the bridge will be revegetated with cassowary attractant plants and ground covers (refer to Chapter 9 for details).

Storm runoff from the bridge road surface will be collected in concrete kerbing and directed to scuppers and discharge to the ground level in drop structures on the eastern side. Concrete invert kerbing will be used along the gabion retaining walls, with regular droppers.

The bridge and bridge approach runoff will be collected in a vegetated swale.

Bridge 2 CH2981- 3011 - (EBR1CE-DD16)

The bridge will replace an existing pipe culvert which has created erosion holes in the stream bed and restricted aquatic movement due to the high velocity. The old culvert will be removed together with the road base, and the stream bed and banks will be lined with river rocks. The bridge will span the creek and the banks and will allow restoration of the stream bed to replicate the upstream conditions and as close as possible, the hydrological conditions. The creek banks and surrounding area will be revegetated with cassowary attractant plants (refer to Chapter 9 for details).

Storm runoff from the bridge road surface will be treated as per Bridge 1.

Bridge 3 CH3227- 3257 - (EBR1CE-DD18).

Bridge 3 will be constructed on a new alignment over an old logging trail. The bridge will span the creek and banks. Construction of the bridge will be from top down with the creek banks protected from the works. The creek banks and surrounding area will be revegetated with cassowary attractant plants (refer to Chapter 9).

Storm runoff from the bridge road surface will be treated as per Bridge 1.

Vegetated Swale

A vegetated swale will run alongside both the east and west of the bridge. The bridge and approach runoff will be collect in the eastern swale. The swales will provide a pollutant removal mechanism by biofiltration, enhanced sedimentation and particle adhesion. The swale will have a rock invert and rock check structures, to reduce erosion-causing velocities and discharge the storm water in to the creeks with the minimum of disturbance. The eastern vegetated swale for Bridge 2 and Bridge 3 will have a bioretention function for low flows. The storm water flowing through the bioretention filter will have a residence time suitable for reduction in Nitrogen, Phosphorous and heavy metals levels. The goal is to remove the highest levels of toxic flush of road runoff entering the rainforest creeks.

Eastern Drainage

The drainage on the eastern side of the road alignment will vary depending on location.

CH 0000 to CH 1700 Flying Fish Point to Heath Point Park

Along this section of the road the discharge from the road pavement gently slopes towards the east. The road fall has been designed to guide road runoff to the eastern side of the alignment to the bioretention swale. The first flush will be treated within the bioretention swale with excess flow overflowing the swale to the eastern vegetation. The swale will consist of short lengths of 20 to 50m of vegetated bioretention pit with a drainage pipe collecting the seepage and discharging the filtered water into the adjoining vegetation. The collection area of the swale will have rock check dams to increase the residence time of the storm water.

The location of the bioretention swale has been notionally located on the drawings (EBR1CE-PD06 and details EBR1CE-DD03-04, 16 and 17-18) the exact location will be positioned in detail design. The distance of the swale from the side of the road will allow grasses and other vegetation to aid the filtration of runoff (see Chapter 9). Sized rocks will be used as mulch on the surface of the swale to reduce weed growth and provide an erosion resistant surface.

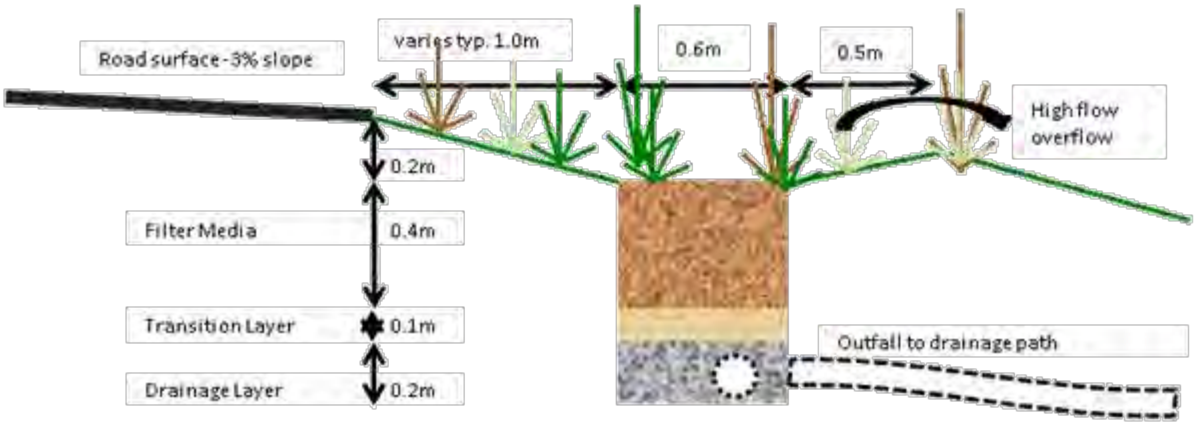

Figure 6:10 Cross section of Bioretention swale, the distance from the road varies.

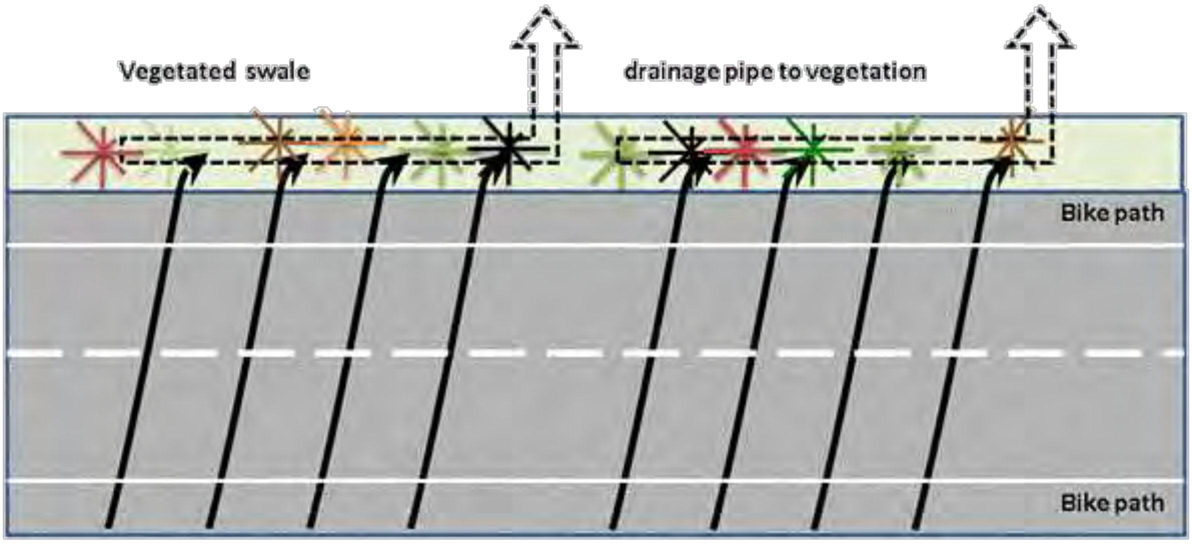

Figure 6:11 Plan of Bioretention Swale runoff and drainage collection pipes.

In some areas subsurface drainage will be required below the road surface, and will be included where applicable. For example, behind Heath Point park and close to Culvert 19 are areas of hydrological interest. The subsurface drainage will intercept the bioretention swale and be collected with the drainage pipe to discharge.

CH 1700 to 2600 Heath Point Park to North of WHA.

The stormwater from the headland currently discharges down a poorly vegetated woodland and rocky cliff onto the beach or directly into the sea. The area is predominately weathered rock and has very little infiltration. The stormwater from the road surface will be channelled by hotmix kerbs into batter chutes, where required to direct the flow to the lower level rocks to minimise erosion. The hotmix kerbs will drain frequently with turn outs positioned according to gradient in order to reduce the potential for erosion (EBR1CE-DD10-16). Due to the difficulty with the terrain and distance from the town no gross pollutant capture will be installed around Heath Point except at the Vista carpark.

At the two ephemeral streams, vegetated bioretention swales will be installed leading into the creeks on both sides of the road and will provide a pollutant removal mechanism by biofiltration, enhanced sedimentation and particle adhesion. The rock filled gabion wall at the discharge into the creek will be used as part of the bioretention basin.

CH 2600 to 4000 North of WHA to Ella Bay

Storm water from this section of the road will be treated with bioretention swales as described in the section above for *Flying Fish Point to Heath Point Park,* except for the initial short length of road to CH 2900 where the road is still elevated around the headland. To CH2900 the discharge from the road pavement will be treated as per the *Heath Point Park to North of WHA* section above.

Bioretention swales will lead into the permanent streams as described above in the *Bridges* heading.

Hydrocarbon Spill Basins

Total management of water discharge would typically require the inclusion of hydrocarbon spill basins be installed to manage the event of a tanker accident. In this case Ella Bay is a destination road and it is proposed to use LPG powered backup generation. There will also be no fuel station or heavy vehicle refuelling on site. Where possible all site based maintenance vehicle will be battery electric or LPG hybrid. Site based diesel storage required for diesel tractor etc. unable to be easily converted to LPG will be restricted to less than 5,000L and bunded. Refill frequency will be low and the risk of a day time accident is considered a low environmental risk.

Water Quality Baseline and Site Specific data

Ella Bay Road passes over two permanent creeks and twenty-two ephemeral drainage paths. The existing water quality has been monitored extensively over 4 separate catchment areas for a two year period. The water quality has been monitored both hydrologically above (representing pristine rainforest runoff) and below the unsurfaced road and compared to ANZECC Guidelines (2000) and Queensland Water Quality Guidelines (2009). Refer to Table 6.2 and Table 6.3 in which the guidelines are compared to the range of monthly readings with values that exceed the guidelines highlighted in the coloured cells.

The Undisturbed guideline (99% trigger value) represents the range of values that would be expected from pristine water courses (above the road). Values for the Field Data and Nutrients are not provided in either the ANZECC (2000) or Queensland Water Quality Guidelines (2009) for undisturbed freshwater. In this absence, the undisturbed measured values have been compared to the disturbed guidelines values. Note that in nearly all cases the range for field and nutrient has values above the Disturbed Guidelines

The Disturbed guideline (95% trigger value) represents a “slightly to moderately disturbed ecosystem”, which is listed in Queensland Water Quality Guidelines (2009) for Field and Nutrient values and the equivalent 95% trigger level in the ANZECC Guidelines (2000) for Metals (Golder, 2009). Note that nearly all the disturbed measured range exceed the disturbed guidelines.

The water quality along Ella Bay Road from October 2008 to September 2010 has been reported by consultants Golder Associates (Refer Volume 6 Report 6.4h as:

- Basic parameters – values exceeding the guidelines were found consistently at the above and below road sites associated with acidity, alkalinity, oxygen and turbidity readings. The data indicates the obvious significant visual issues of turbid waters and fine sediment deposition from road runoff caused by erosion of the roadway, table drains, cut and batters. (refer to Figure 6:3 and Figure 6:4);
- Nutrients – values exceeding the guidelines were found regularly at above and below road sites involving all forms of nitrogen, phosphorus and occasionally ammonia. This is due to the saturated nature of substrate and high levels of rainforest biomass;
- Metals – values exceeding the guidelines were found frequently at above and below road sites consisting of aluminium, cadmium, chromium, copper, nickel, lead and zinc;
- Herbicides and pesticides – Values did not exceed guidelines for a high level of assessment including organochlorines, organophosphorus and fungicides and solvents. This indicates there is no accumulation along the alignment due to current or previous weed management maintenance practices or Seahaven Prawn Farm operations; and
- Hydrocarbons – Values did not exceed guidelines for a high level of assessment including TPH, MAH, volatile compounds, halogenated benzenes and phenols. This indicates low traffic numbers and the absorbent nature of the unsealed road.

The goal will be to improve the water quality of those parameters that are caused by the impact of the road to the quality of the water discharging form above the road.

			Catchments							
					Freshwater Upland Ephemeral Drainage Paths				Freshwater Upland Creeks	
					Heath Point WHA Section		Prawn Farm Section		Ella Bay Section	
			Undisturbed Guideline 99% Protection	Disturbed Guideline 95% Protection	Undisturbed Above road	Disturbed Below road	Undisturbed Above road	Disturbed Below road	Undisturbed Above road	Disturbed Below road
Parameters	Field	pH (units)		6.0-7.5	6.6-7.6*	6.6-7.6	6.0-7.6*	5.3-7.3	5.5-7.2*	6.0-7.6
		Oxygen (%)		90-100	56-150*	48-149	44-119*	4.0-150	40-147*	39-140
		Turb (NTU)		6	0.5-52*	8-120	9-191*	6-176	0.5-58*	0.5-64
		E.C. (µS/cm)		N/A	6-61	4-64	4-74	59-2422	3-69	2-180
	Nutrients (µg/L)	Ammonia N		6	<5-140*	<5-80	<5-100*	<5-1400	<5-270*	<5-40
		Oxidised N		30	120-700*	90-580	120-480*	6-360	110-360*	<50-390
		Organic N		125	<50-1800*	<50-2600	<50-320*	170-4600	<50-1100*	<50-2300
		Total N		150	260-2200*	270-2900	440-2400*	280-6100	210-1300*	110-2600
		Reactive P		5	<5-10*	<5	<5-89*	<5-370	<5	<5-40
		Total P		10	<10-40*	<10-180	<10-800*	<10-1000	<10-30*	<10-70
	Metals (µg/L)	Aluminium	27	55	<5-100	27-209	92-7520	62-1360	<5-627	<5-694
		Arsenic	1.8	37	<0.2	<0.2	<0.2-1.0	<0.2-2.0	<0.2-0.4	<0.2-0.5
		Cadmium	0.06	0.2	<0.05-0.2	<0.05-0.2	<0.05	<0.05	<0.05	<0.05
		Chromium	N/A	1.0	<0.2-0.3	<0.2-0.4	0.2-11.3	<0.2-3.3	<0.2-0.8	<0.2-0.8
		Copper	1.0	1.4	<0.5-1.8	<0.5-3.2	<0.5-23.7	<0.5-25.9	<0.5-2.4	<0.5-2.2
		Iron	N/A	N/A	35-479	58-424	135-10800	722-2250	40-642	81-702
		Lead	1.0	3.4	<0.1-0.2	<0.1-0.3	0.1-7.6	<0.1-1.1	<0.1-0.6	<0.1-0.6
		Mercury	N/A	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Nickel	8.0	11	<0.5-3.8	<0.5-0.7	<0.5-284	0.6-2.9	<0.5-2.1	<0.5-0.7
		Zinc	2.4	8.0	2.0-42	2.0-8.0	<1.0-27	2.0-16	<1.0-15	1-13

Table 6.2 Freshwater Values for physicochemical indicators assessed along Ella Bay Road.

ella

			Catchments			
			Undisturbed Guideline 99% Protection	Disturbed Guideline 95% Protection	Middle estuary	
					Sandfly Creek (Stage 2 Bypass)	
					Undisturbed Above road	Disturbed Below road
Parameters	Field	pH (units)		6.5-8.4	5.6-6.7*	5.6-7.8
		Oxygen		80-105	15-115*	20-135
		Turb		0-10	16-133*	1-184
		E.C.		N/A	18-2123	1640-44130
	Nutrients (µg/L)	Ammonia		15	<5-43*	<5-100
		Oxidised N		30	<5-230*	<5-200
		Organic N		200	640-1200*	130-1800
		Total N		250	650-1200*	140-2800
		Reactive P		5.0	<5-20*	<5-180
		Total P		20	<10-60*	<10-580
	Metals (µg/L)	Aluminium	N/A	N/A	156-1780	20-830
		Arsenic	N/A	N/A	<0.2-0.6	<0.5-1.8
		Cadmium	0.7	5.5	<0.05	<0.05
		Chromium	7.8	31.8	0.7-2.7	<0.5-4.0
		Copper	0.3	1.3	1.0-2.3	<0.5-3.0
		Iron	N/A	N/A	493-4640	356-1630
		Lead	2.2	4.4	0.2-2.1	0.1-0.4
		Mercury	N/A	0.4	<0.1	<0.1
		Nickel	7.0	70	0.7-1.4	<0.58-1.4
		Zinc	7.0	15	1.0-26	<1.0-8.0

Table 6.3 Middle estuary values for physicochemical indicators assessed along Ella Bay Road.

Guidelines:
Undisturbed Guideline 99% Protection values for field and nutrient parameters are not reported in ANZECC (2000) nor Queensland Water Quality Guidelines (2009). Values for metals are reported in ANZECC (2000, p.3.4-5)
Disturbed Guideline 95% Protection values for Field and nutrient parameters are from Queensland Water Quality Guidelines (2009, p.64) and metal parameters are from ANZECC (2000, p.3.4-5); refer to (Department of Environment and Resource Management (DERM), 2009)
Non-compliance above road values:
*Undisturbed Above Road cells are shaded where the range for field and nutrient has values above the Disturbed Guidelines.
Undisturbed Above Road cells are shaded where the range for metals above the Undisturbed Guidelines.
N/A is to be interpreted as 'no data (nd) published' reported in the Guidelines.
Non-compliance below road values:
Disturbed Below Road cells are shaded where the range has values above the Disturbed Guideline 95% Protection.

7. Visual Values

Ella Bay Road has significant visual values along the majority of the road from Flying Fish Point to Ella Bay and encompassing the WHA of Heath Point. The alignment of Ella Bay road is located adjacent to and passes through the Wet Tropics World Heritage Area (WHA) within a sensitive visual catchment which exhibits moderate to high levels of visual sensitivity.

A Visual Landscape Assessment (VLA) (Appendix 1: *Visual Landscape Assessment Ella Bay Road*) has identified key values forming the basis of the scenic amenity;

- The rainforest canopy formed by the proximity of mature trees to the roadside;
- The corridor effect of dense roadside vegetation; and
- The extensive vistas of the Great Barrier Reef Marine Park from Heath Point park and headland

Since the report completion, Cyclone Yasi (2011) has destroyed significant canopy connectivity with the destructive winds breaking off the canopy crown of a large number of trees along Ella Bay Road. The visual character of the road alignment has been changed and will take a number of years to regrow.

Visual Analysis

The visual sensitivity of Ella Bay road was identified through fourteen viewpoints representing the existing visual experience for the road user. In summary, the visual sensitivity of the alignment is:

Stage 1

- Prawn Farm - moderately high visual significance;
- Heath Point - high visual significance; and
- Little Cove - moderately high visual significance.

Stage 2

- Flying Fish Point Bypass West - moderate visual significance; and
- Flying Fish Point Bypass East - moderately high visual significance.

The visual catchment identified four places visible externally from the road alignment. Apart from the four breaks in the visual catchment, Ella Bay Road is confined by dense rainforest and woodland.

- The road past the Seahaven Prawn Farm (CH 1000-1200). The relative sight distance to the road is between 20-200m for prawn farm employees.
- Heath Point park is visible from the ocean. The visibility of the road above the beach sand is negligible.
- The road along Heath Point Headland and vista point breaks into the visual catchment with partial views of the road cutting.
- The Stage 2 tunnel may be initially visible after construction from the GBRMP and from Flying Fish Point., but will be screened by revegetation.

Change to Visual Character

The change to Ella Bay Road alignment is discussed with detail in the VLA (Appendix 1: *Visual Landscape Assessment Ella Bay Road*). The visual characteristics have been condensed below:

- Canopy cover and tree corridor retention will remain similar. The alignment has been optimised to minimise tree clearing and guard rails have been used to protect mature trees where the evasive action envelope has been compromised (Austroads, 2003a),

- Clearing will be minimal with 0-2m along the prawn farm section and 1-4m along the Heath Point section with the wider clearing required with the cuttings around the sharp corners of the vista area;
- The Heath Point section will have a visible change to the existing road appearance with the widening of the road and increased radius corners for articulated vehicle movement and safe sight distance;
- The cassowary underpass (Bridge 1) will elevate the roadway height by 4.0m above the existing roadway, the traffic however will be below the canopy of height of the neighbouring vegetation and future revegetation and not visible externally;
- The Cassowary fence will be neutral coloured (dark grey) to blend into the vegetation and will run between 3 to 5m behind the vegetation. The cassowary fence, traffic calming and signage will be visible at the entrance to Ella Bay Road for approximately 40m where the entrance and escape gates are close to the road and visible. Occasional 10-50m partial visuals of the Cassowary Fence will be apparent at some bridges and culverts; and
- Revegetation methodology (refer to Chapter 9 *Flora Sensitive Road Design*) will focus on replacing existing weed infested batters, drains and shoulders with endemic plants designed to seal the rainforest and shield the view of the cassowary fence and revegetating exposed cutting within the visual catchment.

Landscape Integration Strategy

A landscape integration strategy has been prepared to provide safe travel for the public between Ella Bay and Flying Fish Point whilst retaining the natural visual sensitivity and catchment values. This vision will be achieved by incorporating the following objectives into road design methodology:

- Retain the corridor effect created by dense vegetation;
- Retain existing mature trees, in particular trees with canopy connectivity;
- Relocate where possible EVR flora within clearing envelope;
- Remove existing weed infestations of batters, drains and shoulders and revegetate with frangible edge closure vegetation;
- Include water sensitive design coupled with revegetation to improve roadside aesthetics and assist in weed control;
- Discrete shadecloth fencing to reduce the potential mortality of the Southern Cassowary;
- Influence the natural surrounds with a comprehensive revegetation strategy;
- Stabilisation of embankments using vegetated gabions;
- Protect the existing rainforest and woodland from edge effects; and
- Promote this 4km stretch of road as a tourist drive in conjunction with local council and WTMA.

8. Fauna Sensitive Road Design

The fauna sensitive road design of Ella Bay Road has been based on mitigation strategies which facilitate continuation of normal fauna behaviour while minimising the possibility of adverse contact with traffic and people. The strategies are designed to minimise the impact of habitat isolation by providing safe connectivity and prevent fauna access to the road and direct fauna to crossings. The mitigation strategies cover the endangered cassowary, marsupials including macropods and amphibious species including endangered stream dwelling frogs.

Monitoring - Cassowary Interaction with Ella Bay Road

Regular surveys of cassowary movement along Ella Bay Road, (Buosi, 2009b), (Buosi, 2010a), (Buosi, 2010b), (Moore, 2006), (Moore, 2007) and (Moore, 2009), local opportunistic sightings and Ella Bay's cassowary monitoring program have established a pattern of crossing areas. Some of the crossing points are regularly used and have been reported in most of the surveys while two crossing points around Heath Point Headland have only been reported in the most recent survey (Buosi, 2010b),. The surveyed crossing points are shown in Figure 8:1.

The pattern of cassowary movement along Ella Bay Road is restricted to a few individual cassowaries foraging for seasonal fruiting trees or water access on the fringe of their home ranges, between the Seymour range and the coast. According to (Moore, 2006, p. 50)

> *"Cassowary home ranges vary over time depending on environmental conditions and patterns of food abundance. Thus, the total extent of any bird's home range (i.e., that area used over a number of years) can only be determined by long-term field studies and are subject to continual change and adjustment."*

Human interaction has also attracted cassowaries to Ella Bay Road with a post Cyclone Larry EPA feeding station being placed on the eastern side of Ella Bay Road (Moore, 2006) which encouraged birds to cross the road and inhabit the area. The problem of people feeding cassowaries has also attracted cassowaries to the road. Cassowaries are sometimes seen feeding in backyards at Flying Fish Point. Human interactions are manageable and future better planning of cyclone feeding stations and continual education of people not to feed or intentionally interact with cassowaries. As an example, future feeding stations post adverse environmental events should be placed to the west away from the road alignment or adjacent to the fauna underpasses which would encourage the birds to the underpasses and fauna corridors. Feeding stations were not required post cyclone Yasi in this area.

CH 0000 to 1700 Flying Fish Point to Heath Point Park

Along this section, Ella Bay Road has been aligned along the base of the slopes to the Seymour Range and is separated from the coast by a state reserve and the prawn farm. The area of suitable cassowary habitat to the east of the range occupies a thin strip from the north of Flying Fish Point to Heath Point of about 30ha of accessible habitat in total of which the reserve occupies a little more than half. This strip is formed by the eastern slope of the Seymour Range which ascends at greater than 1:2 and is approximately 60m from the Ella Bay Road. The alignment of Ella bay Road bisects this habitat. The Seymour Range forms a bowl with the access point for the cassowaries from above Flying Fish Point to the western side of Ella Bay Road and along that side until crossing in one of two general locations (Moore, 2007), (Hogg, A, 2010) and (Buosi, 2010a) or from above Heath Point to the coast (Buosi, 2010b). Cassowary movement along Ella Bay Road tends to be movement parallel to the road within the vegetation with crossings at distinct crossing pathways. The fauna underpass has been located on a crossroad pathway.

The home range for a cassowary is reported at 2-5km² or 200-500ha (Latch, 2006) meaning that the reserve and beach front would only be a small portion of a cassowary home range. It appears that cassowaries move into this area and stay on the coastal side of the range for a period of a couple of months before moving back over the range with the change in fruiting cycle. The result is that cassowaries are regularly sighted crossing Ella Bay Road and within Flying Fish Point area. Cassowary usage of the beach is reported and access is thought to be obtained via the reserve however over the last few years only limited access to the coastal vegetation has been identified.

Two birds, an adult male (and juvenile), and a female have been monitored using the reserve (Moore, 2007), (Buosi, 2009b) and (Buosi, 2010a). A more recent cassowary sighting and potential crossing point (Buosi, 2010b) has been observed adjacent to the Heath Point park with what is believed to be the same cassowaries feeding on native olives which littered the ground at that time.

CH 1700 to 2600 Heath Point Park to North of WHA

The area around Heath point is steeply sloping woodland (RE 7.11.34) with two rainforest areas within the sheltered gullies of the creeks and the coastal vegetation on the beachfront. In general it has been observed that cassowaries (SEIS appendix 2.6) do not use the steepest slopes in this area. Refer to Figure 8:19 which has a slope analysis of the region from Flying Fish Point to Ella Bay showing the steep slopes of the Seymour Range.

Cassowaries in the most recent survey (Buosi, 2010b) have been observed travelling from the gully (waterfall) down a walking track to the beach. From here the cassowaries travel along the beach searching for coastal fruits, pandanus, sea almonds, etc.

The cassowaries have been followed partway up the embankments on the western side towards the hill top and it appears that the birds move over the top of the range to the Heath Point park feeding area or to further along the hilltop. It is not feasible to install a cassowary underpass in this location. The cassowaries use a manmade path to the beach instead of the steeply sloping stream bed. Access will be restricted by guard rail and gabion embankment on both sides of the crossing area.

CH 2600 to 4000 North of WHA to Ella Bay

From the northern border of the WHA there appears to be only one or two routes from the range down to the road and then once the lowland has been reached, the birds branch out and move along the flatter areas alongside the road. The surveyed crossing points are within the two creek banks and along the cleared logging paths and around the edge of the Little Cove property.

North of the WHA area cassowaries are also attracted to the road edges by fruiting exotics in particular mangos, with individual mango trees visited frequently while fruiting. This extends the movement range of the cassowaries more south towards culvert 18 at CH 2770.

Stage 2

The cassowary surveys of the road alignment for Flying Fish Point Bypass have observed some movement along the proposed alignment and crossing of the alignment. The proposed road will run alongside what is thought to be the pathway down to Ella Bay Road. Monitoring cameras have not been placed along this path to confirm usage. The proposed road alignment requires a tunnel through the ridge and this will maintain connectivity in this area.

Planning Mitigation - Cassowaries

Road kill is considered to be one of the main threatening processes for cassowaries in particular with regards to the significant road mortality at Mission Beach and the Daintree lowlands (Goosem, et al, 2010b). Over the last 15 years there have been 59 known adult cassowary deaths registered in Mission Beach due to road collisions (C4, 2010). The road mortality at Mission Beach is ongoing and the efforts to prevent or reduce the deaths have been largely unsuccessful in retrofitting an existing road.

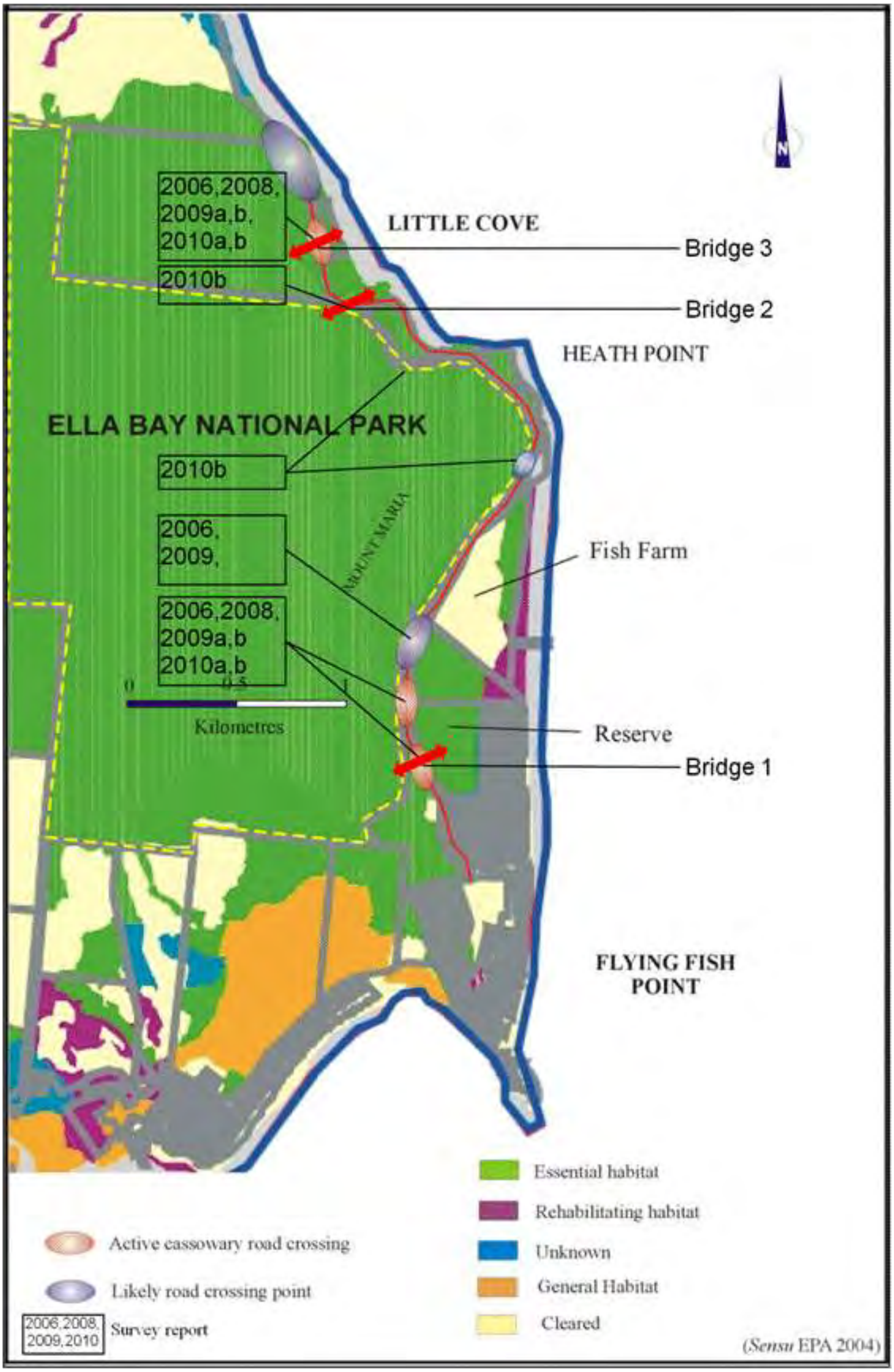

Figure 8:1 Cassowary crossing points along Ella Bay Road. (after Moore)

The mitigation measures at Ella Bay have been prepared from an integrated approach and have looked at the whole road, known cassowary crossing points and behaviour. The integrated approach has focussed on:

- Excluding the cassowary from the road;
- Excluding cassowary visibility of the roadside;
- Providing a safe crossing with attractant vegetation;
- Providing an escape mechanism if the cassowary accesses the road; and
- Slowing the traffic in case of a cassowary on the road.

This integrated methodology combines the strategies proposed for other fauna (eg Koalas) and that for cassowaries as in the latest environmental road design guides; Fauna Sensitive Road Design Vol 2, (DTMR, 2010a), Roads in Rainforest (Goosem, et al, 2010a).

Mitigation Design - Cassowary Underpasses

There will be three (3) elevated bridge structures within the road Stage 1 – Flying Fish Point to Ella Bay alignment where cassowaries and other fauna will freely move under the road. A road tunnel Stage 2 – Flying Fish Point Bypass will allow fauna free movement above the road. All structures will allow the uninterrupted movement of fauna without any interaction with road traffic. The designs of these structures are based on:

- Location: over existing cassowary corridors. Cassowaries will only be required to make minor changes to their behaviour;
- Apparent opening size: similar to bridges that have reported cassowary movement;
- Clear access without impediments;
- Light conditions: existing canopy cover maintained so the light conditions do not fundamentally change between the vegetation and the underpass; and
- Vegetation connectivity: maintaining vegetation and natural appearance within the area.

A specific cassowary underpass (Bridge 1) will be provide movement to the reserve at Flying Fish Point and additionally two cassowary underpasses (Bridge 2 and 3) will be installed at the creeks in Little Cove.

The location of bridge 1 has been determined from the surveys and monitoring at the most southern crossing point identified as regularly used by cassowaries. Moore and Buosi have identified and inferred cassowary crossing areas within the Ella Bay Road alignment (Moore, 2006), (Moore, 2009), (Buosi, 2009b), (Buosi, 2010a) and (Buosi, 2010b). The site is also favourable for elevation with the centre of the bridge located over a natural dip and an existing pipe culvert.

> *"Along the access road a fauna crossing opposite the reserve is to be constructed as a raised bridge that cassowaries can cross beneath. The road can then be fenced both sides and birds can be funnelled into it - we would only need the one road crossing point. This mitigation strategy would remove ALL the current risk for road crossing birds at the reserve, and raise the reserve's habitat value significantly."*
>
> L.Moore pers.comms email 9.10.2007

Bridges 2 and 3 are located over creeks where the bridge could be elevated above the hydrological requirements sufficiently to satisfy cassowary use. The two creeks have been regularly monitored for cassowary use with cassowaries often using the old logging tracks along both creeks.

Refer to drawing EBR1CE-PD08 and EBR2CE-DD(01-08), EBR1CE-DD(01-22) for the location of the bridges.

There are no known structures that have been specifically designed and have been successful for cassowary use. The apparent opening size has been the subject to much debate with various arguments over sizes and whether culverts would be suitable. A wide Bebo arch culvert was proposed in the SEIS for the cassowary underpass at Bridge 1 location. A number of respondents of a proponent questionnaire to researchers have reported that they have seen or it has been reported to them that cassowaries have used culverts, however to resolve the issue a workshop of stakeholders and cassowary experts (Ella Bay, 2008) was held by the proponent in Cairns on November 2008 where the argument concluded that the size of the underpass should be that which could be proved to be used by cassowaries, for example, North Hull Bridge.

The proponent surveyed both culverts and bridges in the area and confirmed that two bridges near Mission Beach; North Hull Bridge and Wongaling Bridge are used by cassowaries. Refer to Volume 6 of the Ella Bay Submission Response 6.1h *Cassowary Underpass Survey 2008, 2009.* The general dimensions of these bridges were:

- height at crossing point - 3.5 to 4m; and
- span of passage between abutment and stream: 10 to 15m.

The bridge dimensions have been applied to the 3 bridge underpasses and a minimum height of 3.5m and minimum span of 10m used. Each bridge because of location has a slightly different specification:

- Bridge 1 CH 0426 – 0451 15m x 3.5m;
- Bridge 2 CH 2981 – 3011 30m x 3.7m; and
- Bridge 3 CH 3227 – 3257 30m x 5.1m.

Light conditions and vegetation connectivity have been shown to be not important as to whether cassowaries use the underpasses. In the (Volume 6.1h Cassowary Underpass Survey) both bridges did not have attractant or camouflaging vegetation but the distinguishing characteristic was that the bridges were aligned with a clear visual pathway. (Refer to Figure 8:2)

Figure 8:2 Wongaling Creek Bridge Nov 2008.

The three bridge underpasses on Ella Bay Road will allow a clear pathway. At Bridge 1 minor clearing on the western approach will be required to satisfy this requirement.

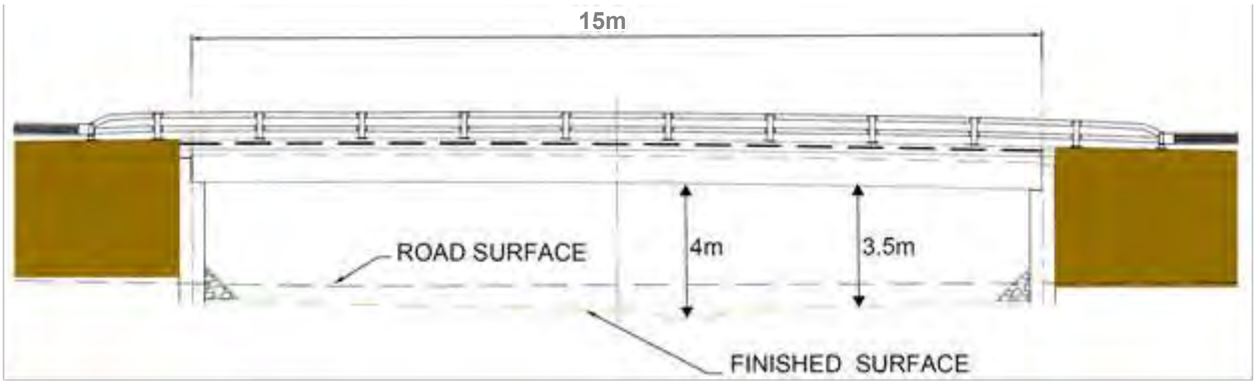

Figure 8:3 Cassowary Underpass Bridge 1.

The selection of vegetation will then be important to ensure that the visual opening will be maintained whereas the choice of adding cassowary attractant vegetation as recommended in

Goosem (Goosem, et al, 2010a) would appear to be not so critical. However, cassowary attractant vegetation will be included in the surrounding area to the bridge to reduce the transition time for cassowaries to use the bridge after construction (Refer to 9 *Flora Sensitive Road Design*).

Mitigation Design - Cassowary Fence, Barriers and Escape Gate

An effective method of excluding cassowaries from the road will be required to integrate with the underpasses to provide the most comprehensive mortality risk avoidance. The cassowary fence and barriers will be required to prevent the cassowary both visually and physically. Wire mesh or open mesh cyclone fences are the standard fauna exclusion fence types, however this fence type has had poor results with cassowaries. The birds are reported to be stressed trying to push through what is probably seen by them as a clear visual path, and rub up along the fence for hours trying to push through (C4, 2009) and injuries have also been reported (Goosem, et al, 2010b).

The fence material selected was shadecloth, both as a visual barrier and as a softer resilient barrier. Observations of captive cassowaries accustomed to cyclone fences where the birds are observed to push against the fence and move along beside the fence, produced totally different results for shadecloth with the birds not trying to test the fence even when food was placed on the other side, preferring to move directly to a visual position (refer to Volume 6 of the Ella Bay Submission Response 6.1i *Cassowary Gate Trial*). The fence was also effective as an injury reduction barrier with a bird on one occasion being startled and running into the fence and bouncing backwards from the taut material.

The fence was decided as requiring a height of 1.8m and would be a nominal 100mm from the ground at the proponent's Stakeholders workshop (Ella Bay, 2008). It was also concluded that cassowaries rarely use steep slopes greater than 1:1 and fencing would not be required in these areas.

The fence will be located 3m to 12m within the vegetation parallel to the road alignment and within the road reserve. The fence will not be installed where the road edge and surrounding slopes are greater than 1:1 or where the embankment is vertically greater than 1.5m e.g. gabions walls. Other barriers such as guard rails and noise fences where installed will provide an exclusion function where the above conditions are met.

The fence will be required to perform in a difficult environment of the wet tropics within rainforest vegetation in cyclone prone area. The design, installation and maintenance will be required to overcome the major risks of;

- Branches from trees and shrubs dropping on the fence;
- Cyclonic conditions with damage from intense winds and debris;
- Fauna chewing and ripping the fence; and possibly
- Bushfire.

A shadecloth material will be neutral coloured (dark grey) to blend into the vegetation and will have a shade factor of greater than 40% will be used to restrict the visibility of the animals through the fence and provide a significant differential appearance between the fence and the escape gates. The shadecloth will also restrict headlight disturbance within the rainforest. The shadecloth material will be 1.8m high and comprise a sleeve at the top and bottom to which a high tension wire runs. The fence will be tensioned from a strainer assembly with the lower wire tensioned to exclude fauna from lifting up the lower edge of the fence with a nominal 100mm gap and the upper wire tensioned to maintain the fence without sag. The fence will run in panels of up to 300m with typical post spacing of 5m to 10m depending on topography.

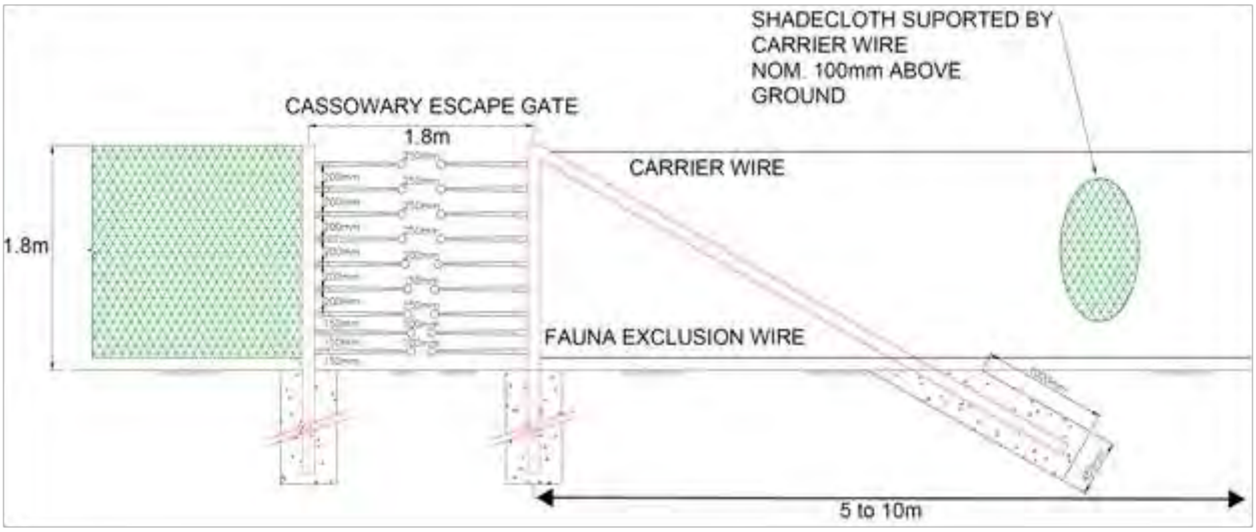

Figure 8:4 Cassowary fence details from Dwg. EBR1CE-DD42.

Cassowary Fence Trials

A trial fence was designed and tested by installing the fence at Ella Bay to exclude wallabies from revegetation. The fence was designed for branch impact and tested in cyclonic conditions. Refer Volume 6 of the Ella Bay Submission Response 6.1j *Cassowary Fence Trial 2010.*

The fence design concept is to stretch the shadecloth between an upper carrier wire and a lower exclusion wire with long spans to be able to wind through the vegetation with little clearing or pruning.

Figure 8:5 Trial Cassowary Fence at Ella Bay Revegetation Site. The Ella Bay fence will be dark grey.

To provide resilience to branch strike the top carrier wire was held in place by shear clips at each post. The clips were designed to fail and release the wire should a branch or similar debris drop from above with force. In the event that a number of clips fail and drop the wire, the tension on the carrier wire was sufficient to maintain that section of fence erect with tolerable sag levels. The clips design also allowed for the wire to be easily re-clipped in place by hand. The wire used during Ella Bay's fence design and trial was a high tensile wire requiring a force equivalent to a static load 1600kg falling on the wire to break it, therefore the wire's probability of breaking is reduced and debris should brush off the fence.

The failure of shadecloth structures is common in cyclone prone areas and research has established that the shadecloth acts as an apparent solid sheet to high winds with little relief from the open weave (Letchford, Row, Vitale, & Wolbers, 2000). It is neither practical nor desirable to construct the fence to withstand a severe cyclone within the confines of the vegetation without substantial interference and clearing of the vegetation. For such a design the requirement would 100mm steel posts at closer than 3m spacing concreted in to a depth of 1m and shadecloth to be permanently fixed to posts. This would be too invasive to the vegetation, in particular tree roots and create extensive forest interior weed colonisation due to the extra clearing.

Figure 8:6 Cassowary shear clip assembly.

A valid engineering solution is to provide a design with a management procedure for extreme conditions. To minimise the damage impact to the fence and reduce the repair costs and downtime of the fence for cyclone events, the construction of the fence has allowed for an operating design procedure where the top carrier wire can be manually removed from the clip and relocated with the lower exclusion wire where both wires will be held together and thereby reducing the threat of damage to the fence. The shadecloth fence will be effectively folded down to the ground and the shade cloth material tied every 2-3m in between posts by use of cable ties or similar to keep it rolled up and safe from damage.

The fence will only be pulled down immediately prior, during and immediately post adverse weather events. (Moore, 2009) has indicated that following cassowary surveys at Ella Bay area in February 2008, that cassowaries relocate during the extreme wet season to higher ground on the Graham Seymour Range, and this may be tied to cyclonic threat (Buosi, 2009b) this would significantly reduce the risk of interaction. However additional traffic management procedures will be required to minimise the risk of cassowary vehicle strike while the fence is down, such as temporary warning signs will be used identifying that the fence has been temporarily removed and the vehicle speed limit reduced to 40km/hr.

Post Cyclone Larry which hit the Innisfail region in March 2006, it was observed that cassowaries had wider foraging habits and an increase in cassowary-human interactions (also due to feeding stations being close to town and roads) was evident. There was a significant reduction in food sources and with forest destruction covering of many cassowary paths some cassowaries were found to be using roads as paths in search of food, which dramatically increased chances of accidents with vehicles. Post Cyclone Yasi 2011 the debris alongside the road was cleared by CCRC within 4 days and cassowaries were seen to be frequenting backyards within that period. It should also be noted that there have only been 4 cyclones greater than category 4 in the past 100 years, 2 of which have been in the past 5 years.

With this in mind, reinstatement of the fence will be a high priority post cyclone events. Initially, the debris will be removed from fence area to facilitate the erection where the fence top carrier wire will be placed in clips and inspected for damage. The fence's design will allow for the damage to be repaired locally by either replacing entire sections of the fence from strainer assemblies or only repairing small sections by cutting the wires, threading a new shadecloth section and rejoining the wire using a mechanical wire joiner and sowing the replaced shadecloth. Damage to the tensioning assemblies will be a low risk unless by direct tree strike.

A bushfire is a low risk in the rainforest and were this to occur in the fenced area, the same procedures detailed above will be implemented to minimise damage.

Cassowary One Way Escape Gate Design

One of the issues with fencing the roadside is that if there is a breach of the fence exclusion by a cassowary the bird will become trapped within the fenced area. An escape mechanism has been trialled for cassowaries at Mission Beach (Goosem, et al, 2010b) which comprises a series of funnels to allow cassowaries to re-enter behind the fence. Research in the US and Canada (Sielecki, 2005) (Huijser, et al., 2007) on deer has focussed on one way finger escape gates similar to spear gates used with wild cattle in Australia.

The proponent has developed and trialled a one-way gate system designed for a cassowary which allows passage from inside the road enclosure back to the forest, but blocks entry to the road enclosure (refer Volume 6 of the Ella Bay Submission Response 6.1i *Cassowary Gate Trial*.) The gate was designed specifically for cassowaries with pliable spring loaded HDPE fingers. The fingers of the cassowary gate were fabricated from UV stabilised High Density Polyethylene (HDPE), which was smoothly cut and rounded to avoid any sharp edges that could snag, and featured an integral ball end to prevent impalement.

The escape gate was developed and successfully trialled with captive cassowaries at the Johnstone River Crocodile Farm. The cassowaries used the gate regularly for an extended period with no injuries and no wrong way entries. The gate has also proved effective with the removal of wallabies from the Ella Bay revegetation enclosure.

Figure 8:7 Cassowary one way Escape Gate.

The gate was constructed to fit inside the 1.8m cassowary fence and provide a visual window of 1.8m x 1.5m in contrast to the shadecloth fence and therefore creating a visual opening for the cassowaries. Of particular note was the success of the visual window, as applications of this type of escape gate in the USA and Canada were typically set within a chainwire exclusion fence, where visual differentiation of the location of the gate by fauna was poor.

Figure 8:8 Wallaby using the Escape Gate.

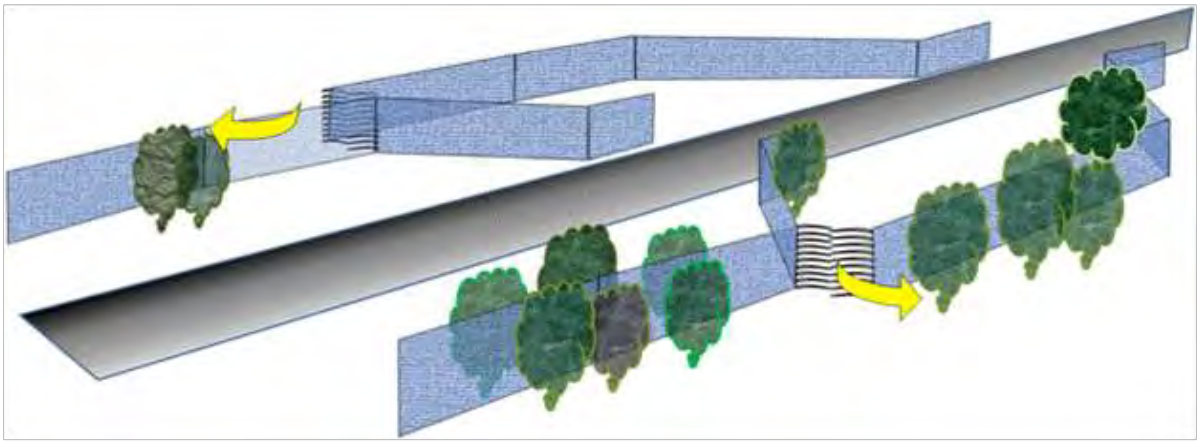

Figure 8:9 Proposed installation of cassowary escape gate at road entrance. Vegetation would be strategically placed to camouflage the fence.

The escape gates will be located at critical locations along the fenced section of the road. Refer to drawings EBR1CE-PD08 and EBR2CE-DD(01-08), EBR1CE-DD(01-22) for locations of the escape gates.

Other Barriers

Along the road alignment there are other barriers that will exclude the cassowary from the road.

Gabions and natural cut embankments will exclude the cassowaries from sections of Heath Point Headland. The gabions will be near vertical barriers of rock, whereas the natural cut embankments will be 1:1 when cut in weathered rock. The height and lack of footholds will exclude cassowaries from entering the roadway from above.

Guard rails will be placed where there is a significant risk to the motorist (refer to Chapter 5 Road Design and Design Criteria) and while the guard rail will not be sufficient as an exclusion fence, the combination of the guard rail and the embankment requiring the guard rail will be sufficient for exclusion. The location of guard rails will be based on the DTMR Severity Index and if required for specific addition to increase cassowary exclusion.

The Sea Haven Prawn Farm has a cyclone mesh property boundary fence. While the fence is not desirable as a cassowary fauna fence the fence has been erected for 30 years and separates a cleared area that has no attractant vegetation. This fence will be renewed in its current location as part of the road upgrade. The fence will form the eastern exclusion barrier in that section of road. The fence will be covered with shadecloth subject to approval of Sea Haven.

The stage 2 Flying Fish Point Bypass road will include a noise barrier fence on the eastern side of road between the tunnel and Ruby Street. The noise barrier will be a 2m high solid structure which will provide effective cassowary exclusion.

Mitigation Design – Fauna Overpass

The fauna overpass will be constructed in stage 2 of the Flying Fish Point Bypass. The overpass will be 90m wide and located on the Seymour Range behind Flying Fish Point. The fauna overpass will be a road tunnel under the range with fauna moving across the vegetated cover of the tunnel. The tunnel will be either a bored tunnel or cut and cover tunnel depending on the geotechnical properties of the underlying strata of the range. With a cut and cover tunnel the overpass will be revegetated providing connectivity to fauna to the area above Flying Fish Point.

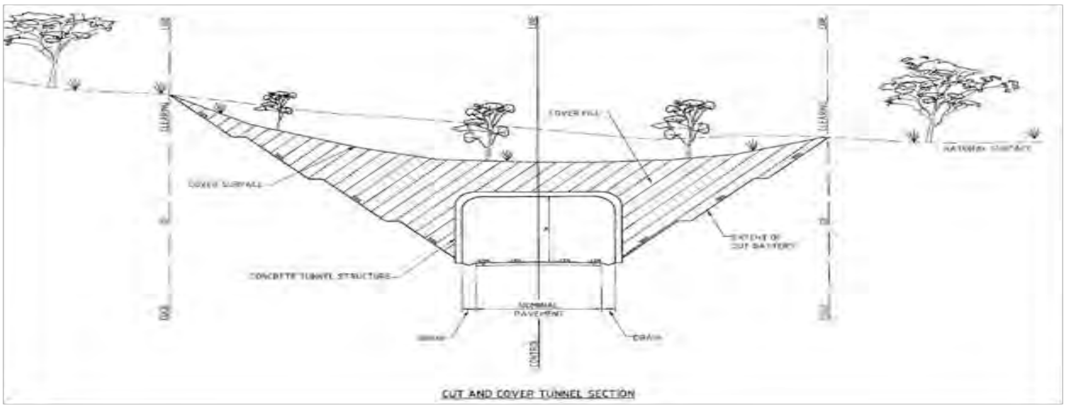

Figure 8:10 Fauna Overpass Flying Fish Point Bypass.

Monitoring - Other Fauna

A fauna survey was completed in 2008 along the road alignment (BAAM, 2008b) (Volume 6.3a). The EVR and Endangered fauna reported during the survey are presented in Figure 8:11 and Table 8.1.

	Zoological Name	Common Name	NCA Status	EPBC Status
FROGS				
CH 3000	Litoria genimaculata	New Guinea Tree Frog	Rare	
CH 2400	Litoria rheocola	Common Mist Frog	Endangered	Endangered
CH 2400, 3000	Cophixalus infacetus	Inelegant Frog	Rare	
REPTILES				
CH 1700	Crocodylus porosus	Saltwater Crocodile	Vulnerable	Migratory
CH 2400, 3250	Eulamprus tigrinus	Yellow-blotched Forest-Skink	Rare	
BIRDS				
CH 630, 3000,3250	Casuarius casuarius	Southern Cassowary	Endangered	Endangered
CH 2400	Accipiter novaehollandiae	Grey Goshawk	Rare	
CH 3000	Cyclopsitta diophthalma macleayana	Macleay's Double-eyed Fig-Parrot	Vulnerable	
MAMMALS				
CH 000 Stage 2, CH 3000	Pteropus conspicillatus	Spectacled Flying-fox	Least Concern	Vulnerable

Table 8.1 Fauna reported along Ella Bay Road.

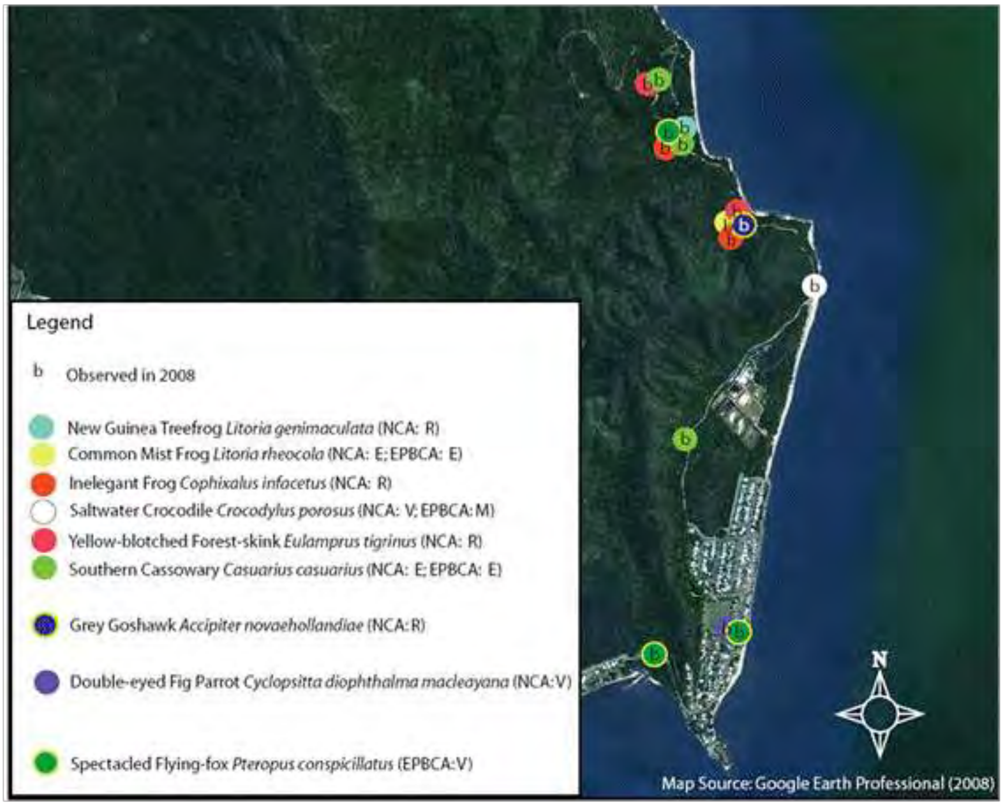

Figure 8:11 Location of Fauna reported along Ella Bay Road.

In the survey of Ella Bay Road no arboreal species were found (BAAM, 2008b), however a Striped Possum *Dactylopsila trivirgata* was found on Ella Bay development site, indicating that arboreal mammals may be present in limited numbers.

Planning Mitigation – Other Fauna

The location of fauna underpasses has been determined both by hydrological requirements and by the location of fauna hotspots.

- The three bridge underpasses, which will allow cassowaries, macropods, and amphibious, understorey, and ground dwelling fauna. Two of the bridge underpasses will be located on permanent streams. One of these (bridge 2) will replace two pipe culverts and enable free passage of aquatic and amphibious fauna by replacing the high flow culverts. The bridge will also allow repair of the stream bed where the discharge of the pipes have created an impact hole.
- One fauna overpass for cassowaries, macropods, understorey and ground dwelling fauna. The fauna overpass in stage 2 will allow normal movement of all fauna over the road tunnel;
- Four purpose built underpasses for macropods, understorey and ground dwelling amphibious and aquatic fauna (refer to *Small Fauna Culverts* below);
- Replacement of the 22 existing pipe culverts with larger box culverts to allow under road crossing by reptiles and amphibious fauna. The culverts will not be specific fauna culverts but standard box culverts and provide a close spacing of access.

Arboreal fauna was not reported in the fauna survey (BAAM, 2008b) and it is considered that the installation of canopy bridges is not warranted as part of the road fauna mitigation. Goosem (2008) recommends the provision of canopy connections in areas of high concentrations of arboreal species or where threatened or rare arboreal mammals occur, as well as in areas where high levels of arboreal mammal road kill occurs. The road will be surveyed post construction and canopy bridges will be installed if justified.

Mitigation Design – Small Fauna Culverts

The small fauna culverts will be purpose designed with elevated dry fauna ledges for safe passage of fauna during wet periods. Each culvert has different requirements, but the basic design will consist of:

- The culverts will be for macropods, amphibians, understorey and ground dwelling fauna. The small fauna culverts will not be designed for cassowaries;
- A minimum culvert height of 1.2m selected as the required height for the agile wallaby (Taylor & Goldingay, 2003);
- Two dry ledges, one 1m wide ledge and one elevated narrow ledge (refer to Figure 8:12 and Figure 8:13). The elevated ledge will be constructed from Besser blocks which will provide a rough easily climbed surface, with hiding and escape holes under the ledge and will be resistant to termites and white tailed rats. The elevated ledge will have a ramp of cut blocks to the ledge height. (Culvert 15 CH 2170 will not have a fauna ledge)

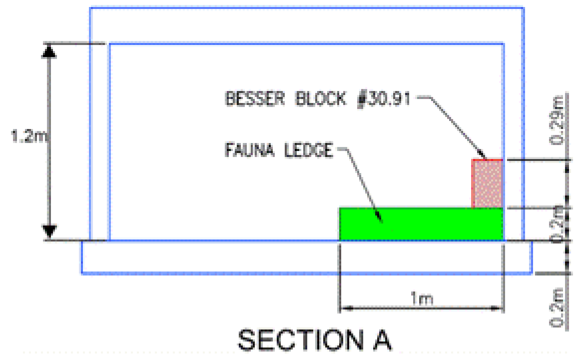

Figure 8:12 Cross section showing two fauna ledges.

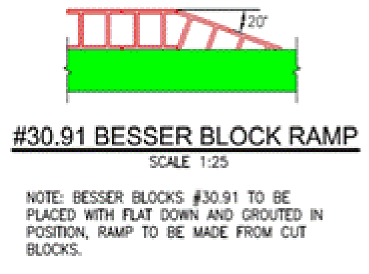

Figure 8:13 Dry ledge ramp of Besser block.

The culverts will be installed at;

- Culvert 3. CH 0635. (Figure 8:14)The location is over an ephemeral drainage path, and is aimed at connectivity between the WHA and Flying Fish Point reserve. The water that is collected in the western table drains flows through the culvert to the east. The water flows from springs and soaks on the west creating a drainage path that flows for the wet season and part of the dry season. The design will allow sedimentation within the culvert floor. Ramps will be required on both ends of the fauna ledges to allow dry access to land. Rock riprap will used to slow the water velocity on the discharge from the culvert. Mature trees are located on both sides of the culvert creating shade. The cassowary fence will run behind the trees and funnel fauna to the culvert entrance;

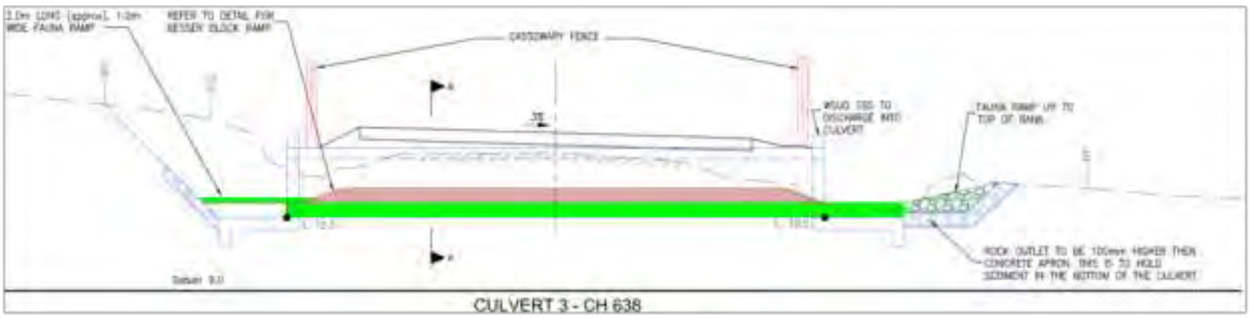

Figure 8:14 CH 0635 Fauna culvert long section showing location of ledges, ramps and rock protection

- Culvert 15. CH 2170. (Figure 8:15). This location is over an ephemeral stream in the rainforest gully of Heath Point Headland (RE7.11.1a). The stream flows strongly during rainfall events but dries out quickly. The stream bed currently flows through pipe culverts and discharges from the end of the pipe into an erosion hole with a >1m fall. The culvert will be designed with large rocks to slow the flow and prevent further erosion. Fauna will be able to access over and around the rocks. This ephemeral stream is unlikely to be a location of endangered stream dwelling frogs. Frog fences will be installed to funnel frogs to the culvert;

Figure 8:15 CH 2170 Fauna Culvert long section showing rocks to retard stream velocity.

- Culvert 16. CH 2400. (Figure 8:16 and Figure 8:17) This location is over an ephemeral stream in the rainforest gully of Heath Point Headland (RE7.11.1a). The stream has a greater catchment than CH 2170 and has a waterfall providing a higher humidity. An endangered Common Mist Frog *Litoria rheocola* was reported by (BAAM, 2008b). Frog fences will be installed to funnel frogs to the culvert. The western surrounding slopes have a lower slope than the headland (woodland) and this creates a natural funnelling of fauna to this area. Cassowaries (male, chick and female) were reported here in the November 2010 Cassowary survey (Buosi, Cassowary survey November 2010, 2010b). This culvert will not be for cassowaries and barrier fencing on the western side will prevent cassowaries from accessing the beach. The stream will be slowed by large rocks and additional blind culverts will be placed on the eastern side. These will be filled with rock scree and provide habitat. The upper surface of the blind culverts will be roughened to enable bat roosting

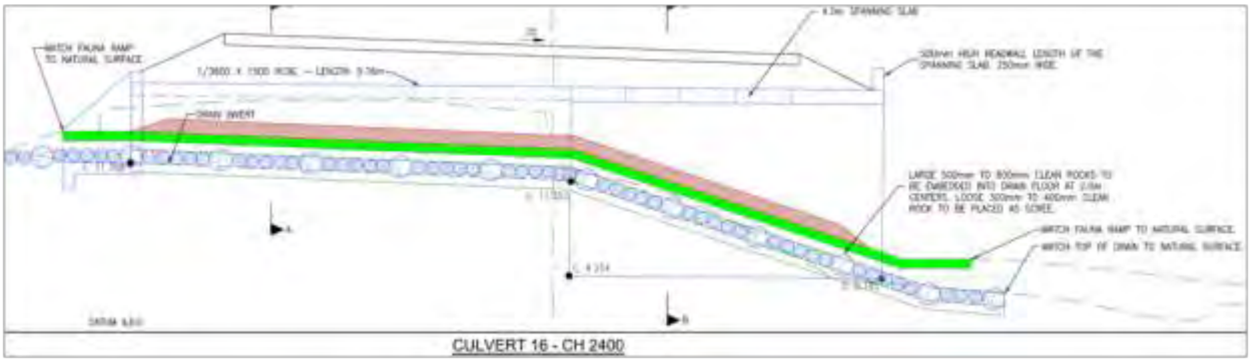

Figure 8:16 CH 2400 Fauna culvert long section showing location of ledges and rocks to retard stream velocity.

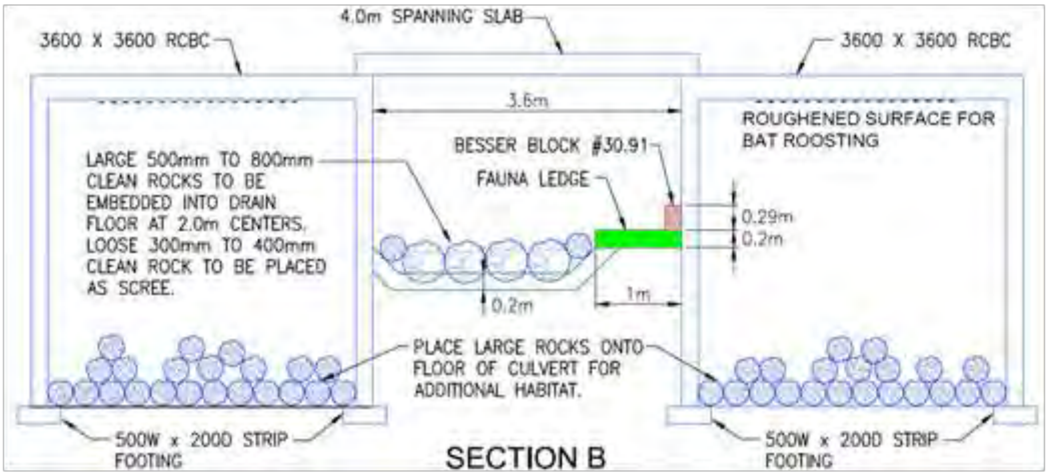

Figure 8:17 CH 2400 Fauna culvert cross section showing scree and fauna ledges.

- Culvert 20. CH 3123. This location is over an ephemeral drainage path, and is aimed at connectivity within Little Cove. The cassowary fence will funnel fauna to the culvert entrance. The culvert will be for macropods, understorey and ground dwelling fauna. The design of the culvert will be the same as for Culvert 3 CH 0635.

Frog-Exclusion Fencing

The frog fence will exclude frogs from the road and direct frogs to the fauna culverts. The target species is the endangered stream dwelling frogs likely to occur in the streams crossing the road. An endangered Common Mist Frog (*Litoria rheocola*) was reported by (BAAM, 2008b) at culvert 16 CH 2400.

Some species of stream dwelling frogs are nocturnal wanderers with recorded travels up to 95m in one night returning to the same stream during the day (Rowley & Alford, 2007) The medium distance travelled is much less while the horizontal distance from the stream is again much reduced. Medium horizontal distance from stream is less than 2m.

Stream dwelling and tree frogs of the wet tropics are typified with adhesive toe pads and are able to adhere to wet or overhanging surfaces. This is especially present in the tree frogs which are able to stay gripped to overhead leaves and branches. Torrent Tree Frogs (*Litoria nannotis*) are able to stick to wet rocks under a stream of water. The ability of stream dwelling frogs to stick to wet surfaces also enables the frogs to climb trees. The mechanism for the ability of the frog to stick to wet and overhanging surfaces is known to be wet adhesion of a secreted mucous under the toe pad (Hanna & Barnes, 1991). Research on stickiness of frog adhesion has only been reported for non-endemic tree frog species and the application to Wet Tropic frogs can only be taken as similar adhesion mechanism (Emerson & Diehl, 2008) (Persson, 2007) (Federle, Barnes, Baumgartner, Drechsler, & Smith, 2006) (Hanna & Barnes, 1991).

The frog fence will require a rough non-adhesive and dry type surface vertical component of sufficient height to minimise the risk of the frogs jumping over the fence. The mechanism of wet adhesion breaks down on dry surfaces and where the roughness of the material is sufficient to interrupt the multi cell toe pads. An overhanging lip is critical to a frog barrier to prevent the frogs from climbing using their sticky/adhesive pads and the inverted position increases the likelihood of adhesion break down.

The fence style chosen was based on the Tugun bypass and information contained in DTMR's Fauna Sensitive Road Design Manual (2010). A height of 600mm was chosen as being suitable based on anecdotal information. Most frog fences are built to 400mm in height. Information on frog jumping height is limited, and the use of frog-exclusion fencing combined with culverts is considered to be still in its investigational stage for frogs of the Wet Tropics.

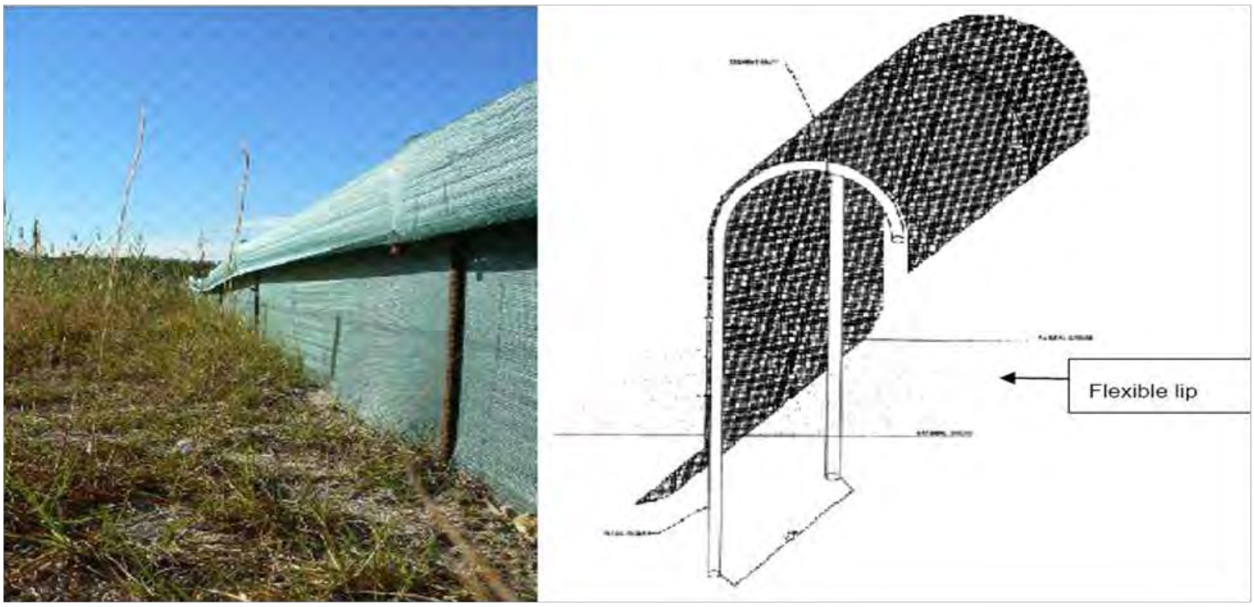

Figure 8:18 Frog fence design. Source: (DTMR, 2010a).

Frog fences will be located at streams which have been identified as likely frog habitat areas and extend along the road alignment for 25m either side. The fence locations are identified in drawings EBR1CE-DD12 - 13, 16 - 18.

Location of Fauna Sensitive Road Design Elements

The table below is a summary of the entire cassowary and fauna mitigation measures design along the proposed Ella Bay Road alignment. For the details and locations refer to drawings: EBR1CE-PD08 and EBR2CE-DD(01-08), EBR1CE-DD(01-22) and detail drawings EBR1CE-DD(30-33) & EBR1CE-DD(40-42).

Location	Western Chainage	Structure	Eastern Chainage	Structure
EBR Road Reserve CH 0000 - 1042	0000 - 0110	Existing Residences	0200	Speed Sign
	0200	Speed Sign	0140– 0385	Cassowary fence
	0090	Wildlife Sign & Speed Hump	0110	Cassowary Gate
	0100 - 0385	Cassowary fence	0190	Wildlife Sign & Speed Hump
	0110	Cassowary Gate	0380	Cassowary Gate
	0380	Cassowary Gate	0380 – 0425	Retaining Wall
	0380 - 0425	Retaining Wall	0425 - 0450	Fauna Underpass Bridge 1
	0425 - 0450	Fauna Underpass Bridge 1	0450 – 0530	Retaining Wall
	0450 - 0525	Retaining Wall	0510	Cassowary Gate
	0510	Cassowary Gate	0510 – 0810	Cassowary fence
	0510 - 1042	Cassowary fence	0640	Fauna Culvert
	0640	Fauna Culvert	0695	Cassowary Gate
	0695	Cassowary Gate	0805 – 1042	Existing Fence Seahaven Prawn Farm
WHA Zone C CH 1042 - 2600	1042 - 1750	Cassowary fence	1042 – 1500	Existing Fence Seahaven Prawn Farm
	1750	Cassowary Gate	1500 – 1610	Cassowary fence
	2140 – 2200	Frog Fence	2140 – 2200	Frog Fence
	2170	Fauna Culvert	2170	Fauna Culvert
	2370 - 2420	Frog Fence	2370 - 2440	Frog Fence
	2395	Fauna Culvert	2395	Fauna Culvert
	1750 - 2600	Retaining Walls	1605 - 2600	Steep Descent & Retaining Walls
Esplanade CH2600 - 2950	2600 - 2820	Retaining Walls	2600 - 2850	Steep Descent & Retaining Walls
	2760 - 2950	Cassowary fence	2850 - 2950	Cassowary fence
	2950	Cassowary Gate	2950	Cassowary Gate
Little Cove CH 2950 -3665	2950 – 2980	Retaining Wall	2950 – 2980	Retaining Wall
	2960 – 2980	Frog Fence	2960 – 2980	Frog Fence
	2980 - 3010	Fauna Underpass Bridge 2	2980 - 3010	Fauna Underpass Bridge 2
	3010 - 3020	Retaining Wall	3010 – 3030	Retaining Wall
	3010 – 3040	Frog Fence	3010 - 3040	Frog Fence
	3015	Cassowary Gate	3025	Cassowary Gate
	3015 - 3215	Cassowary fence	3025 - 3190	Cassowary fence
	3120	Fauna Culvert	3120	Fauna Culvert
	3205 – 3230	Frog Fence	3190 – 3230	Retaining Wall
	3210 - 3230	Retaining Wall	3195	Cassowary Gate
	3215	Cassowary Gate	3200 - 3230	Frog Fence

Location	Western Chainage	Structure	Eastern Chainage	Structure
	3230 - 3260	Fauna Underpass Bridge 3	3230 - 3260	Fauna Underpass Bridge 3
	3260 - 3270	Retaining Wall	3260 - 3270	Retaining Wall
	3260 – 3270	Frog Fence	3260 – 3270	Frog Fence
	3265	Cassowary Gate	3265	Cassowary Gate
	3265 - 3620	Cassowary fence	3265	Cassowary fence to creek
	3600	Cassowary Gate		
	3620 - 3665	Steep ascent		
Esplanade CH 3665 - 4010	3665 - 3990	Steep ascent		
	3970	Wildlife Sign & Speed Hump	4020	Cassowary Gate
	3990 - 4010	Cassowary fence	3995 – 4010	Cassowary fence
Ella Bay from CH4010	4010	Ella Bay Cassowary fence	4010	Ella Bay Cassowary fence
	4010	Cassowary Gate	4060	Wildlife Sign & Speed Hump

Table 8.2 Stage 1: All fauna mitigation by chainage.

Ella Bay Road Stage 2 Flying fish Point Bypass				
Location	Western Chainage	Structure	Eastern Chainage	Structure
Alice Street Road Reserve CH 0000-0350	0030 - 0060	Retaining Wall	0030 - 0330	Retaining Wall
	0040	Wildlife Sign & Speed Hump	0120	Wildlife Sign & Speed Hump
	0060- 0290	Cassowary Fence	0330 – 0420	Cassowary Fence
	0080	Cassowary Gate		
	0290	Cassowary Gate		
	0290 - 0350	Retaining Wall	0330	Cassowary Gate
State Land USL CH 0350 - 0790	0350 - 0430	Retaining Wall		
	0430 - 0450	Cassowary Fence		
	0440	Cassowary Gate	0420 - 0440	Retaining Wall
	0440 - 0465	Retaining Wall		
	0465 - 0585	Fauna Overpass Tunnel	0440 – 0560	Fauna Overpass Tunnel
	0585 - 0595	Retaining Wall	0550 – 0680	Retaining Wall
	0595 - 0790	Cassowary Fence	0560 – 0790	Noise Attenuation Fence
Road Reserve CH 0790 - 0940	0790 - 0910	Cassowary Fence	0800 – 0930	Cassowary Fence
	0800	Cassowary Gate	0795	Cassowary Gate

Table 8.3 Stage 2: All fauna mitigation by chainage.

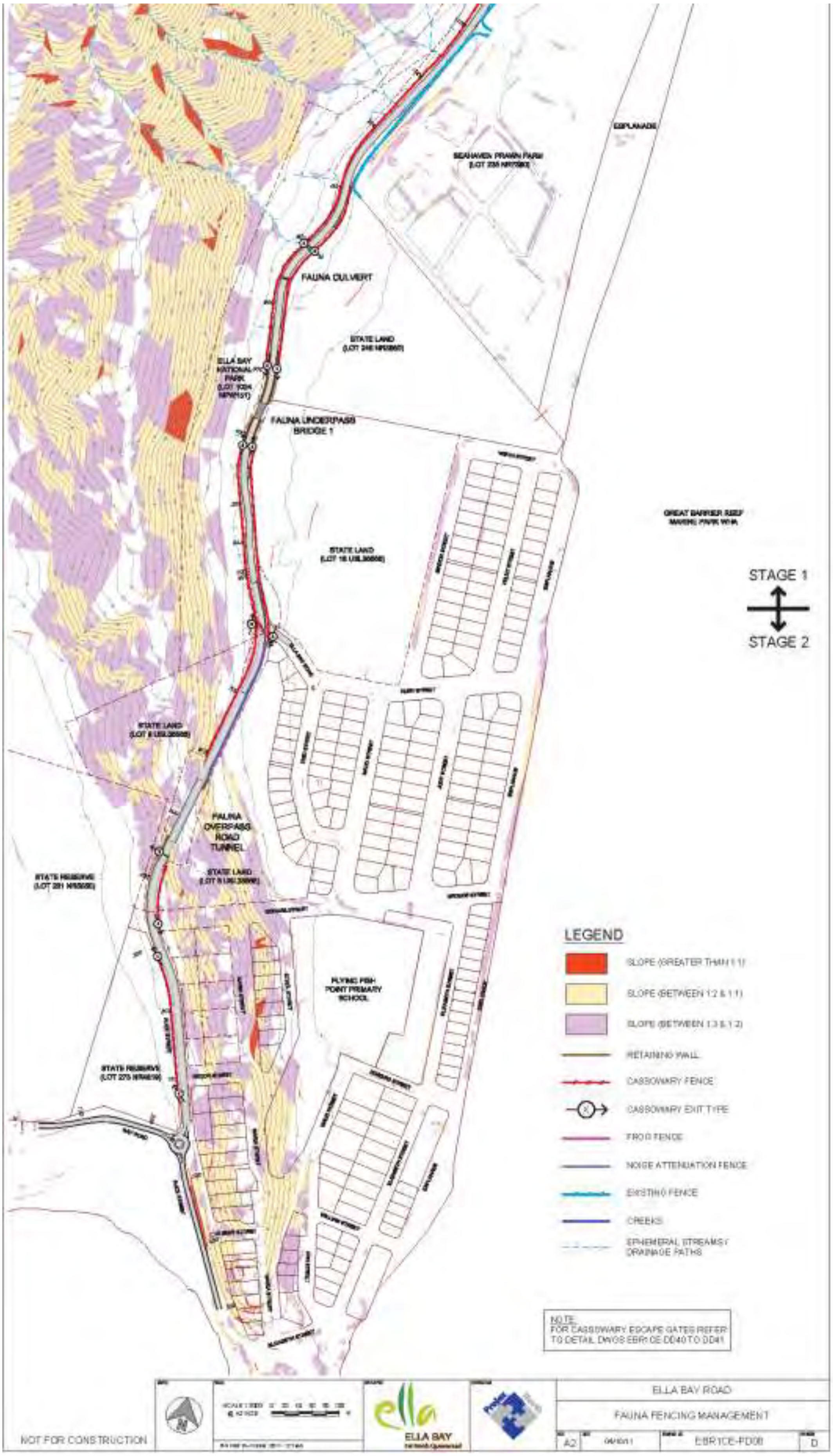

Figure 8:19 Fauna Mitigation Design Ella Bay Road Alignment Dwg. EBR1CE-PD08 (part 1).

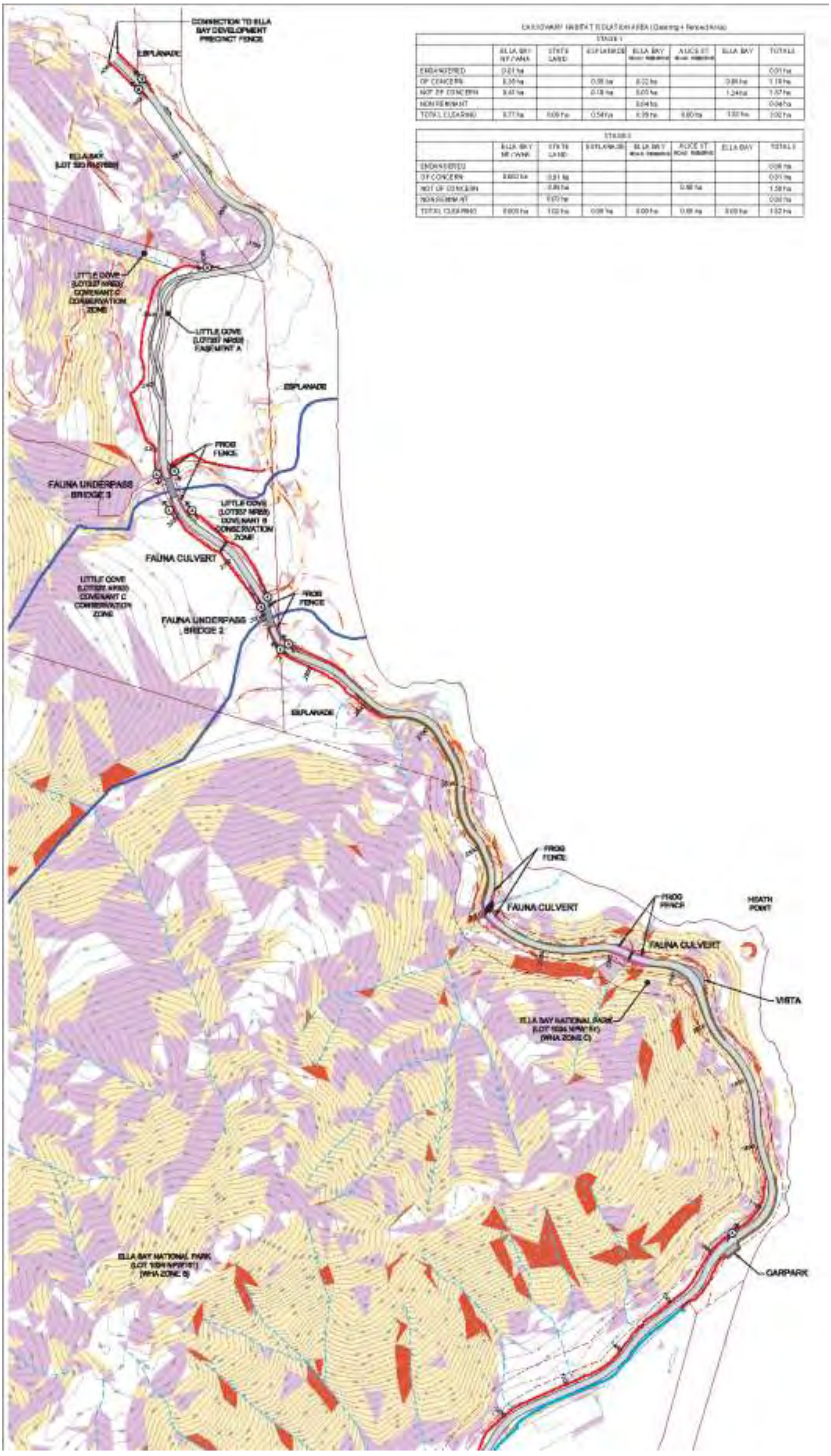

Figure 8:20 Fauna Mitigation Design Ella Bay Road Alignment Dwg. EBR1CE-PD08 (part 2).

Road Noise

The impact of traffic noise was not addressed in the EIS or SEIS, as the low road speed, low traffic numbers and the distance to dwellings placed the road below the legislative noise threshold. Consideration that there could be an impact on fauna was mentioned in the Appendix *A2.6 Access Road Strategy* and a recommendation to use Stone Mastic Asphalt was made.

EPA is responsible for the administration of the Environmental Protection Act 1994, and the Environmental Protection (Noise) Policy 2008. Under the EPP the acoustic environment is identified in terms of "planning levels" criteria.

The planning levels for a public road are the following noise levels, assessed 1m in front of the most exposed part of an affected noise sensitive place:

a. The following levels assessed as the L10 (18 hour) level:
    - For a State-controlled road - 68dB(A); and
    - For another public road – 63dB(A).
b. 60dB(A), assessed as the highest 1 hour equivalent continuous A-weighted sound pressure level between 10.00 pm and 6.00am [(Leq (1hour)]; and
c. 80dB(A), assessed as a single event maximum sound pressure level (Lmax).

The peak hourly noise level for Ella Bay Road is predicted to be less than 60dB(A) Leq (1hour) at 10m from the centre of the lane. Only one residence is within 25m from the road and the predicted noise for that house may possibly exceed the 63dB(A)L10 (6minutes) on occasion due to the noise of vehicles climbing the grade of the Stage 2 Flying Fish Point Bypass. To mitigate this potential exceedance a noise attenuation fence will be installed extending 100m to the south along the increase in grade.

While current noise legislation has focussed on the impact of noise on residents only, recent studies with research for the Kuranda Range Road Upgrade has investigated the impact on fauna (Dawe, G. and Goosem, M, 2008). Typically with new roads and highways the noise levels are evaluated by simulation and the level of disturbance to each residence estimated from existing data (DMR, 2008). The noise level estimates from modelling are derived from a standardised model (CoRTN (after p.68)) and have been shown to be relatively consistent for highways in Australia (DMR, 2008). The recent Kuranda studies (Dawe, G. and Goosem, M, 2008) have expanded this work to include the possible impact on fauna, in particular investigating the impact of compensatory pitch adjustments to the dominant frequency of song in avian rainforest fauna and the reduced densities of avifauna in habitat adjacent to roads. In the literature study reference was found to possible impact on frog vocalisation, and flying foxes.

The differences between Ella Bay Road and Kuranda Range Road Upgrade are extensive. The Kuranda Range Road (Kennedy Highway) transports up to 8,535 vehicles/day 9 km from Smithfield (25m elevation) over the top of the range (450m elevation) to Kuranda. Traffic noise levels exceeding 50db(A) were recorded in the rainforest at distances of over 200m. The data that has been collected on the existing Kuranda Range Road can be used to compare and evaluate the possible noise impacts along Ella Bay Road.

The proposed road traffic of Ella Bay Road will have a projected peak traffic count of 350v/h (3,134v/d AADT) which will be half the current measured Kuranda Range peak traffic count of 700v/d (7,268 to 8,535v/d) with full projected upgrade utilisation of 48,200v/d.

The road speed of Ella Bay Road will be 60km/h versus the current Kuranda Road speed of 80 km/h with proposed increase to 100km/hr.

The traffic mix for the residential and resort community will be different to that of the highway. The traffic mix for Ella Bay Road is estimated to be 95/2.5/2.5 (car, medium truck, heavy truck) (Appendix 3:) whereas the Kuranda Range traffic mix is estimated to be 60/10/30. No data was provided in (Dawe, G. and Goosem, M, 2008) although this ratio of heavy vehicles strongly affects the total noise level.

More importantly the topography is very different, whereas Ella Bay Road alignment is relatively flat, with a range in elevation from 5m to 33m elevation and has extensive open eastward topography along Seahaven Prawn Farm and along Heath Point Headland, the Kuranda Range road has confined topography elevating from 25m to 445m within a distance of 6km winding through cuttings and gullies. The Kuranda Range road noise levels are strongly impacted by the noise of vehicles climbing the grade.

The topography also impacts on reflected noise, with a component of the total noise being the reflection of the opposite side reflecting back into the rainforest. This is a significant effect in built up areas but it also impacts where the reflection is from solid embankments and within gullies as characteristic of the Kuranda Range.

Reflection of noise back towards the rainforest and WHA will be minimal along Ella Bay Road as on the eastward side of the Seahaven Prawn Farm and around Heath Point the road is open. Around Heath Point headland the reflected noise from the western side embankments will be towards the sea.

The Kuranda Range Road EIS has proposed that the road use Stone Mastic Asphalt for the surface however the recommendation is not applicable to Ella Bay Road. Extensive evaluation by (DMR, 2008) has established a long term difference in Noise Level of only 1dB(A).

The rainforest interior noise levels for Ella Bay is different to that of Kuranda Range. Ella Bay Road is adjacent to the sea with the maximum distance of the road from the sea between Flying Fish Point and Heath Point of 400m and less than 50m for the road around Heath Point. The noise from the wind and waves is a significant factor which will increase the ambient noise within the rainforest.

An additional consideration along the road alignment past Seahaven Prawn Farm is that this industry uses large electric pumps and agitators running 24 hours per day providing an increase in background noise.

Noise Impact on the World Heritage Area

A noise model for Ella Bay Road traffic has been prepared by ASK engineers (Appendix 6:) based on the noise modelling for the Kuranda Range Road Upgrade (ASK Consulting Engineers, 2004). The Ella Bay Road modelling was based on applying the traffic numbers, road surface material, heavy vehicle mix and road speed from Ella Bay Road to the Kuranda Range model to determine the distance that the noise from the reduced traffic volumes and road conditions would transmit through the rainforest. The topography of the Kuranda Range model was used for both simulations. A grade of 3.9% was used for the Kuranda Range Road versus 1% for Ella Bay Road. Note that Ella Bay Road is predominantly less than 0.1% grade.

Parameter	Kuranda Range Road*	Ella Bay Road
Traffic volume (AADT)	6,125	3,000 – 4,000
Percentage heavy vehicles	7.3	5.0
Speed Limit (km/hr)	80	60
Road Surface	SMA (stone mastic asphalt)	DGA (dense graded asphalt)

Table 8.4 Road traffic parameters used in noise model (ASK Consulting Engineers, 2004).

The result was that the noise levels of the Kuranda Range will be higher by approximately 7 dB(A) when compared to Ella Bay Road. It has been calculated that the L10(18 hour) noise level at 100m from Kuranda Range Road will be approximately equal to the noise level at between 31m to 40m from Ella Bay Road. An additional comparison was also made to the noise level at 100m of the proposed Kuranda Range Road Upgrade which is to transport 48,200v/d; the equivalent noise level distance for Ella Bay Road would be only 10m.

The distance from Ella Bay Road to WHA Zone B varies along the route;

- Section of Ella Bay Road to the Prawn Farm. The WHA Zone B boundary is located at the foot of the range and varies in distance from 55m to 100m from the proposed alignment.
- The section of Ella Bay Road to Heath Point park within Zone C. The WHA Zone B boundary is located at 41 to 51m from the proposed road alignment. On the East is the prawn farm and the sea.
- The section of Ella Bay Road around Heath Point Headland within Zone C. The WHA zone B boundary is located at 31 to 41m from the proposed alignment. On the east is the cliff face down to the sea.

The noise levels discussed above are for the peak hourly traffic flow which would occur twice per day for Ella Bay Road. Noise levels for traffic flows less than the peak will reduce the noise levels significantly, as described by (DMR, 2008) for traffic levels of less the 300v/h:

> *"The generation of road traffic noise is somewhat different under low traffic flow conditions ....* and *......the rate at which road traffic noise varies with traffic flow is more rapid than under the nominal 'normal' conditions. In addition, the noise/traffic flow relationship also varies with the distance from the roadway, the measurement location and the average speed under low traffic flow conditions."*

Noise Impact on the Cassowaries

Cassowaries have been surveyed in two main locations along Ella Bay Road:

- Section of Ella Bay Road to the Prawn Farm; and
- Section of Ella Bay Road north of the WHA.

Both of these locations will have cassowary fencing and bridge underpasses and based on observations at other bridge underpasses cassowary usage and movement is not impacted by traffic noise.

Studies at Mission Beach (Moore pers comm.) indicate that cassowaries appear to have habituated to the sound of cars and trucks on the roads. This is illustrated by many observations of cassowaries standing by the roadside waiting for an adequate break in the traffic flow to allow them to cross. They take little notice of cars even when birds are foraging close to the road corridor, but loud trucks, noisy trailers, or sudden noise do startle them. In these situations they move away from the road initially but generally come back if the source of the unexpected noise ceases.

Road Light Impact

Headlights are able to penetrate into the rainforest, potentially disturbing fauna. The road alignment and headland topographical conditions along Ella Bay road will help to mitigate the impact. The shadecloth fence will significantly reduce the light penetration at ground level and below 3m height. The shadecloth is rated for sun penetration perpendicular to the surface, where as headlights will impact at an incident angle and there will be a greater reduction in light transmission.

The embankments around Heath Point Headland are much higher than the relative position of the light source and will reduce the likelihood of light penetration into Zone B. Light penetration will occur in a few locations where the topography and direction of turning of the vehicle will allow light into the canopy of the trees in zone B. It should be noted also that the population of arboreal species is minimal near the coast and below 300m. (Goosem, M., Harding, E., Chester, G., Tucker, N., Harriss, C. and Oakley, K, 2010a).

9. Flora Sensitive Road Design

The flora sensitive road design of Ella Bay Road has been based on minimising the impact of the road alignment by:

- Minimising clearing by selective alignment and design;
- Maintaining mature trees and canopy connectivity and canopy shading;
- Protecting or relocating EVR flora;
- Revegetating any cleared or weed invested areas to increase shade and limit weed growth;
- Revegetating to seal the edge of the rainforest with frangible endemic species; and
- Utilising vegetated and bioretention swales to reduce pollutants and sediment reaching the waterways.

Reference was made to current literature in particular the methodology adopted in the Cardwell, and Kuranda Range upgrades, Roads in Rainforest and DTMR manuals.

Extensive Flora surveys were undertaken post Cyclone Larry (Nov 2006) and again 2 years later in 2008. Additionally two permanent baseline monitoring sites were established within the WHA to identify any changes in edge effect (3D, 2009a).

Edge Effects

The reduction of the edge effect impact is the main driver of the flora sensitive road design. (Goosem & Turton, 2000) have shown that the reduction of edge effects is enhanced by canopy cover shading, the width of the clearing and disturbance within the clearing. Canopy cover shading reduces weed infestation, road heating (in particular from sealed roads) and increases moisture.

Ella Bay Road travels through two totally different vegetation types:

- Vine rainforest (7.2.1, 7.2.5, 7.1.1 and 7.3.10) along the section from Flying Fish Point to Heath Point park and from the north of the WHA to Ella Bay; and
- Shrubby woodland (7.11.34) around Heath Point Headland.

The difference between the two is dramatic in terms of microclimate; moisture and wind exposure:

- The road through the rainforest has little existing canopy cover, mostly destroyed by Cyclone Larry and Yasi and has a weed infested verge but with little internal disturbance or internal edge effect (3D, 2009a); and
- The woodland is a much more windswept and dry environment with increased thermal heating from the exposed northerly position and sparser vegetation. The road around the headland does not fragment vegetation with the headland separated from the coast by 5 to 10m of thin vegetation before descending over steep rocky outcrops near vertical to the beach or coastal rocks.

The strategies for reducing edge effect are similar between the two vegetation types however the details and plantings are different (refer to Table 9.1 adapted from (Goosem M. , 2007).

Edge Effect	Mitigative Action
Road Noise Headlight disturbance	Reduced speed limit of 60 km/h. Sealed edges of the rainforest. Fauna fencing within the rainforest edge, preventing light infiltration.
Dust on vegetation	Sealing the road.
Raised air and surface temperature; Increased light penetration;	Revegetation / restoration of the existing cleared verges. Sealing the forest edges with vegetation filling the space between canopy and understorey and with canopy cover.

Edge Effect	Mitigative Action
Decreased soil and air humidity Photosynthetically active radiation (PAR)	Regenerating forest next to the edge provides greater potential for succession. Maintenance of existing canopy cover – PAR gradients are less pronounced in the closed canopy. Removal of weed, vine and pioneer species on the verges will encourage rainforest species growth and canopy shading.
Reduced canopy cover	Existing cover will be maintained and efforts made to replace what was lost in Cyclone Larry and Yasi. Revegetation beyond safety envelope with canopy closure trees.
Clearing	Commitment to keeping any clearing to a minimum. Minimising road width and verges as much as safety will allow. Building bike path within the construction envelope or along alternative routes to minimise clearing. Large trees (>30cm diameter) kept wherever possible. Remove the requirement for grading, mowing or spraying. Low height vegetation planted on verges.
Habitat Connectivity	Vegetate fauna underpasses to provide visual and food source connectivity.

Table 9.1 Reduction in edge effect adapted from (Goosem M. , 2007).

Clearing Design

The aim of the clearing design of Ella Bay Road upgrade is to save mature trees, and utilise the existing cleared road alignment as much as possible and selectively clear to widen the road and provide drainage. However in some cases the saving of mature trees has increased the area required for clearing as the road alignment has been moved to avoid these trees. The order of priority for the clearing design was set as follows:

1. Save mature trees where possible to retain canopy cover;
2. Utilise the existing cleared envelope;
3. Provide safety in terms of evasive action and correct sight distances;
4. Widen and increase the radii of corners for road safely and articulated vehicles; and
5. Provide the correct drainage design.

CH 0000 to 1700 Flying Fish Point to Heath Point Park

The clearing design for this section of road has focussed on saving mature trees and minimising the creation of new edge effects. The existing road alignment was previously cleared sufficiently along this section except for narrowings where the mature trees remain at the side of the road. Along the majority of the length of the road either no clearing or less than 1m width of clearing will be required, except where the road was realigned to save mature trees where up to 4-6m width of localised clearing will be required.

STAGE 1	**CH 0000 to 1700 Flying Fish Point to Heath Point Park**						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Endangered							**0.00 ha**
Of Concern	0.02 ha			0.17 ha			**0.19 ha**
Not Of Concern	0.23 ha			0.01 ha			**0.24 ha**
Non Remnant				0.04 ha			**0.04 ha**
Total Clearing	**0.25 ha**	0.00 ha	0.00 ha	**0.22 ha**	0.00 ha	0.00 ha	**0.47 ha**

Table 9.2 Clearing Areas CH 0000 to 1700.

CH 1700 to 2600 Heath Point Park to North of WHA

The clearing design for this section of road has focussed on saving mature trees and widening and increasing the radii of corners for safety and for articulated vehicles. The existing road alignment is very narrow and single lane, corners are blind and extremely tight radii. The two severe sharp corners will require extensive cut to increase the radii for safety. The culverts over the two ephemeral streams are narrow pipe culverts which will require reworking and localised widening and realignment. Clearing will be required along the majority of the length of the road of 2-4m width with the realignment of the corners requiring up to 10m width of localised clearing. The extensive clearing is also required for stabilisation of the steep embankments.

STAGE 1	**CH 1700 to 2600 Heath Point Park to North of WHA**						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Endangered							**0.00 ha**
Of Concern	0.31 ha						**0.31 ha**
Not Of Concern	0.10 ha						**0.10 ha**
Non Remnant							**0.00 ha**
Total Clearing	**0.41 ha**	0.00 ha	0.00 ha	0.00 ha	0.00 ha	0.00 ha	**0.41 ha**

Table 9.3 Clearing Areas CH 1700 to 2600.

CH 2600 to 4000 North of WHA to Ella Bay

The clearing design for this section of road has focussed on saving mature trees and widening for safety. The existing road alignment is narrow along the Esplanade and will require widening with clearing widths of up to 6-8m due to realignment to save mature trees, and clearing required for battering back steep embankments. Clearing within Ella Bay will be along the designated easement, part of which was a logging track that has since revegetated.

STAGE 1	**CH 2600 to 4000 North of WHA to Ella Bay**						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Endangered							**0.00 ha**
Of Concern			0.35 ha			0.07 ha	**0.42 ha**
Not Of Concern			0.13 ha			0.62ha	**0.75 ha**
Non Remnant							**0.00 ha**
Total Clearing	0.00 ha	0.00 ha	**0.48 ha**	0.00 ha	0.00 ha	**0.69 ha**	**1.17 ha**

Table 9.4 Clearing Areas CH 2600 to 4000.

TOTAL CLEARING CH 0000 to CH 4000

The overall clearing for Stage 1 is 2.05Ha of which 0.66Ha is within the World Heritage Area.

STAGE 1	**Total Clearing CH 0000 to CH 4000**						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Endangered							**0.00 ha**
Of Concern	0.33 ha		0.35 ha	0.17 ha		0.07 ha	**0.92 ha**
Not Of Concern	0.33 ha		0.13 ha	0.01 ha		0.62ha	**1.09 ha**
Non Remnant				0.04 ha			**0.04 ha**
Total Clearing	**0.66 ha**	0.00 ha	**0.48 ha**	**0.22 ha**	0.00 ha	**0.69 ha**	**2.05 ha**

Table 9.5 Stage 1 Total Clearing CH 0000 to 4000.

STAGE 1	Total Clearing CH 0000 to CH 4000					
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Clearing	0.66 ha		0.48 ha	0.22 ha		0.69 ha	**2.05 ha**
Revegetation	0.69 ha		0.41 ha	0.53 ha		0.70 ha	**2.33 ha**
Net loss / gain	0.03 ha	0.00 ha	-0.07 ha	0.31 ha	0.00 ha	0.01 ha	**0.28 ha**

Table 9.6 Net revegetation totals CH0000 to 4000.

Stage 2 CH 0000 to 0940 Flying Fish Point Bypass

The clearing for Stage 2 is for the full length of the road alignment. A very minor extent of existing clearing occurs at the exit along the proposed road along Alice Street. Extensive clearing 0.5Ha has been allowed for the cut and cover tunnel option. The maximum clearing will occur with this option over the bored tunnel option. No decision can be made on the options until detailed geotechnical studies have been performed to assess the viability. The clearing envelope along the road alignment will be 14 to 16m wide.

Two alternative options have been proposed for the integration to the Stage 1 road. The optimum from a clearing and road alignment perspective; option D(2) would require a section of 140m² of the Ella Bay National Park to convert to road reserve with a clearing of 30m². The alternate option D(1) is for the road to pass into State reserve and require clearing of 1,000m². The clearing analysis for option D(1) includes the maximum clearing for Stage 2.

STAGE 2	Total Clearing CH 0000 to CH 0940 (Option D1)						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Endangered							**0.00 ha**
Of Concern		0.10 ha		0.01 ha			**0.11 ha**
Not Of Concern		0.95 ha			0.52ha		**1.47 ha**
Non Remnant		0.03 ha					**0.03 ha**
Total Clearing	0.00 ha	**1.08 ha**	0.00 ha	**0.01 ha**	**0.52 ha**	0.00 ha	**1.61 ha**

Table 9.7 Stage 2 Total Clearing CH 0000 to CH 940 (Option D1).

STAGE 2	Total Clearing CH 0000 to CH 0940 (Option D2)						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Endangered							**0.00 ha**
Of Concern	0.003 ha	0.01 ha					**0.01 ha**
Not Of Concern		0.95 ha			0.52ha		**1.47 ha**
Non Remnant		0.03 ha					**0.03 ha**
Total Clearing	**0.003 ha**	**0.99 ha**	0.00 ha	0.00 ha	**0.52 ha**	0.00 ha	**1.51 ha**

Table 9.8 Stage 2 Total Clearing CH 0000 to CH 940 (Option D2).

STAGE 2	Total Clearing CH 0000 to CH 0940 (Option D2)						
	Ella Bay NP/WHA	State Land	Esplanade	EBR Road Reserve	Alice St Road Reserve	Ella Bay	**Totals**
Clearing		0.99 ha		0.00 ha	0.52 ha		**1.51 ha**
Revegetation		0.93 ha		0.06 ha	0.20 ha		**1.19 ha**
Net loss / gain	0.00 ha	-0.06 ha	0.00 ha	0.06 ha	-0.32 ha	0.00 ha	**-0.32 ha**

Table 9.9 Net revegetation totals CH 0000 to CH 0940

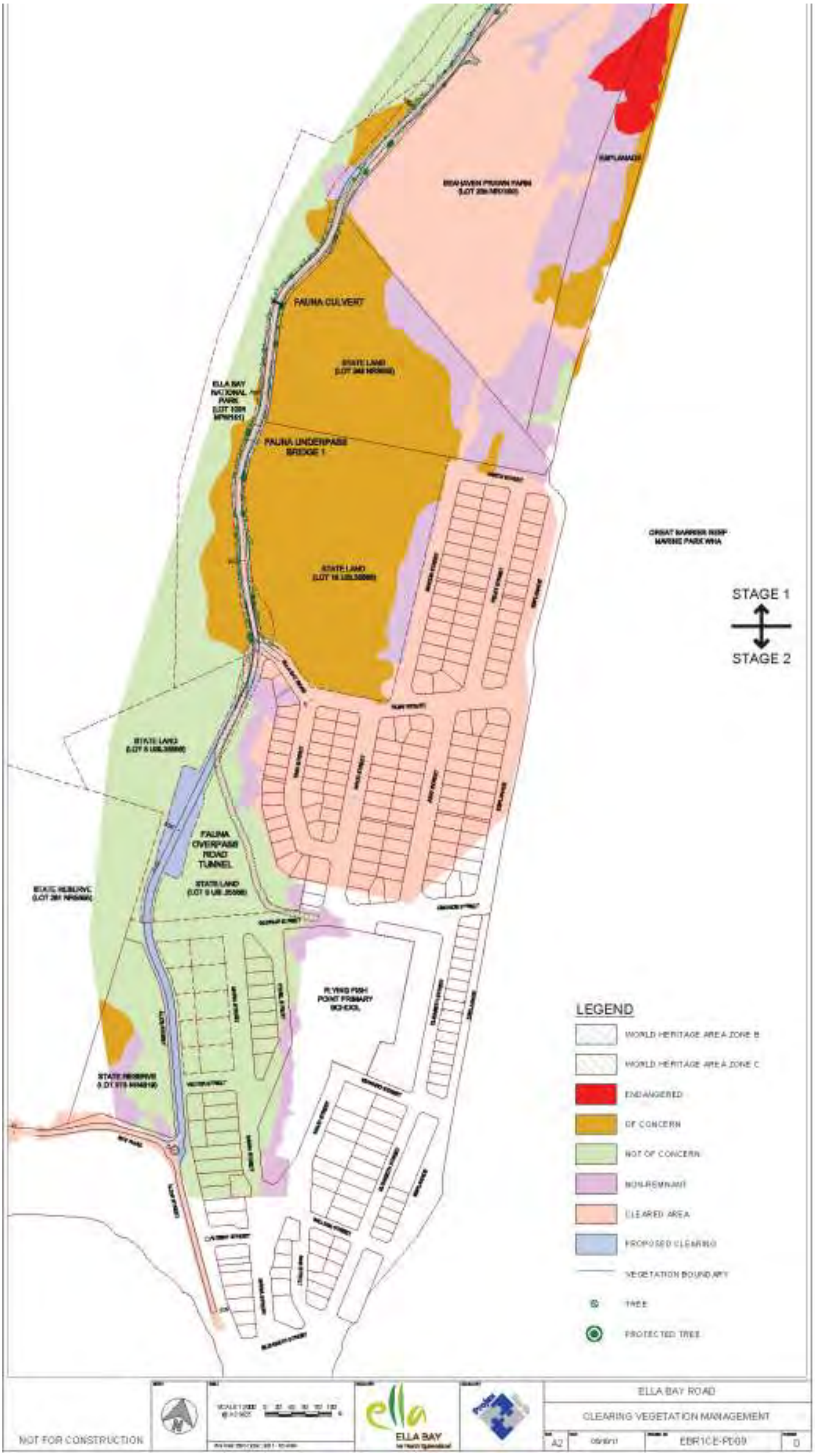

Figure 9:1 Clearing Vegetation EVR status (EBR1CE-PD09 part 1).

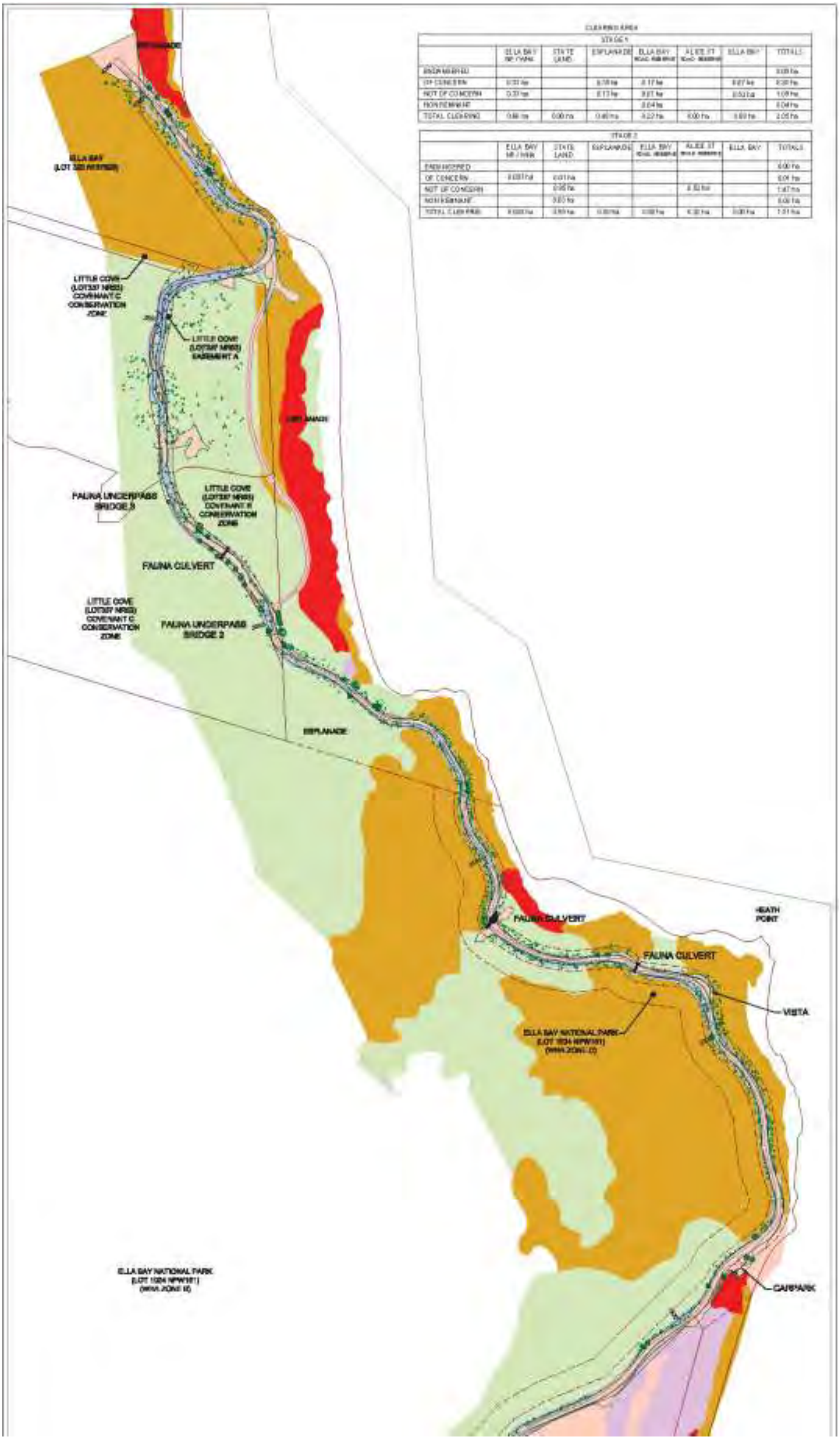

Figure 9:2 Clearing Vegetation EVR status (EBR1CE-PD09 part 2).

Figure 9:3 Heath Point park at CH1600. The new carpark will finish in front of the Mexican Rain Tree (Samanea saman) on the right and the White Apple (Syzigium forte) on the left.

Canopy Connectivity and Mature Tree Retention

Maintaining an existing rainforest canopy over a road is one of the most important mitigation strategies to be employed within Wet Tropics road design in terms of edge effect reduction (Goosem M. ,Fragmentation Impacts Caused by Roads through Rainforests, 2007). Maintaining canopy connectivity in the form of touching branches as distinct from canopy shading is primarily for arboreal marsupial movement. In two surveys of Ella Bay Road no arboreal species were found (BAAM, 2008b), however a Striped Possum (*Dactylopsila trivirgata*) was found on Ella Bay development site, indicating that arboreal mammals may be present in limited numbers. However it should also be noted that sensitive arboreal fauna are limited along the coast and below 300m elevation. (Goosem et al. 2010a)

The canopy connectivity of Ella Bay Road was significantly damaged by Cyclone Larry in 2006 (refer Figure 9:4). The high shear winds broke many of the canopy crowns and the large branches that formed the canopy particularly on the edge of the road.

The canopy connectivity recovered following Cyclone Larry and was a clear visual indicator of the growth of the canopy tops, however very few trees had branches sufficient growth for arboreal movement. Cyclone Yasi has since destroyed most of this regrowth and further broken canopy crowns. (Figure 9.6)

The connectivity was documented along the road (Table 9.8) prior and post Cyclone Yasi.

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Figure 9:4 Damage to mature trees and canopy connectivity from Cyclone Larry.

Figure 9:5 Damage to mature trees and canopy connectivity from Cyclone Yasi 2011. Flying Fish Point Reserve on right. CH 0080

Prior to Cyclone Yasi the canopy connectivity only numbered a few locations showing branches touching with a few more locations with leaves touching. However all canopy connectivity along the road to CH3000 has been destroyed. A limited amount of connectivity still exists along the entrance to Ella Bay property.

The worst of the Cyclone Yasi destruction was from the beginning of Ella Bay Road to Heath Point park (CH1700) where many of the mature trees that had formed the canopy connectivity were either felled or had crowns broken (figure 9.5).

Around Heath Point Headland, many trees close to the road remain and branches will regrow within a few years, however this location does not provide rainforest connectivity. The location is limited to the woodland remnant vegetation on the steep faces down to the coastline.

In two other areas at the Prawn farm, the mature tree canopy connections are located where the eastern side does not provide vegetation beyond the road verge.

Effective canopy connectivity, with branches suitable for arboreal species, a suitable habitat on both sides and not formed by pioneer species, was found in only six locations, prior to Cyclone Yasi. Of these locations, one was along the section of road from Flying Fish Point to Heath Point Park and the other five were around Heath Point Headland. The predominance of connectivity was located at the narrower parts of the road where the greatest conflict with road safety will occur.

In designing the road a number of areas of existing canopy connectivity were compromised with trees on the west or east of the road alignment requiring removal either because of direct alignment requirements or due to the tree being unhealthy or the roots would be exposed with cutting of the embankment. Since Cyclone Yasi two of these trees have fallen. Road widening at the headland will unavoidably remove four of areas that had previous connections from established trees. Of these several of the trees have been severely damaged by Cyclone Yasi and connectivity will not be able to be re-established.

Mature trees have been protected where possible with over 20 trees requiring guard rail protection because of proximity to the road, however this saving of mature trees has not meant that canopy connectivity has been extensively retained due to the lack of canopy crown and large branches over the road of the mature trees. To achieve this level of tree retention the road alignment has been modified to specifically avoid the trees and road safety mitigation added where the alignment has remained too close to the tree.

Specific design elements that have been used in the design of the Stage 1 road:

- Modify the road alignment clear of significant flora at 13 locations;
- Divide the road alignment at Little Cove;
- Stop and restart the clearing for the western drain at five locations for 5-20m and modify the drainage;
- Split the alignment from the western drain for 250m at Ella Bay Esplanade;
- Stop and restart the eastern bioretention swale at many locations for 5-10m; and
- Gabions used as protection at the embankment toe of select trees.

The trees to be protected are listed in Table 9.10. For Stage 1 all trees with a diameter greater than 300mm have been surveyed and identified in drawings EBR1CE-PD09. Table 9.10 also lists the canopy connectivity status, safety requirements with regard to tree guard protection and whether the tree is within safety evasion distance of the road laneway requiring a tree guard or requires removal for safety.

CH (m)	Common Name	Scientific Name	Prior Yasi Canopy Connectivity	Post Yasi Canopy Connectivity	Status
0126	Variegated Fig	*Ficus variegata*	Nil	>15m	
0130	Kuranda Quandong	*Elaeocarpus bancroftii*	Nil	>15m	
0175	Candle Nut Tree	*Aleurites rockinghamensis*	<2m apart	>15m	*Guard*
0185	Black Bean	*Castenospermum australe*	<2m apart	>15m	
~~0195~~	~~Blue Quandong~~	~~*Elaeocarpus grandis*~~	~~Nil~~	Fallen	
0196	Milky Pine	*Alstonia scholaris*	Nil	>15m	
0197	Brown Laurel	*Cryptocarya triplinervis*	Nil	>15m	
0312	Blue Quandong	*Elaeocarpus grandis*	Nil	>15m	*Guard*
0314	Milky Pine	*Alstonia scholaris*	Branches	>15m	*Guard*
0366	Cape York Cedar	*Dysoxylum alliceum*	Nil	>15m	
~~0368~~	~~Candle Nut Tree~~	~~*Aleurites rockinghamensis*~~	~~Nil~~	Fallen	
0370	Black Bean	*Castonspermum australe*	Nil	>15m	*Guard*
0373	Milky Pine	*Alstonia scholaris*	Nil	>15m	*Guard*
0434	Onion Wood	*Syzigium alligneum*	Nil	>15m	
0436	Toechima	*Toechima sp.*	Nil	>15m	
0438	Native Olive	*Chionanthus ramiflora*	Nil	>15m	
0480	Hard Milkwood	*Alstonia muelleriana*	Nil	>15m	*Remove*
0482	Daintree Hickory	*Ganophyllum falcatum*	Nil	>15m	*Remove*
~~0555~~	~~Native Olive~~	~~*Chionanthus ramiflora*~~	~~Nil~~	Fallen	
0577	Daintree Hickory	*Ganophyllum falcatum*	Nil	>5m	*Guard*
0612	Milky Pine	*Alstonia scholaris*	<2m apart	>5m	*Remove*
0633	Milky Pine	*Alstonia scholaris*	<2m apart	>5m	
0636	Milky Pine	*Alstonia scholaris*	<2m apart	>5m	*Guard*
0641	Hard Milkwood	*Alstonia muelleriana*	<2m apart	>5m	*Remove*
0680	Native Olive	*Chionanthus ramiflora*	Leaves	>5m	
~~0686~~	~~Pepperwood~~	~~*Cinnamomum laubatii*~~	~~Leaves~~	Fallen	
0769	Cheese Tree	*Glochidion ferdinandi*	<2m apart	>15m	*Guard*

CH (m)	Common Name	Scientific Name	Prior Yasi Canopy Connectivity	Post Yasi Canopy Connectivity	Status
0879	Black Bean	*Castanospermum australe*	<2m apart	2m	
0880	Black Bean	*Castanospermum australe*	<2m apart	2m	*Guard*
0933	Black Bean	*Castanospermum australe*	Nil	>5m	*Guard*
0935	Black Bean	*Castanospermum australe*	Nil	>5m	*Guard*
0938	Drube Fig	*Ficus drupacea*	Nil	>5m	*Guard*
1001	Brown Laurel	*Cryptocaria triplinervis*	Nil	>5m	*Remove*
1055	Black Bean	*Castanospermum australe*	Leaves touching – Habitat to the west only	>2m	*Remove*
1056	Damson Plum	*Terminalia seriocarpa*	Leaves touching – Habitat to the west only	>2m	
1192	Milky Pine	*Alstonia scholaris*	<2m apart	>2m	*Guard*
1263	Daintree Hickory	*Ganophyllum falcatum*	<2m apart	>2m	*Remove*
1320	Brown Laurel	*Cryptocaria triplinervis*	Nil	Nil	*Remove*
1437	Damson Plum	*Terminalia seriocarpa*	Nil	Nil	
1446	Cassowary Pine	*Barringtonia calyptra*	Nil	Nil	
1448	Native Olive	*Chionanthus ramiflora*	Nil	Nil	*Remove*
1541	Native Olive	*Chionanthus ramiflora*	Nil	Nil	*Remove*
1542	Brown Damson	*Terminalia arenicola*	Nil	Nil	*Remove*
1571	Cassowary Pine	*Barringtonia calyptra*	Nil	Nil	
1593	White Fig	*Ficus virens*	<2m apart	>2m	
1610	Rain Tree (exotic)	*Samanea saman*	Nil	Nil	
1641	White Apple	*Syzigium forte*	Nil	Nil	
1645	Sea Almond	*Terminalia catappa*	Nil	Nil	
1668	White Fig	*Ficus virens*	Nil	Nil	
1948	Swamp Mahogany	*Lophostemon suaveolons*	Leaves touching	>2m	*Remove*
1999	Daintree Wattle	*Acacia cincinnata*	Branches touching	<2m	*Remove*
2002	Swamp Mahogany	*Lophostemon suaveolons*	Branches touching	<2m	
~~2106~~	~~Swamp Mahogany~~	~~*Lophostemon suaveolons*~~	~~Nil~~	Fallen	
2170	Hairy Fig	*Ficus hispida*	Nil	>5m	
2214	Daintree Wattle	*Acacia cincinnata*	Nil	Nil	
2229	Hard Milkwood	*Alstonia muelleriana*	Nil	Nil	
2395	Variegated Fig	*Ficus variegata*	Leaves touching	<2m	
2408	Black Bean	*Castanospermum australe*	<2m apart	<2m	
~~2531~~	~~Swamp Mahogany~~	~~*Lophostemon suaveolons*~~	~~Leaves touching~~	Fallen	
2575	Daintree Wattle	*Acacia cincinnata*	Branches touching	<2m	
~~2578~~	~~Swamp Mahogany~~	~~*Lophostemon suaveolons*~~	~~Branches touching~~	Fallen	
2600	Brown Kurrajong	*Commersonia bartramia*	Branches	<2m	*Guard*

CH (m)	Common Name	Scientific Name	Prior Yasi Canopy Connectivity	Post Yasi Canopy Connectivity	Status
			touching		
2601	Brown Kurrajong	*Commersonia bartramia*	Branches touching	<2m	*Guard*
2605	Swamp Mahogany	*Lophostemon suaveolons*	Nil	Nil	*Guard*
2612	Swamp Mahogany	*Lophostemon suaveolons*	Nil	Nil	*Guard*
2700	Swamp Mahogany	*Lophostemon suaveolons*	Leaves touching	<2m	*Remove*
2780	Broad Leafed Lilly- Pilly	*Acmena hemilampra*	Nil	Nil	*Remove*
2791	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
2792	Dog Bane	*Cerbera manghas*	Nil	Nil	
2799	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
2837	Damson Plum	*Terminalia sericocarpa*	Nil	Nil	
2838	Brown Laurel	*Cryptocarya triplinervis*	Leaves touching	<2m	*Guard*
2839	White Apple	*Syzigium forte*	Nil	Nil	
2840	White Apple	*Syzigium forte*	Nil	Nil	
2841	White Apple	*Syzigium forte*	Leaves touching	<2m	
2842	White Apple	*Syzigium forte*	Leaves touching	<2m	
2843	Mango (exotic - Asia)	*Mangifera indica*	Leaves touching	<2m	*Remove*
2857	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
2858	Indian Beech	*Millettia pinnata*	Nil	Nil	
2950	Blue Quandong	*Eleocarpus grandis*	Nil	Nil	
2959	Cassowary Pine	*Barringtonia calyptra*	Leaves touching	Leaves touching	
2961	Onion Wood	*Syzigium alligneum*	Leaves touching	Leaves touching	
~~2979~~	~~Cork Wood~~	~~*Carallia braciata*~~	~~Nil~~	~~Fallen~~	
2981	Milky Pine	*Alstonia scholaris*	Nil	Nil	
2982	Blue Quandong	*Eleocarpus grandis*	Leaves touching	<2m	
2983	Melicope	*Melicope elleryana*	Nil	Nil	
2984	Wedlands Palm	*Hydriastele wedlandiana*	Nil	Nil	
2988	Northern Brush Mahogany	*Geissois biagiana*	Nil	Nil	
2989	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
2990	Hairy Fig	*Ficus hispida*	Nil	Nil	
2993	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
2995	Mango (exotic - Asia)	*Mangifera indica*	Leaves touching	<2m	
2996	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
3003	White Apple	*Syzigium forte*	Nil	Nil	
3004	Queensland Greenheart	*Endiandra compressa*	Nil	Nil	
3006	Native Nutmeg	*Myristica insipida*	Nil	Nil	
3011	Brown Laurel	*Cryptocarya triplinervis*	Nil	Nil	
Tree survey has not been completed in this section – further detailed road optimisation and safety					

CH (m)	Common Name	Scientific Name	Prior Yasi Canopy Connectivity	Post Yasi Canopy Connectivity	Status
		analysis required			
3853	Native Olive	*Chionanthus ramiflora*	Branches touching	>2m	*Guard*
3855	Weeping Paperbark	*Melalueca lucadendra*	Branches touching	>2m	*Guard*
3859	Daintree Wattle	*Acacia cincinnata*	Nil	Nil	*Guard*
3959	Daintree Wattle	*Acacia cincinnata*	Nil	Nil	*Guard*
3989	Native Nutmeg	*Myristica insipida*	Nil	Nil	*Guard*
4006	Native Olive	*Chionanthus ramiflora*	<2m apart	>2m	*Guard*

Table 9.10 Mature trees to be protected stage 1 – list is indicative, subject to Arborist inspection.

The following examples demonstrate the method used to retain mature trees.

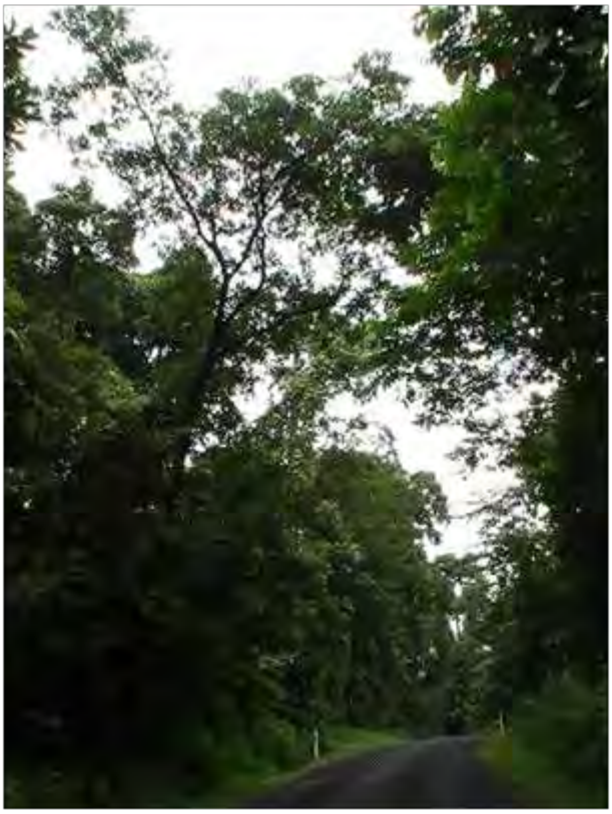

Figure 9:6 Protected tree, CH0680, Native Olive (*Chionanthus ramiflora*) (centre left).

Location:CH0680-686 Native Olive and Pepperwood tree located very close to the road.

Connectivity: The Native Olive and Pepperwood tree had canopy connectivity between large branches. The Pepperwood tree was felled during Cyclone Yasi.

Design alterations: The road was realigned to the east to save the Native Olive requiring clearing of 52m² between CH0685-0720 consisting of 50% weeds and 50% remnant regrowth. To the north will be located a cassowary exit gate. One significant tree in this clearing path was required to be saved by reducing the localised clearing footprint - CH0686, Pepperwood (*Cinnamomum laubatii*). The Pepperwood tree was subsequently felled in Cyclone Yasi.. Refer to drawing EBR1CE-DD04.

Figure 9:7 Protected Tree CH1192, Milky Pine (*Alstonia scholaris*) (centre) and post Cyclone Yasi. Note the broken crown on the western side tree

Location: CH1192 A large iconic Milky Pine is located adjacent to the road. The existing road has been locally narrowed to retain this tree.

Connectivity: This tree had canopy connectivity with branches touching across the road. It was locally damaged by Cyclone Yasi. There is no vegetation beyond the eastern road verge with clearing for the Prawn Farm. This is an impressive tree and all efforts were made to save it.

Design alterations: Realignment of the road to the west will require clearing of 320m² between CH1175-1255 consisting of 50% weeds and 50% remnant regrowth, for the full road alignment. One significant tree; Daintree Hickory (*Ganophyllum falcatum*) in this clearing path will be saved by stopping and resuming the western drain at CH1263. The Milky Pine will require a guard rail for a vehicle crumple zone and the small trees and shrubs that are growing under the tree may require removal for improved sight distance. Additional design will be required for drainage planning and root base preservation area. Refer to drawing EBR1CE-DD07.

Further to this assessment the mature Daintree Hickory at CH1263 on the opposite side of the road will be required to be removed. It was considered too close to the road lane way and would have compromised the shoulder of the road and potentially vehicle safety.

 

Figure 9:8 Four Trees CH2600-2612, two Brown Kurrajongs (*Commersonia bartramia*) and two Swamp Mahoganies (*Lophostemon suaveolons*).

Location:CH2600 Four mature trees are located on the Eastern side of the road. The first two trees are Brown Kurrajongs located one in front of the other with a Swamp Mahogany located 2m to the north. A further Swamp Mahogany is located 8m further north.

Connectivity: There was canopy connectivity between small branches (pre Cyclone Yasi).

Design alterations: The western embankment will be cut to retain the eastern trees with clearing of 420m^2 between CH2580-2650, consisting of approximately 50% remnant regrowth, 25% mature small woodland and 25% weeds. Embankment stabilisation will be modified to retain the western trees. The Brown Kurrajong closest to the road will require removal to maintain a 1.5m wide shoulder.

Stage 2 Canopy Connectivity

The alignment and trees for Stage 2 design have not been detail surveyed and no evaluation of canopy retention and edge effect impact can be made. The process described above will be utilised to assess the retention of mature trees and manage the road alignment where possible.

Revegetation

As each stage or partial stage of works is completed, revegetation and ground treatment will take place as soon as possible. In most cases this will be completed within one week of a completion of the embankment, drain or earthworks.

The aim of revegetation along Ella Bay Road is to:

- Provide stabilisation for erosion;
- Removing existing weed infestations of batters, drains and shoulders and revegetate with native frangible edge closure vegetation to increase shade and limit weed growth;
- Increase linkages between fragments of remnant vegetation;
- Influence Cassowaries to the three fauna underpasses;
- Provide microhabitats at fauna underpasses, embankments, gabions and drains;
- Provide vegetation for swales to reduce sediment reaching the waterways;

- Stabilize and camouflage the embankments and cuts along Heath Point Headland; and
- Retain aesthetic nature of the WHA.

Revegetation Plant Selection

Plant selection for revegetation has been based on selecting endemic plants that suit the criteria for the roadside vegetation and seal the edge of the forest to reduce the potential of edge effects. The selection of the revegetation species is site specific so that the species blends with the surrounding vegetation and complements the natural surroundings. Chenoweth have prepared a planting list for Ella Bay Road based on species listings obtained from (3D, 2009a) *Vegetation Survey Report*. While the roadside vegetation criteria are habitat and size specific, a maximum diversity approach (Goosem & Tucker, 1995) will be used to maximise the species variety. Ideally species should be resilient and preferably fast growing with an inherent ability to be self-replicating under roadside conditions and commercially available. The plant selection has been difficult in that commonly used plants (Goosem et al, 2010b) recommended for roadside revegetation are not endemic to the area. The detailed planting list is included in Appendix 5 *Revegetation Planting List*

Revegetation will match the Regional Ecosystem mapping lists (3D, 2009a) (refer to Table 9.11), except where the roadside criteria does not match the RE such as the table drains and vegetated swales. The species will be of local origin, predominately collected at Ella Bay Development site to ensure local genetic material is used particularly to prevent geographic variation from being introduced. These will be propagated as tube stock to improve the chance of survival.

Regional Ecosystem	Status	Description	Occurrence Chainage (m)
7.2.1i	Endangered	Mesophyll vine forest. Beach ridges and sand plains of beach origin, mainly in small patches in the lee of coastal beach ridges in very high rainfall areas.	2400 – 2500 (east) (Little Cove Conservation Covenant)
7.2.5	Endangered	Mesophyll to notophyll vine forest of *Syzygium forte* subsp. *Forte* (White Apple) on sands of beach origin.	1500 – 1650 (east) 3950 – 4069 (east)
7.3.10a	Of Concern	Simple to complex mesophyll to notophyll vine forest. Moderate to poorly drained alluvial plains of moderate fertility.	0100 – 0630 0730 - 0860 Stage 2 0800 – 0900
7.11.1	Not of Concern	Simple to complex mesophyll and notophyll vine forest. Moderately to poorly drained metamorphics of moderate fertility. Moist and wet lowlands, foothills and uplands.	1050 – 1650 2250 – 2400 Stage 2 0000 – 0750
7.11.1a	Not of Concern	Mesophyll vine forest. Very wet lowlands and foothills.	2750 – 3600
7.11.8b	Of Concern	*Acacia mangium* and *Acacia celsa.* Open to closed forest. Very wet lowlands and foothills.	3600 – 4069
7.11.34a	Of Concern	*Corymbia tessellaris* and *Lophostemon suaveolens.* Complex of shrubland, shrubby woodlands or open forests.	1650 – 2250 2400 – 2750

Table 9.11 Regional Ecosystem Communities Influencing Road Side Revegetation Localities.

Cassowary fruiting trees will be excluded from revegetation along the roadside within the fenced road reserve. It is not intended to influence Cassowaries to food sources along the road alignment due to human and traffic interaction. Cassowaries currently use the road as a transport corridor crossing from one side to the other and do not use the roadside for feeding purposes (BAAM, 2007b).The abundant presence of weed species along the alignment provides zero food source. Cassowary fruiting trees will however be used as an attractant within the fauna underpass area and on the external area of the cassowary fence escape gates as movement incentives and for familiarisation.

Hydromulch may be used with a cover species such as sterile millet and with select native species on steep batters. Very few species endemic to the Regional Ecosystems along the road are suitable for hydromulch due to the seed size with the exception of acacia species and *Dianella caerulea* (Flax Lily).

The selection of species will also be required to meet road safety criteria where:

- Planted trees must not pose safety risks by regular branch shedding;
- Planted trees and shrubs must be frangible within the evasive action zone; and
- Driver sight distances must not be compromised with smaller low growing species near to the road.

The plant height criteria is also further determined by whether the plantings are on the inside of a corner with a radius of less than 150m, where sight distance will require plant heights of less than 1m immediately adjacent to the road. On straight road and on outside corners the plant heights can be higher, up to 3m which will improve the sealing of edge vegetation.

The roadside vegetation criteria have been based on function and location.

- Western drains and batters;
- Bioretention swale;
- Edge closure;
- Fauna Underpass and bridges; and
- Gabions.

Western drains and batters

The western drains and batters will require specific riparian plants within the table drain and species sourced from the appropriate RE that are:

- frangible plants that satisfy evasive action safety criteria;
- species of progressive height moving away from the road to satisfy sight distance requirements; and
- plants that secure substrate, prevent erosion and hinder weed growth.

Strategy	Road alignment	Location	Species
Table Drain	Straight road or outside of corner	Road batter to drain, and low flow drain invert (lined with jute)	Ferns, sedges and grass species that are >1m<3m, dense to deter drivers, occasional inundation and tolerant to low flow velocity, and provide ground cover to prevent weeds
		High flow drain invert (lined with geofabric or rock).	Ferns, sedges and forb species that are >1m<3m, tolerant to high stream flow and frequent inundation, erosion protection
	Inside of corner	Road batter to drain	Sedges, forbs, herbs and grass species that are <1m, dense to deter drivers and provide ground cover to prevent weeds
		Drain invert low flow (lined with jute)	Ferns, sedges and grass species that are <1.5m, tolerant to low flow velocity and frequent inundation
		Drain invert (lined with geofabric or rock).	Ferns and sedge species less than 1.5m that are resilient to high flow velocity >0.5m/s with frequent inundation, erosion protection.

Table 9.12 Revegetation Criteria for Western drains and Batters.

Bioretention swales

The vegetation criteria for the bioretention swales is very selective and few local species satisfy the requirements:

- Frangible plants that satisfy evasive action safety criteria;
- Plants that provide a root filtering function and survive in free draining soil with periods of inundation; and
- Plants of a variety of height depending on sight distance criteria.

Strategy	Road Alignment	Location	Species
Bioretention swales	Straight road or outside of corner	Road batter to swale	Ferns, sedges and grass species that are >1m<3m, dense to deter drivers, resilient and provide ground cover to prevent weeds.
		Bioretention swale	Ferns, herbs and sedges >1m<3m, shade tolerant, root filtering, and hardy, survive in free draining soil
	Inside of corner	Road batter to swale	Ferns, sedges herbs and grasses. <1m sun tolerant, root filtering, and hardy.
		Bioretention swale	Ferns, herbs, and sedges <1.5m, shade tolerant, root filtering, and hardy, survive in free draining soil

Table 9.13 Revegetation Criteria for Bioretention Swales.

Edge Closure

The vegetation chosen for edge closure is important in sealing the cleared road side as fast as possible to reduce the drying impact and weed invasion typical of cleared edges. The goal will be to re-establish the canopy closure quickly with pioneering species where the clearing is greater than 3m from the roadside. Within that distance lower height frangible species will be required for road safety evasive action distance.

The criteria for edge closure is that the species selected

- must be from the appropriate RE,
- plants that are bushy that seal the edge of the rainforest; or
- plants that fast growing and provide early canopy shading.

Strategy	Road Alignment	Location	Species
Edge Closure	Straight road or outside of corner	Embankment and edge closure, between drain/swale and forest.	Shrubs, ferns and trees for appropriate RE can be >4m. Shade tolerant and bushy to seal wind and temperature, frangible edge closure species. Fast-growing pioneer species to establish canopy where >3m from road laneway. All plant types not to be cassowary fruiting.
	Inside of corner	Embankment and edge closure, between drain/swale and forest.	Shrubs, ferns and trees for appropriate RE <3m. Shade tolerant and bushy to seal wind and temperature, frangible edge closure species. All plant types not to be cassowary fruiting.

Table 9.14 Revegetation criteria for edge closure.

Fauna Underpasses

The vegetation chosen for the fauna underpasses and bridges will be required for specific criteria to influence cassowary and other fauna movement. To increase the attractiveness of the underpasses to cassowaries; species with a range of fruiting cycles outside the typical period of peak fruit abundance will be included. Known cassowary “favourites” such as Blue Quandong (*Elaeocarpus grandis*) and the Figs (*Ficus spp.*) in particular will be will be planted along the watercourses to encourage movement.

The vegetation will be implemented in areas surrounding seven culverts, fauna culverts entrance/exit, cassowary escape gates and three bridges.

- Aid habitat connectivity of riparian and general movement corridors;
- Provide food sources for attraction at underpasses;
- Influence a line of sight leading under the alignment at underpasses; and
- Implement a line of sight at cassowary exit gates.

Strategy	Road Alignment	Location	Species
Fauna Underpasses	All	Fauna culverts (exit) and Cassowary escape gates.	Grasses Low lying ferns, forbs and herbs <0.5m. Maintain a fauna line of sight. Ground covers which provide high wear and erosion protection. Cassowary fruiting species will only be used external to the fence.
		Underneath bridges for visual corridor	Ferns, forbs, cycads, vines and small shrubs <4m. Shade tolerant. Maintain a line of sight for Cassowaries. Can be cassowary fruiting.
		Adjacent to bridges and along riparian areas	Palms and trees can be up to 20m. All cassowary food sources for attraction to the underpass. Range of fruiting cycles.
		Swales, adjacent and below the bridges	Sedges. ferns, herbs, grasses and vines <1m. Low water velocity, can be groundcovers. Maintain a line of sight for cassowaries whilst adding food sources as an attractant. Shrubs suitable for external of cassowary escape gates.

Table 9.15 Revegetation Criteria for Fauna Underpasses.

Vegetated gabions and embankments

Many of the embankments currently along the road are near vertical and have a history of failure of the colluvium (Refer to Figure 9:9). Road cuts will require stabilisation with gabions and/or soil nails/passive dowels in conjunction with protective mesh depending on detailed Geotechnical evaluation. The Heath Point Headland comprises extensive weathered rock which may be amenable to steep cuts (refer to Chapter 5 *Geotechnical).* The height of the cuts in general are less than 3m except for the two sharp corners which are being reshaped, where the height extends to 8-10m for a short length of less than 20m. Given the short length of the high cut and the underlying weathered rock it is not considered that benching is required (Golder, 2007).

Figure 9:9 Existing bank stability at Heath Point. There are currently no mitigation measures to prevent landslides.

Two methods of bank stabilisation will be used:

- Where cut embankments are less than 3m and in predominant weathered rock the cut face will be battered back at 1:1 or less and further stabilised with soil nails/rock anchors and rockfall netting if required; and
- On cut embankments that are >3m or in colluvium and for fill batters on the low side of the road, rock filled gabions will be used.

Cut embankments will be covered with rockfall netting and/or geotextile as a substrate to hold soil and revegetation will take place with plants placed through the substrate.

Rock filled gabions will be placed in a stepped manner leaving a shelf between each row of gabions. Studies along the Kuranda range have established that vegetating gabions is a successful method of greening and improving the aesthetic appearance. The Heath Point Headland has a relatively drying environment despite the high rainfall and is windswept with exposed surfaces to the onshore breezes. It is anticipated that embankments facing north with higher solar radiation will be more difficult to revegetate and will require greater monitoring for signs of moisture stress.

Gabions will be used up to a height of 3 to 4m and above that height, stabilisation with soil nails/rock anchors and rockfall netting will be used (where geotechnical conditions allow) to soften the visual hardness of the gabions.

Gabions will be planted with species matching the RE; 7.11.34 around Heath Point Headland and 7.11.1 in the sheltered gullies of the two ephemeral streams. The vegetation selection criteria in Table 9.16 are based on location and exposure level.

Strategy	Road Alignment	Location	Species
Heath Point gabions and batters western side of road	Inside of corner	Low gabions and batters <2m.	Non bushy shrubs, vines, ferns and sedges <2m can be prostrate.RE 7.11.34.
	Straight road or outside of corner	Low batters and gabions	Shrubs, trees, ferns, vines and forbs can be any height. Low maintenance and wind tolerant species.
	All	Batters and all gabions >2m.	Taller trees and shrubs complement lower plantings.
		Steep batters, rock fall netting	Ferns, grasses, vines and forbs <1.5m visual cover only, due to steepness and potential for tree and branch fall.
Heath Point gabions and batters eastern side of road	All	Adjacent to low wall gabions.	Shrubs, ferns and vines low height <2m. Wind tolerant and low maintenance.
		Edge of road	Grasses, ferns and prostrate vine ground cover <1m. Wind tolerant and dry conditions.
	Heath Point park	On top of gabions	Grasses forbs, ferns, prostrate vine ground cover <1m. Salt and wind tolerant, primarily for aesthetic appeal.
		In front of gabions	Grasses, shrubs and sedges <3m. Salt and wind tolerant species, camouflage of gabions.

Table 9.16 Revegetation criteria for gabion and stabilised cut embankment

The "planter box" method trialled on the Kuranda Range (Environment North, 2004) will be utilised where appropriate. Due to the concerns with solar radiation and salt and wind exposure the proponent will trial alternative methods of plantings utilising "long stem" methods to enable the root ball to contact the soil substrate between the embankment cut and the inside of the gabion. The long stem method will use pipes placed in the gabion similar to the lifting pipes in Figure 9:11. A final planting method will be based on the success of these trials.

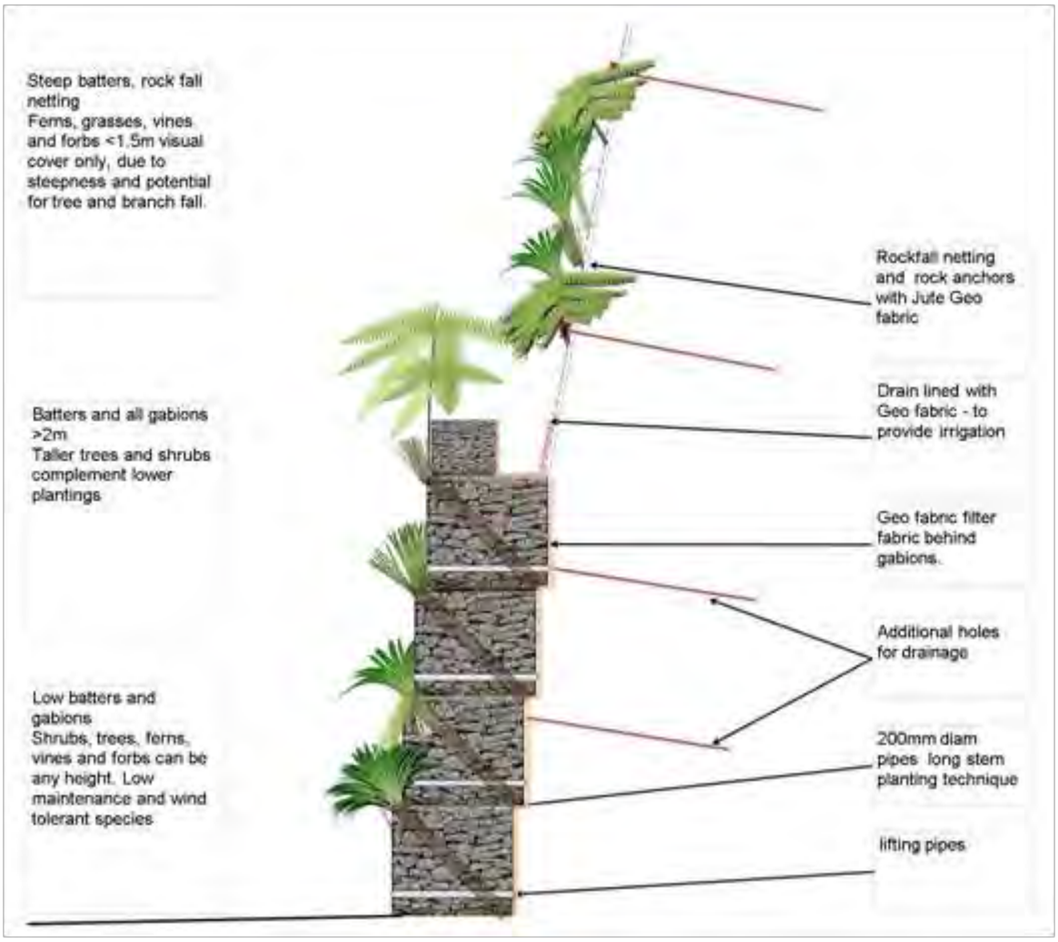

Figure 9:10 Schematic of gabion revegetation using long stem planting concept.

Figure 9:11 Installation of lifting pipes in gabions.
Figure 9:12 Section of unlined gabion showing establishment of ferns (Photos courtesy of Macaferri).

Weeds and Weed Control

The majority of weeds are restricted to the disturbed roadside margins to a distance of 2 to 3 metres but are unable to effectively compete in the shaded areas of the rainforest. The section of road from the Flying Fish Point to Heath Point Park is more disturbed and has a higher concentration and variety of weeds than the exposed elevated areas of Heath Point Headland. The dumping of domestic cuttings has introduced some exotic species.

The management of weeds will be critical pre and during construction of the road upgrade. The major issues to address are:

- Treat the weeds prior to construction;
- Minimise disturbance of soil and vegetation and limit clearing to the footprint of the construction envelope;
- Management of weed importation through pre and post cleaning of all vehicles accessing construction areas;
- Management of weed importation by control of any soil / sand / gravel, hydromulch or vegetation brought onto the site to be from a weed free source; and
- Covering of any loads leaving the site to minimize the spread of weeds along the transport corridor.

Species	Common name	Comment
Lantana camara	Lantana	Significant near and into WHA.
Megathyrsus maximus	Guinea Grass	Common along WHA headland.
Mimosa pudica	common sensitive weed	Extensive along most of the road
Sphagneticola trilobata	Singapore Daisy	Spreading infestation along most of road
Rubus alceifolius	bramble	Significant along the reserve and into WHA
Stachytarpheta cayennensis	Snake Weed	Occasional, both sides of the road.

Table 9.17 Most common and potentially invasive weeds (3D, 2009b).

Weeds will be treated prior to construction with a regime of traditional methods of application of non-residual herbicide applied on a regular basis prior to the start of construction. At the start of earthworks for that section the top 2cm of topsoil will be scraped and placed in a sealed and covered truck suitable for dumping offsite in a controlled emplacement. During the construction and after revegetation the area will be sprayed with non-residual herbicide on a regular basis until canopy cover or the start of succession seeding, where more controlled spot spraying or hand weeding may be required.

Fire

Fire is an ever present risk to revegetation and is further exacerbated by the use of geotextile materials and mulches. The driest most prone areas will be on the northern faces of the Heath Point Headland however it has been noted by (3D, 2009b) that the predominance of pioneer species along the headland reflects the cessation of the historic fire regime by the position of the road and the steep road cutting which has effectively prevented the spread of fires lit from the coast. Fire risk management will in any case be a requirement of the roadside revegetation management.

10. Construction Methodology

The construction methodology will be to focus on environmental controls and plan the works to fit within the dry season constraint.

Stage 1 construction Flying Fish Point to Ella Bay is scheduled to commence and be completed within the first construction year period, with major earthworks being conducted from May till December to coincide with the dry season. The construction schedule is complex in that the works are impeded by lack of articulated vehicle access past Heath Point and the narrow work footprint. Interruptions and change of construction focus will be made depending on fauna spotter reports of EVR breeding fauna. The use of offsite prefabricated components will be maximised to reduce heavy through-traffic and traffic disruption to local residents. For the project this will reduce construction time, and material storage at construction locations. Prefabricated components will include the bridge beams, culverts and gabion retaining walls. Gabions will be pre-fabricated off site and transported to locations only when required for assembly construction.

Stage 2 construction of the Flying Fish Point bypass and tunnel is scheduled to be conducted over a two dry season period due to the lengthy construction requirement of the cut and fill tunnel. The option of boring the tunnel if feasible may reduce the construction duration.

The Stage 1 construction will consist of three phases of construction. All construction phases are linked but not dependent on each other and can be performed simultaneously if appropriate or required to reduce time, resources and take advantage of the Wet Tropics dry season period.

Environmental Code of Conduct

To convey the importance of the environment to the construction workforce an Environmental Code of Conduct will be prepared to encompass all areas of environmental management. The Code of Conduct will draw from the National Parks regulations, WTMA codes and from the *Road Maintenance Code of Practice for the Wet Tropics World Heritage Area* and include further environmental conditions discussed within this document. This document together with the EMP will form the basis of the "why" the various elements apply.

The Code of Conduct will be prepared in a booklet and form part of the contract conditions for contractors and will be enforced through inductions, prestart training courses, tool box talks and Work Method Statements. The goal of the code will be to ensure that all construction workforces are aware of the environmental requirements' of the project.

The Code of Conduct will be conveyed to the local community and the major elements will be signposted in strategic places for visitor information.

Site Establishment & Environmental Management

The site establishment will be conducted prior to all other phases and its objective is planning and setting up the required infrastructure, environmental and traffic management processes. The site establishment will consist of setting up four Construction Management Compounds for coordination of the works (refer to *Management of Construction Infrastructure* in this chapter.)

The site establishment and environmental management will precede the construction activities and some aspects are able to be started before the dry season. The high level activity list for this phase is:

1. Weed Control (Current Alignment);
2. Local Area Traffic Management Plan (LATM) and Construction Traffic Plan Implementation;
3. Construction Management Compounds Establishment; and
4. Tree Clearing and Mulching All Sections

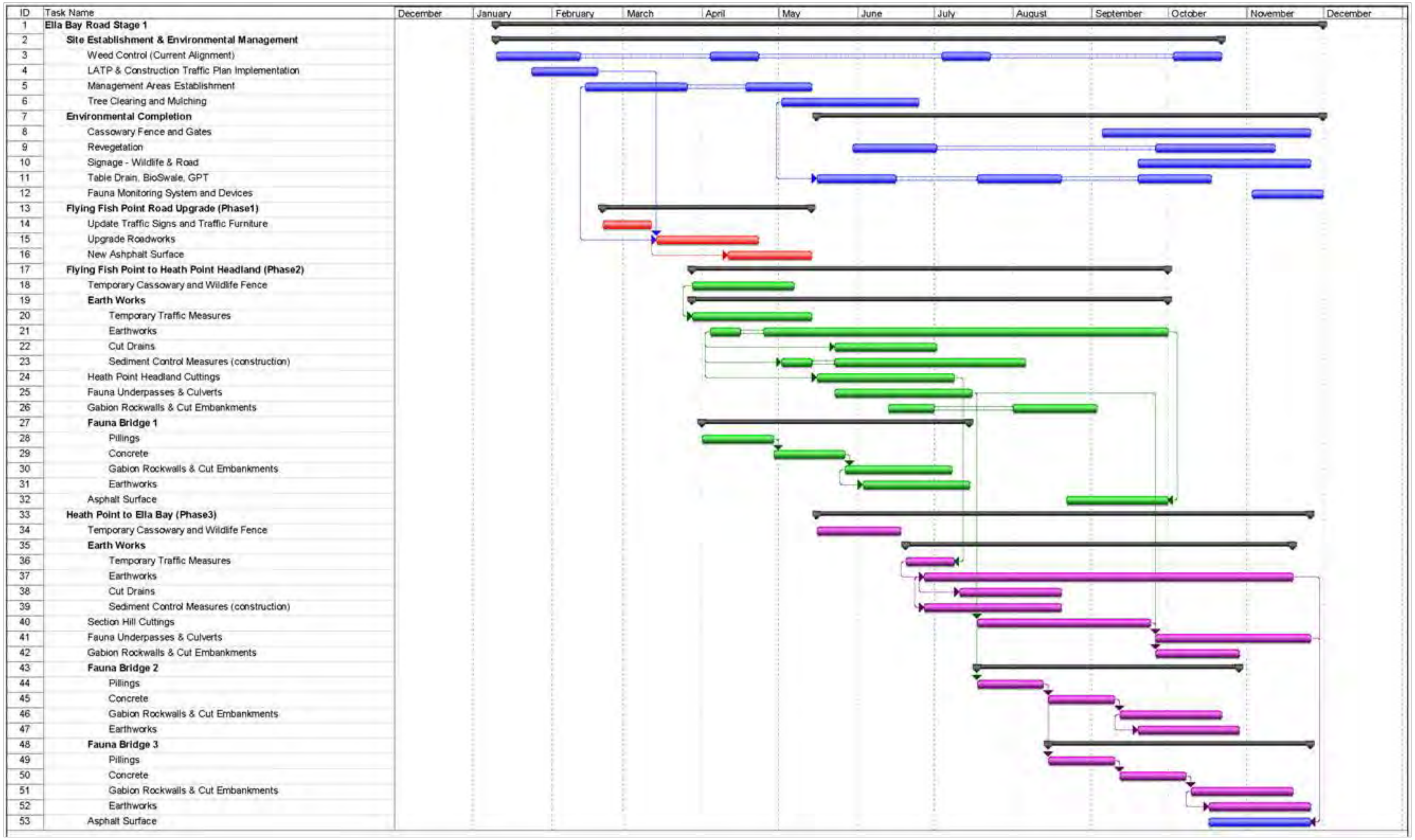

Figure 10:1 Schedule of Stage 1 Road Construction - Flying Fish Point to Ella Bay.

Environmental Completion

Environmental Completion has been added as a separate activity as it is applicable to all phases of the construction and can be initiated independently based on any portion of works nearing completion. Revegetation and erosion control measures will be performed throughout all of the construction process. With the exiting of the construction vehicles and construction personnel the installation of the permanent shadecloth cassowary fence will be conducted. Final fauna, flora and traffic monitoring devices and environmental awareness road signs will be installed.

1. Cassowary fence and gates;
2. Revegetation;
3. Wildlife signs;
4. Erosion and sediment control; and
5. Fauna, flora and traffic monitoring devices.

Stage 1 Phase 1 – FFP Road Upgrade

The upgrade of the current Flying Fish Point road network is necessary for the increased traffic flow due to construction traffic and future Ella Bay access. The upgrade will involve widening of the roads (refer to chapter 11 *Traffic Management Plans*) for increased traffic usage and safety of motorists and locals. Some aspects of Phase 1 that do not involve earthworks are able to be started before the dry season. The high level activity list for this phase is:

1. Updated traffic signs and traffic furniture;
2. Upgrade earthworks; and
3. New asphalt surface.

Stage 1 Phase 2 – Road Construction Flying Fish Point to Heath Point Headland

The initial construction of Ella Bay Road will concentrate on the section between Flying Fish Point to the end of Ella Bay National Park World Heritage area at road chainage 2600.

The priority will be to protect cassowaries from any interaction with construction traffic with the installation of a temporary shadecloth fauna fence along the proposed cassowary fence alignment to Heath Point. Cassowaries will be temporarily prevented from access to the reserve area during construction of the cassowary underpass. The approach ramps of cassowary underpass (bridge 1) and the elevation of Heath Point park to 5.0mAHD will require a substantial quantity of fill which will be partially sourced from excavated material from the Heath Point Headland cuttings at chainages 2100 and 2200. Construction work will be carried out simultaneously at the two locations. The fauna bridge 1 will be constructed using pre-fabricated concrete beams and pre-assembled gabions to minimise installation time. Tarmac sealing of surface will be conducted in sections to minimise stockpile storage of materials along the road. The high level activity list for this phase is:

1. Wildlife fence (Temporary Shadecloth);
2. Earthworks:
    a. Temporary Traffic Measures;
    b. Earthworks;
    c. Cut Drains;
    d. Geo Fabric; and
    e. Sediment Control Measures.
3. Heath Point headland cuttings;
4. Fauna underpasses and culverts;
5. Gabion rock walls;
6. Fauna Bridge 1; and
7. Asphalt surface.

Stage 1 Phase 3 – Heath Point to Ella Bay

Construction from the end of Ella Bay National Park area to the end of Ella Bay Road (CH 2600 to 4020), will involve construction through winding undulating section. The construction will involve embankment cuts, and low wall retaining walls. Construction will flow from south to north due to the need to widen the road in locations and the placement of pre-fabricated gabions (rock walls). The bridge construction will start as soon as the piles and bridge beams can be transported to the locations. The high level activity list for this phase is:

1. Wildlife Fence (Temporary Shade Cloth);
2. Earth Works:
    a. Temporary traffic measures;
    b. Earthworks;
    c. Cut drains;
    d. Geo fabric installation;
    e. Erosion and sediment control measures; and
    f. Pondage areas.
3. Section hill cuts;
4. Gabion Rock walls and embankments;
5. Fauna Bridge 2 Construction;
6. Fauna Bridge 3 Construction; and
7. Asphalt Surface.

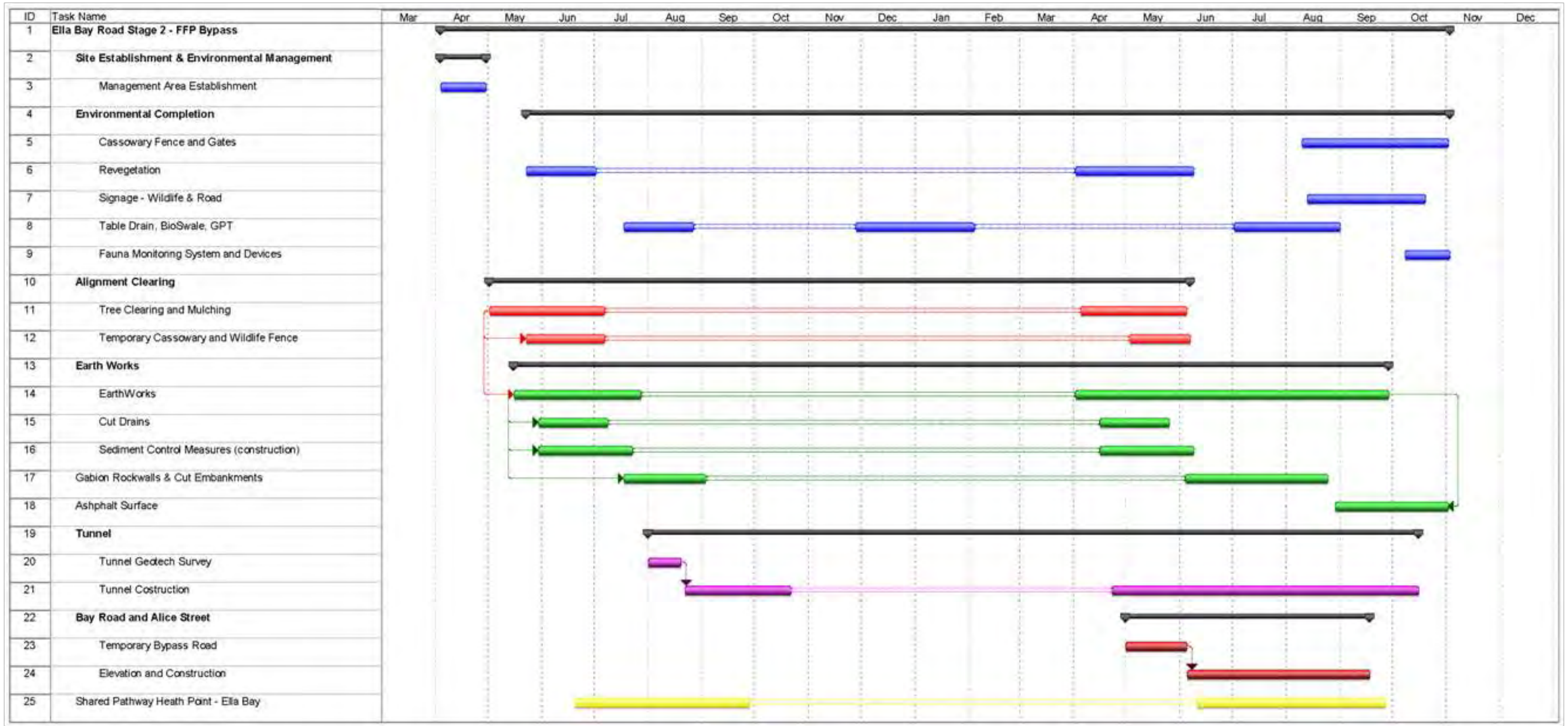

Figure 10:2 Schedule of Stage 2 Road Construction - Flying Fish Point Bypass and Shared Pathway.

Stage 2 Phase 1 – Flying Fish Point Bypass and Tunnel

Ella Bay Road Stage 2 construction will involve clearing a new road alignment over the ridge behind Flying Fish Point and the construction of the tunnel through the ridge.

The road alignment will be cleared and a temporary cassowary fence progressively installed to prevent contact with the construction process. After clearing and installation of a suitable access track, geotechnical studies will survey the ridge strata and determine the best approach for tunnel construction, whether suitable for direct tunnelling or cut and cover. Direct tunnelling will be the preferred method.

Material removed from the tunnel will used for the road alignment and for the upgrade of Bay Road and Alice Street. The upgrade of Bay Road and Alice Street will increase the road height of the roundabout to 5mAHD to cater for climate change sea level rise. Bay Road will require a local bypass within the alignment and traffic management. The high level activity list for this phase is:

1. Alignment clearing;
2. Progressive wildlife fence (temporary shade cloth);
3. Tunnel geotechnical survey;
4. Earth works:
    a. Earthworks;
    b. Cut drains;
    c. Geo fabric installation; and
    d. Sediment control measures.
5. Tunnel construction;
6. Bay Road and Alice Street:
    e. Temporary bypass road; and
    f. Elevation and construction.
7. Embankment installation; and
8. Asphalt surface.

Construction Environmental Management

The environmental management plan for the Ella Bay Road upgrade and construction will be a subset of the Ella Bay EMP (Environmental Management Plan). Environmental issues specific to Ella Bay Road construction have been identified and described below:

Clearing Inspection (Pre, during and post clearing)

Prior to any alignment clearing, an inspection to the area will be conducted by qualified flora and fauna spotter(s). The goal is to identify and mark any EVR and protected species, mark out clearing boundaries with tape and inspect for fauna within and near area to be cleared. This will ensure locations are clearly identified and all documentation and species locations on maps are updated prior to commencement of clearing. An arborist will assess the tree health and identify hazardous trees to be removed.

During the clearing process the qualified spotter will be present to guide and manage the avoidance of any over-clearing, damage to identified trees and injury to fauna and reclaim epiphytes and arboreal flora. During this process the spotter will be able to pause work and take appropriate measures to remove and relocate species where possible (flora and fauna). Post clearing a final inspection will be carried out to survey the area and its boundaries. Cleared vegetation stockpiles will also be inspected for fauna during the wood chipping process and removal from construction area.

Fauna Mortality Avoidance

Mortality avoidance to fauna in particular Cassowaries during the road construction will be specifically managed and carried out in methods described below:

- Education will be the primary method of fauna mortality avoidance. All construction workers and contractors will undertake fauna awareness training as part of the induction process. The training will focus on a conduct guideline for workers to follow in avoiding, responding and reporting fauna sightings or interaction. Traffic calming, temporary signage, monitoring and reporting measures will assist in enforcing guidelines;
- Fauna inspections prior and during clearing and construction by qualified fauna spotters and handlers. If fauna is spotted during the clearing or construction process, the spotter will pause operations and perform actions to remove, relocate and/or report to authorities (which ever are appropriate). Fauna spotting and reporting will be a major element of the overall construction progress where all construction staff will be educated to report sightings; and
- Progressive installation and maintenance of cassowary and fauna fence along road alignment section will be conducted during the construction process to prevent animals especially cassowaries coming in contact with machinery and personnel working within those sections. The fence will be installed at the perimeter of the construction works. Extra area isolation measures will also be implemented if required to isolate existing movement corridors during construction near those corridors.

Imported Materials - Weeds, Pathogens and Feral Animals

The goal will be to ensure that no weeds, pathogens or feral animals are introduced to the WHA and along Ella Bay Road. The proximity of the road to neighbouring townships and the long record of farming has meant many weeds and soil borne pathogens have already entered the area. It has been proposed (BAAM, 2007a) that all materials entering the site be certified weed and pathogen free, however after investigation this has been found to be impractical given the quantities involved and that many pathogens cannot be detected in the soil and only on the host once infected. The other problem is that pathogens are test specific so that testing for certain known pathogens does not guarantee that the sample is pathogen free.

For example; Chytrid fungus was found at Ella Bay site after extensive survey (Alford, 2010) , however Chytrid fungus cannot be detected in soil and to guarantee statistically that the fungus is not present on site would have required a minimum of 368 independent frog swab samples with zero positives, to provide an indication of a prevalence below 1% with 95% confidence.

The use of best practice with imported materials will be required (Department of Main Roads, 1998):

- Crushed rock from quarries is unlikely to contain contaminants, either weeds or pathogens, however strict quality control will be required to ensure that any alluvial or colluvial material from the high wall is not included;
- Gravels, sands and uncrushed rock may contain weeds and pathogens. There is no method of viable sterilisation for the quantities involved and the only option is to evaluate the sites and test for common pathogens, if there is any record of occurrence at the locality. The bioretention swales in particular will be filled and covered with imported materials;
- Topsoil may be required in limited quantities and will require testing or sterilisation with heat or fumigants. Preference will be to reuse topsoil and humus from the construction earthworks which will be stockpiled and respread; and
- Hydromulch often uses Bagasse (sugar cane byproduct) which has been heated in the processing. While the heating is part of the processing it does not guarantee sterilisation of pathogens and seeds. Some seeds are still viable after processing, although this has an extremely small risk.
- Potting mix and imported seeds. Potted plants will be sourced from certified nurseries which sterilise all potting mixes, chlorine wash seeds and sterilise equipment.

Best practice also includes wash down of all road plant, equipment and haulage trucks. Refer to *Management of Construction Infrastructure* in this Chapter. Covering of stockpiles is recommended where the stockpiles are off site or freshly quarried.

Feral animals are present in the WHA with pigs (*Sus scrofa*), cane toads (*Bufo marinus*) and domestic dogs and cats the most common. A feral pig control program has been ongoing for the past 2 years and the number of feral pigs has been significantly reduced. This programme will be continued. Cane toad trapping has been initiated and will be continued. The trapping has had limited results and will require more research into effective trapping methods. Domestic dogs and cats will be banned on the construction site. The problem will be with the general public and difficulty in stopping “pigging” (chasing down feral pigs with hunting dogs) which is an Innisfail pastime. Security and wildlife monitoring cameras have been installed and trespassers with dogs are reported to QPWS and police.

Erosion and Sediment Control

Environmental erosion and sediment control (ESC) best practice measures during the road construction will be used along the road alignment to minimise the amount of suspended, dissolved solids and construction pollutants entering the watercourses. Management of Stormwater runoff will be challenging during the construction phase due to the presence of steep slopes, high intensity rainfall and the constrained project footprint. The steep slopes will result in high runoff flow velocities and potentially causing high erosion. The constrained project footprint will limit the ability to install conventional downstream sediment control necessitating a much greater emphasis on erosion control.

The philosophy of the construction stormwater management will be similar to the operational practice with separation of clean run-on water from potentially contaminated construction site water. This will be achieved by:

- The western drainage and cross road culverts including culvert inlet and outlet protection will be installed early in the road works program to divert the cleaner run-on water through the disturbed area;
- The early installation of temporary drain linings, energy dissipaters and geofabric batter protection; and
- The use of diversion drains including end of day control measures to maximise dirty runoff into sediment traps and sediment basins.

Control of erosion from disturbed areas will be critical to meet discharge water quality criteria and to protect the site from damage. This will be achieved by:

- Careful scheduling to minimise the area and duration of soil exposure;
- Temporary lining of exposed soils including drains and batters until permanent erosion protection can be installed;
- The extensive use of rock filled wire basket retaining walls and reinforced earth embankments;
- Progressive stabilisation and revegetation of disturbed areas jute blankets and hydomulch where appropriate; and
- The use of temporary bunding, sediment and silt fences, sediment basins, pollutant traps, strategically positioned drains and cuts will be used across the entire length of the road construction.

Discharge of waters from the construction site will require meeting the water quality criteria. This will be achieved by:

- The use of temporary Type D/F sediment basins and chemical flocculation to minimise the discharge of turbid water from site;
- The sediment basins and retention ponds will be constructed within the road clearing envelope;

- Due to the constrained project footprint sediment basins will be constructed from geofabric lined rock filled wire baskets. The sediment basins will be two celled with an internal rock filled wire basket wall.
- Liquid calcium chloride will be used as the flocculation agent due to its benign chemical makeup.
- Erosion and sediment control plans (ESCP's) will be prepared for all phases of construction and land disturbing activities including each discrete catchment area. Progressive ESCP's will be prepared and each Each ESCP will be certified by an erosion and sediment control specialist.

An erosion and sediment control specialist will be employed during construction phase to:

- Prepare and certify ESCP's and provide technical advice;
- ensure best practice erosion and sediment control is practiced;
- undertake ESCP and site audits; and
- train the construction personnel.

The construction Contractor will be critical to the success of the erosion and sediment control and must be able to demonstrate an environmental track record with specific experience within a high rainfall environment.

Ella Bay Road Environmental Reporting and Auditing

A reporting and auditing systems for the Ella Bay Road construction will be in form of scheduled reports (monthly, weekly) and event based reporting. The combination of various separate legislative, industry and internal individual reports will form the basis and content for the Road Construction Progress Report which will be created and distributed monthly to main project stakeholders such as Ella Bay management, contractors' management, government and environmental authorities. The report's main objective will be to communicate to stakeholders the road construction project schedule progress and environmental monitoring, issues and resolutions. The report will be structured in two sections; Construction Progress and Environmental with the Environment section further divided into Flora, Fauna and ESC (Erosion Sediment Control).

The construction progress section of the report will inform stakeholders on key project issues and information such as:

- Report date ;
- Project status (% complete);
- Project summary;
- Key issues;
- Identified risks;
- Tasks and next steps;
- Decisions required; and
- Key future dates.

The environmental section will report the monitoring and any non-compliance to environmental issues for Flora, Fauna and ESC.

The reporting of environmental factors, environmental responsibilities of individuals, overall environmental management structure will be detailed in the Environmental Management Plans and Subplans (refer Volume 3 of the Ella Bay Submission Response Report).

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
Flora				
EVR and Protected Species Clearing	Implement: Pre-clearing inspection and marking by flora spotter. Identify EVR, Protected and other important fauna species.	Once: Prior to initial clearing	Event Based: Immediate reporting after inspection and marking. Report is a requirement prior to clearing activities.	Damage to EVR or Protected Species: Identify, notify environmental manager. Create Report. If individual can be saved: relocate and plant.
	Implement: Inspection by allocated spotter during the clearing period for EVR and Protected species	Ongoing: During clearing process and activities	Event Based: Reporting after clearing process is complete and area is inspected	
	Implement: Inspection and survey of cleared area after clearing.	Once: After clearing	Event Based: Reporting after clearing process is complete and area is inspected.	Damage to EVR or Protected Species: Identify, notify environmental manager. Create Report. If individual can be saved: relocate and plant.
Over Clearing	Implement: Pre-clearing inspection and marking of area boundaries by responsible construction staff	Once: Prior to initial clearing	Event Based: Immediate reporting after inspection and marking. Report is a requirement prior to clearing activities	Under Clearing: Identify report and adjust clearing if required.
	Implement: Inspection by allocated spotter during the clearing so as not to over or under clear.	Ongoing: During clearing process and activities	Event Based: Reporting after clearing process is complete and area is inspected	Over Clearing: Identify and report. Plan revegetation strategy for affected area.
	Implement: Inspection and survey of cleared area after clearing.	Once: After clearing	Event Based: Reporting after clearing process is complete and area is inspected.	
Weed Management	Weed maintenance and control of cleared area	Ongoing: As required during construction period	Monthly: as part of construction and	Evaluate the effectiveness of control measures and change

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
	as per EB EMP Weed Management Sub-plan		environmental reporting	if appropriate.
Cleared Vegetation Material Handling and Management	Implement: Inspection of cleared material such as trees, vegetation piles prior, during wood chipping and removal from construction area.	Ongoing: Prior, during wood chipping and removal of material.	Monthly: as part of construction and environmental reporting	
Dead Trees in clearing zone	Implement: Inspection of dead trees for fauna, relocation of fauna and dead trees beyond clearing zone	Ongoing: As required during construction period	Monthly: as part of construction and environmental reporting	If fauna are spotted during clearing, stop work, identify, report and relocate if possible
Cleared Soil Material Handling and Management	Implement: Inspection of cleared material such as soil, rocks and others prior and during removal from construction area for fauna. Relocate fauna beyond clearing zone.	Ongoing: Prior and during removal of material.	Monthly: as part of construction and environmental reporting	If fauna are spotted during clearing, stop work, identify, report and relocate if possible
Fauna				
Fauna Mortality Avoidance	Implement: Pre-clearing inspection by fauna inspector	Once: Prior to initial clearing	Event Based: Immediate reporting after inspection and marking of area. Report is a requirement prior to clearing activities	If fauna are spotted during clearing, stop work, identify, report and relocate if possible
	Implement: Progressive installation of cassowary and fauna fence prior and during construction	Ongoing: Working in conjunction with clearing activities	Monthly: as part of construction and environmental reporting	
	Implement: Continuous inspection for cassowaries within	Ongoing: During clearing process and activities	Event Based: Reporting after clearing process is complete and area is inspected	If fauna are continually within fenced enclosures. Identify problem, relocate animal and

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
	fences area during clearing activities by fauna inspector			rectify problem
	Implement: Traffic calming and monitoring measures	Ongoing: Monitoring during construction period.	Monthly: as part of construction and environmental reporting	If fauna are becoming an issue adjustments will be required to traffic calming measures and management plan
Fauna Management	Implement: Sightings reporting system	Ongoing: Pre and during construction period	Monthly: as part of construction and environmental reporting	If continuous near misses or fauna road kill or sightings near or on construction site adjustments to prevention measures will be required.
	Implement: Animal avoidance or relocation management system	Ongoing: Pre and during construction period	Monthly: as part of construction and environmental reporting	
	Implement: Reporting measures and conduct for animal road kills	Ongoing: Pre and during construction period	Monthly: as part of construction and environmental reporting	
Existing Movement Corridor Management	Implement: Specific isolation measures to areas prior to construction at locations	Event based: Isolation necessary during construction at specific location.	Monthly: as part of construction and environmental reporting	
	Implement: Strict monitoring procedures.	Event based: Monitoring necessary during construction at specific location.	Monthly: as part of construction and environmental reporting	
Fauna Awareness	Implement: Education and information package for all workers as part of induction process.	Event based: As part of induction	Monthly: as part of induction register within construction and environmental reporting	Inappropriate conduct will be managed appropriately. If required modification to education and information package will be conducted.

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
Erosion Sediment Control				
Deterioration of Water Quality	Implement: Water management sub-plan for construction	Ongoing: Monitor quality of streams and drainage paths in accordance with Water Management Sub-plan.	Ongoing: Regular compliance reporting	Non compliance diversions from baseline will be reported and immediately rectified.
Staff awareness and procedures	Implement: Training program as part of induction procedures.	Event based: As part of induction		If not appropriate conduct by construction staff modify an update training methods. Redo training if required.
Storm Water Control	Implement: Drains and graded surfaces (gravel surfaces, rock barriers, concrete surfaces, jute material, grasses).	Ongoing and event based after rain periods: Monitor quality of streams and drainage paths in accordance with Water Management Sub-plan.	Monthly: as part of induction register within construction and environmental reporting	Non compliance with control measures will be: - Reported, - Cause Identified - Rectify
Sediment Control	Implement: sedimentation dams, Sediment Fences, Silt Fences, Gravel surfaces.	Ongoing and event based after rain periods: Monitor quality of streams and drainage paths in accordance with Water Management Sub-plan.	Monthly: as part of induction register within construction and environmental reporting	Non compliance with control measures will be: - Reported, - Cause Identified - Rectify
Vehicle and Machinery Pollutants Control	Implement: Vehicle Spill Kits and user training	Event based: As part of induction	Monthly: as part of induction register within construction and environmental reporting	Compliance to spill procedures must be revised if not appropriate for containment.
	Implement: Vehicle & Machinery Maintenance standards procedures and compliance	Ongoing: During construction period	Monthly: as part of construction and environmental reporting	Vehicles must be serviced and comply with operational standards
Stockpiles Management	Implement: Measures to contain stockpile material and water runoff from stockpiles (ie	Ongoing: Prior, during and post construction measures will be in place and monitored	Monthly: as part of construction and environmental reporting	Non compliance with control measures will be: - Reported,

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
	bunded areas, Sediment and/or silt fence enclosures, covers if required).			- Cause Identified - Rectify
	Implement: Hydrologic sound areas away from possible water path and water courses.	Once: Selection and set up of areas prior to construction.	Event based: Report presented after areas are prepared for stockpiles.	If areas are found to not be adequate, relocation will be necessary.
Chemical Stores	Implement: Appropriate area containment area and appropriate storage as per regulation and standards	Once: Set up of area and facilities prior to construction		
	Implement: Handling of chemicals as per management sub plan , training, procedures and emergency planning	Ongoing: Monitoring and auditing	Event based: Report presented after areas are prepared for chemical stores	If areas are found to not be adequate, relocation will be necessary
	Implement: Spill kits, emergency kits and training	Once: Spill and emergency kits provided. Training as part of induction procedure	Monthly: auditing and reporting as part of construction reporting updates and environmental reporting	Non compliance with control measures will be: - Reported, - Cause Identified - Rectify
Disturbance to soil caused by construction traffic activities.	Implement: Apply Construction Traffic Management Plan	Ongoing: Prior, during and post construction measures will be in place and monitored	Monthly: as part of construction and environmental reporting	Non compliance with control measures will be: - Reported, - Cause Identified - Change TMP
	Implement: Avoid unnecessary construction vehicle and machinery operation and movements during	Ongoing: Prior, during and post construction measures will be in place and monitored.	As required: Report as required if necessary.	Non Compliance with control measures, reinforce Traffic Management Plan

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
	heavy or continuous rain periods.			
Embankment Stabilisation	Implement: Continuous inspections of exposed embankment cuts.	Ongoing: Prior, during and post construction measures will be in place and monitored	Monthly: as part of construction and environmental reporting	If notices that embankments are not stable: - Reported, - Identify cause -Implement stabilisation measurements
	Implement: Change water runoff paths by use of diversion drains	Once and event based: Selection and construction diversion measures prior to embankment work. Inspection during rain events	Monthly: as part of construction and environmental reporting	Change water runoff paths if not appropriate
	Implement: Stabilisation and manage measures to embankments (fences, gabions, rock structures, nailing)	Once and ongoing: Prior, during and post construction measures will be in place and monitored.	Monthly: as part of construction and environmental reporting	If notices that embankments are not stable: - Reported, - Identify cause -Implement stabilisation measurements
Construction Machinery Waste Management	Implement: Procedure and management process for onsite collection, containment, storage and removal of waste.	Ongoing: Prior, during and post construction measures will be in place and monitored.	Monthly: as part of construction and environmental reporting.	If system is found to not be adequate, modification will be necessary.

Issue	Mitigation / Control Measures	Monitoring / timing	Reporting	Corrective actions
Construction Material Waste Management	Implement: Procedure and management process for onsite collection, containment, storage and removal of waste or excess construction material (skip bins, containers, trucks)..	Ongoing: Prior, during and post construction measures will be in place and monitored.	Ongoing: Prior, during and post construction measures will be in place and monitored.	If system is found to not be adequate, modification will be necessary.
Human Waste Management and Removal	Implement: Provision of amenities at specific locations and appropriate removal of waste	Once and ongoing: Construct and install amenities in appropriate locations. Manage the removal of waste appropriate	Monthly: as part of construction and environmental reporting	If notices that control measures are not appropriate immediately report, identify cause and rectify.
	Implement: Education to construction staff on appropriate use of facilities (ie not going to toilet in bush).	Event based: As part of induction	Monthly: as part of induction register within construction and environmental reporting	
Wash Down Area Discharge Management	Implement: Hydrologic sound areas away from possible water path and water courses	Once: Selection and set up of areas and procedures prior to construction.	Once: Report of areas after selected and constructed.	
	Implement: Bunded areas with settling pond and filtering measures.	Ongoing: Prior, during and post construction measures will be in place and monitored		
	Implement: Appropriate removal and destruction of material form construction area.	Ongoing: Prior, during and post construction measures will be in place and monitored.	Monthly: as part of construction and environmental reporting.	

Management of Construction Infrastructure

Four Construction Management Compounds (CMCs) will be established to service construction areas, control project materials and equipment and minimise construction traffic movement:

1. Catelan Road;
2. Seahaven Prawn Farm;
3. Little Cove property; and
4. Ella Bay Property.

The Catelan Road CMC, to west of Coconuts, has been chosen for vehicular movement control to minimise construction traffic through Coconuts and Flying Fish Point. The road is opposite the Carello Palm Swamp Conservation Park and provides a slow point for construction traffic to minimise risk of fauna mortality in turning north into Catelan Road. The existing intersection from Bay Road has left and right hand turn lanes.

Light vehicles of construction workers will be prevented from driving directly to the construction site. This will be a requirement off the construction contract. A bus set-down / pick-up area and parking centre will be provided for bussing of workers to the construction site. Heavy vehicles carrying payloads and plant will be required to stop for inspection, washdown and traffic management instructions prior to continuing their journey to Ella Bay Road.

Figure 10:3 Catelan Road Construction Management Area concept layout.

The compound at the Seahaven Prawn Farm will be the Ella Bay Road construction office, amenities and site based laydown area. The site one is one of the old pondage areas which has perimeter fencing, been previously bunded and will provide environmentally secure materials and equipment storage. The Little Cove CMC will be a lay down area for bridge materials and equipment parkup. The Ella Bay CMC will be the lay down area for materials, stockpiles and equipment parkup.

The use of four separate compounds will enable a considerable reduction in heavy and large vehicle construction traffic as materials and components can be stored and assembled at the CMC locations. The four CMC’s have been selected for their strategic, and environmentally safe locations and are identified in Table 10.1 which identifies each CMC’s services.

Storm Water Treatment

Each of the CMCs will be bunded and storm water runoff from within the enclosure will be treated through silt fences, gross pollutant traps, oil traps and sediment ponds to avoid any discharge of pollutants and sediments into water courses. Water monitoring and regular site inspections after rainfall events will be administered as part of the management procedures and control.

Equipment Parkup and Maintenance

Construction equipment will be parked up and stored within the CMC areas to control the possible discharge of oils and greases. A focus will be to minimise the transportation of heavy machinery via the local road traffic by storing and maintaining the equipment within the CMC areas until the equipment is no longer required.

	Laydown Area Catalan Road	Laydown Area Seahaven Prawn Farm	Laydown Area Little Cove	Laydown Area Ella Bay
Office/Amenities	X	X		
Parking	X			
Pick Up / Drop Off	X	X		
Machinery Storage		X	X	X
Material Storage	X	X	X	X
Stockpile Storage	X	X	X	X
Chemical Storage	X	X		
Wash-Down Semi Permanent Facility	X	X		X
Wash-Down Mobile Facility			X	
Gabion Prefabrication	X			

Table 10.1 Construction Management Compounds.

Clearing and Dead Tree Management

The upgrade and total construction of Ella Bay Road alignment will consist of clearing of 3.15ha including 0.66ha of the World Heritage Area. Area clearing will be performed prior to any other construction work. Inspections by fauna and flora spotters will be conducted prior and during the clearing process. As clearing is conducted the vegetation material upon visual inspection will be wood chipped immediately by mobile wood chipping machines and transported to Ella Bay property where it will be stored in stock piles for future revegetation use. Erosion and Sediment Control measures will be implemented immediately after clearing has finished in each individual area.

Any dead trees or limbs will be inspected for fauna and then moved into adjacent vegetation for fauna use i.e. 'fauna furniture'

Weed Management

The identification, prevention and treatment of weed species within the road construction alignment area and surroundings will be managed as per Ella Bay EMP for Weed Management. Also refer to Chapter 4 *Weeds, Pathogens and Feral Animals* and Chapter 9 *Weeds and Weed Control* Chapter 10 *Imported Materials - Weeds, Pathogens and Feral Animals*

The road alignment weed management will start prior to clearing to avoid the further spread of weeds within the area and contaminating wood chip material. Wash-down facilities will be used for weed control management during construction for all Vehicle and Equipment.

Wash-down Facilities

All vehicles, and off road equipment will be inspected and washed down prior to entry into Ella Bay Road Construction site at the Catelan Road CMC. All Vehicles exiting the Ella Bay Road Construction site will be inspected and washed down either at the mobile washdown facilities off road exit or at the Seafarm or the Little Cove CMC prior to entering onto the Flying Fish Point public roads.

Detailed procedures, check lists and audit measures and records of use will be developed for strict adherence to cleaning and wash down procedures to ensure there is no introduction or contamination of exotic weeds and / or pests.

Washdown water will be contained, recycled and treated at the facility and no local discharge will occur. The recycled water sediment will be removed off site and treated to destroy seeds and then irrigated. Waste from the oil-water separators will be disposed of by an approved disposer.

Concrete waste water will not be allowed to discharge outside of the bunded wash-down facility. The concrete waste water is highly alkaline and will require naturalisation or pH adjustment.

Material and Stockpile Store

Construction material delivery will be sequenced to minimise on-site storage. The Catalan Road CMC will provide temporary storage for some materials prior to construction site delivery. Refer to Chapter 11 *Traffic Management Plans* for details of delivery management.

Stockpiles of materials such as road base, crusher dust, rocks, topsoil, sub grade fill, wood chips and other asphalt components will be located within defined and labelled laydown areas.

Stockpiles will be located in most cases within the Construction Management Compounds. Temporary stockpiles will be required adjacent to work areas. All stockpiles will be contained by perimeter sediment control fences. Stockpiles outside the Construction Management Compounds will be placed within the road alignment envelope on a hydrological sound area with appropriate storm water diversion drains and sediment control fences.

Covers to stockpiles will be used when necessary. Stockpiles will be in accordance with Department of Main Roads QLD Standard Specifications with a maximum height of 2 metres. Water and air quality meters will be used in conjunction with legislative requirements outlined in the Environmental Protection (Water) Policy 2009 and the Environmental Protection (Air) Policy 2008.

Chemicals Store

Chemicals will be stored in the CMC areas. Chemical storage and usage will be limited, and will be mainly confined to herbicides, flocculants and water treatment chemicals, oils, greases and fuels. Appropriate storage facilities will be constructed within the CMC to comply with environmental and legislative requirements for the safe chemical storage and management. The storage areas will incorporate all the safety and emergency containment requirements such as Materials Safety Data Sheets (MSDS), bunding, containment fences, shelter, pollution controls, spill kits, emergency kits and security. On-site chemical use will adhere to TMR Technical Specifications for Environmental Management.

Storage of chemical wastes, such as waste fuels, oils, batteries and chemicals, will be within the chemical storage compound, and on bunded pallets.

Gabion Prefabrication

Retaining wall gabions will be prefabricated offsite or at the Catelan Road CMC. The prefabricated Gabions will be transported via truck and craned into the position to minimise environmental impact, construction time and road delay. This technique is suitable for top down construction of low walls and high walls to minimise the disturbance footprint.

Acid Sulphate Soils:

The road alignment has been designed to be above a minimum elevation of 5mAHD. Areas that are below that level will be filled with compacted road base. The Queensland State Planning Policy applies to areas that are below 5mAHD and filled with greater than 500m². The Stage 1 road alignment has two areas that are below 5mAHD and the fill required is significantly less than 500m². The proposed Stage 2 road alignment elevation of Bay Road requires fill in excess of 500m² with an average depth of 0.5m and may trigger SPP2/02. The elevation of Bay Road is not critical to Ella Bay development and is part of planning for climate change sea level rise and will be raised with EPA at the preliminary design of Stage 2.

Asphalt batch plant:

Asphalt mix and laying processes will be in accordance with Department of Main Roads Standard Specifications MRS 11.30 where the asphalt will be manufactured, laid and compacted by approved suppliers. The approved supplier will also adhere to strict environmental guidelines imposed by Ella Bay in managing the equipment, paver machines, material and staff throughout the asphalting process. Mobile batch mixing plants will be located at Catalan Road or the Seafarm CMC and will supply the mix which will be transported to asphalt works location via vehicles equipped with leak proof, spill proof tipping trays as per Main Roads standards.

Material Reuse and Recycling

Material and Waste reuse and recycling are environmental principles of Ella Bay Development and all contractors will adhere to best practice waste management and recycling practices and comply with Environmental Protection (Waste Management) Policy 2000 and Environmental Protection (Waste Management) Regulation 2000.

The major construction wastes, such as cleared vegetation and waste rock, fines, soil and concrete, as well as washdown water, will be reused or recycled at the construction site and Ella Bay Development area.

Cleared Vegetation

Cleared vegetation material will be mulched as it is cleared and transported to the Ella Bay CMC where it will be stored in stockpiles for later use with revegetation along Ella Bay Road or within the Ella Bay development.

Internally Sourced Fill Material

Road and embankment, cut and fill will be balanced progressively as much as possible. During excavation, cuttings or earth works blasting will only be considered as last resort. All dust suppression and erosion/sediment controls will be in place in accordance with EPA 1994 and DTMR guidelines.

Excavated material from cuttings and/or earth works will be prioritised to be used as engineered fill within the road construction at other locations where required. Excess material will be transported to Ella Bay property where it will be placed and stored in stockpiles for future construction use incorporating the current erosion sediment controls of bunding, sediment fencing, berms, settling ponds and location consideration in relation to waterways and local hydrological paths. Stormwater flows from the stockpiles will be captured for collection for reuse on-site where possible. Any excess material inappropriate for future construction or rehabilitation requirements will be removed from construction site by haulage trucks and will be subject to the disposal and transportation regulations.

Topsoil

The success of the revegetation is affected by the quality of the topsoil. Topsoil on the site will be reused as soon as possible with preference to directly returning the topsoil to areas under revegetation. The topsoil should not be stockpiled and allow to become anaerobic and destroy the soil structure organic matter and nutrients.

The top soil along the weed infested roadside margin will be stripped of the top 2cm and removed. The remaining topsoil (the A1 horizon typically 100-300mm) will be removed without including excess clay and deeper soils. Topsoil stripping should not occur when the soils are too wet or too dry (Department of Main Roads, 1998).

Imported Fill Material

The use of excavated material generated from construction activities will be utilised in preference to any imported fill. Imported fills are expected for selected materials, which may include but not restricted to: drainage layer material; unbound and bound road sub-base, selected gravels. Imported materials will be hauled by road as detailed in the Traffic Management Plan and delivered to designated stockpile areas. Road Construction imported materials will be in accordance with Department of Main Roads Specifications MRS 11.04 and VENM (Virgin Excavated Natural Material) and Excavated Natural Material (ENM).

Concrete

Excess concrete will be recycled by boxing in gabion block sized moulds and used in base course embankment construction.

Waste Reuse and Recycling

Waste will be recycled or reused as far as practical, including:

- Reuse of timber formwork at Ella Bay Development site;
- Recycling of scrap metals and plastics;
- Recycling of packaging waste (e.g. bottles, cans, boxes, drums);
- Recycling of office paper;
- Recycling of waste oils and batteries; and
- Reuse of excess chemicals (e.g. solvents, herbicides) at Ella Bay Development site.

Recyclable wastes will be stored in separate bins or areas as appropriate, for collection by a licensed waste contractor and recycling off-site.

Storage of domestic rubbish and packaging wastes will be in covered bins or skips located near to the site office, ablutions and workshop areas, with the bins colour coded and/or marked to denote waste segregation requirements.

Storage of mixed building wastes and recyclable building wastes (e.g. scrap metal, plastic or timber) will be in skips and located at a designated area.

Sewage will be stored in tankage and removed from site, designed to Australian Standards and to the approval of the relevant authority.

All regulated wastes will be tracked as required under Queensland legislation, and collected by licensed waste contractors for off-site recycling, treatment or disposal.

It is anticipated that there will be a range of wastes requiring treatment or disposal to landfill, wastewater treatment plants or other licensed waste facilities, including the following:

- Domestic rubbish (e.g. food, textiles, packaging);
- Non-recyclable packaging (e.g. foam, shrink wrap);
- Non-recyclable building wastes;
- Tyres;
- Contaminated soil and spill response materials;
- Non-reusable waste fuels, oils and chemicals; and
- Sewerage tank and oil-water separator pump outs.

All waste will be removed from construction site in covered approved containers (skips, bulk haulage trucks) and no waste will be burned or buried. Upon completion of works area will be inspected where any extra waste and other unwanted material or equipment will be removed.

11. Traffic Management Plans

The objective of the traffic management plan is to:

- Minimise disturbance and inconvenience for residents of Coconuts and Flying Fish Point through the Local Area Traffic Management Plan;
- Minimise workforce traffic movements through Coconuts and Flying Fish Point;
- Manage traffic during construction; and
- Communicate the plan to residents and workforce.

Local Area Traffic Management Plan

The Local Area Traffic Management Plan (LATM) is designed to manage the traffic through Flying Fish Point to minimise disturbance, inconvenience and provide the highest safety to local residents. The local community, primarily impacted by the traffic will be the residents, school students, caravan park guests and tourists. The plan comprises upgrading the local Flying Fish Point roads and a construction traffic usage plan. The local traffic will also be slowed by street furniture, in particular near crossings and bus stops.

Bussing of workers will be used to minimise traffic movements in particular of light traffic. A mustering and parking centre will be provided to the west of Coconuts at Catelan Road for bus set-down / pick-up area.

Workforce movements will be restricted to daylight hours of 6:30am to 6:00pm, Monday to Saturday. Saturday work will be required to be able to complete the construction during the restricted dry season window.

Heavy vehicles and plant equipment will be restricted to travel through Flying Fish Point during daylight hours (6:30am to 6pm). Heavy vehicle and plant equipment travel will be reduced to less than 10 heavy vehicle movements per hour during the school zone times (7.30-9am to 2.30-4pm). All heavy vehicles travelling to the construction area will be required to report to the Catalan Rd office for weed inspection, washdown and to satisfy traffic management curfew restrictions.

The heavy vehicle traffic will comprise predominately large rigid and articulated trucks, for gravel, concrete and gabion transfer with the exception of oversize loads for bridge piles and beams. Oversize loads will be restricted to non school zone time and non peak hour time of the day travel.

Construction Traffic Management through Flying Fish Point

Three traffic routes (figure 11.1) will be utilised to reduce disturbance:

- Heavy Vehicle Route. This route passes along Elizabeth St and then east to the Esplanade and west along Ruby St. The route was chosen to pass the least number of houses (23), larger radius corners, less overhead power lines, and the major power pole at the intersection of Elizabeth and George Streets will not require relocation;
- Light Vehicle Route North. The route travelling north passes along Elizabeth St and the west along George St, north along Maud St; and
- Light Vehicle Route South. The route travelling south passes along Ruby St to Maud St, south to George St and then south along Elizabeth St.

Resurfacing and corner upgrades will be required at:

- Along Elizabeth Street, Ruby St and the Esplanade in Flying Fish Point with widening of the sealed road to 2 x 3.5m lanes, consistent with Bay Road;
- The intersection of the Esplanade and Ruby St will require localised widening and the inclusion of chevron marking for articulated vehicle sweep path;
- The intersections of Elizabeth and George St, George and Maud St, Ruby and Maud will require street furniture and splitter islands;

Figure 11:1 Local Area Traffic Management in Flying Fish Point.

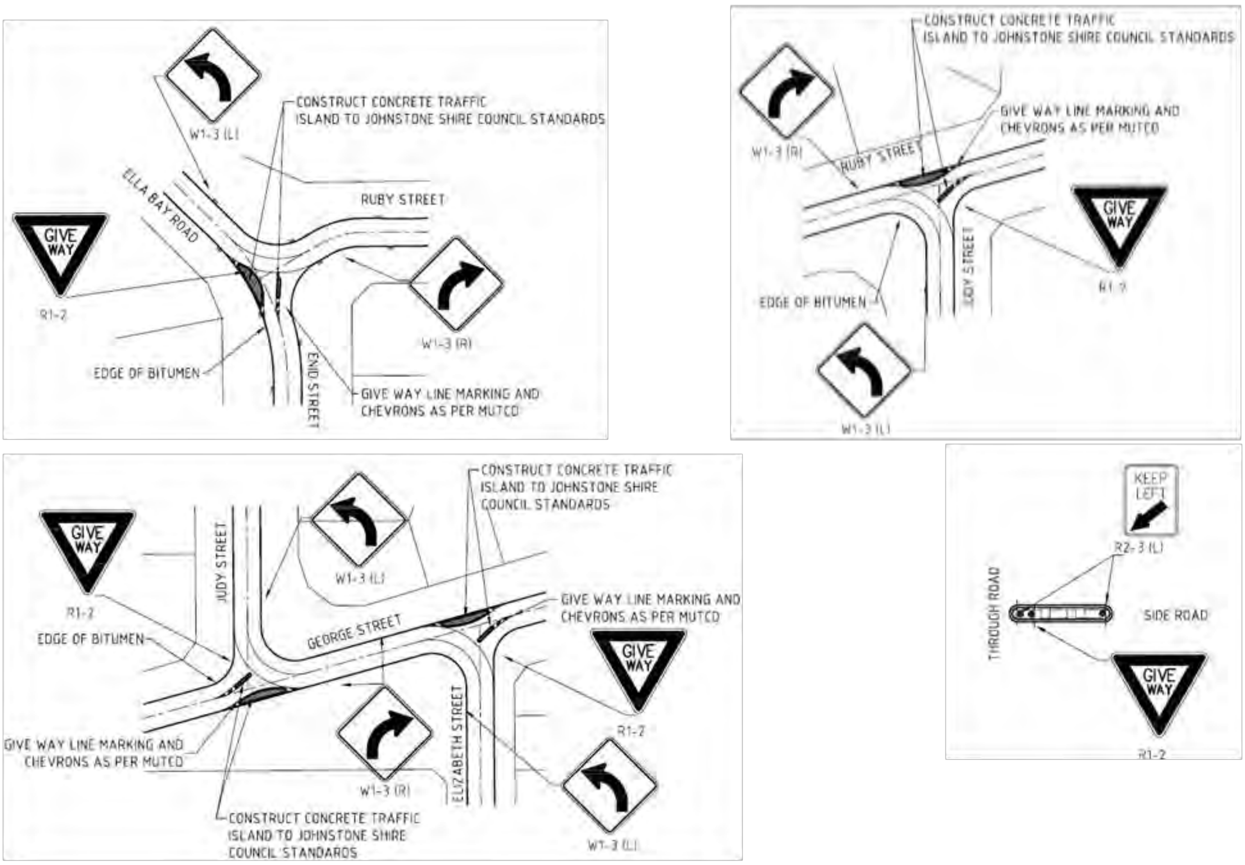

Figure 11:2 Local Area Traffic Road Furniture.

- Localised slow points (platform pedestrian/school/bicycle crossings) will be installed at school crossing points and bus stops; and
- Coconuts; With the increase in traffic turning left from the Palm Avenue into Bay Road, it is anticipated that the three way intersection with current concrete kerb channelisation will require replacement with further separation for north bound traffic.

During Stage 2 works, entries will be established from both ends of the Flying Fish Point Bypass. The entry from the south will be at the intersection of Alice St and Bay Rd and will only require intersection management not local traffic management. The entry from the north will require the same management plan as per the Stage 1 LATM for Flying Fish Point.

Workforce Vehicular Movements

The Catelan Road site has been chosen for vehicular movement control to minimise construction traffic into Coconuts and Flying Fish Point. The existing intersection from Bay Road has left and right hand turn lanes.

From Catelan Road busses will transport the majority of workers through Flying Fish Point and onto the Ella Bay Road alignment. Light vehicles such as Ella Bay staff, contracting management and specific use vehicles will be permitted to use Flying Fish Point. Heavy vehicles carrying payloads and plant will require inspection, washdown and traffic management prior to continuing their journey for a further 6kms, travelling through Coconuts and Flying Fish Point until they reach the work destination.

The use of the Catelan Road Compound during the stage 1 road construction will reduce the traffic movements through Flying Fish Point and along Ella Bay Road to 208 trips/day. Refer to Appendix 3 Revision to Road Usage Demographics.

Traffic Generation	To Catelan Road v/d	To Site Two way v/d	Basis
Employee Light Vehicles	150	40	15 management and tech staff in/out plus business trips
Site Visitors	20	10	Restricted to High occupancy Vehicles 5/HOV
Bus	25 (East)	50	250 workers ave 10/bus
Truck Deliveries - Fuel	2	4	Delivery to Seahaven compound
Truck Deliveries - Parts	2	4	Delivery to Seahaven compound
Truck Deliveries – Bulk Materials	40	80	2 deliveries/day/$m road works
Other Deliveries	10	16	80% direct delivery
Small to Medium Trucks	10	4	Contents marshalled at compound
Total traffic movements per day	468	208	

Table 11.1 Road Construction traffic movements Year 2.

Ella Bay Road Traffic

Ella Bay Road is a low traffic gravel road passing through Ella Bay WHA and primarily functions are for recreational use, Seahaven Prawn Hatchery movements and access to Ella Bay properties. The measured road traffic is between 75 to 150 vehicles per day, with a peak of 10 vehicles per hour. The posted speed is 40km/hr, with vehicles travelling between Flying Fish Point and Heath Point Park travelling at up to 60km/hr and around Heath Point at 20 to 30 km/hr.

Speed limits during construction will be kept to current signage. Vehicles passing the specific areas of works will be slowed to 20km/hr. Once the road is sealed the limit will be increased to a design-based standard of 60km/hr.

Local Traffic

Movement of local traffic during construction will be determined by the type of construction activity:

- Tasks involving cassowary fence assembly, clearing, bridge piling, grading, small cuts and embankment construction, will allow traffic to flow past construction areas with possible 5-10 minute delays and single lane travel at lowered speeds; and
- Tasks such as culvert installation, large cuts and embankment construction on Heath Point (CH 1600-2700) and activities with a potential safety risk to passing traffic will cause road closures. Notification of the closures will be as per the communication plan.

Emergency traffic will have priority over all works. If requested an escort will be provided by Ella Bay staff using their comprehensive knowledge of the road and construction activities.

Construction Traffic

Road based construction traffic; haulage and delivery trucks, and busses will run through the worksite and mix with local traffic. Some mixing of heavy plant will occur due to the limited footprint of the worksite, together with the low numbers of local traffic. In general heavy plant will be separated from the local traffic.

A detailed Construction Traffic Management Plan will be required to reflect the current proposal of works. The contractor chosen will be responsible for providing such documentation outlining workforce training and awareness. This concept is paramount for contracted plant operators and haulage experts entering the World Heritage Area (CH1040-2600).

Construction Traffic Management

The road design concept of minimising clearing and environmental footprint of temporary and permanent works will require the majority of the road to be constructed under traffic. A sidetrack will be required for construction of Bridges 1 and 2.

Temporary closures will be unavoidable, but it is proposed to maintain the existing minimum single lane movement during the majority of construction. This will be delivered through use of traffic signals in conjunction with a single lane bypassing the specific area/s of construction. The cutting works past Heath Point park will require more extended closure of the road. This portion of the road services the Ella Bay Properties and visitors to the WHA.

Table 11.1 below describes how traffic will move along Ella Bay Road during Construction Phase of Stage 1 and Stage 2. Stage 2 is a new alignment and will only require construction management for the elevation and upgrade of Bay Road.

Section	Work Description	Construction Operation	Traffic Management
0000 - 0350	Upgrade of existing alignment.	Small area of clearing and cut to widen the alignment for drainage and protected trees. Replacement of pipe culverts with box culverts.	Single lane open. Traffic lights or traffic personnel to control movement. Short periods of temporary closure.
0350 - 0650	Fauna Underpass Bridge 1 and Fauna Culvert 3 installation.	Bridge construction and a large fauna culvert. Small area of clearing and cut to widen the alignment for drainage and protected trees.	Temporary Construction sidetrack CH0370–0530 to bypass bridge construction, Single lane open. Traffic lights or traffic personnel to control movement. Short periods of temporary closure.

Section	Work Description	Construction Operation	Traffic Management
0650 - 1600	Realignment and upgrade along Prawn Farm property.	Alignment changes to protect trees. Small area of clearing and cut to widen the alignment for drainage and protected trees. Replacement of pipe culverts with box culverts.	Prawn Farm employees to have priority entering and exiting (CH1100). Single lane open. Traffic lights or traffic personnel to control movement. Short periods of temporary closure.
1600 - 1750	Car park construction.	Gabion installation and fill at existing carpark; to be raised by 1.5m. Embankment installation on eastern side. Small area of clearing, cut and fill to widen the alignment for drainage and protected trees.	Single lane open. Traffic lights or traffic personnel to control movement. Temporary sidetrack through existing tracks of car park at Heath Point Park. Short periods of temporary closure.
1750 - 2900	Heath Point Headland earthworks. Installation of Fauna Culverts 15 and 16. Vista Point construction.	Large cut/fill sections along Heath Point. May require some blasting and stabilisation techniques pending on geotechnical outcomes. Two large culverts to be installed as fauna underpasses.	Road closures required for blasting and for extensive cuts or constructing retaining walls. Other times - single lane open. Traffic lights or traffic personnel to control movement.
2900 - 3700	Fauna Underpass Bridges 2 and 3 with Fauna Culvert 20 installation.	Extensive bridge construction and large culvert installed for fauna underpass. Small area of clearing, cut and fill to widen the alignment for drainage and protected trees.	Traffic at CH2900 will be detoured via a sidetrack before the southern bank and over a temporary extension to the existing pipe culvert crossing of the creek. The road will continue along the existing alignment. Delays during retaining wall and bridge construction. Other times - single lane open. Traffic lights or traffic personnel only at Bridge 2 location.
3700 - 4069	Ella Bay Esplanade upgrade.	Small area of clearing, cut and fill to widen the alignment for drainage and protected trees.	Single lane open. Traffic lights or traffic personnel to control movement.
0000 - 0500	Stage 2 Elevation and upgrade of Bay Road.	Elevation of existing road and widening, construction of roundabout.	Single lane open. Traffic lights or traffic personnel to control movement. Possible requirement for sidetrack in existing easement.

Table 11.1 Traffic Management of Ella Bay Road during construction.

Communication Strategy

The communication strategy is designed to ensure residents, tourists and construction workforce are informed of the proposed works in terms of specific times and locations along Ella Bay Road.

The following direct and indirect resources will be used in conveying any traffic closures, major activities and the LATM:

- Communication of the LATM to the workforce will be through the induction process, and direct verbal briefings at tool box talks and regular written instruction. Communication of the LATM for heavy vehicles, deliveries and oversize loads will be directly at the Catelan

Road marshalling point and written instruction will form part of the contract documentation. Additional project specific signage will be placed at relevant intersections for route selection;

- Direct public consultation and feedback – the residents of Coconuts and Flying Fish Point will be informed when road closures or large amounts of construction traffic are expected through letter box drops. They will also be able to provide feedback on the construction activities through a complaints hotline and website;
- Direct communication with Seahaven Prawn Farm, the only business to be effected by Ella Bay Road construction activities will entail regular meetings, by phone and through email. When total road closures are unavoidable the activities will be planned well in advance in consultation with the prawn farm management;
- Media – the use of newspapers before and regularly during the project to inform Ella Bay Road users before the start of significant works;
- General public signage – to provide a continual method of communication for travelling residents, visitors and tourists; and
- Special signage for sightings of Cassowaries. Specific signage will be placed where Cassowaries have been known to cross and locally the speed limit will be reduced to 20km/hr.

Ella Bay Road will be guided by:

- Barricades – for temporary construction lanes;
- Flagmen – for guidance of workforce traffic; and
- Signage – electronic and fixed temporary.

Construction Evacuation and Emergency Response

The major identified risks associated with Ella Bay Road construction are the threat of flooding and / or wind damage during an extreme weather event such as cyclonic conditions and to a less extent bushfires during extreme dry periods. A Construction Evacuation and Emergency Response Plan will be prepared with a clear set of guidelines and instructions tailored to Ella Bay Road environment and risks. The emergency evacuation response for Ella Bay Road construction will be an immediate, rapid and managed movement of construction and all other personnel away from localised hazards or actual evacuation of entire construction area due to major threat or natural event occurrence (i.e. cyclone, flooding, fire, etc).

The plan will be prepared prior to commencement of road construction during the final design phase, based on guidelines from Queensland Government Department of Community Safety - State Planning Policy 1/03 Guideline: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (SPP 1/03 Guideline) and in conjunction with the Department of Fire and Rescue Services (Innisfail Branch) and State Emergency Servicer (SES).

The plan will be for evacuation to the Catelan Road CMC for accountability of all personnel and then if required to an external area. The plan will take into account that Ella Bay Road is the only terrestrial access.

The final road alignment has taken the critical event of evacuation into account with the elevation of the road designed to a minimum of 5m AHD of which is above the 100 year ARI, Global Warming and wave run up inundation levels. Other risks associated with the road construction and operation of which will be included in the plan will include but not limited to; Spill Response, Traffic accidents, security threats to public safety and property, life threatening injuries to individuals.

12. Operational Management and Monitoring

Operational management of Ella Bay Road will comprise maintenance of the road assets, maintenance of the environmental mitigation measures and monitoring of the mitigation. The road assets will be maintained by the Cassowary Coast Regional Council under agreement with the Proponent (JSC cor, 2007) and subject to conditions of WTMA permit for World Heritage Areas. The environmental mitigation measures will be maintained by the Proponent under a Corridor Management Plan. Monitoring of impacts and wildlife movements will be managed by the Proponent. The monitoring will be performed by researchers, consultants and Ella Bay staff depending on the task and criticality of the monitoring.

The desired outcome is for maintenance and ongoing operation of roads to have no disturbance of surrounding natural or rehabilitating areas (Department of Main Roads, 1998).

Road Asset Maintenance

The road assets; the asphalt surface, culverts, guard rails, gabions, signage and road furniture will be maintained by Cassowary Coast Regional Council. The council would be responsible for activities in the road reserve in the same manner that applies to all other new roads created as a normal consequence of development activities.

The list of activities include:

- Maintenance of asphalt surface, and any damage to the surface;
- Maintenance of cycle path infrastructure;
- Maintenance and replacement of guardrails, signage and road furniture;
- Maintenance of batters and drains including the hydraulic aspect of the fauna underpasses and fauna culverts;
- Removal of all waste materials and vandalism; and
- Vegetation control including weed control and mowing.

Corridor Management Plan

The Ella Bay Road Corridor Management Plan will focus on maintaining the natural features of the corridor and the environmental mitigation measures. The proponent or subsequently the Body Corporate will be responsible for

- Flora mitigation – revegetation;
- Visual amenity and sight distance;
- Cassowary fence and escape gate maintenance;
- Frog fence maintenance;
- Fauna culvert operations; and
- Bioswale vegetation;

Fauna, Flora and Aquatic Monitoring

The Ella Bay Fauna, Flora and Aquatic Monitoring Programme will focus on monitoring the impacts and mitigation of the road on the following:

- Fence and funnel strategy including usage of the Cassowary underpass;
- Fauna underpasses;
- Frog fences;
- Edge effects; and
- Aquatic ecosystems.

Operational Environmental Principles

The overall principles for the WHA and the roadside along Ella Bay Road will be taken from *Road Maintenance Code of Practice for the Wet Tropics World Heritage Area 2002* and will be applicable to all operational management and monitoring along Ella Bay Road.

Road Asset Maintenance

Maintenance of road assets within the World heritage area will comply with the guide *Road Maintenance Code of Practice for the Wet Tropics World Heritage Area 2002* which outlines environmental procedures within the footprint of disturbance of the road including the formation and cleared roadside and cutting embankments.

The guide details requirements for most surface works on fixed assets. Items that will require particular attention along Ella Bay Road include:

- Drainage works including culverts, table drains and swales will be inspected and cleaned of litter, vegetation growth, weeds and sedimentation;
- Steep gradient sections will be inspected for scour and rill erosion, and damage to geotextiles;
- Gabions will be inspected for damage to wire baskets, and geotextiles;
- Covered waste disposal bins will be provided at Heath Point Vista and Heath Point park and emptied and transferred to the CCRC Waste Transfer Station; and
- Gross pollutants and all human made wastes will be removed to the CCRC Waste Transfer Station;

Corridor Management Plan

The Ella Bay Road Corridor Management Plan will focus on maintaining the environmental mitigation measures and the natural features of the corridor:

- Cassowary fence maintenance;
- Frog fence maintenance;
- Fauna culvert operations;
- Flora mitigation – revegetation;
- Bioswale design vegetation; and
- Visual sight distance;

The following sub-sections outline long-term management of the mitigation measures that will be required in order to minimise local and regional impacts on terrestrial and aquatic ecosystems.

Cassowary Fencing and Escape Gates

Cassowary fencing and escape gates along the road will require checking weekly during the first year of operation and adaptively improved if required or until confidence in continuous operation is achieved and then on less frequent period (monthly) as determined by review with the Cassowary Advisor. Remote monitoring cameras, scat and footprint identification and visual sightings are methods used to determine the criteria below:

- Ensuring Cassowary access to Ella Bay Road is prevented through correct length, height and strength of the fence;
- Ensuring that escape gates are functional and if used determine the mechanism of entry of the cassowary on to the roadway and correct;
- Guaranteeing Cassowaries are not being hurt by interaction with the fence or the escape gates;
- Confirming Cassowaries are utilizing the “funnel strategy” at bridges created by fencing and revegetation methodologies;
- Make certain vegetation does not encroach on the fence causing damage;
- Determine whether smaller fauna are safely crossing through the fence whilst Cassowary chicks remain withdrawn from the alignment; and
- Ensure no other activity is compromising the specific functioning of the fence.

Frog Fencing

The frog fencing will be located either side of the ephemeral and permanent streams for a distance of 25m to ensure that the endangered stream dwelling rainforest frog species: Torrent Tree Frog (*Litoria nannotis*), Common Mist Frog *(Litoria rheocola)* and Australian Lacelid (*Nyctimystes dayi)* are not killed by road traffic.

The frog fencing along the road will require checking monthly during the first year of operation and adaptively improved if required or until confidence in continuous operation is achieved and then on less frequent period or as determined by review with the Fauna Advisor. Frog fencing will be also be inspected after major rain events (greater than 50mm in 24 hours).

Visual sightings, road kill, and spot lighting will be used to determine the criteria below:

- Ensuring that the fence is effective in preventing frogs climbing over it and escaping on the road;
- Monitoring that Endangered Stream Dwelling Rainforest Frog Species are not road casualties;
- Making certain that the fence has not been damaged and is fully functional; and
- Ensure no other activity is compromising the specific functioning of the fence.

Fauna Underpass & Culverts

The fauna culverts will require checking on a monthly basis for the first year of operation and adaptively improved if required and then on a less frequent period (quarterly) as determined by review with the Fauna Advisor. And additional round of monitoring will also be triggered by flood events. Remote cameras and footprint identification will be used to determine the criteria below:

- Ensuring that the functionality for fauna passage has not been affected;
- Confirming that small fauna are using the underpasses and not bypassing on to the road;
- Ensure that erosion and sediment controls, hydrological integrity, and water quality are satisfactory; and
- Ensure no other activity is compromising the specific functioning of the fence.

Flora Management

Native habitat rehabilitation and revegetation will require monitoring along roadsides, near box culvert entrances and exits, under and around fauna bridge pylons, fauna underpasses and fauna overpass (stage 2).

Maintenance will be undertaken according to the following principles:

- Vegetation that has not survived will be analysed for cause and then either replaced or substituted with comparable species;
- Aim of successful revegetation will be to achieve 100% ground cover on batters greater than 5% grade and 60% cover on batters less than 5% grade;
- Areas where natural succession revegetation has not re-established would require follow-up plantings or seeding to be undertaken;
- Monitor canopy cover and travelling site distance and selective prune where appropriate;
- Protected trees with guard rails are to be monitored for the success of root zone preservation and general tree health;
- WSUD vegetation will be checked for plant fatigue. Drainage of discharge pipe outlets will be inspected blockages and nuisance plant growth;
- Watering requirements will be monitored in dry periods; and
- Hand weeding or spraying will need to be undertaken with care to ensure no spray drift occurs.

Waterways

The permanent and ephemeral creeks will be inspected for waterway health particularly after times of major rainfall events (greater than 100mm in 24 hours)

- Ensure that road works do not initiate erosion and that creek banks are stable;
- Ensure that debris does not block waterways; and
- Ensure that the GPT are not full of litter and that litter does not pass over the GPT.

Fauna, Flora and Aquatic Monitoring

Monitoring and assessment of the mitigation measures is essential in evaluating the effectiveness of fauna, flora and water sensitive design principles of the road design. Although the mitigation measures proposed are to minimise barrier impacts along the road, the effectiveness of culvert underpasses, fauna bridges/overpasses and frog-exclusion fencing is unknown for species occurring in the road envelope. It is therefore important that these species are monitored during the short and medium-term.

Monitoring will be undertaken over a five year period, including two years during design/construction phases and three years during operational phase. Mitigation effectiveness and performance will be evaluated after this period and reported to WTMA and other Environmental agencies.

It is proposed that relevant experts from the scientific community be involved in designing and establishing these programs in the form of research projects run through education facilities such as James Cook University and/or expert consultants as specific targeted surveys. The goal being is to have a rigorous and proven scientific approach with appropriate analytical methods, authenticating the outcome of the monitoring.

The mitigation will be evaluated on the following management aims:

- Protect and influence existing biodiversity;
- Maintain and protect species and populations of conservation significance;
- Retain and improve existing water quality and hydrological flow regimes;
- Enable habitat connectivity to be influenced across the road and throughout the study site;
- Minimise mortality and injuries to flora and fauna species;
- Promote vegetation ground and canopy cover and eradicate weeds through a comprehensive revegetation; and
- Minimise the edge effect on Flora and Fauna.

Cassowary Monitoring

Cassowaries will be monitored throughout pre-construction, during and post-construction periods to assess the impact Ella Bay Road construction has on fauna and the level to which fauna sensitive road designs can be used to mitigate mortalities, injuries and habitat abandonment. Cassowary movement patterns are poorly understood as to the dynamics of the home range and how it is impacted by season, rainfall and ultimately food availability. The dynamics of movement will determine the usage and ultimate success of the fauna underpasses and success of the mitigation.

Cassowary monitoring will comprise a range of monitoring methods;

- Opportunistic sighting and data reporting by the public, staff and reporting from cassowary fence surveys of the Corridor Management Plan;
- Remote monitoring cameras in use during the design and construction phases will be utilised under the three bridge fauna underpasses and on the tunnel whilst in operation. This method of surveillance will be able to track all types of fauna, focusing on the Cassowary. Cameras will be full time and data collected fortnightly for three years during operations;

- Transect Surveys of road envelope area combined with strategic placement of monitoring cameras. The frequency of monitoring during operation will be twice yearly. Surveys will be conducted for a minimum of three years after the start of operation; and
- Monitoring of dynamic movement by GPS telemetry to model cassowary land use patterns within the reserve and east side of the range to fauna underpass usage. This is the ultimate monitoring tool however is in the development phase and if successful may make some of the other monitoring redundant. Decisions on usage of the GPS telemetry will be made by the Cassowary Advisor in consultation with DERM.

Fauna Monitoring

Fauna monitoring throughout pre-construction, during and post-construction periods will be utilised to assess the impact Ella Bay Road fauna sensitive road designs. Results will be used to compare pre-construction baseline survey information with effectiveness of fauna mitigation measures such as:

- Road kill monitoring undertaken weekly for the first year and monthly for the next two years;
- Corridor use of the small fauna underpasses by small mammals will be evaluated using trapping techniques, sand tracking and/or ink trays and possibly remote sensing cameras quarterly for the first year and biannually (wet / dry season) for the next two years;
- Determining whether fauna structures require alteration to maximise effectiveness;
- Monitoring of canopy connectivity and habitat connectivity of arboreal species through monitoring cameras placed at canopy level. This monitoring will be undertaken quarterly for the first year and biannually (wet / dry season) for the next two years;
- Understanding the arboreal requirements and if rope bridges are required for increased canopy connectivity; and
- Understanding of how fauna moves through and/or around mitigation structures.

The increased road noise may impact on avifauna with regards to the impact of reduced densities of avifauna in habitat adjacent to roads. The survey information will be used to compare pre-construction baseline surveys in the permanent Edge Effect survey plots to any change in numbers. The surveys will be performed pre-construction and annually post construction for 3 years:

- Noise Surveys in conjunction with traffic data recorders to monitor the traffic at ten, thirty, fifty, one hundred metres from the forest edge; and
- Avifauna surveys utilising acoustic and visual identification to be undertaken with four transects running parallel to Ella Bay Road at ten, fifty, one hundred metres from the forest edge.

Frog Species of Conservation Significance

During the first two years of operation, surveys would be conducted on a seasonal basis (quarterly) and undertaken at least once following heavy rains in the wet and dry seasons respectively. Thereafter, three years of biannual (wet / dry season) monitoring is required.

Frog monitoring will be designed to both monitor populations close to the road footprint and also enable the detection and monitoring of individual frogs captured from within the footprint to be translocated into nearby habitats. Survey methods used would incorporate the following:

- Counts by acoustic survey would be undertaken while walking along 50m transects of the general road footprint and where frog fence are installed at culverts;
- Active searches involving spotlighting should also be conducted in appropriate habitat areas where frog fences are installed in order to catch individual frogs and assess their health and habitat condition; and
- Pit falling using 20L buckets should also be used and checked regularly throughout the night to minimise individual frogs escaping.

If translocation is undertaken then all frogs captured within the footprint prior to construction would be permanently marked with toe clipping (this is the only method available to effectively monitor these small frog species) prior to release into nearby habitats (subject to an animal ethics license).

Flora and Edge Effects monitoring

The success of the revegetation in sealing the edge of the forest after the road clearing will ensure minimisation of edge effects. In this case the revegetation will be monitored and the edge effect will be surveyed. Permanent edge effect monitoring sites have been established and a baseline survey undertaken. The permanent site will enable a repeatable process to determine temporal trends in the condition of vegetation adjacent to the existing road edge and any zonation in vegetation condition.

Edge effects comprise “changes in the abiotic and biotic environment associated with the abrupt, artificial margins between natural habitat and a clearing” (Goosem M. , Fragmentation Impacts Caused by Roads through Rainforests, 2007). Edge effects brought about by changes to the forest edge microclimate through greater light availability, temperature extremes and increased moisture stress (Goosem M. , 2007), include increased cover and abundance of disturbance-adapted plants including weeds, wiry lianes and early successional species, as well as increased levels of branch fall and tree mortality.

- The revegetation will be monitored to estimate rate of growth, species composition, levels of weed infestation, general health, die back, safety and to identify and mitigate any areas that have not re-established;
- Plant Translocations will be monitored for growth rates, general health and reproductive status;
- Quarterly monitoring will be undertaken until the vegetation is self sustaining (Goosem, et al, 2010b) and then for an additional three years;and
- Edge effect surveys should be undertaken once every two years for 6 years after construction. A baseline survey has already been completed (3D, 2009b).

Monitoring Aquatic Ecosystems

Surface water and aquatic ecosystems will be monitored to establish the success of stormwater drainage and erosion and sediment control mitigation. For the first year post construction the surface water and creeks will be event monitored at a trigger point of greater than 25mm in 24 hours. The aquatic ecosystems (creeks) will be surveyed for change in aquatic flora and fauna annually.

Results of the waterway surveys will be communicated to the local residents if found to be unnecessarily contaminated with anthropogenic waste to educate and minimise.

	Monitoring Required	Timing of post construction Inspections First year	Timing of subsequent inspections	Timing of initial survey	Timing of subsequent survey	Time of Year
Corridor Management Plan						
Cassowary fence and escape gates	Inspection for function and damage	Weekly for 12 months	Monthly or as required			N/A
Frog fencing	Inspection for function and damage Active searches along road side recording frog kills	Monthly	Monthly or as required			September–April Monthly
Fauna Underpass & Culverts	Inspection for function, fauna bypass of underpass	Monthly	Quarterly or as required			N/A
Flora Management	Inspection for survival, natural succession, weeds & watering	Weekly for 12 months	Monthly or as required			N/A
Canopy cover and travelling site distance	Visual inspection, measurement	Quarterly	Quarterly			
Protected trees with guard rails	Visual inspection	Monthly	Quarterly or as required			
WSUD vegetation	Visual inspection/ replacement	Weekly for 12 months	Monthly or as required			
Waterways	Visual inspection and clean	Monthly or as required	Quarterly or as required			
Fauna, Flora and Aquatic Monitoring						
Cassowary Fence and underpass	Transect surveys			Biannually (3 years)	Biannually (3 years) or as required	Wet & Dry
Cassowary underpass	Remote camera monitoring			Continuous (3 years)		
Fauna Monitoring	Survey possibly including pit falling, ink pads or remote sensing cameras			Quarterly (1-2 years)		Seasonally
Edge Effects Fauna	Noise monitoring Transect surveys in 4 permanent sites			Baseline Pre construction & annually for 2 years	2 years for 6 years	Dry Season (October)
Frogs	Intensive survey including pit falling, acoustic calls and active searches			Quarterly & after major rain events (1 year)	Biannually (3 years)	Quarterly then Seasonally
Edge Effects Flora	Transect surveys in 4 permanent sites			Post construction	2 years for 6 years	Dry Season (October)

	Monitoring Required	Timing of post construction Inspections First year	Timing of subsequent inspections	Timing of initial survey	Timing of subsequent survey	Time of Year
Flora Monitoring Rehabilitation/ Revegetation inc. Fauna underpass & overpass	Monitor growth rate, species composition, levels of weed infestation, general vigour and health, and areas that have not re-established			Quarterly (2 years)	Annually (3 years)	Seasonally then Spring
Flora Monitoring Plant Translocations	Monitor growth rates, general health and reproductive status			Quarterly (2 year)	Annually (3 years)	Seasonally then Spring
Surface water surveys	Water survey			Event based >25mm in 24hours (2 years)	Annually (3 years)	Seasonally then Spring
Monitoring Aquatic Ecosystems				Annually (3 years)		Seasonally then Spring

Table 12.1 Summary of monitoring required (may vary depending upon results) species/mitigation measure.

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14. APPENDICES

Appendix 1: Visual Landscape Assessment Ella Bay Road

ELLA BAY
Far North Queensland

APPENDIX 1

Visual Landscape Assessment

Ella Bay Road

August 2010 Revision 1



Contents

Figures

1. Executive Summary

Ella Bay Road links Flying Fish Point to Ella Bay property, 6km east of Innisfail in Northern Queensland. The proposed upgrade of the existing Ella Bay Road and bypass of Flying Fish Point will provide safe access to visitors and residents of the Ella Bay Development whilst maintaining natural visual integrity. The alignment of Ella Bay road is located adjacent to and passes through the Wet Tropics World Heritage Area (WHA) within a sensitive visual catchment which exhibits moderate to high levels of visual sensitivity.

This landscape assessment has identified key values forming the basis of the scenic amenity:

- The rainforest canopy formed by the proximity of mature trees to the roadside;
- The corridor effect of dense roadside vegetation; and
- The extensive vistas of the Great Barrier Reef Marine Park from Heath Point park and headland.

Additionally it has identified the visual and environmental impact of the existing dirt road in smothering vegetation and silting streams.

The recent Cyclone Yasi (2011) has destroyed much of the canopy connectivity and crowns of many of the mature trees.

The proposed road design takes into account the competing requirements of road safety requiring extensive clearing; versus visual sensitivity with limited clearing, by restricting speed limits to maintain the scenic amenity and in some places utilising alternative management of road safety requirements for sight and evasive action distances.

The landscape integration strategy identified the following outcomes:

- Retention of canopy and corridor values;
- Protection of mature and EVR trees;
- Resurfacing of the road;
- Stabilisation of embankments using vegetated gabions;
- Comprehensive revegetation strategy; and
- Discrete shadecloth fencing to reduce the potential mortality of the Southern Cassowary.

The visual catchment values of Ella Bay Road can not only be maintained but improved through sensitive design without compromising safety or ecological design.

2. Background

This Visual Landscape Assessment forms a part of the Environmental Design Report for Ella Bay Road. The report is a high level assessment of the visual and ecological elements of Ella Bay Road primarily focussed on the World Heritage Area of Ella Bay National Park.

Level of Landscape Assessment Undertaken

This report is based on guidelines from the Department of Transport and Main Roads' Road Landscape Manual (DMR, 2004a) matrix assessment. The proposed upgrade is rated as a moderate level of works under the matrix of works guideline (DMR, 2004a. p.A2-7). The works involve minor realignments of the existing road, three bridges, a roundabout and a tunnel. The planned works will pass through a landscape setting of rainforest and woodlands with high natural values. A landscape assessment is recommended to evaluate the impact of the proposed upgrade in particular in relation to the clearing required to improve the safety and level of service.

Methodology

DMR recommends that the Landscape Assessment Process is to include the following:

- Description of the existing landscape conditions;
- Identify interactions with the planned road proposal;
- Undertake detailed ecological studies;
- Assess and mitigate combined effects; and
- Prepare a landscape integration strategy.

Source: DMR (2004, p.A2-1)

The Supplementary Environmental Impact Statement distinguishes impacts to social amenity. A desk top study was commissioned to evaluate Heath Point works from a visual catchment perspective.

3. Visual Analysis

The Wet Tropics Management Authority (WTMA) aims to protect the natural values of the Wet Tropics World Heritage Area in which Ella Bay Road passes through. Values such as the World Heritage Area, natural amenity, cultural heritage, tourism, community and recreation are essential to emphasise for the preservation of high biodiversity areas (WTMA, 2000). The mission of WTMA is summarised accordingly in their Tourism Statement:

"Regional, national and international recognition, understanding and appreciation of the unique values of the Wet Tropics WHA through the development and maintenance of dynamic, culturally appropriate and ecologically sustainable, professional and innovative presentation opportunities to world best standards. Lead, inspire, advise and support the Australian and global community to protect and share the Wet Tropics World Heritage Area in perpetuity."

WTMA (2000, p.9)

These values have been used in this visual analysis to evaluate the proposed upgrade whether within the WHA, along the road reserve or on private land.

Existing Visual Setting

The existing Ella Bay Road connects Flying Fish Point to Ella Bay passing through Heath Point WHA. The distance of 4.0km transcends two creeks and several ephemeral drainage paths.

The road construction is proposed in two stages, the first stage consisting of road realignment and surfacing of Ella Bay Road and the second stage is a new road bypass of Flying Fish Point requiring clearing of vegetation and a tunnel.

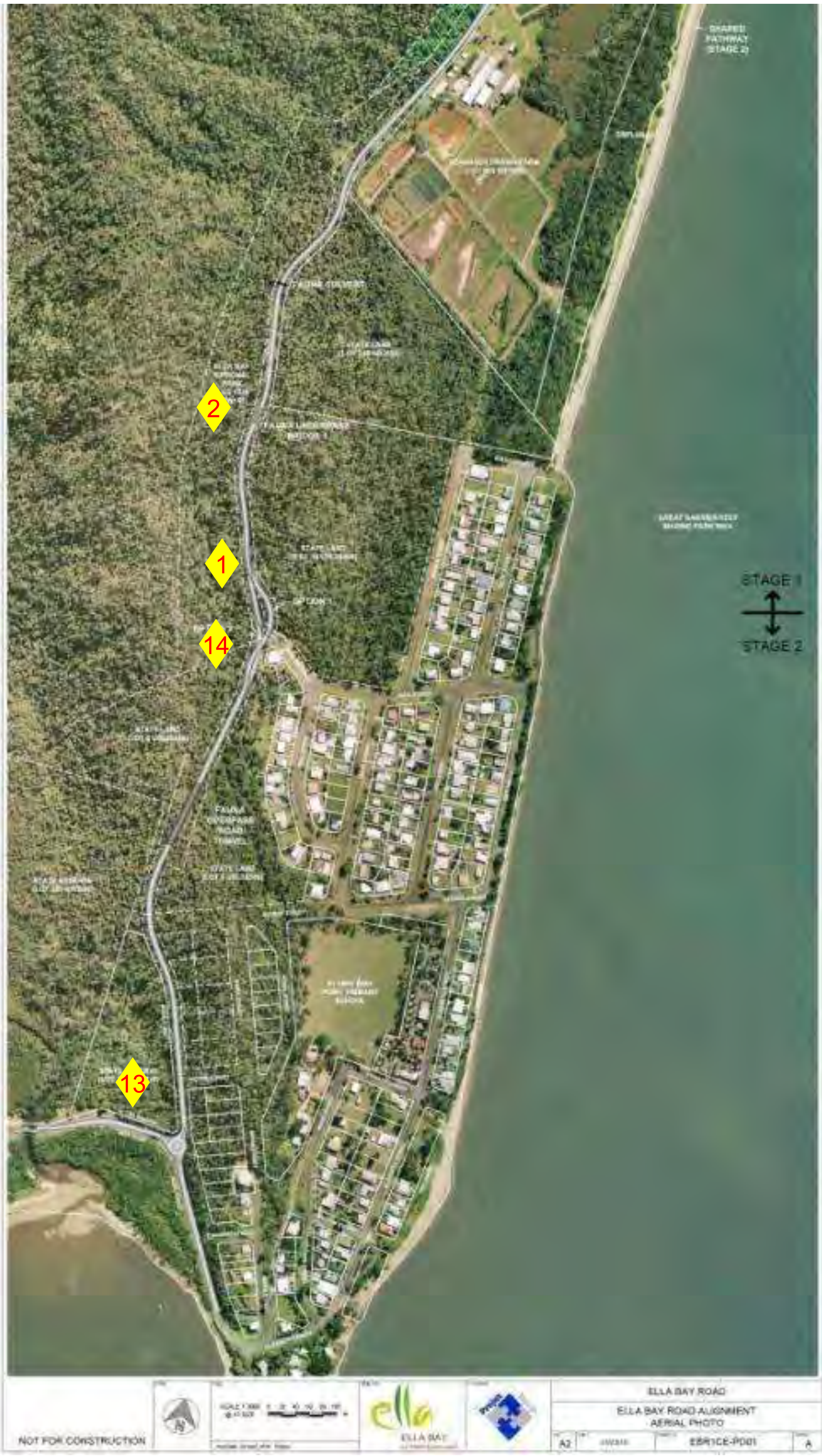
The following section is a description of the existing visual amenity of Ella Bay Road with overlays of the proposed upgrade; indicative of landscape integration strategies. Visual setting locations (1-12) can be found in drawing EBR1CE-PD01, pp. 3,4. Below is a summary of the visual assessment locations based on topography and vegetation types:

- Visual settings 1-3: Prawn farm (chainage 0000 – 1040);
- Visual settings 4-7: Heath Point (chainage 1040 – 2600); and
- Visual settings 8-12: Little Cove (chainage 2600 – 4070).

The visual amenity of the stage 2 road alignment has been assessed externally focussing on areas that are within the visual catchment:

- Visual settings 13: Bay road and Alice Street (Chainage 0000), and
- Visual settings 14: Join to Ella Bay Road (Chainage 0800)

Post this study Cyclone Yasi (2011) decimated the area and felled many of the mature trees and broke off canopy crowns that contributed to canopy connectivity. The impact was primarily from Flying Fish Point to Heath Point park where many of the trees were also denuded of all foliage especially near Heath Point park. The area around Heath Point Headland had a number of trees fall; in particular trees on the high bank where there was undercut from the embankment. Many of these trees were earmarked for arborist inspection. Photographs have been included to Heath Point park.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STAGE 1
STAGE 2
NOT FOR CONSTRUCTION
ELLA BAY ROAD
ELLA BAY ROAD ALIGNMENT
AERIAL PHOTO
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Visual Setting 1

Located at the start of Ella Bay Road, the scenic attributes of the area come into focus once travellers have left suburban Flying Fish Point. This part of the alignment is generally flat with long corners. The corridor effect allows the traveller to see 100-250m ahead otherwise the alignment is closed to the western and eastern sides. Canopy connectivity occurs rarely with recovery of trees lining the road since the destruction of Cyclone Larry. The road is lined with weed infested shoulders and drains.

Rating: Moderately high visual significance.

Photo 3.1 The initial impression of vegetation and topography on Ella Bay Road users (CH0160).

Photo 3.2 The entry to Ella Bay after Cyclone Yasi (CH0160)

Visual Setting 2

A noted sensitive area to fauna and crossing point for cassowaries, this section of road features long rolling corners and slight elevations. Corridor effect is maintained as both sides of the road are enclosed by thick rainforest vegetation, as per setting 1. Tree canopies are mature, however they do not connect at the present primarily from crown damage of Cyclone Larry. Shoulders and drains show a high weed presence.

Noted along the road side is vegetation smothered in dust. Figures 3.3 and 3.5 show new foliage emerging from dust covered foliage highlighting the extended period that the dust coats the roadside vegetation.

Rating: Moderately high visual significance.

Photo 3.3 Ella Bay Road facing north, canopy to the east thins as the traveller reaches the prawn farm (CH0350).

Photo 3.4 CH 0350 facing north after Cyclone Yasi showing the destruction of canopy.


Photo 3.5 Ella Bay Road facing east, showing dust covered foliage with new shoots emerging. (CH0350).

Visual Setting 3 (WHA)

This part of Ella Bay Road passes the only development along the road; the Seahaven Prawn Farm is on the eastern side and contains two employee residences. An expansive view of the prawn farm can be obtained along with Heath Point in the northwest background. A lone Milky Pine (eastern side) is significant within the landscape and requires protection. The western side of the alignment is thick with native rainforest species, however with weed infested drains. The Ella Bay WHA begins here and encompasses Heath Point.

Rating: Moderate visual significance.

Photo 3.6 Seahaven Prawn Farm decreases the visual sensitivity for the road user at the beginning of Ella Bay World Heritage Area (CH1060).

Photo 3.7 Seahaven Prawn Farm after Cyclone Yasi.

Visual Setting 4 (WHA)

Heath Point park (south side) is a major design consideration. Extensive views of the Great Barrier Reef Marine Park (GBRMP) can be obtained in this area to the north, east and southeast. Flying Fish Point and Moresby Range National Park can be seen to the south. The western side rises steeply and is covered with extensive rainforest. The existing view will be enhanced by elevation of the road surface level above storm surge height. The canopy recedes along this section due to the large public amenity space.

Rating: High visual significance.

Photo 3.5 Heath Point park offers travellers the first chance to contrast both Ella Bay and Great Barrier Reef World Heritage Areas (CH1590).

Photo 3.8 Heath Point park after Cyclone Yasi showing the total denudation of leaves.

Visual Setting 5 (WHA)

Heath Point is characterised by a change from rainforest to the woodlands of the headland. The Vista is surrounded by drier ascending woodland to the south and west. The road travelling south allows for a scenic 300m long descent to the carpark with intermittent ocean views through trees. A scenic 180º view, albeit intermittent through the coastal foliage expands to the north and east encompassing Cooper Point and the Great Barrier Reef Marine Park, as far as visible. This view showcases the World Heritage Area and the Great Barrier Reef Marine Park.

Undulating to the west, Ella Bay Road continues through the dry part of the World Heritage Area (Heath Point).

Rating: High visual significance.

Photo 3.9 Travelling north over the highest elevation of the alignment at Heath Point (CH 2070).

Photo 3.10 CH 2090 after Cyclone Yasi

Photo 3.11   Cooper Point and Great Barrier Reef Marine Park can be seen to the north and east (CH2080).

Visual Setting 6 (WHA)

The sides of the road change from the drier Heath Point woodland vegetation into a sheltered pocket of rainforest. The natural topography is steep, with the road descending at a 10% gradient to a scenic water cascade on the western side. The elevation allows for a view of the Little Cove Conservation Covenant area and fragmented views of the GBRMP and Ella Bay to the north. Weeds infest the shoulder of the road. There is minimal canopy connectivity.

The creek below the road is tainted by heavy silt and slimes runoff from the dirt road. The creek has eroded bed and banks from the damage of concentrated flow exiting an elevated pipe culvert.

Rating: Moderately high visual significance.

Photo 3.12 Vegetation influences a strong corridor effect with minimal connectivity; features indicative of the majority of Ella Bay Road (CH2250).

Photo 3.13 An ephemeral water feature can be seen to the west (CH2400).
Photo 3.14 Stream below road, showing smothering silt from road runoff between the road and the beach (CH2400).

Visual Setting 7

Similar to visual setting 6, the sides of the road change back to dry woodland vegetation. This undulating part of the road exits the World Heritage Area and descends at 13% into rainforest of the Little Cove property. The eastern side offers occasional broken ocean views, while the western view is restricted by a steep embankment and vegetation. The natural descent offers a brief look at Little Cove Conservation Covenant to the northwest. The tree canopies are overhanging but do not connect.

Rating: Moderately high visual significance.

Photo 3.15 Intermittent views of GBMP east of view point 7 (CH2700).


Photo 3.16 Dust laden vegetation detracting from the visual amenity (CH2700).

Visual Setting 8

This flat section of the road along the esplanade is bound by heavy vegetation on each side where minimal visual appraisal can be made. A rainforest corridor effect is created by the thickening of vegetation after Heath Point. To the east glimpses of a dunal swale can be caught. The road weaves slightly from west to east. Branches only touch briefly at one location (CH2840).

Rating: Moderate visual significance.

Photo 3.17 Esplanade section flattens out after the undulating WHA Heath Point section (CH2270).

Visual Setting 9

This section of the road is on the road easement of Little Cove property and follows an old access road. The easement was previously cleared although the road is unformed. This heavy rainforest offers moderate to high viewing opportunities to travellers. Openings in the rainforest edges give short outlooks to the western side. Connectivity within this part of the alignment is only high surrounding the two creek crossings; otherwise the corridor effect is maintained with no overarching branches. Once bridge construction is completed, views of two fresh water creeks will be visible functioning as fauna underpasses in Little Cove's Conservation Covenant.

Rating: Moderately high visual significance.

Photo 3.18 Canopies merge 200m forward and aft of visual setting 9 over existing creek lines (CH3050).

Visual Setting 10

The unformed road alignment meanders within the road easement along this section. This is a short descent where the road is planned to split into two lanes to minimise clearing and maximise canopy connectivity. To the east, partial views of Little Cove Development Zone are obtained. The western side of the alignment rises steeply and is heavily forested and ascends a further 20m to the north, encompassing Little Cove Conservation Covenant. There is a slight corridor effect made by the rainforest.

Rating: Moderate visual significance.

Photo 3.19 Little Cove Development Zone and dense rainforest vegetation ascending to the west (CH3570).

Visual Setting 11

Setting 11 is a flat and narrow visual setting where the unformed road from the west joins with Ella Bay Esplanade. Significant cultural features such as a large rock and grinding stones can be seen at Chainage 3740. The eastern side exhibits views of the Great Barrier Reef Marine Park and beaches. Ascending rainforest to the west creates an overarching effect on the road after leaving visual setting 10.

Rating: High visual significance.

Photo 3.20 Vegetation thickens again at the termination of Little Cove Development Zone (CH3700).

Photo 3.21 GBRMP and Cooper Point can be seen to the north and east (CH3740).

Visual Setting 12

During the 200m approach along Ella Bay Esplanade the canopy thickens and provides connectivity. Occasional glimpses of the ocean can be seen to the east with closed rainforest to the west. The corridor opens toward the end revealing a 180º panoramic view of the Ella Bay property. Setting 12 is a straight section of road with a slight incline. The vegetation is predominately thickened regrowth of approximately 20-30 years.

Tree canopies do not connect at present primarily from crown damage by Cyclone Yasi

Rating: Moderately high visual significance.

Photo 3.22 Highest level of connectivity could be found along Ella Bay Esplanade (CH3900).

Photo 3.23 Canopy connectivity destroyed by Cyclone Yasi

Photo 3.23 Ella Bay Esplanade opening up into Ella Bay property at the termination of Ella Bay Road (CH4040).

Visual Setting 13

Stage 2 of the Ella Bay Road upgrade is the Flying fish Point Bypass which exits Bay Road to Alice St. Alice Street is a road reserve of an unused surveyed development along the ridge above Flying Fish Point. The road exits up along a track used for the Flying Fish Point pumping station. The old town dump is on the western side of the road. The Flying Fish Point Bypass will require clearing of the road alignment, creating temporary visual scarring.

Bay Road is adjacent to the mangrove lined shore of the Johnstone River to the East and to the west is a mangrove lined tidal estuary.

Rating: Moderate visual significance.

Photo 3.24 Aerial view showing the alignment of stage 2 from Bay Road on right to tunnel on left.

Photo 3.25 View from Bay Road towards the stage 2 round about location and Alice Street alignment to the left (north) in centre of image.

Visual Setting 14

The proposed road will run from the ridge above Flying Fish Point in a north easterly direction towards Heath Point. The tunnel and road alignment will be straight, towards the junction of Ella Bay Road. The lower section of the road onto Ella Bay Road is along a previously cleared track behind the houses.

Rating: Moderately high visual significance.

Photo 3.26 Aerial view showing the exit of the tunnel to the junction with Ella Bay Road.

Photo 3.27 Proposed road alignment along drain behind Flying Fish Point houses (CH0800).

Visual Catchment

A visual distance within 6km usually comprises the visual setting of an area of catchment interest (DTMR, 2004). Features outside of this defined length normally do not come into assessment due to the strong influence of closer landscape features. Vegetation and topography govern the Ella Bay Road alignment within this 6km buffer.

There are only four places visible externally from the road alignment.

- The road past the Seahaven Prawn Farm at chainage 1000-1200 is within the visual catchment. This section of road follows the property boundary for approximately 700m; however the prawn farm is only visible for a 200m section. The relative sight distance to the road is between 20-200m for prawn farm employees.
- Heath Point park is visible from the ocean. A 200m section of road appears from the forested areas on the southern side of Heath Point. This part of the alignment runs close to the fore dunes, breaking through from rainforest corridors and adding a slight impact on the visual catchment. The visibility of the road above the beach sand is negligible.
- The road along Heath Point Headland and vista point breaks into the visual catchment with partial views of the road cutting. It encompasses a 100m section on the north-eastern side of Heath Point with ocean views. The proposed alignment will require further cutting of the sharp bend at Heath Point enabling the addition of a vista point with car parking. The cut will be visible from the GBRMP and will require treatment of the embankment with revegetated gabions (see Figure 3.17).
- The Stage 2 tunnel may be visible from the GBRMP and from Flying Fish Point. The tunnel elevation is relatively low on the horizon, with a road level of 26m and top of tunnel at 31m ADH; some 10m below the ridge line. The tunnel exit will be below the canopy height of the trees shielding the tunnel and road from view. The construction of the tunnel will create a temporary scar with the proposed method of cut and cover, before revegetation takes place.

Apart from the four breaks in the visual catchment, Ella Bay Road is confined by dense rainforest and woodland. Combining the notion of vegetation density and over-arching cover, this particular alignment receives moderate to high ratings. The visual catchment is very much enclosed.

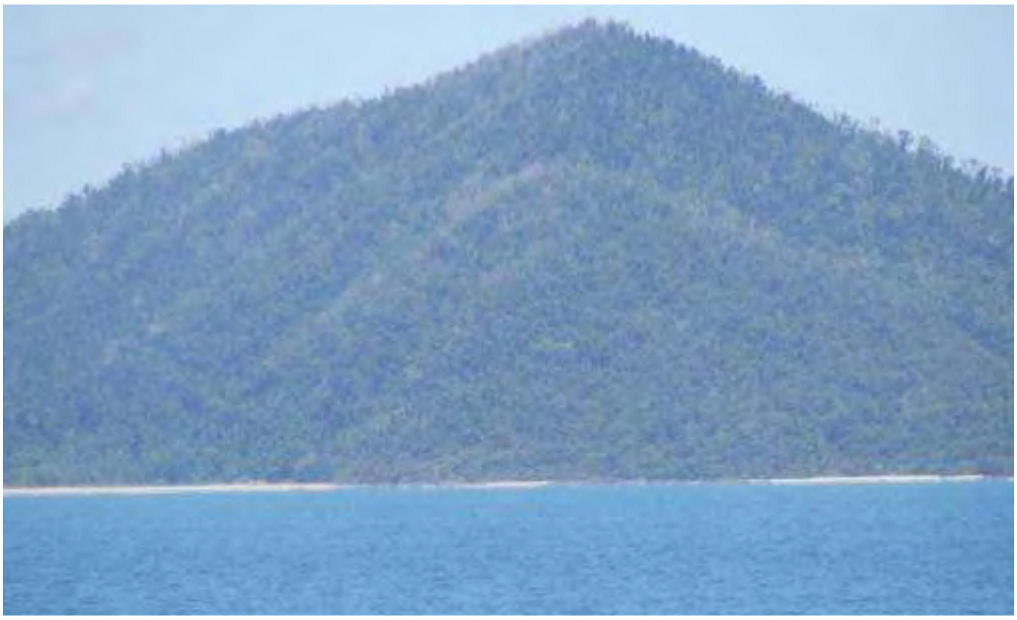

Photo 3.28 Heath Point Vista viewed within the visual catchment of Ella Bay Road. The existing alignment cannot be seen (CH1800-2200).

Visual Sensitivity

The visual impact of the existing physical surrounds on the local community and the users of Ella Bay Road determine the level of visual sensitivity. The physical attributes influencing visual susceptibility to users are vegetation and topography. The visual sensitivity of Ella Bay Road never falls below moderate due to its existing high value World Heritage surrounds.

Vegetation influences the view attainable for the majority of the 4km travel experience. Both sides of the road are shielded by dense rainforest vegetation, thus inhibiting the distance travellers can see east and west. A maximum of 50m visuals can be intermittently obtained when breaks in vegetation are prominent (e.g. fallen trees from Cyclone Larry). The average view is 10-20m; creating a corridor effect and enhancing the visual sensitivity to users. Occasionally the canopies on both sides touch, further increasing sensitivity by creating a sheltered effect. Continuous visual distance forward of the traveller is 65-200m.

Topography has the most profound effect at two locations. The carpark at the southern end of Heath Point opens to the ocean, revealing large scenic views to the north, east and southeast. The presence of coastal dunes reduce the amount of rainforest vegetation in succession until finally there is minimal vegetation on the fore dune; aiding the distance in which visual appraisal can be achieved. Secondly, rises and falls in elevation generally give travellers the opportunity to see further than they would on flat ground. Steep declines such as the Heath Point Vista allow extensive viewpoints to be obtained and enjoyed by travellers to the north, east and west. While heavy rainforest vegetation to each side blocks internal vision, the undulating nature of Heath Point still allows for direct views to be seen up to 500m straight ahead (e.g. visual setting 6, p.10).

The stage 2 Flying Fish Point Bypass will provide an enclosed view as the road elevates to the tunnel with glimpses towards the west along the Johnstone River. The road will be cut into and along a ridge ascending from 3m to 26m elevation. The road will be enclosed by vegetation and have a similar feel to Ella Bay Road ascending to Heath Point, with the same regional ecosystem community 7.11.1 as the western side of Ella Bay Road. The quality of the vegetation is not as intact as that along Ella Bay Road. The tunnel will divide the ridge providing an expansive view as the road descends towards Ella Bay Road of the prawn farm and Heath Point in the distance together with glimpses of the ocean through the vegetation canopy. This section of the road will have the same appearance as the western side of Ella Bay Road with extended views.

In summary, the visual sensitivity of the alignment is:

Stage 1

Prawn Farm -	Moderately high visual significance;
Heath Point -	High visual significance; and
Little Cove -	Moderately high visual significance.

Stage 2

Flying Fish Point Bypass West -	Moderate visual significance, and
Flying Fish Point Bypass East -	Moderately high visual significance.

Change to Visual Character

The road upgrade of Ella Bay Road Stage 1 inclusive of correct drainage and shoulder design will have a width of 10-16m. The clearing envelope of the existing road ranges from 6-16m, as below:

The Prawn Farm section-	current width 7-16m, upgraded width 12-14m;
Heath Point –	current width 6-10m, upgraded width 12-14m; and
Little Cove –	current width where cleared, 6-10m, upgraded width 12-14m or where the road is split to 2 x 6m widths.

It is expected the clearing will impede 0-2m along the prawn farm section and 1-4m along the Heath Point section with the wider clearing required with the cuttings around the sharp corners of the vista area. The road alignment has been selected to minimise clearing and removal of mature trees. The clearing envelope has been governed primarily by existing road width and providing improved drainage, however deviation has been required to save at least 5 mature trees providing a best practice design encompassing the significant values of maintaining a tree corridor effect and canopy connectivity.

The alignment has been optimised to minimise tree clearing and where exceptions to Austroads (2003) an evasive action envelope has been identified, with guard rails used to protect mature trees. For Stage 1 the tree corridor effect and canopy line of Ella Bay Road will show minimal changes along the prawn farm and Heath Point WHA with the exception of the cassowary fence. The cassowary fence will be neutral coloured (dark grey) to blend into the vegetation and will run between 3 to 5m behind the vegetation. The cassowary fence, traffic calming and signage will be visible at the entrance to Ella Bay Road during stage 1 for approximately 40m where the entrance and escape gates are close to the road.

The existing weed infested vegetation within the clearing envelope will be improved by removal and revegetation with endemic plants designed to seal the rainforest and shield the view of the cassowary fence. Overall, a high level of visual sensitivity will be retained.

The Heath Point section will have a visible change to the existing road appearance with the widening of the road and increased radius corners for articulated vehicle movement and safe sight distance. The road will have a new cut along the western embankment for approximately 1000m. This cut will be stabilised with gabions or natural cut embankment subject to final geotechnical evaluation. On the eastern side guard rails will be used on corners and where the safety assessment necessitates. At the two major corner realignments, vegetated gabions and vegetated rock fall netting will be used for stabilisation, which will visually improve the stability of the cut embankments. The Heath Point Headland has more sparse woodlands vegetation than the rainforest sections of the road, however retaining the few mature trees will maintain the feel of the road. Due to the steepness of the terrain cassowary fencing will not be required in this area. The visual character will remain of high visual significance.

The road at Little Cove will be constructed in the dedicated road easement which was established from the clearing of the old access and logging track. Where uncleared the road lanes will be split to minimise disturbance. The road will be slightly undulating and meandering with a speed limit reduced to 40km/h to further minimise clearing. The road will cross two creeks with elevated bridges to function as both crossings and cassowary underpasses. The trees adjacent to the bridge will be retained where possible and the tree top canopy will be visible from the bridge. The cassowary fence in this area will be set back from the road from 10 to 20m and will not be visible except at exits and escape gates where the fence will be adjacent to the road. The visual character will remain of high visual significance.

The Stage 2 Flying Fish Point Bypass will be constructed on a new road alignment which will entail clearing of the rainforest for the road. There will be significant change to the present visual character.

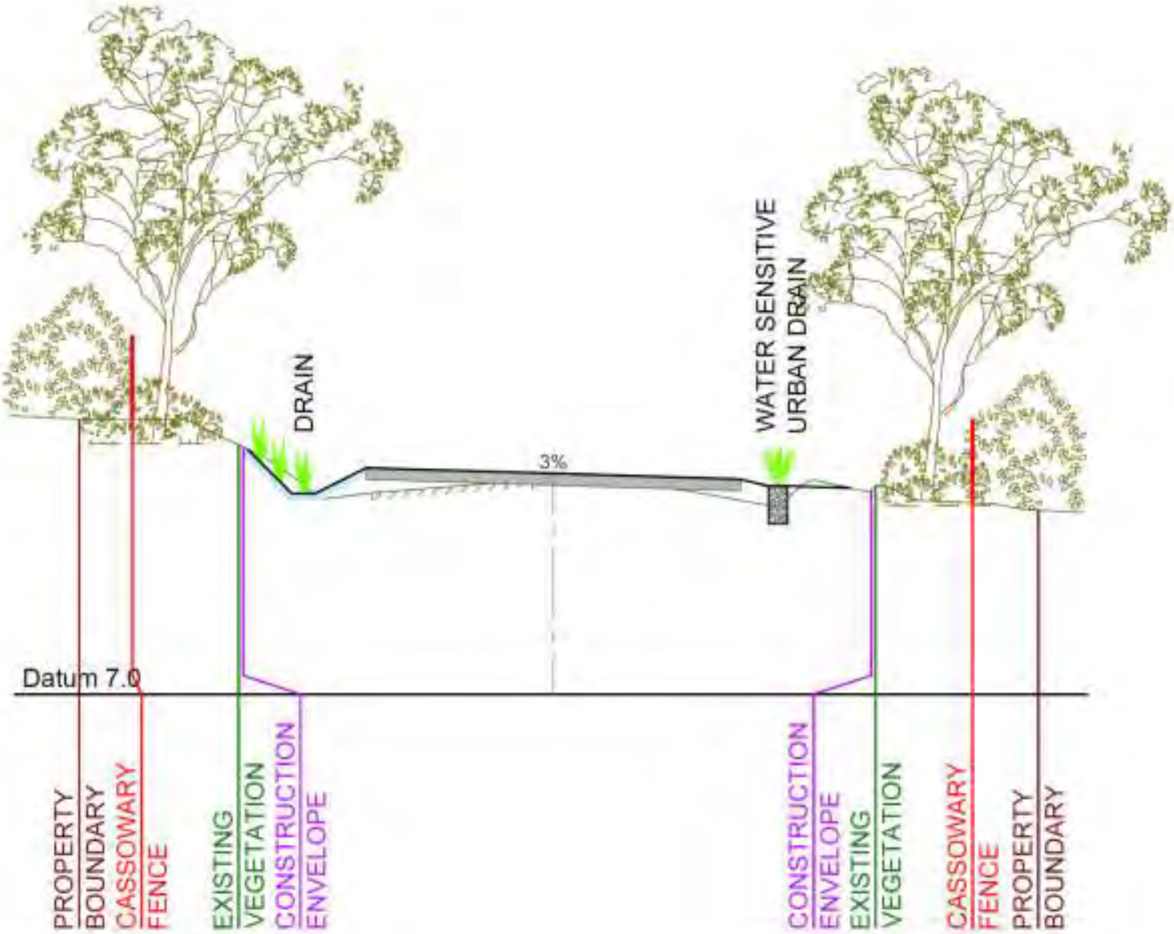

Figure 3.29 Typical cross section of Ella Bay Road (CH0760).
The asphalt width is 10m inclusive of a 1.5m shoulder on each side of the roadway, with a further 2m buffer on both sides for drainage. The cleared width and construction envelope have been constrained to preserve trees and visual values whilst retaining the retain 3m of evasive action easement required at 60km/h.

Visual Experience for Road Users

Ella Bay Road upgrade will improve the safety and trafficable nature of the alignment in conjunction with retaining its existing visual assets. Minimal view changes will occur to the prawn farm and Little Cove sections. The visual resources of Heath Point will be moderately disturbed as a result of compliance with Austroads Standards (2003) and (2006).

The proposed road upgrade will visually benefit travellers accordingly along the sections of Ella Bay Road:

Prawn Farm: The existing alignment will be maintained and only widened at points where mature trees do not impede. Canopy and corridor retention will be preserved, offering the traveller the same visual experiences. Approximately nine guard rails will have a slight visual impact around protected trees. The cassowary fence will be visible at the start and end of the section where an entrance chicane of the fence with escape gates will be visible. The cassowary fence, speed bumps and signage will be used to make travellers aware of possible cassowary presence. Revegetation methodology will focus on replacing the weed infested batters, drains and shoulders with frangible edge closure vegetation to minimise the edge effect damage from the road.

Heath Point: Due to the undulating nature of Heath Point, widening will reduce the small amount of current canopy connectivity in order for sight distances to be maintained. The corridor effect through ascent and descents will remain the same as pre-construction due to the existing density of woodland vegetation. Four guard rails protecting trees will be apparent. A minimal 30m of Cassowary Fencing will be visible on approach to Heath Point park in the WHA Area. Revegetation methodology influencing the natural occurrence and succession of ecosystem 7.11.34a at Heath Point will replace the weed infested batters, drains and shoulders.

Little Cove: Minimal changes to the Little Cove section of Ella Bay Road will result from the proposed works. Canopy connectivity will be slightly reduced along the last 300m of the road; twelve guard rails protecting trees will be visible. The current tree corridor effect will be retained due to the dense nature of rainforest vegetation and utilization of existing clearings. The cassowary fence will be visible at brief 10-30m intervals at each bridge approach and at the fence entrance chicane and escape gates. Revegetation methodology will focus on replacing the weed infested batters, drains and shoulders with frangible edge closure vegetation to minimise the edge effect damage from the road.

The Stage 2 Flying Fish Point Bypass will be in a new cleared road alignment. The road will be constructed as per the Landscape Integration Plan and will have a similar canopy appearance and roadside feel to the existing Ella Bay Road.

4. Mitigation Measures

In order for Ella Bay Road to retain its visual value the following mitigation measures have been integrated into the design phase:

- Changing the road alignment to protect significant mature trees;
- To retain mature trees that are within the evasive action clearance envelope required for safety, by installing guard rail protection;
- Maintaining sight distances compliant with DTMR (2004) or where this is not possible reducing advisory speed limits to the available sight distance;
- A thorough revegetation strategy encompassing 17 different micro habitats for the alternating physical conditions;
- Planned installation of plant-able gabions where cuts are visible from the WHA at Heath Point;
- The installation of neutral coloured cassowary fence 3-5m within the vegetation and the shielding with frangible edge closure vegetation on the fresh embankments;
- The preparation of extensive surveys of flora, fauna cassowary surveys, and additionally baseline vegetation monitoring of edge effect;
- The prerequisite of a specialist flora spotter to identify and advise on relocation of EVR trees and flora during clearing; and
- Initiate a Tree Health Survey as an addendum to the Vegetation Management Plan to audit the safety of existing trees along the road alignment prior to protection.

5. Landscape Integration Strategy

The proposed upgrade and Flying Fish Point Bypass will provide safe travel for the public between Ella Bay and Flying Fish Point whilst retaining its natural visual sensitivity and catchment values. This vision will be achieved by incorporating the following objectives into road design methodology:

- Retain the corridor effect created by dense vegetation;
- Retain existing mature trees, in particular trees with canopy connectivity;
- Relocate where possible EVR flora within clearing envelope;
- Remove existing weed infestations of batters, drains and shoulders and revegetate with frangible edge closure vegetation;
- Include water sensitive design coupled with revegetation to improve roadside water quality, aesthetics and assist in weed control;
- Discrete shadecloth fencing to reduce the potential mortality of the Southern Cassowary;
- Influence the natural surrounds with a comprehensive revegetation strategy;
- Stabilisation of embankments using vegetated gabions;
- Protect the existing rainforest and woodland from edge effects; and
- Promote this 4km stretch of road as a tourist drive in conjunction with local council and WTMA.

The Ella Bay World Heritage Area requires preservation and presentation in a manner indicative of its natural context. The small changes to the road together with sealing the surface and remedial revegetation will strengthen biodiversity. The visual integrity of Ella Bay Road can be maintained and improved through utilising a landscape integration strategy whilst satisfying traveller safety.

6. References

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Appendix 2: Revision to Multi Criteria Analysis of Ella Bay Road Options

APPENDIX 2

Revision to
Multi Criteria Analysis of
Ella Bay Road Options

Ref. University of South Australia Report to DEWHA 2008

August 2010 Revision 1



Executive Summary

This report is a revision of the MCA (Multi Criteria Analysis) presented in the Supplementary Environmental Impact Statement for the Ella Bay Integrated Resort of the Ella Bay Road alignment options. It is in response to the submission provided by DEWHA in mid-2008 to the Supplementary Environmental Impact Study for the Ella Bay Integrated Resort which was a third party review by the University of South Australia - Institute for Sustainable Systems and Technologies.

The aim of this MCA is to evaluate the road alignment options between Flying Fish Point and the Seahaven Prawn Farm to minimise the impact to cassowaries of isolation of the Flying Fish Point reserve. This MCA focussed more directly on impact to cassowaries when evaluating the road options and the attribute for impact to cassowaries was elevated to be one of the main categories with environment, social transport and cost. This MCA was also modified as per recommendations from the University of South Australia report.

The road alignment options comprised options D(1) and D(2) which are along the existing Ella Bay Road alignment and options RB1 and RB2 which are variants of an alignment along Ruby and Bindon Streets.

The overall result of the MCA was that the highest scoring option was Option D(2). Option D(2) rated high in all areas of transport and social attributes and highly in environmental and due to the mitigation, in cassowary risk attributes. Option D(2) will create the least impact on edge effect of the neighbouring rainforest, however Option D(2) rated lowest in flora and fauna connectivity. Option D(2) rated lowest in constructability based on difficulty in maintaining access however with the low road usage of 75 to 150 v/d this would not be a major problem. Option D(2) was the second highest cost.

Option D(1) rated second; rating lower due to increased clearing at the start of the road alignment. It is the non preferred road alignment of the two options D.

Option RB2 rated third. RB2 rated highly in improving flora and fauna connectivity and was the least risk to cassowary mortality. This option required the highest area of clearing and would create the most edge effect into the surrounding rainforest. Option RB2 rated moderately in all social amenity attributes that reflect on the proximity and impact on residences.

Option RB1 performed lowest but more importantly was considered not a viable option due to low Level of Service (LOS) to road users and the risk of flooding due to its low elevation. RB1 was the lowest cost option, as it utilised an existing road alignment, and scored highest in improving flora and fauna connectivity. RB1 scored lowest in all attributes of transport and social amenity that reflect on the alignments proximity and impact on residences.

The overall highest rating option was option D(2) and this is consistent with the previous less rigorous MCA analysis of the SEIS Appendix A2.6 Access Road Strategy, Addendum 1 17 March 2008.

The use of an MCA is a tool to aid in decision making and the result is dependent on the selection of attributes and categories and the weighting applied to each criteria. In this MCA a sensitivity analysis was undertaken using weightings applied to only the environmental and impact to cassowary categories. The final ranking of Option D(2) as the preferred option was confirmed with Option D(2) performing highest in all combinations of the sensitivity analysis including weighting of the ***impact to cassowary*** criteria of 6 times.

Contents

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1. Introduction

This report presents a revision of the MCA (Multi Criteria Analysis) of nominated road options for the proposed upgrade to Ella Bay Road. The revision is in response to a third party review by the University of South Australia - Institute for Sustainable Systems and Technologies by request of DEWHA in mid 2008. This revision is based on the latest road alignment and road design of Ella Bay Road and contains modifications and improvements that have not presented previously.

This report does not address the demographics of the Ella Bay Integrated Resort Development or the traffic impact issues identified in item 6 of the Uni of SA report. These are addressed in the separate reports; Revision to Road Usage Demographics for Ella Bay Road; and in the design section of Ella Bay Road Design and Environmental Management Report.

2. Road Options

The SEIS listed alternative road alignments for Ella Bay access road derived from consultation with, government agencies and other stakeholders. The result was the selection of four (4) best-fit options of which were assessed in an initial MCA analysis in the SEIS – Access Road Strategy report (November 2007). An additional two (2) extra road options suggested by WTMA and DERM (RB1 and RB2), in January 2008 were added to the MCA analysis in the SEIS – Access Road Strategy Addendum report (March 2008). In SEIS and addendum the result of the analysis suggested the selection of access road "Option D – FFP Bypass with Cut and Cover Tunnel) as preferred. This report provides a more detailed MCA to further analyse the current preferred road option against the two (2) extra road options (RB1 and RB2) with analytical changes as recommended by the Uni of SA.

The Uni of SA report highlighted the following issues in preparation of the MCA (Uni of SA Access Road Review Report section 5.4);

1. The MCA should use the existing condition as the base for assessment

   *"To deal with this issue in Ella Bay project, the **existing conditions** of the **existing route** (not option A) should be used as the benchmark, and all four options should be compared with this benchmark to obtain their standard scores."*

2. The MCA evaluation results should be standardised, aggregated and scored using an interpolation method based on the highest and lowest scores.

   "For each attribute within any one criterion, one could always assign -5 to the worst measurement and 5 to the best measurement (or using 0, 100 instead), and then use linear interpolation to obtain the intermediate scores. No specific benchmark is used for each attribute. "

3. The MCA should use different weights for some of the key criteria eg Cassowary

   "The review team also found it might be appropriate to allocate different weights (not simply the equal weights) to some important attributes of each criterion when aggregate the standard scores to criterion level"

4. The MCA should use weightings obtained through consultation with stakeholders.

   "Weighting at the criteria level involves taking more notice of some criteria than others. The review team agrees on this point that 'criteria weights are dependent on the preferences of the decision-maker and ideally should be derived through close interaction between the decision-maker (the proponent and/or government) and the decision analyst (the IAS consultant aided by stakeholders".

3. Ella Bay Road and Reserve Description

Ella Bay Road is a long established gravel road which services the Seahaven Prawn Farm, visitors to Ella Bay National Park and access to Ella Bay property. The road is a two lane gravel road with little edge clearing and varies from 6m wide to 10m wide with an extended verge of 1 to 2m. The road has been aligned along the base of the slopes to Seymour Range and to the west and above the reserve between Flying Fish Point and the prawn farm.

Ella Bay Road has been in operation since early 1900's (Brisbane Courier 1903, 1912) when Ella Bay was an important banana growing area to supply Brisbane and Sydney. The alignment in this area would have been chosen as an all weather route above the ephemeral wetlands of the reserve on the change in slope to the steep hills.

Ella Bay Road is maintained by the local council by grading and intermittent herbicide weed control. The road surface suffers extensive damage during the wet season and requires regrading and filling of erosion gullies during each season.

Ella Bay Road is aligned on the foothills of the Seymour Range above and adjacent to a low lying ephemeral swamp which forms the reserve on two lots of unallocated state land USL35566 and NR3550, and approximates 17.5ha (refer Figs. 1 & 2). Central in the reserve is a basin shaped swale which runs from Ruby St to the Prawn Farm. The swale is relatively linear to the existing coastline and may have been formed under the influence of a prograding shoreline. The vegetation is severely wind degraded, with broken canopy crowns from past disturbances. The vegetation communities throughout the reserve change based on the elevation and the resulting degree of seasonal inundation. The centre of the basin is RE community of 7.3.3a: Mesophyll Vine Forest with *Archontophoenix alexandrae (*feather palm) dominated by an even mix of *Archontophoenix alexandrae* and *Licuala ramsayi (*feather and fan palms) with *Acmena hemilampra*, *Acacia mangium* and *Alstonia muelleri*. This type merges into 7.3.25a Melaleuca leucadendra open forest which surrounds it in a longitudinal band central to the reserve. The RE is found with feather palms and is indicative of waterlogging. This is further surrounded by RE community of 7.3.10c Mesophyll Vine Fforest with prominent *Archontophoenix alexandrae (*feather palm) on poorly drained plains. Dominant canopy species of 15 - 40m were recorded as *Syzygium cormiflorum, Alstonia scholaris, Commersonia bartramia, Cananga odorata, Endiandra montana, Aleurites rockinghamensis* and *Endiandra globosa.* It should be noted that *Endiandra globosa,* listed as 'rare' under the NCA is a prominent canopy and shrub species where this community occurs adjacent to Ella Bay Road. Similarly, *Rourea brachiandra* (Rare, NCA) forms a prominent wiry liane in ground and shrub layers (Stanton 2009a).

High numbers of exotic weeds and early successional species line the edge of the road but extend into the forest only 4m from the road edge due to the density and cover of the rainforest. Weed incursions are present in increased light areas due to canopy loss of the recent cyclones and anthropogenic disturbance. The canopy coverage of the forest interior reduces due to position on the footslope (Stanton 2009b).

Stanton (2009b) also comments that:

> 'In studies examining microclimatic variables as indicators to edge effects in nearby rain forested areas of the Wet Tropics, Goosem and Turton (2007) suggest that narrow roads have far less severe or extensive microclimatic edge effects than wide, paved roadways which may lack canopy extension. Furthermore, they conclude that newly created open edges or those maintained by continual grading, mowing or vegetation trimming along the road verge incur an increase in the severity of microclimatic edge effects, which in turn result in changes to floristic composition, structure and habitat'.

Which indicates that the road being narrow and long established is relatively stable and has limited impact on edge effects. The road would also have incrementally caused isolation of flora and fauna over the more than century of use.

The reserve is rated as essential cassowary habitat under the Southern Cassowary Recovery Plan (Latch 2006). Moore (2007) reported that the habitat quality was rated medium and the beach area as low quality. Moore also states that the area *'may hold the only water source available to cassowaries in this area during dry periods'* and *'probably provides both food and water resources for cassowaries'.* Buosi (2009a) in his critique of Moore's work questions why these areas were not rated higher given the vegetation types and water source. Buosi then comments that '*Given the available information we suggest that this area be regarded as important or 'High Quality Habitat' unless proven otherwise.'* Survey of the availability of water in October 2009 established that the water holes were dry during the dry season of 2009 Volume 6.1 g Ella Bay Submission Response (Ella Bay, 2009). This can be explained as the basin is elevated above sea level (2.0 mAHD minimum) and is drained by deep drains (1.5m to 1.75 mAHD) running the full length of the southern and eastern boundaries draining into the beach swale east of the prawn farm. The loss of water during the dry season detracts from the habitat quality for all year cassowary use.

The other issue detracting from the quality rating is the accessibility from the Seymour Range. The area of suitable cassowary habitat to the east of the range occupies a thin strip from the north of Flying Fish Point to Heath Point of about 30ha of accessible habitat in total of which the reserve occupies a little more than half. This strip is formed by the eastern slope of the Seymour Range which ascends at greater than 1:2 and is approximately 60m from Ella Bay Road. Refer to Figure 3.2 which is a slope analysis of the region from Flying Fish Point to Ella Bay showing the steep slopes of the Seymour Range in colour bands of >1:1 (45º) >1:2 (27º) and >1:3(18º). The access point for the cassowaries from the Seymour Range is from above Flying Fish Point to the western side of Ella Bay Road and along that side until crossing in one of two general locations (Moore 2007, Hogg 2010 pers. obs., Buosi 2010a).

The home range for a cassowary is reported at 2-5km² or 200-500ha (Moore, 2008) (Latch, 2006). The area of the reserve at 17ha represents less than 10% of the home range of one bird at the extremity of the birds range. Two adult birds, a male (and chick) and a female have been monitored using the reserve (Moore 2007, Buosi 2009b, Buosi 2010a). Cassowary usage of the beach has been reported with access obtained via the reserve.

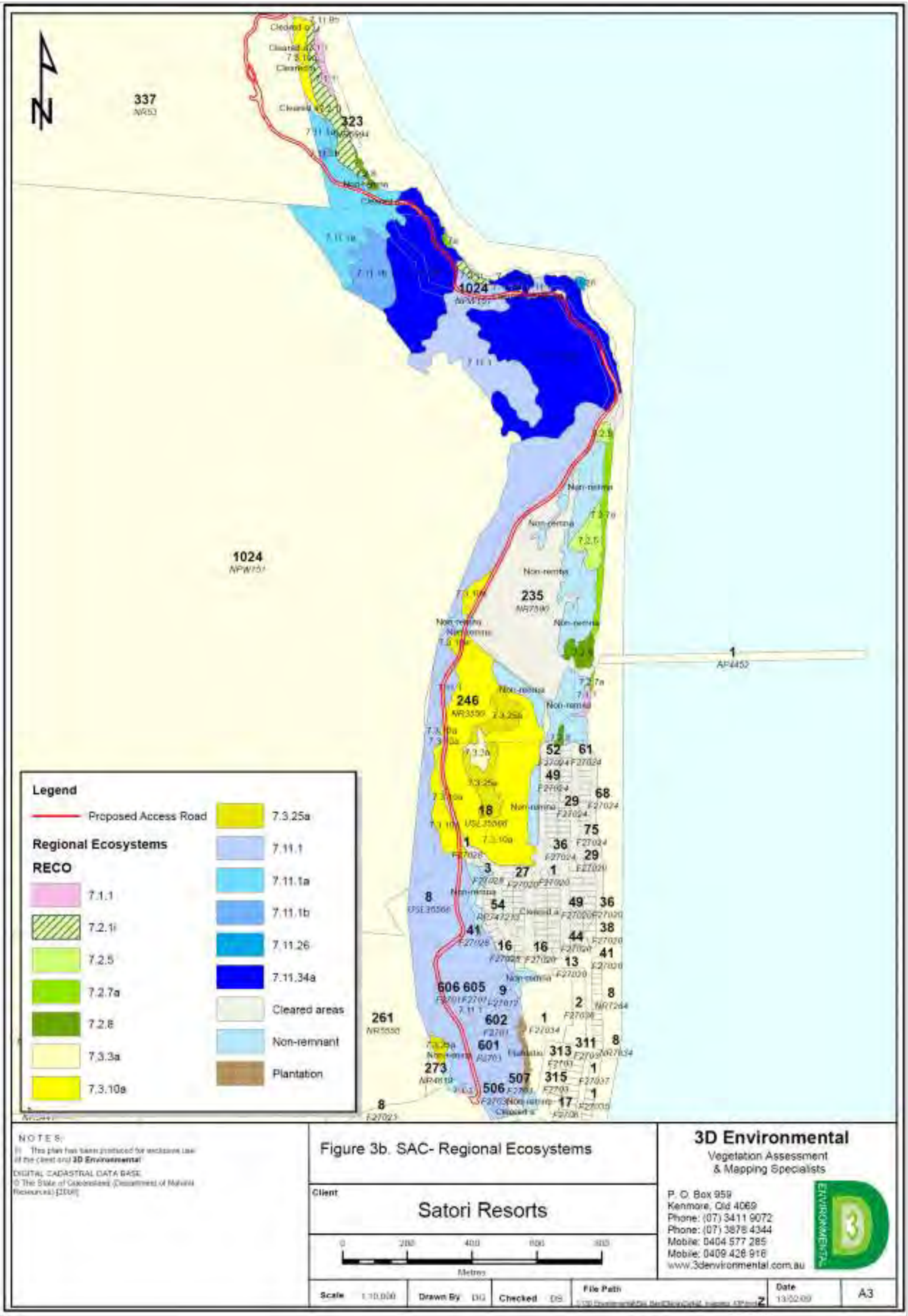


Figure 3:1 – Regional Ecosystems for Ella Bay Road and Flying Fish Point Reserve

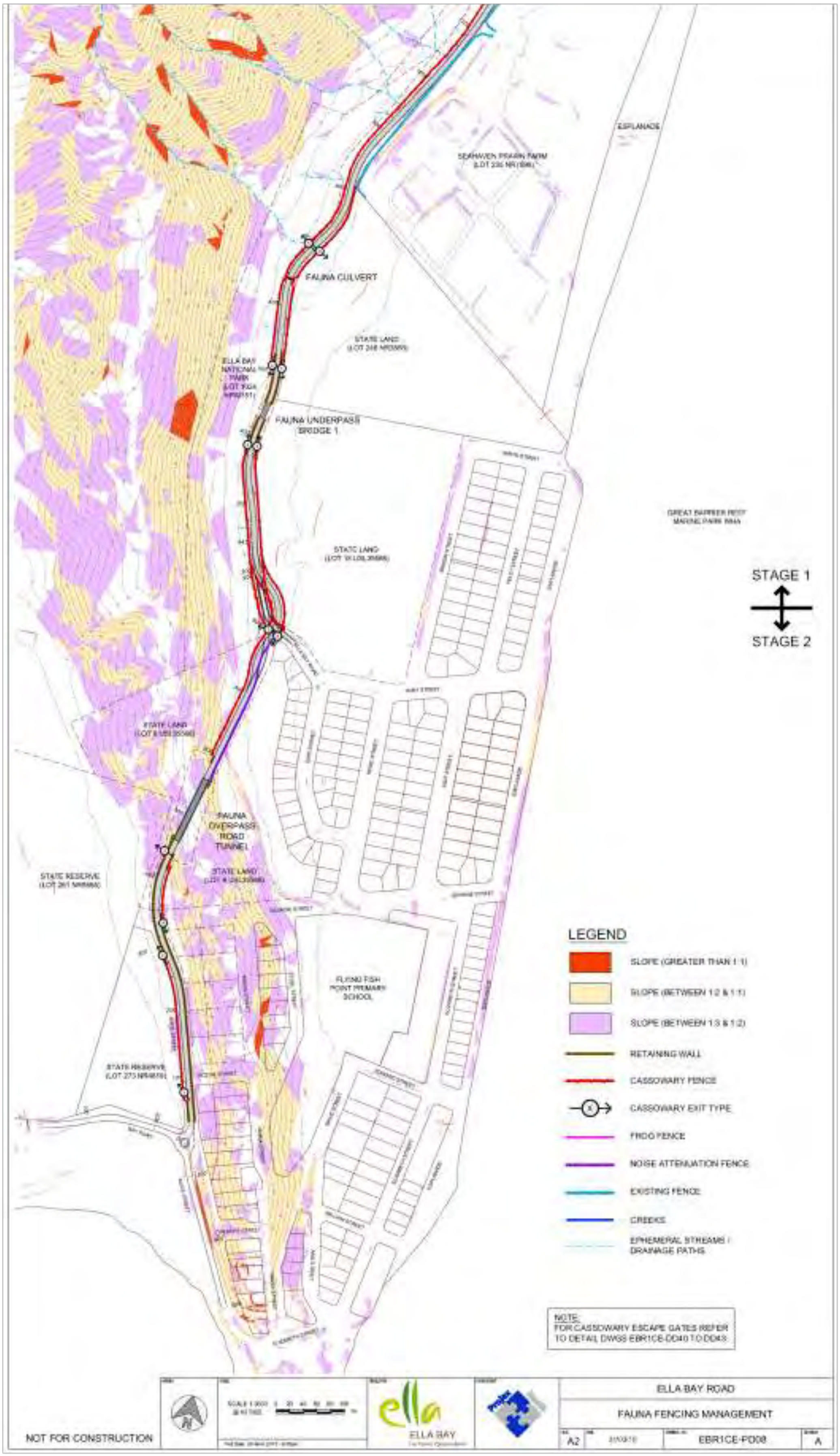


Figure 3.2 - Drawing EBR1CE-PD08. Slope Analysis - Section to Prawn Farm

4. MCA – Multi Criteria Analysis

This MCA has been revised to use the current road conditions as the reference and has compared this to two alternative routes for option D; D(1) only using State Land and D(2) intersecting 150m² of National Park, and to the alternative RB1 and RB2 options.

RB1 and RB2 options are subsections of the preferred option D and have a common initial road section "Flying Fish Point Bypass with Cut and Cover Tunnel" which has not been included. This MCA has been conducted on the relevant sections from point B to D (Ella Bay Road) and B C D, refer to figure below:

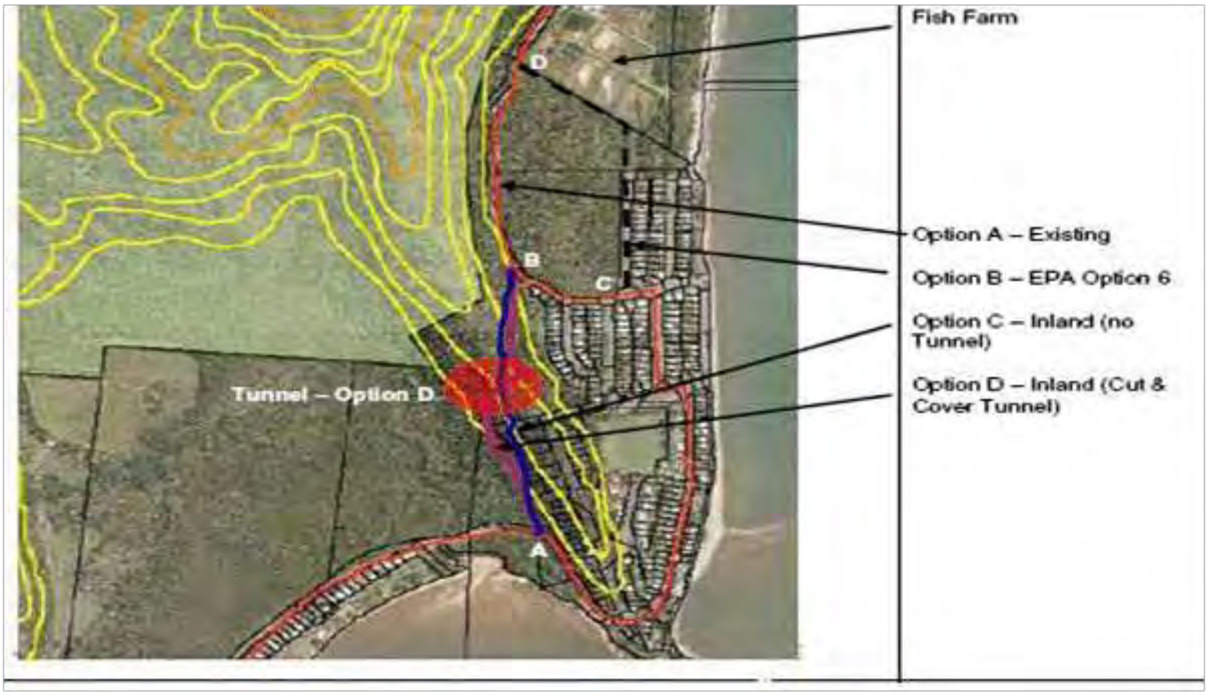


Figure 3 - MCA Road Options

Ella Bay Road: Current conditions (unsealed dirt road);

- **Option D (1):** A B D – Flying Fish Point Bypass via Tunnel;
- **Option D (2):** A B D – Flying Fish Point Bypass via Tunnel;
- **Option RB1:** A B C D – Flying Fish Point Bypass via Tunnel continuing onto Ruby St, Bindon St, Seahaven Prawn Farm Boundary; and
- **Option RB2:** A B C D – Flying Fish Point Bypass via Tunnel continuing via reserve North of Ruby St, West of Bindon St, Seahaven Prawn Farm boundary.

This MCA analysis has utilised the same criteria and attributes as described in the SEIS except where the attribute requires greater definition or the attribute did not adequately describe the specific conditions of this section of road.

Note that the score standardisation and aggregation for each attribute has been calculated as per the Uni of SA report. All scores were benchmarked to Ella Bay Rd at its current condition. Weighted scores were converted to the -5/+5 range based on linear interpolation equation. The highest weighted score was converted to -5 which is the most adverse and the lowest weighted score was converted to **+5 which is the most beneficial**.

Reference Quantities

Table 1 shows the overall total clearing quantities for the MCA analysis. It compiles the total lengths, clearing and revegetation for all considered road options.

	Total Length (m)	Total Area Clearing 14m Width (ha)	Revegetation (ha)	Total Clearing – Revegetation (ha)
Ella Bay Road	722	0.0	0.0	**0.0**
Option D (1)	732	0.117	0.100	**0.017**
Option D (2)	722	0.013	0.005	**0.008**
RB1	1,082 *(466 clearing new section only)*	0.652	0.607	**0.045**
RB2	940	1.316	0.607	**0.709**

Table 4.1 - MCA Road Options Clearing Reference

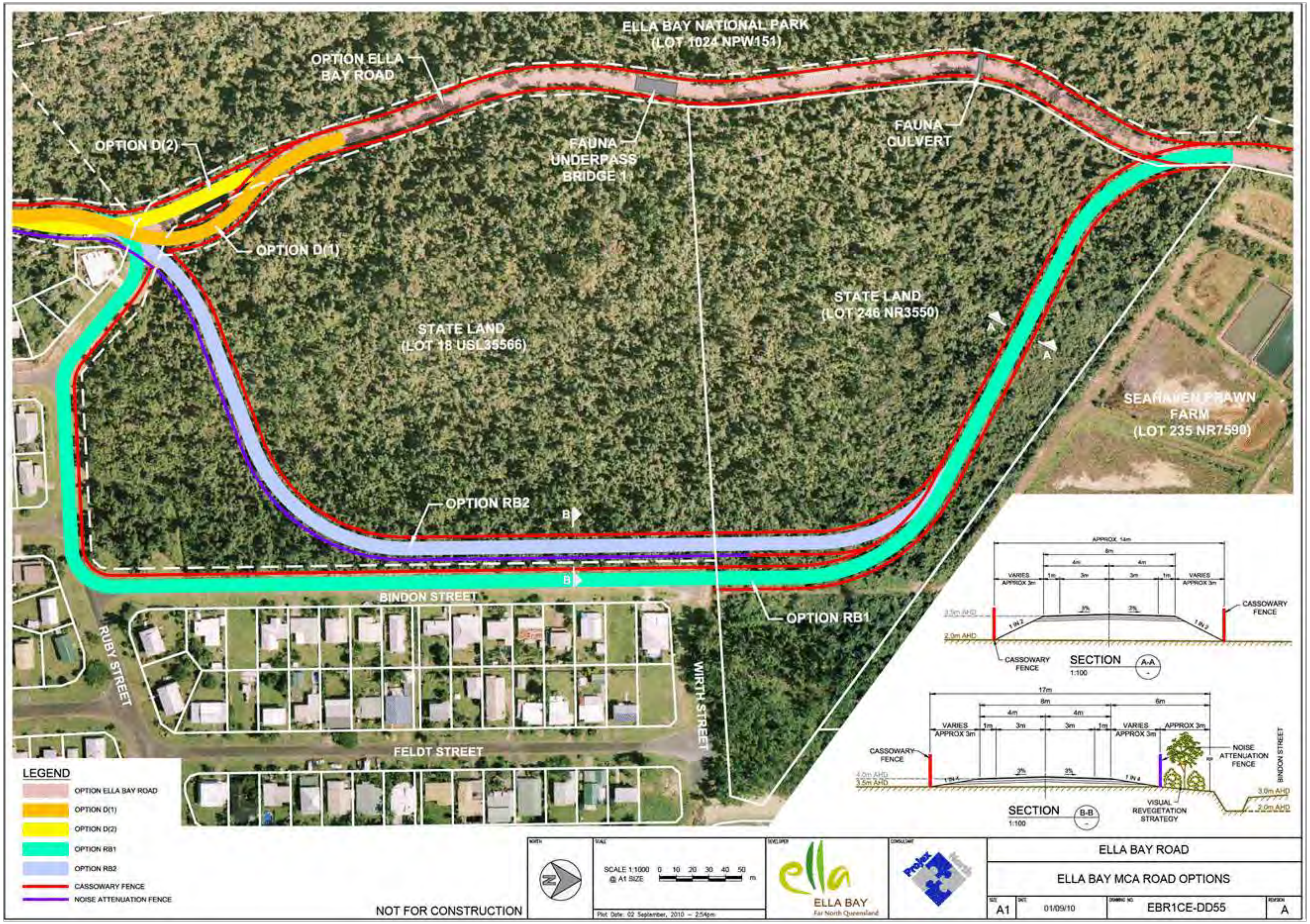


Figure 4 - Drawing EBR1CE-DD55 MCA Road Alignment Options

Environmental Sustainability

Attribute E1: Important Areas for Plants (Communities)

Description of Attribute: This attribute refers to areas that are important for plant communities, based on regional ecosystem mapping. There are no changes to the Elements of this attribute, refer to SEIS – Access Road Strategy 4.6.1 for description.

Measurement of impacts have been updated "Conservation Status" based on the Vegetation Survey Report (Stanton 2009a) and areas of clearing for earthworks for each road option has been based on updated engineering drawings for option D and general drawings design for options RB1 and RB2. The areas of clearing were calculated from the conservation area status corresponding to the figure and tables below. The weighting of importance was maintained as per the SEIS.

Figure 5 - E1: MCA Area Conservation Status

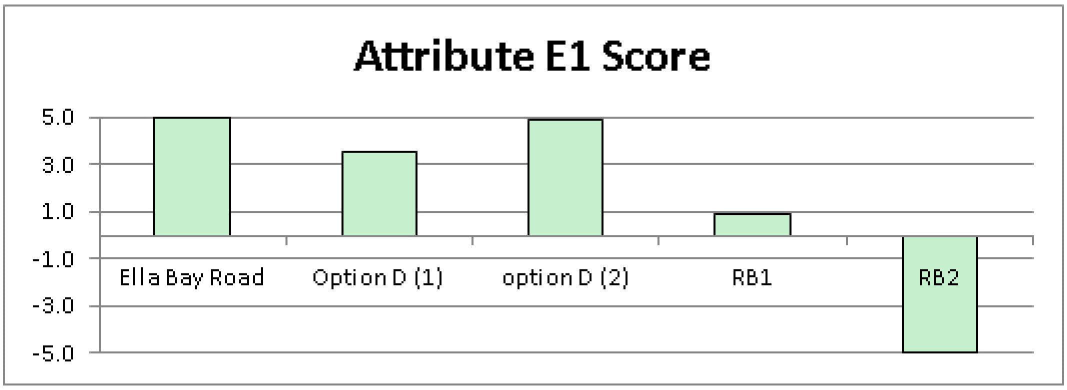
Conservation Status	Total Area (hectares)
Endangered	0.0
Of Concern	14.6
Not of Concern	0.3
Non-remnant	1.8

Table 2 - E1: MCA Area Conservation Status Area Calculation

Raw and Weighted Measurements

	Endangered (A)		Of Concern (B)		Not Concern (C)		Non Remnant (D)		Weighted Total	Attribute Total
Weight		6		4		2		1		
Ella Bay Rd	0	0	0	0	0	0	0	0	0	**5.0**
Option D (1)	0	0	0.117	0.466	0.0003	0.0006	0	0	0.45	**3.6**
Option D (2)	0	0	0.012	0.050	0.0003	0.0006	0	0	0.05	**4.8**
RB1	0	0	0.239	0.958	0	0	0.382	0.382	1.34	**0.9**
RB2	0	0	0.654	2.615	0	0	0.624	0.624	3.24	**-5.0**

Table 4.2 - E1: Data Important Areas for Plants (Communities)



Graph 1 - E1: Results Important Areas for Plants (Communities)

Result Comment: The results for E1 show that option RB2 scores the lowest due to extensive clearing along the length of the alignment through the reserve. Option RB2 and RB1 require 1.2ha and 0.6ha of clearing respectively. For RB2, half of the clearing is vegetation classified as “Of Concern”.

Option D (2) has the highest score for this attribute with the least amount of clearing as the alignment maximises use of the existing alignment. The total clearing is 130m² for a road length of 732m.

Attribute E2: Important Areas for Plants (Species)

Description Of Attribute: This attribute refers to areas which are important for individual plants of conservation significance.

Measurement of impacts have been updated to “Conservation Status” (Stanton 2009a) (Volume 6.2b) *figure 6* and table 4 below is the Regional Ecosystem mapping of the reserve for plants of conservation significance specific to this MCA.

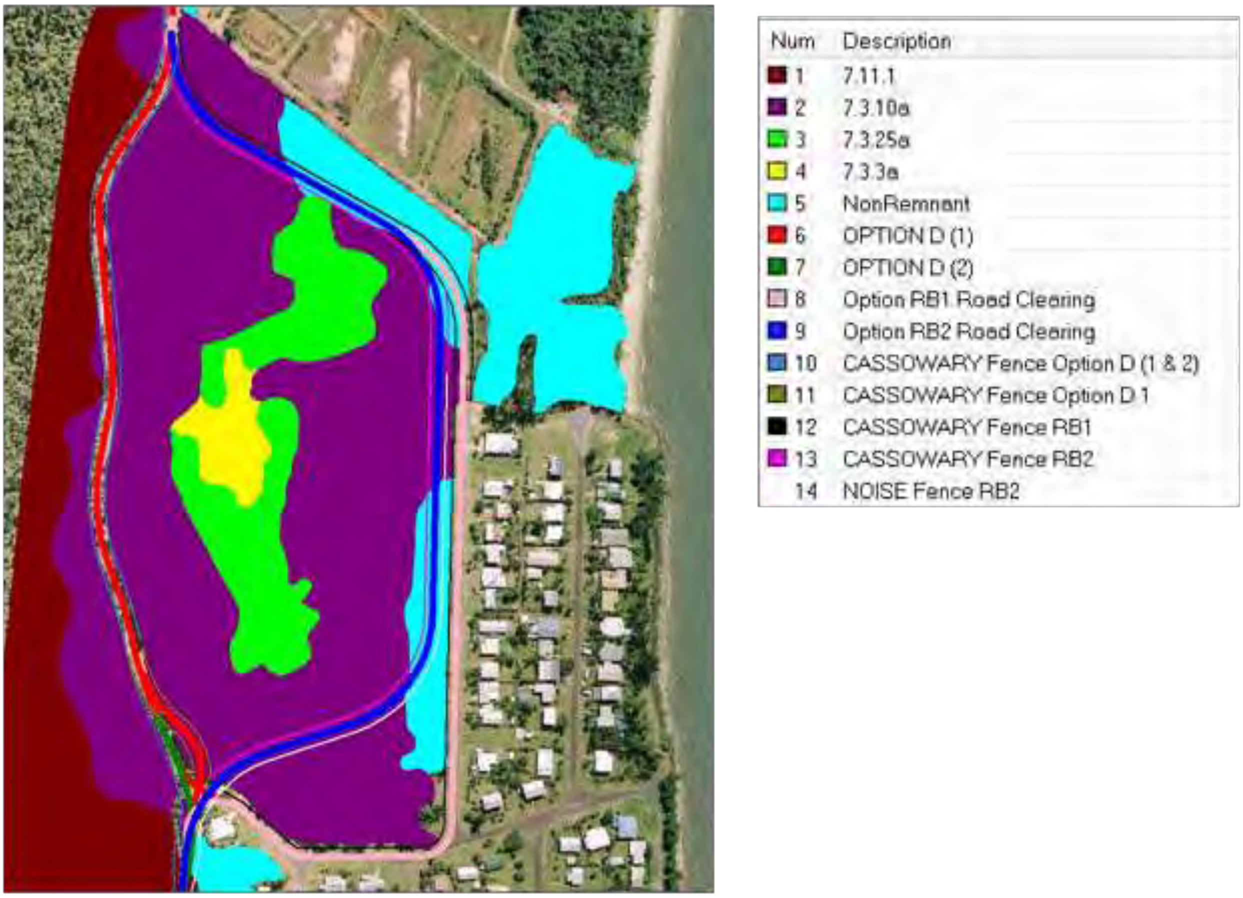


Figure 6 - E2: Important Areas for Plants

Stanton (2009a) lists the locations of EVR species along the current Ella Bay road (refer *Vegetation Survey Report 2009* - *figure 6b Road Area – EVR species locations and Appendix I.)* The report also comments that the EVR species are represented outside of the immediate road alignment and for this study it has been considered that the EVR species would also be present along proposed RB1 and RB2 routes in the respective communities.

Area	Regional Ecosystem	Known Threatened Flora Species	Habitat For Likely EVR Plant Species
Purple	7.3.10a	Endiandra globosa (Rare NCA), Rourea brachyandra (Rare NCA)	Canarium acutifolium var. acutifolium (Vulnerable NCA), Macaranga polyadenia (Rare NCA), Piper mestonii (Rare NCA), Rourea brachyanda (Rare NCA)
Green	7.3.25a	No site records	Piper mestonii (Rare NCA)
Yellow	7.3.3a	No site records	Macaranga polyadenia (Rare NCA)
Brown	7.11.1	Endiandra globosa (Rare NCA),	Carronia pedicellata (Endangered NCA), Polyalthia sp. (Wyvuri B. p. Hyland RFK2632).
Blue	Non-remnant	No site records	Unlikely suitable habitat

Table 4 – E2 Important Areas for Plants Description

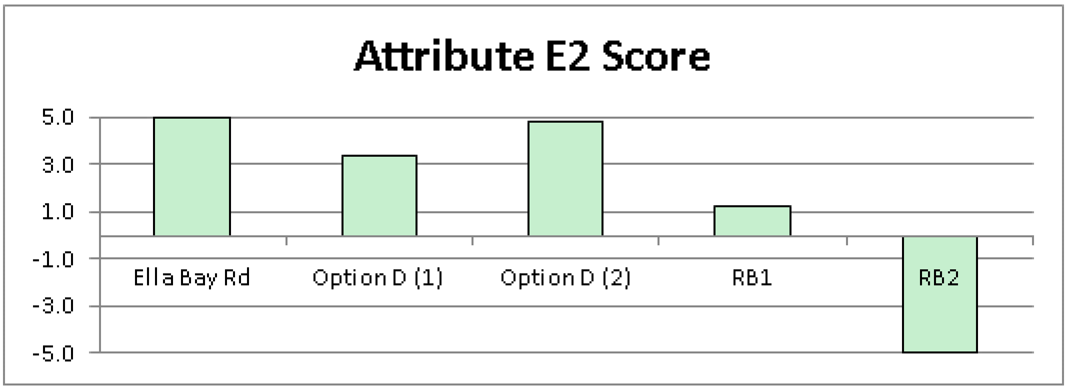
Measurement of impacts has been changed to updated areas of clearing limits of earthworks for each road option based on updated detailed engineering drawings for option D and general drawings design for options RB1 and RB2.

Scoring of Impacts: Due to the likely habitat of multiple different species within one specific RE location, the scores have been measured by the area of clearing by RE. The relative weighting has been maintained to that of the SEIS MCA using the RE's based on known threatened flora species found within the flora survey.

Raw and Weighted Measurements

	(7.3.10a) Purple		(7.3.25a) Green		(7.3.3a) Yellow		(7.11.1) Brown		(Non remnant) Blue		Weighted Total	Attribute Total
Weight		6		2		2		3		1		
Ella Bay Rd	0	0	0	0	0	0	0	0	0	0	0.0	**5.0**
Option D (1)	0.114	0.344	0	0	0	0	0.001	0.004	0	0	0.348	**3.3**
Option D (2)	0.011	0.033	0	0	0	0	0.001	0.004	0	0	0.038	**4.8**
RB1	0.242	0.726	0	0	0	0	0	0	0.382	0.382	1.108	**1.2**
RB2	0.658	1.974	0	0	0	0	0	0	0.628	0.628	2.602	**-5.0**

Table 5 - E2: Data Important Areas for Plants (Species)



Graph 2 - E2: Results Important Areas for Plants (Species)

Result Comment: Due to the extensive clearing required for option RB2 of RE 7.3.10a with the presence of endangered flora species, this option scores the lowest. Option D (2) scores the highest due to the least amount of clearing. The revised road alignment for Option D has been specifically surveyed for EVR species locations (figure 6b Road Area – EVR species locations and Appendix I).,

Attribute E3: Important Conservation Areas for Fauna (other than cassowaries)

Description Of Attribute: Areas which are important for Fauna (other than cassowaries) of conservation significance.

The original EIS MCA conducted in 2007 used figure 4.2 and table 4.11 of Working Paper 2 to identify regional ecosystems that could be considered as a surrogate for animal species of consideration significance. Based on that information the current MCA study area resulted in being of similar scoring category for all road options. Supported by information contained in BAAM (2008), no significant fauna (apart from cassowaries) was identified for this location (refer BAAM (2008) figure 5.1), all options would have scored the same value and therefore this attribute has been removed for this MCA exercise.

Attribute E4: Important Conservation Areas for Cassowaries

Description Of Attribute: This attribute has been modified compared to the SEIS to specifically refer to the reserve use by cassowaries.

The weighting of E4 and the resulting cassowary impact measurement is one of the main environmental determinants for the road options. There are two measurements that are considered and weighted differently:

- Loss of habitat; and
- Risk of mortality;

Habitat connectivity is essential for cassowaries, with reported home ranges of 2-5km² (Latch 2007). The area of the reserve at 17ha represents less than 10% of the home range of one bird at the extremity of the birds range. Two adult birds, a male (and chick) and a female have been monitored using the reserve (Moore 2007, Buosi 2009a, 2009b, 2010a). The regional ecosystem of the reserve is rated as Essential Cassowary habitat (Latch 2007 Appendix 2). The importance of the reserve for cassowaries is in access to watering points and alternative seasonal food and possibly as an area where juveniles may establish a territory away from resident adults (Latch 2007).

The reserve has periods of no water during the dry season (Ella Bay 2009)(EBSR Volume 6.1g). Moore (2008) reported that the habitat quality was rated 2 or medium; however the loss of water during the dry season detracts from the habitat quality for all year usage.

Moore (2007b, PVA analysis) reported that the cassowaries of the Graham Seymour Range subspecies are in danger of extinction due to anthropogenic factors within the next 60 to 100 years. The risk of mortality is influenced by the two major impacts; road deaths and dog attack. In the past 5 years there has only been one reported cassowary death in the area and that has been from dog attack, however with the proposed increase in traffic numbers the road risk is increased significantly.

Measurements of Impacts: The categories for measurement are listed below:

- Vegetation Balance: This was calculated by calculating the difference between the road clearing and a weighted revegetation area.

    Road Clearing: Area of clearing required for the road alignment

    Revegetation: Total area of revegetation as a result of bypassing the Ella Bay Rd section. Revegetation scores were weighted to 0.5 *(displayed within parentheses)* as the revegetated area is classified to be less significant than the existing established vegetation within the reserve.

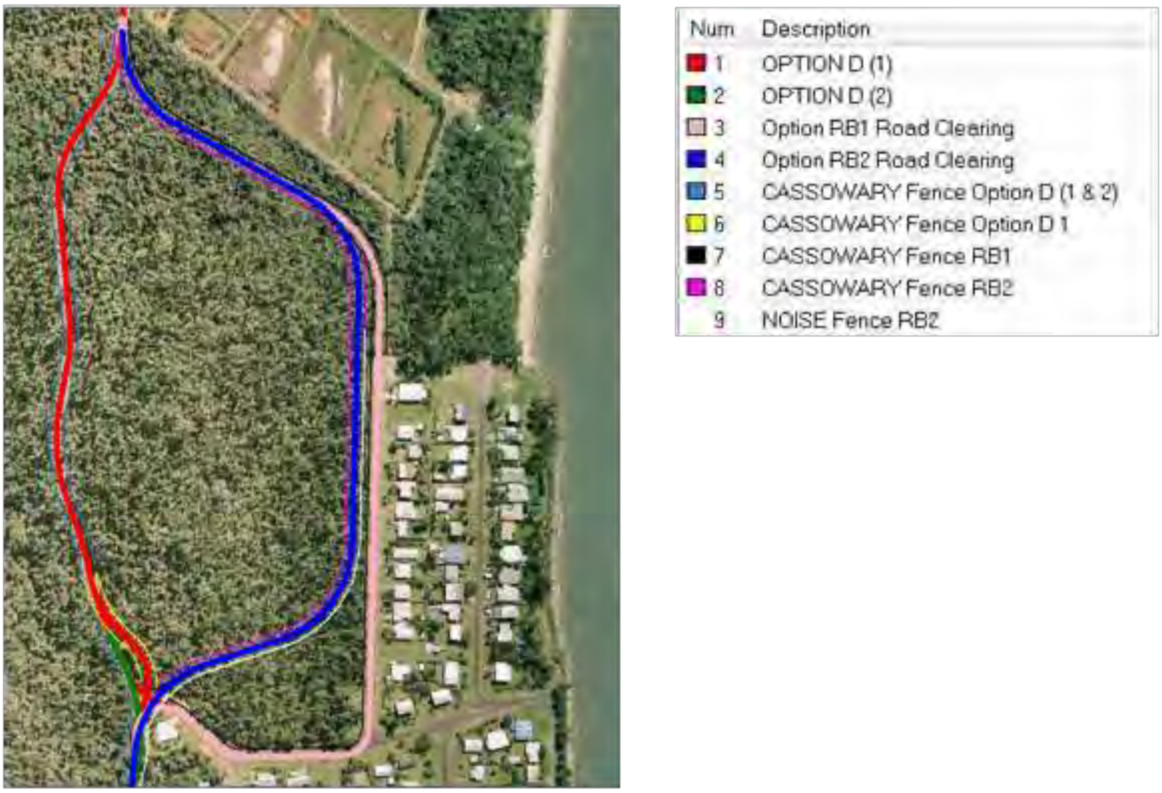


Figure 7 - E4: Road Clearing Balance

- **Loss of access to habitat**. Loss of access to habitat is caused by separation or isolation of the habitat by the road or a restricted access. This was measured by calculating the area of the essential and nonessential habitat that was isolated. Access through the fauna underpass (Bridge 1 of Option D(1) & D(2)) was weighted as a restriction to movement at a weighting of 0.5 representing a possible but uncertain continuing usage.

Figure 8 - E4 Loss of Access to Habitat

- Risk of Mortality; The risk of mortality is directly related to the frequency of cassowary usage, vehicle speed, ability for the vehicle to take evasive action and mitigation measure effectiveness.
- The use of shade cloth fencing to restrict and direct cassowary access through underpasses has been recommended as a primary method used to remove the risk of mortality from road collision with vehicles (Goosem et al' 2010, Roads in the Rainforest, and DTMR, Fauna Sensitive Road Design Manual Vol2),

Vehicle Speed: The average vehicle speed is a function of posted speed and road conditions. For the purposes of this MCA posted speed has been used as the criteria. The weighting of 1 reflects the closeness of the speeds.

Cassowary Frequency: This is subjective measure that has been applied to reflect the relative risk of cassowaries being on the road. Option D(1) and D(2) have been weighted a ten fold less risk of a cassowary on the road due to the use of fencing. Options RB1 and RB2 have been weighted a ten fold less risk of a cassowary on the road due to the use of fencing and an additional ten fold less risk of a cassowary crossing, as the primary destination is the reserve (**total of 100 fold less risk rating**). Cassowary usage of the beach is reported and access is often obtained via Flying Fish Point. Cassowary frequency has been weighted a 3 to reflect the higher risk to mortality.

Vehicle Frequency: This has been taken from the revised demographics Appendix 3 *Revision to Road Usage Demographics for Ella Bay Road*. The weighting of 1 reflects the similarity between the options.

Fencing: This criteria reflects the degree of fencing. The weighting of 3 reflects the risk of increased mortality from possible road access.

Vegetation Balance

	Clearing (ha)	Reveg (ha)	Reveg Weighted *(weight 0.5)*	Balance *Clearing - Reveg*	Attribute Total
Ella Bay Road	0	0	0	0	**5.0**
Option D (1)	0.1168	0.100	0	0.0168	**3.8**
Option D (2)	0.0127	0.005	0	0.0077	**4.9**
RB1	0.6524	0.6072	0.3036	0.3488	**1.6**
RB2	1.3160	0.6072	0.3036	1.0124	**-5.0**

Table 6 – E4: Vegetation balance

Loss of access to Habitat

	Essential Habitat Habitat Rating *(weight 3)*		Non Essential Habitat Rating *(weight0.5)*		Weighted Total
	Area (ha)	**Area U/pass** *(weight 0.5)*	**Area (ha)**	**Weighting**	
Weighting		3		0.5	
Ella Bay Road	17.5	17.5	26	31	**-5.0**
Option D (1)	17.5	9	15.8	17	**0.8**
Option D (2)	17.5	9	15.8	17	**0.8**
RB1	0	0	13	7	**5.0**
RB2	0	0	16	8	**4.4**

Table 7 – E4: Loss of access to essential cassowary habitat

Risk of Mortality

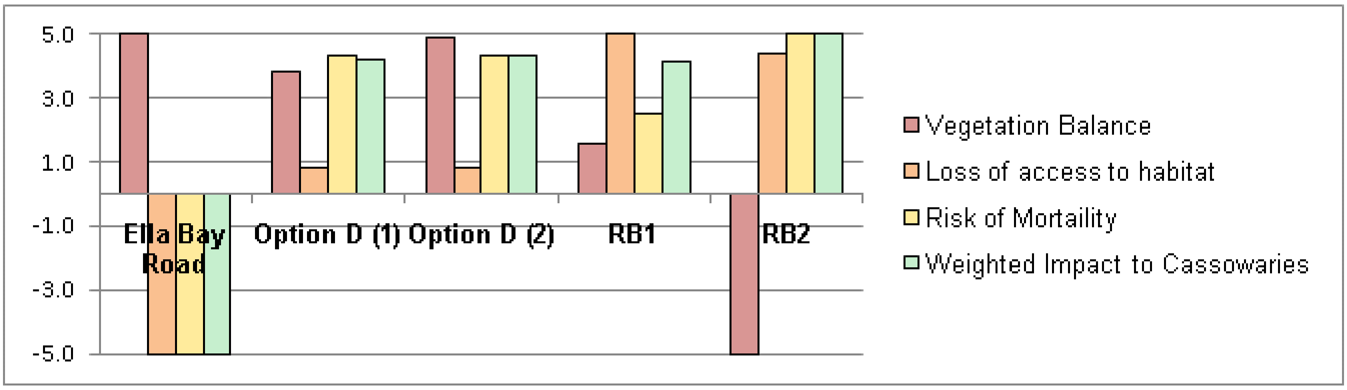
	Posted Speed km/h		Cassowary Frequency Subjective		Vehicle Frequency		Fence (fraction of road)		Weighted Total
Weighting		1		3		1		3	
Ella Bay Road	40	5.0	1	-5.0	150	5.0	0	-5.0	**-5.0**
Option D (1)	60	-5.0	0.1	4.1	3000	-4.9	1	5.0	**4.3**
Option D (2)	60	-5.0	0.1	4.1	3000	-4.9	1	5.0	**4.3**
RB1	50	0.0	0.01	5.0	3020	-5.0	0.5	0.0	**2.5**
RB2	60	-5.0	0.01	5.0	3000	-4.9	1	5.0	**5.0**

Table 8 – E4: Risk of Mortality

E4 Overall Impact to Cassowaries

	Vegetation Balance	Loss of Access to Habitat	Risk of Mortality	Weighted Impact to Cassowaries	
Weighting	1	3	6		
Ella Bay Rd	5	-5.0	-5.0	-40.0	-5.0
Option D (1)	3.8	0.8	4.3	32.1	4.2
Option D (2)	4.9	0.8	4.3	33.2	4.3
RB1	1.6	5.0	2.5	31.5	4.1
RB2	-5	4.4	5.0	38.3	5.0

Table 9 – E4: Overall Impact to Cassowaries Los of Access x3, Risk of Mortality x6



Graph 3 – E4: Results Overall Impact to Cassowaries

Result Comment:

Further weightings were applied to each category based on subjective relative importance. The vegetation balance representing only 1.3ha disturbance of a total of 17ha was rated a 1. The loss of access to habitat was weighted 3 indicating the importance to cassowary habitat but also reflecting that the total area represents less than 10% of a home range. The risk of cassowary mortality was weighted 6 based on the possible danger of extinction of the local subspecies.

Vegetation Balance. Options RB1 and RB2 performed poorly with the highest clearing required. The highest rated option was Option D(2).

Loss to habitat. The loss to essential cassowary habitat downgraded options D(1) & D(2). The rating of 0.5 to reduced access through a bridge sized fauna underpass is debatable given the known use of bridges by cassowaries (4.0 Ella Bay Road Design and Environmental Report; Appendix 2, Cassowary Underpass Survey 2008 2009)

Risk of mortality. The only difference in risk of mortality between options D(1), D(2) and RB2 in all four risk ratings was through the subjective assessment of cassowary frequency, which assumes a lower frequency of potential risks by a factor of 10 for D(1&2) and a factor of 100 for RB2. The risk of frequency is an unknown and assumes that any risk will be related to the current frequency and not to the mitigation. Cassowary crossings of Ella Bay road are estimated at greater than 100 times per year, (counting multiple cassowaries and crossing both ways).

Overall Results:

The overall results indicated that all of the fully fenced options D(1), D(2) and RB2 were close in overall scoring with Option RB2 scoring highest. Option RB1 ranked the lowest of the proposed options due to the fencing of only one side of the road for access to the residents houses and increased clearing over Option D(1) & D(2).

Attribute E5: Ecological Processes (Flora and Fauna Connectivity)

Description of Attribute: This attribute measures the ecological processes that are important for the maintenance of flora and fauna values and that could be impacted upon by the road upgrade or new road alignment. However it must also be noted that the existing road between Flying Fish Point and Ella Bay has been in used since the early 1900's and the isolation has been a long term change. This measure is relative to an improvement in connectivity.

Elements: Important ecological processes were identified in the original SEIS MCA 2007, however only connectivity was measurable in that MCA and therefore applied to this new MCA.

Connectivity: Geographical contiguity with other forest or vegetation areas. The current road alignment and anthropogenic effect of proximity to Flying fish Point has created a split of the vegetation, therefore causing disruption to fauna and flora movement from west to east. Analysis of the road options is to a potential improvement in the connectivity.

Mitigation measures will be included in the form of fauna culverts and cassowary underpasses as discussed and scored in attribute E4. For this MCA the potential improvement areas are identified in the figure below:

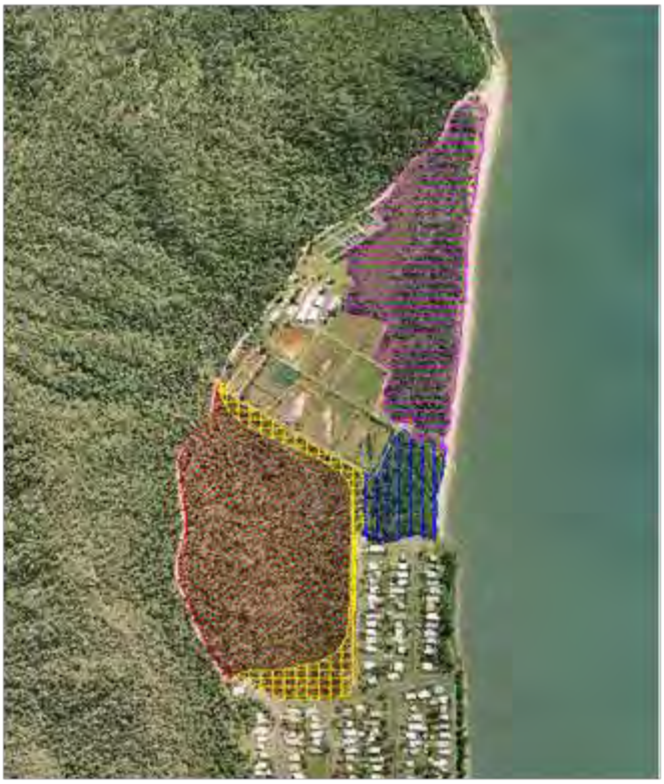


Figure 9 - E5: Fauna and Flora Connectivity Areas

Measurement: The total area which will be split to the east by the road alignment.

- Area A (red): 17.5 hectares of concern vegetation
- Area A1 (yellow): 2.8 hectares predominately non remnant and cleared
- Area B (blue): 2.6 hectares all non remnant
- Area C (pink): 10.4 hectares equal non remnant and of concern

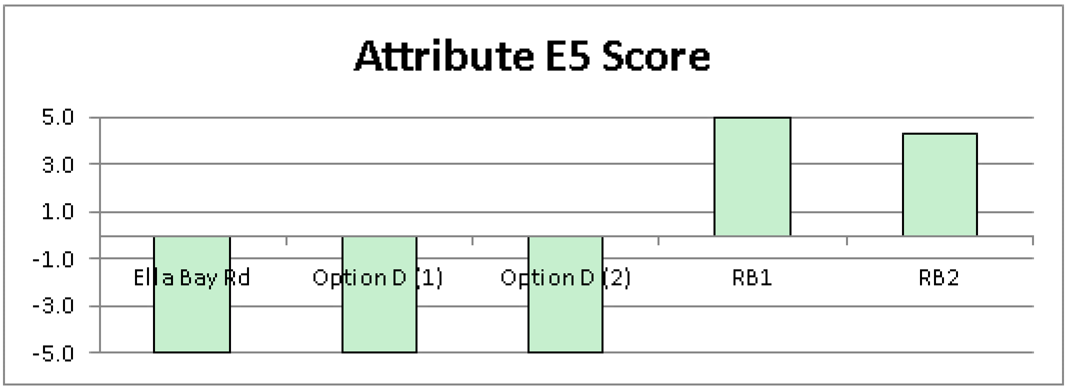
Scoring of Impacts: Each area was measured separately including the area of the road alignment. The total area was added together from west to east depending on the location of the proposed road. Options D(1) and D(2) will have mitigation in the form of bridge fauna underpass and a fauna culvert. This has not been included in the weightings.

Weighting: Weighting was based on proximity to the road and vegetation Conservation Status and applied to each area as a measurement of connectivity importance, refer to table below:

Raw Measurements and Weighted Score

	Area A red		Area A1 yellow		Area B blue		Area C pink		Weighted Total	Attribute Total
Weight		1		0.5		0.25		0.5		
Ella Bay Rd	17.5	17.5	0	0	2.6	1.3	10.4	2.6	21.4	-5.0
Option D (1)	17.5	17.5	0	0	2.6	1.3	10.4	2.6	21.4	-5.0
Option D (2)	17.5	17.5	0	0	2.6	1.3	10.4	2.6	21.4	-5.0
RB1	0	0	0.3	0.3	2.6	1.3	10.4	2.6	4.2	5.0
RB2	0	0	2.8	2.8	2.6	1.3	10.4	2.6	6.7	4.3

Table 10 - E5: Data Flora and Fauna Connectivity



Graph 4 - E5: Results Flora and Fauna Connectivity

Result Comment: The results indicate that RB1 ad RB2 would potentially improve the vegetation and small fauna connectivity of the Flying Fish Point Reserve to the Ella Bay National Park to the west of the current Ella Bay Road location. Of the two options RB1 was marginally higher scoring due to using the current Flying Fish Point road system to the end of Bindon St. (43% of total road length).

Options D(1 & 2) both scored lowest as there is no improvement over the connectivity if the existing Ella Bay Road. Note that the fauna underpasses have not been evaluated as there is no data to indicate improvement.

Transport Efficiency

Attribute T1: Travel Time

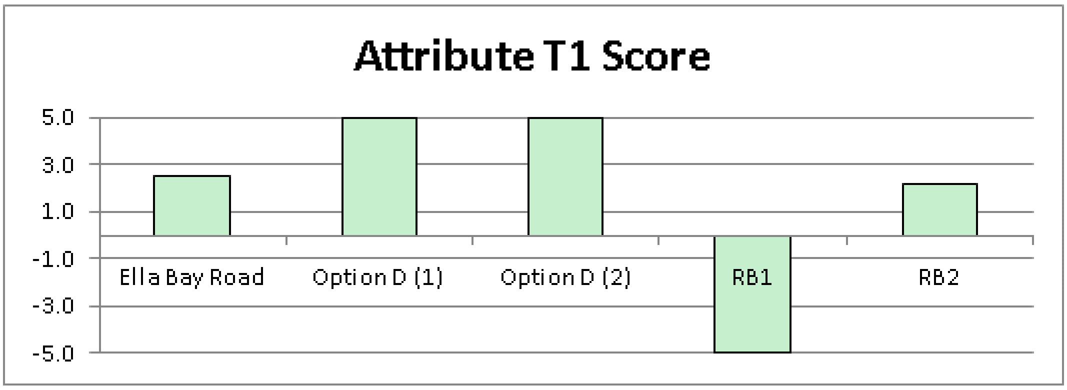
Description of Attribute: The travel time required for vehicles to travel from Point B (end of Flying Fish Point) to Point D (start of Fish Farm) refers to figure 2.1. The travel times determined were based on average speeds determined by the speed limit and environment (intersections, number of corners, tight/sharp corners, etc).

Measurement of Impacts: Travel times for standard vehicle for each option estimated from average travel speed.

Raw Data and Attribute Score

	Length (m)	Av Speed (km/h)	Time (s)	Score
Ella Bay Rd	722	40	64.98	2.5
Option D (1)	732	60	43.92	4.9
Option D (2)	722	60	43.32	5.0
RB1	1,082	30	129.84	-5.0
RB2	940	50	67.68	2.2

Table 11 - T1: Data Travel Time



Graph 5 - T1: Results Travel Time

Result Comment: Option D (2) scored highest due to being the shortest direct route without sharp corners with the average speed of 60 km/h; with option D (1) marginally lower scoring due to the extra 10 metres length and two corners. Surprisingly Ella Bay Road at the current condition (40 km/h unsealed road) scored better than RB2 and considerably more than RB1 which is 360m longer and its average speed is low due to the intersections, corners and local traffic.

Attribute T2: Capacity at LOS

Description Of Attribute: The SEIS used the Average Annual Daily Transport AADT predictions for road capacity, however this is not valid for Ella Bay Road that would be subject to higher intensities during mornings and evenings and would only vary in actual volume depending on the time of year. Without data however the best estimate of design hourly volume (HV) is 15% of the AADT with a possible highest hourly rate of 25% of AADT. The Hourly Volume was then applied to the predicted delay in terms of percent of free flow speed (FFS). The score was based on converting LOS to integers and scaling.

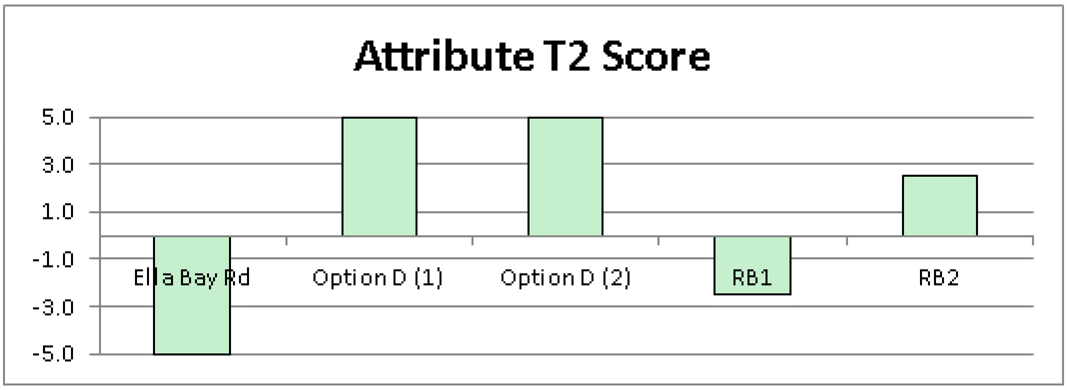
Measurement of Impacts:

Scoring of Impacts: Each road option was scored on the basis of the estimated average capacity and simulated Level of Service.

Raw Data and Attribute Score

	Capacity HV	Predicted delay % of FFS	LOS	Score
Ella Bay Rd	450	25	F	-5.0
Option D (1)	450	90	A	5.0
Option D (2)	450	90	A	5.0
RB1	455	33	E	-2.5
RB2	450	70	B	2.5

Table 12 - T2: Data Predicted LOS



Graph 6 - T2: Results Predicted LOS

Result Comment: The desired level of service for Ella Bay Road is LOS C at peak times (HV - 450-750 v/h). The LOS for a short length of road may not be relevant as other sections of the road may be more restrictive. The estimated LOS for the full road is predicted to be B therefore any reduction below a LOS of B would affect the overall road LOS. Options D(1) & (2) and RB2 maintain the LOS at B. The difference in LOS of D(1) & D(2) and RB2 is produced by the change from a straight length of road by the addition of four corners.

The LOS is an overall road network rating combined with efficiency of distribution. Road closures significantly affect the LOS and what has not been accounted for in this comparison is flooding which would severely affect of the use of Bindon Street as the only means of access to Ella Bay with RB1. This is covered in attribute T5.

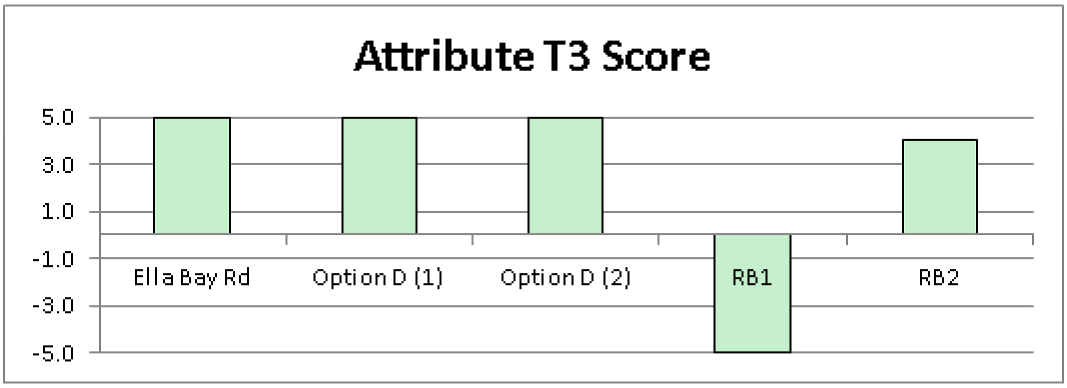
Attribute T3: Accommodate Service Vehicles

Description Of Attribute: Suitability of road options for use by service vehicles accessing Ella Bay. Service vehicles must be able to negotiate road grades and horizontal curves safely without leaving their traffic lane. There is no height restriction within this section of roads. Scores were subjectively allocated based on the forecasted design and safety such as corners, intersections and sight.

Attribute Score and Results

	Comments/Results	Score
Ella Bay Rd	Unsealed gravel surface, not ideal but service vehicles are able to use the road at this current state.	4
Option D (1)	Designed to best practices to suit conditions and surroundings.	5
Option D (2)	Designed to best practices to suit conditions and surroundings.	5
RB1	Due to the tight hairpin turn at start of segment to join with current alignment at Ruby St and sharp intersection turn to Bindon St this option is high risk for service vehicles.	-5
RB2	Designed for continuous safe speed at 60km/h, there is only marginal movement over the articulated vehicle sweep path.	4

Table 13 - T3: Data Accommodate Service Vehicles



Graph 7 - T3: Results Accommodate Service Vehicles

Result Comment: RB1 is clearly not suitable for articulated service vehicles, the tight turns at the intersection of the bypass to Ruby St and the intersection of Ruby and Bindon St would cause complete sweep of both sides of the road by an articulated vehicle, leading to traffic blockage and delays. All other options provided minimal disruption to the sweep path.

Attribute T4: Accommodate Bicycles

Description Of Attribute: Suitability or otherwise options for use by cyclists. Bicycles must be able to negotiate road grades and horizontal curves safely.

All four proposed routes incorporate a common bicycle pathway as the road shoulder. All options would score the same in this MCA therefore removed.

Attribute T5: Stability / Flooding

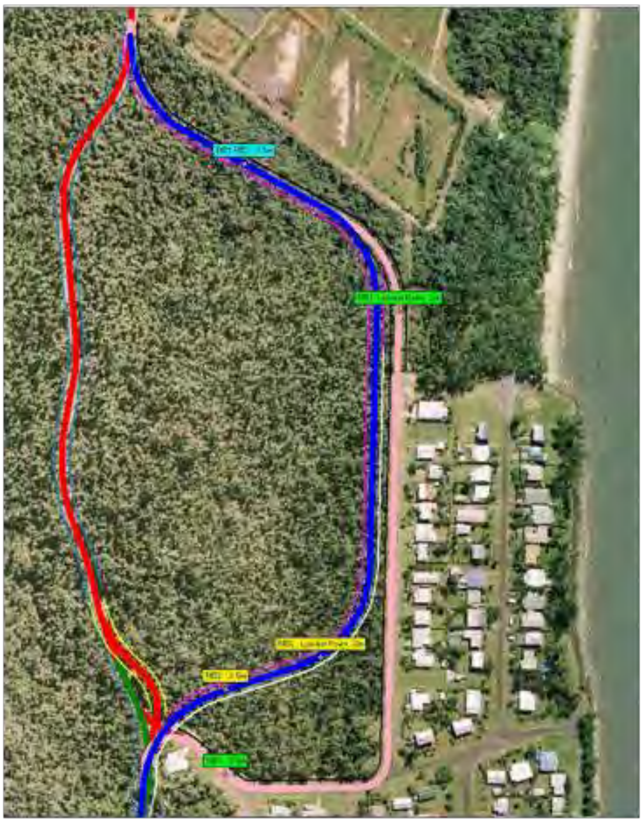
Description Of Attribute: The potential risk of road closures and delays resulting from land slippages, flooding and road deterioration. The identified elements to this attribute are:

- The volume of fill required to elevate the road above the flood event of 3.5 mAHD;
- The risk of flooding as in the case of RB1 the current road level at 3.0 mAHD; and
- It is not practicable to increase the height of Ruby and Bindon St with the existing residences and road network.

Measurement of Impacts: For this MCA; land fill will be required to mitigate and elevate the road options above flood and water course level.

Scoring the Impacts: The volume of fill required to elevate Options RB1 & RB2 to above flood event levels was calculated. For RB1 this only applied to the section that joins Bindon St to Ella Bay Road. The lowest point in the alignment for RB1 and RB2 is 2.0 mAHD.

For risk of flooding the length of road where the final finished level is less than 3.5m was used as the measure. Of note is that the full length of Ella Bay Road and the Flying Fish Point Bypass has been elevated to above 5 mAHD for security of access.



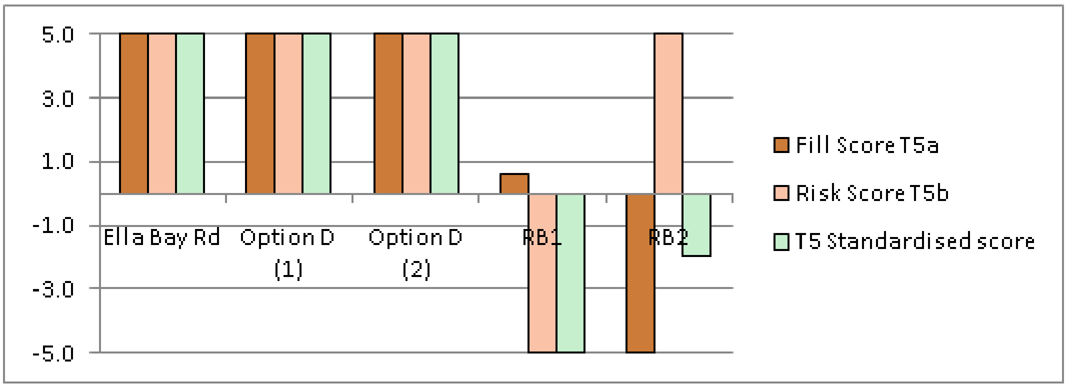
Num	Description
1	OPTION D (1)
2	OPTION D (2)
3	Option RB1 Road Clearing
4	Option RB2 Road Clearing
5	CASSOWARY Fence Option D (1 & 2)
6	CASSOWARY Fence Option D 1
7	CASSOWARY Fence RB1
8	CASSOWARY Fence RB2
9	NOISE Fence RB2

Figure 10 - T5: Road Alignment Low Points

Raw Data and Attribute Score

	Fill	Fill Score	Risk	Risk Score	Total score
Ella Bay Rd	0	5.0	0	5.0	5.0
Option D (1)	0	5.0	0	5.0	5.0
Option D (2)	0	5.0	0	5.0	5.0
RB1	286	0.6	527	-5.0	-5.0
RB2	656	-5.0	0	5.0	-2.0

Table 14 - T5: Data Stability / Flooding



Graph 8 - T5: Results Stability / Flooding

Result Comment: Ella Bay Road and both option D routes have a minimum elevation of 6.5 mAHD and will not require any fill. The alignment of Ella Bay Road was historically chosen to be above the swamp of the reserve, not surprisingly RB1and RB2 performed poorly in this attribute. Not only would the construction of the road be difficult with regards to water infiltration, the probable excavation of Acid Sulphate Soil would complicate management and stockpiling of soil.

Attribute T6: Safety

Description Of Attribute: The potential risk of accidents on the proposed routes and their possible impacts on human life, health and property.

Elements: Number of intersections with non-resort traffic and sharp bends.

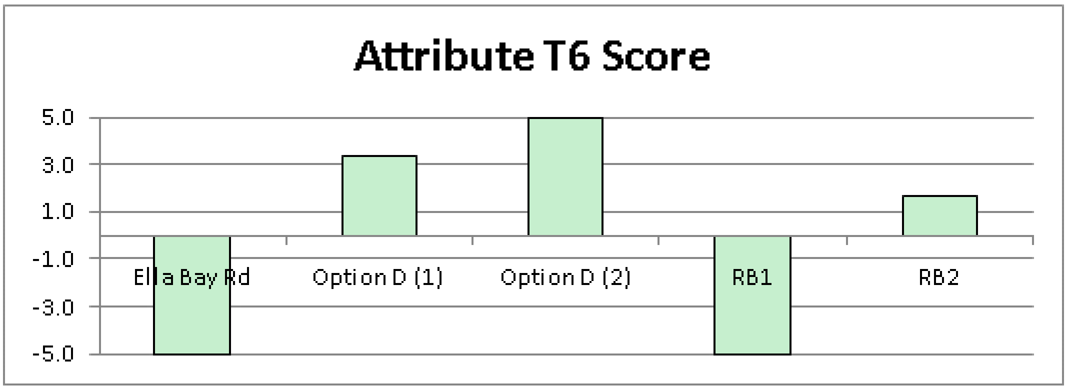
Measurement of Impacts: The number of intersection and sharp bends along the route from point B to D.

Scoring the Impacts: The scores were calculated by weighting the number by 0.5 for T intersections, 1.0 for horizontal curves less than 50m radius and 0.5 for horizontal curves less than 100m radius. The risk of accidents due to the existing dirt road was weighted 5.

Raw Data and Weighted Score

	T Intersection	Horizontal Curve 50m	100m	Dirt Road	Total	T6 Standardised
Weight	0.5	1	0.5	5		
Ella Bay Rd		1		1	6	-5.0
Option D (1)			2		1	3.3
Option D (2)					0	5.0
RB1	4	3	2		6	-5.0
RB2			4		2	1.7

Table 15 - T6: Data Safety



Graph 9 - T6: Results Safety

Result Comment: Option D(2) scored marginally higher than option D(1) due to the additional horizontal curves required to avoid the National Park boundary. Option RB1 scored lowest due to the numerous intersections and sharp bends within the local Flying Fish Point roads.

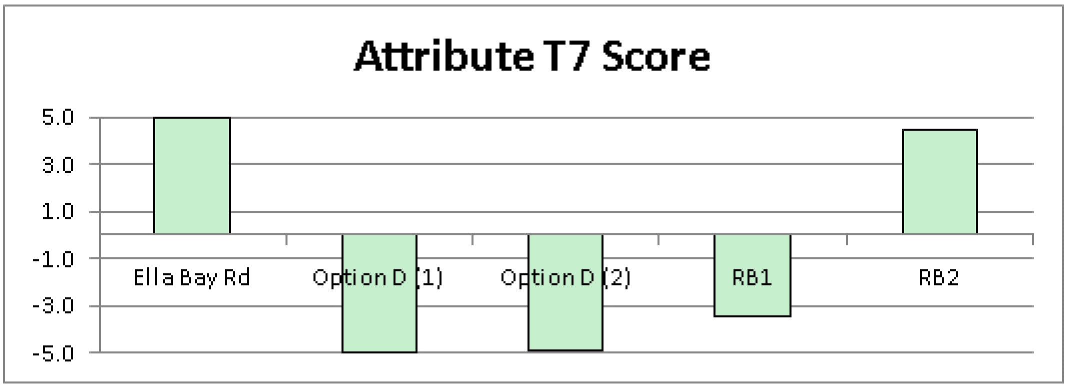
Attribute T7: Constructability

Description Of Attribute: The constructability of the road varies due to construction difficulty of the length of road that is required to be constructed keeping traffic open.

Raw Data and Attribute Score

	Total Road Length (m)	Construction Length Under Traffic	Score
Ella Bay Rd	722	0	5.0
Option D (1)	732	732	-5.0
Option D (2)	722	722	-4.9
RB1	1,082	616	-3.4
RB2	940	40	4.5

Table 14.3 - T7: Data Constructability



Graph 10 - T7: Results Constructability

Result Comment: The current average daily traffic is between 75 to 150v/d and of this approximately half relates to the prawn farm (the only industry and residence along the road) while the rest is mainly tourist or local visitors to Heath Point Park. All options except RB2 will involve disruption to the current traffic conditions of which appropriate traffic management mitigation will be required. RB2 scores the highest as the new road section within the reserve can be constructed without major disruption to the Ella Bay Road, Bindon St and Ruby St.

Social Amenity

Attribute S1: Important Areas for Scenic Amenity

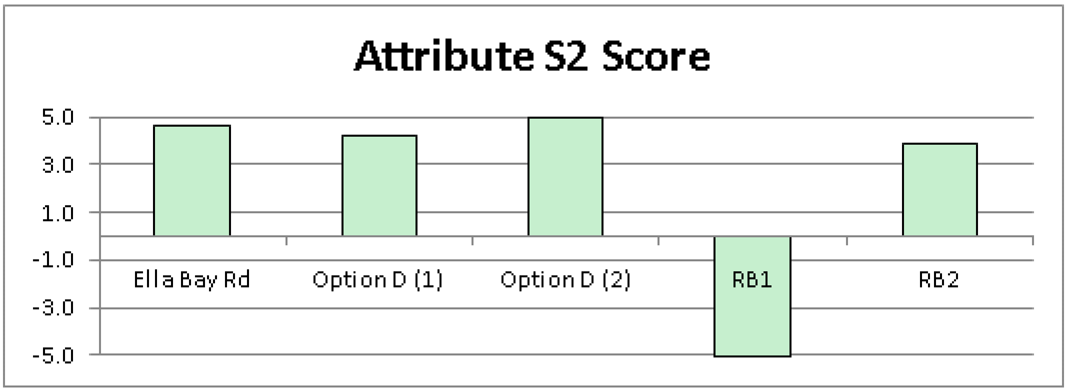
Description Of Attribute: This attribute was included in the SEIS to evaluate the full length of the road options and identify whether there was any difference in the external visual catchment. That is parts of the road that could be visible from the Great Barrier Reef Marine Park. None of the options are visible externally due to the canopy height or house height blocking visual catchment. Therefore this attribute has been removed from this MCA.

Attribute S2: Scenic Quality for Road Users

Description Of Attribute: The same attribute descriptions and scoring have been adopted from the SEIS, however the provision of views is not relevant to this short section of road. This is a qualitative assessment based on:

- Contrast vs Blending-in;
- Gradual Transition vs Sudden change; and
- Regularity vs Variation.

The impacts were measured using subjective opinion on the basis of a scoring of max beneficial +5; neutral 0; max adverse -5. Refer to table 18 for description and analysis of each option.



Graph 11 - S2: Results Scenic Quality for Road Users

Results Comment: Option D (1 & 2) scored highest due to the minimal change in the existing road vista and continuation of rainforest views. RB2 scored poorly in blending in due to the engineered road and visual noise barrier fence. RB1 scored poorest due to loss of rainforest views on re-entering the town.

RB2 would provide additional views of the change from rainforest to wetlands palm forest with stands of feather and fan palm stands.

	Contrast vs Blending-in		Gradual Transition vs Sudden Change		Regularity vs Variation		Total	S2 standardised
Ella Bay Road	4	Blends with natural landscape. Gravel road with weeds and dust.	3	Transition from tarmac town road to gravel. No remarkable points	3	The road is aligned along the change in vegetation type above the wetland of the reserve. Regular	10	4.6
Option D (1)	3	Blends with natural landscape. Visible Fauna fence. Clearing will detract from	3	Road users will experience a similar view to FFP bypass	3	The road has the same vegetation type as the bypass and is aligned along the change in vegetation type above the wetland of the reserve. Regular	9	4.2
Option D (2)	5	Blends with natural landscape. Visible Fauna fence. Improved alignment continues closed rainforest canopy.	3	Road users will experience a view from FFP bypass of the road before them towards Heath Point	3	The road has the same vegetation type as the bypass and is aligned along the change in vegetation type above the wetland of the reserve. Regular	11	5.0
RB1	-5	Road contrasts from rainforest to town to engineered road over reserve with fauna fence - no noise barriers.	-5	Road changes from rural with enclosed rainforest to town lined with houses to reserve road. The transition will be negative.	-5	Many variations. The rainforest of the bypass to town to wetlands including Melaleuca and palm forest. But includes intersections through town and houses. Does not showcase the wet tropics.	-15	-5.0
RB2	-2	Road contrasts from natural landscape with engineered road built up on reserve area and include a visible noise barrier wall and visible fauna fence.	5	Road users will experience a similar view to FFP bypass, with slightly different vegetation	5	Many variations. The rainforest of the bypass to wetlands including melaleuca and palm forests. The eastern side of the road will feature the solid noise fence.	8	3.8

Table 14.4 - S2: Data Scenic Quality for Road Users

Attribute S3: Noise to Residences

DESCRIPTION OF ATTRIBUTE: Relative exposure to noise emission during construction and operation. The measurement is based on the sum of the inverse squares of the perpendicular distance of the residence from the road and is consistent with this attribute in the SEIS.

The residents that would be primarily impacted by the road construction and operation are shown in figure 11 (22 homes).

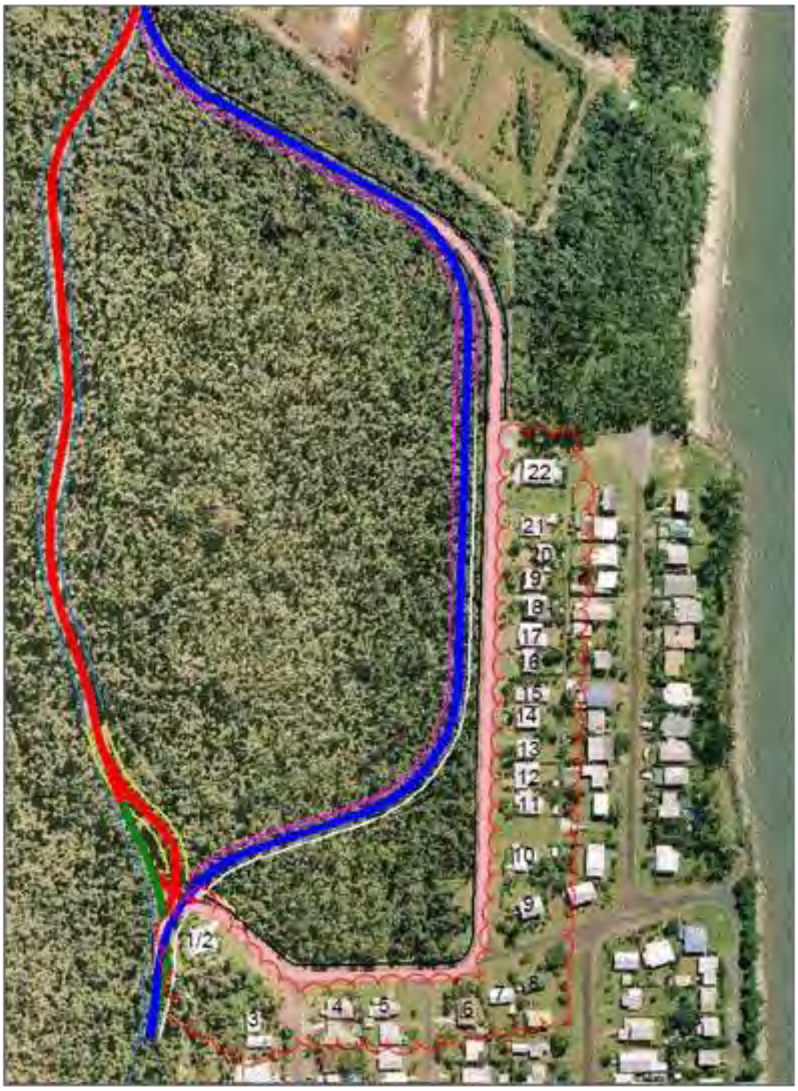
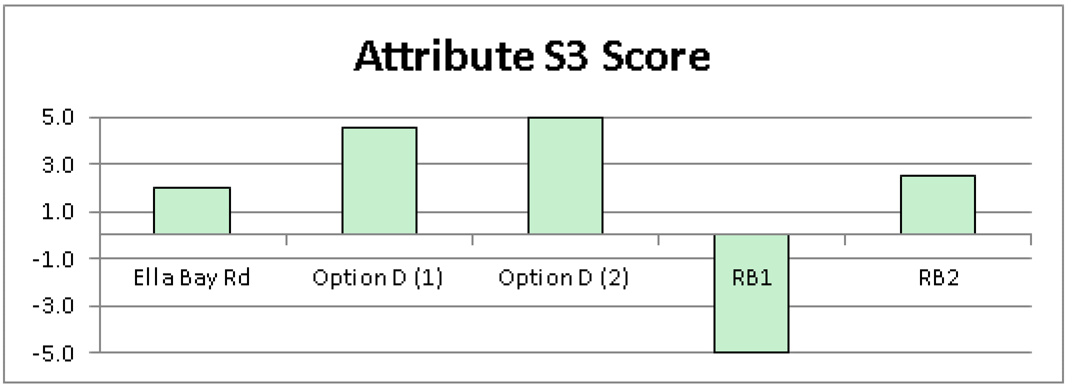


Figure 11 - S3: Area affected by noise

Raw Data and Attribute Score

	Result	Score
Ella Bay Rd	0.0098	2.0
Option D (1)	0.0031	4.5
Option D (2)	0.0019	5.0
RB1	0.0282	-5.0
RB2	0.0084	2.5

Table 19 - S3: Data Noise to Residences



Graph 12 - S3: Results Noise to Residences

Result Comment: No allowance has been made for noise attenuation through the rainforest or from the noise fence, or additional noise generated from the dirt road. As expected the options that are furthest from the residences performed best; Options D (1 and 2). Option RB2 scored well however it affects 10 residences at the end of Bindon St as the road would be within 45 metres. Option RB1 is the worst performing option as it directly affects all 22 homes opposite the proposed RB1 alignment and due the common road there is no ability to construct a noise barrier fence.

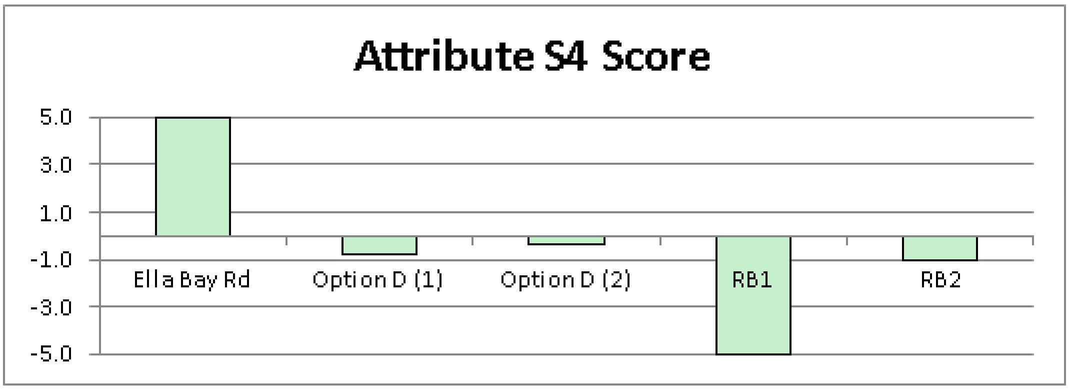
An acoustic fence is proposed for Options D (1 and 2) at the closest residence in Stage 2 which would further reduce the noise received by these residences.

Attribute S4: Construction Issues (During construction period)

DESCRIPTION OF ATTRIBUTE: Short term impacts of construction on social values. There are no changes to the Elements or Scoring to this attribute. Refer to SEIS – Access Road Strategy 4.8.4 for description.

Measurement of impacts has been changed to updated areas of clearing limits of earthworks for each road option based on updated detailed engineering drawings for option D and general drawings design for options RB1 and RB2.

Raw Data and Comments *(max beneficial +5; neutral 0; max adverse -5)*



Graph 13 - S4: Results Construction Issues

Result Comment: The minimal disruption to social values was the no construction option. Options D (1&2) and RB2 performed similarly while option RB1 had the greatest impact on the social values and created the most disturbances to the existing residences.

	Noise Levels		Air Quality		Loss of Access		Reduced Travel Times/Traffic Delays		Visual Impacts		Total	S4 standardised
Ella Bay Rd	5	No Construction	5	No Construction	5	No Construction	5	No Construction	5	No Construction	25	**5.0**
Option D (1)	1	Minimal clearing required. Paving of road and bridge construction.	-1	Construction away from town within vegetation.	-1	Disruption to Ella Bay Road, traffic control provided but low traffic volumes.	-1	Some traffic delay on Ella Bay Road but low traffic numbers.	2	Visual impacts will be restricted to road alignment within established vegetation.	-1.0	**-0.3**
Option D (2)	2	Minimal clearing required. Paving of road and bridge construction.	-1	Construction away from town within vegetation.	-1	Disruption to Ella Bay Road, traffic control provided but low traffic volumes.	-1	Some traffic delay on Ella Bay Road but low traffic numbers.	2	Visual impacts will be restricted to road alignment within established vegetation.	-1.0	**-0.8**
RB1	-3	Upgrade of current alignment only. Upgrade next to dwellings.	-2	Upgrade of road, next to residences. Clearing of vegetation on reserve.	-5	Loss of access via FFP road network. High priority traffic due to resident access.	-5	Subject to high priority traffic delay issues.	-5	High visual impact due to being within FFP road network and next to residences.	-20	**-5.0**
RB2	-5	Clearing of vegetation on reserve required. Fill required, paving and bridge construction.	-5	Most clearing and earth works required of all options and close to dwellings.	5	No interference with current traffic.	5	No traffic delay.	-2	Medium to high visual impact as work will be conducted near residences.	-2.0	**-1.0**

Table 20 - S4: Data Construction Issues

Attribute S5: Severance of Communities

DESCRIPTION OF ATTRIBUTE: Extent to which resort traffic using each road option passes between adjacent parts of the community resulting in some degree of severance. For this section of the road, there will be no division of any dwellings from the main Flying Fish Point community. This attribute is not applicable

Cost

Attribute C1: Capital Cost of Works

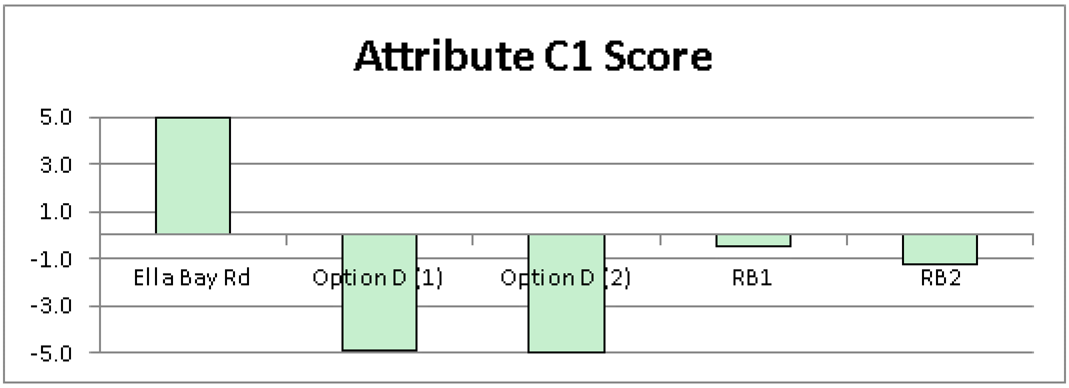
Description Of Attribute: This attribute compares the estimated capital cost of access road between points B to D and B C D (refer to figs 1 & 2).

Scoring The Impacts: The projected total cost was estimated for each option based on data from Rawlinsons (Australian Construction Handbook, 2010) and budget estimates prepared by Civil Engineers - Projex North. The capital cost was considered as a lump sum, including mitigation costs and revegetation. No risk, contingency, contractors profit or establishment costs have been included.

Raw Data and Attribute Score

	Cost $M	Score
Ella Bay Rd	$ -	**5.0**
Option D (1)	$ 1,743,610	**-5.0**
Option D (2)	$ 1,718,292	**-4.9**
RB1	$ 927,176	**-0.3**
RB2	$ 1,034,270	**-1.0**

Table 21 - C1: Data Capital Cost of Works



Graph 14 - C1 Cost Comparison

Result Comment: The results indicate that all options are expensive with Options RB1 and RB2 the cheapest. The cost of the fauna bridge increases the cost of Options D(1&2) by $1.2m. In the SEIS a fauna bridge was added to the RB2 alignment to allow cassowary access to the beach area. This would increase the cost of RB2 to $2.234m.

Not considered in the MCA was the cost of raising RB2 by an additional 1.5m to the same level as the minimum for the remainder of Ella Bay Road at 5 mAHD which would increase the cost by $550,000 to a total of $1.584m. It is not feasible to increase the height of RB1 to 5 mAHD. Raising the road to 5 mAHD was considered as a requirement for protection from emergency events in particular cyclone inundation. The total cost of RB2 with the same features as Options D(1&2) would increase the total cost to $2.784m.

5. Overall MCA Results

The overall MCA results are presented in Table 22 which lists the standardised scores for each attribute and groups the standardised scores into categories. The categories have been modified from the SEIS to include a separate criteria of impact on cassowaries. The risk of cassowary mortality was rated the highest significant attribute and was weighted within that criteria at 6 and access to cassowary habitat was rated at 3. The criteria groupings reflect the important issues to analyse the preferred option. The Standardised MCA results for each criteria and the overall MCA rating using a weighting of unity for each criteria is presented in Table 23 and Figure 15.

	MCA Unity result	Analysis of Attributes
Ella Bay Rd	**4.1**	Although not feasible for the traffic numbers, the existing road rates highly due to no clearing, lowest cost, scenic amenity and location away from the residences. The existing road is marked down because flora and fauna connectivity are not improved, risk of cassowary mortality is highest, and the LOS is worst.
Option D (1)	**2.6**	D(1) is the second highest preferred option. D(1) rates high in all transport and social attributes and moderately in environmental and cassowary risk attributes but clearing at the junction of Ella Bay Road and cost decreases score. This option is marked down because Flora and Fauna Connectivity are not improved, constructability is difficult in maintaining access and the cost is high.
Option D (2)	**5.0**	D(2) Rates highest, rates high in all transport and social attributes and highly in environmental and due to the mitigation, rates highly in cassowary risk attributes. D(2) is marked lowest in Flora and Fauna Connectivity which is not improved, constructability which is difficult in maintaining access and the cost is highest.
RB1	**-5.0**	RB1 rates lowest but additionally is not a viable option due to LOS and risk of flooding. RB1 is the lowest cost option, utilising an existing road alignment, and scores highest in improving flora and fauna connectivity. RB1 scores lowest in all attributes of transport and social amenity that reflect on the proximity and impact on residences.
RB2	**-0.1**	RB2 is the highest rating of the RB options. RB2 rates highly in improving flora and fauna connectivity and is the least risk to cassowary mortality. RB2 rates moderate in all attributes that reflect on the proximity and impact on residences. RB2 is relatively low cost, if constructed at the lower height.

Attribute Scores	Environmental										Transport								Social					Cost	MCA
	E1 Plant Communities	E2 Plant Species	E5 Flora and Fauna Connectivity	Total	Environment Standardised	E4a Vegetation Balance	E4b Access to habitat	E4c Risk of Mortality	Total	Cassowary Standardised	T1Travel Time	T2 Capacity at LOS	T3 Accommodate Service Vehicles	T5 Stability/ Flooding	T6 Safety	T7 Constructability	Total	Transport Standardised	S2 Scenic Quality to Road Users	S3 Noise to Residences	S4 Construction Issues	Total	Social Standardised	C1 Cost Standardised	Overall MCA score
Weighting	1	1	1			1	3	6			1	1	1	1	1	1			1	1	1				
Ella Bay Road	5.0	5.0	-5.0	5.0	3.4	5.0	-5.0	-5.0	-40.0	-5.0	2.5	-5.0	5.0	5.0	-5.0	5.0	15.8	2.3	4.6	2.0	5.0	11.6	5.0	5.0	**4.1**
Option D (1)	3.6	3.3	-5.0	1.9	1.4	3.8	0.8	4.3	32.1	4.2	4.9	5.0	5.0	5.0	3.3	-5.0	18.3	4.6	4.2	4.5	-0.8	8.0	3.6	-5.0	**2.6**
Option D (2)	4.8	4.8	-5.0	4.7	3.1	4.9	0.8	4.3	33.2	4.3	5.0	5.0	5.0	5.0	5.0	-4.9	20.1	5.0	5.0	5.0	-0.3	9.7	4.3	-4.9	**5.0**
RB1	0.9	1.2	5.0	7.1	5.0	1.6	5.0	2.5	31.5	4.1	-5.0	-2.5	-5.0	-5.0	-5.0	-3.4	-25.9	-5.0	-5.0	-5.0	-5.0	-15.0	-5.0	-0.3	**-5.0**
RB2	-5.0	-5.0	4.3	-5.7	-5.0	-5.0	4.4	5.0	38.3	5.0	2.2	2.5	4.0	-2.0	1.7	4.5	12.8	3.4	3.8	2.5	-1.0	5.4	2.7	-1.0	**-0.1**

Table 22 - Overall MCA results

Sensitivity Analysis

While the unity weighting model between categories is based on a balanced model of social and environmental impacts, the sensitivity weighting of each criteria reflects the different values of environmental and social importance.

To evaluate the sensitivity to environmental weighting the environmental and cassowary risk categories were weighted to produce increased emphasis and then the results were standardised to +5 to -5. The weighting and standardisation accentuates differences between the options. A summary of the sensitivity analysis is provided in Table 23 while the individual results are provided in Tables 24 to 27 and Graphs 15 to 18.

Recommendation 4 of the UniSA report was that weighting of the criteria should be obtained through stakeholder consultation. In this case extremes of weighting have been used with no change in the overall result. With sensitivity analysis of the impact to cassowary a factor of 6 has been used while the individual risk to cassowary mortality was weighted 6 fold and the loss of access to habitat was rated 3 fold in the attribute analysis prior to this further weighting.

	Unity	Environmental and Cassowary risk x 2	Environmental and Cassowary risk x 3	Impact to Cassowaries x 6	Analysis
Ella Bay Rd	**4.1**	**-2.2**	**-3.9**	**-5.0**	The existing road rates moderately for all weightings except for cassowary mortality. The unfenced road is accentuated in the cassowary risk weighting.
Option D (1)	**2.6**	**1.6**	**1.9**	**4.3**	D(1) performs moderately in all weightings, the additional clearing for the initial section of the road was not sufficiently extensive to outweigh the social and transport attributes.
Option D (2)	**5.0**	**5.0**	**5.0**	**5.0**	D(2) performs highest in all weightings, including weighted cassowary risk.
RB1	**-5.0**	**-3.0**	**0.5**	**2.1**	RB1 performs moderately in all weightings improving the overall score which was worst affected by the proximity and impact on residences
RB2	**-0.1**	**-5.0**	**-5.0**	**4.3**	RB2 performed worst on the environmental issues due to the extensive clearing, and only performed highly with cassowary risk when the weighting was increased to outweigh the clearing impact.

Table 23 – Sensitivity Analysis summary

Attribute Scores	Environmental	Cassowary	Transport	Social	cost	Total	Weighted Total
Weighting	**1**	**1**	**1**	**1**	**1**		
Ella Bay Road	3.4	-5.0	2.3	5.0	5.0	10.6	**4.1**
Option D (1)	1.3	4.2	4.6	3.6	-5.0	8.9	**2.6**
Option D (2)	3.1	4.3	5.0	4.3	-4.9	11.8	**5.0**
RB1	5.0	4.1	-5.0	-5.0	-0.3	-1.2	**-5.0**
RB2	-5.0	5.0	3.4	2.7	-1.0	5.1	**-0.1**

Table 24 – Weighting Unity MCA results

Attribute Scores	Environmental	Cassowary	Transport	Social	cost	Total	Weighted Total
Weighting	**2**	**2**	**1**	**1**	**1**		
Ella Bay Road	6.8	-10.0	2.3	5.0	5.0	9.0	**-2.2**
Option D (1)	3.7	9.7	4.6	3.6	-5.0	14.5	**1.6**
Option D (2)	6.3	10.0	5.0	4.3	-4.9	19.2	**5.0**
RB1	10.0	6.7	-5.0	-5.0	-0.3	7.9	**-3.0**
RB2	-10.0	9.3	3.4	2.7	-1.0	5.1	**-5.0**

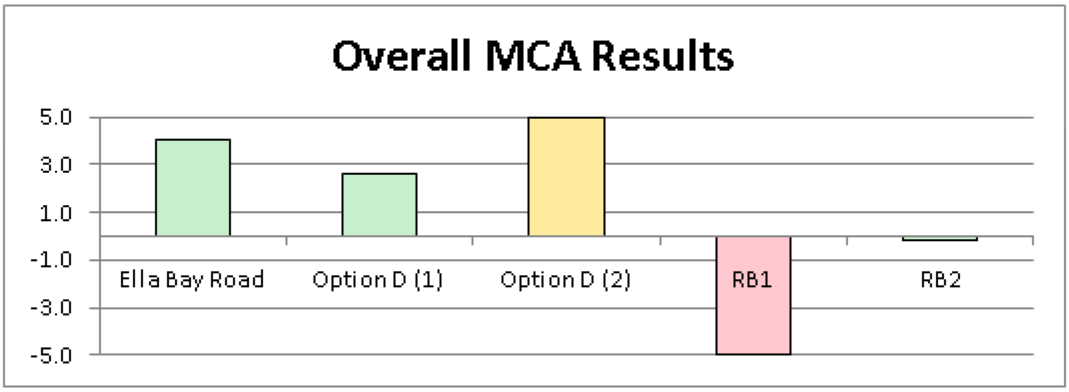
Table 25 – Weighting Environment x2 MCA results

Attribute Scores	Environmental	Cassowary	Transport	Social	cost	Total	Weighted Total
Weighting	**3**	**3**	**1**	**1**	**1**		
Ella Bay Road	10.2	-15.0	2.3	5.0	5.0	7.4	**-3.9**
Option D (1)	5.5	14.5	4.6	3.6	-5.0	20.0	**1.9**
Option D (2)	9.4	15.0	5.0	4.3	-4.9	26.7	**5.0**
RB1	15.0	10.1	-5.0	-5.0	-0.3	17.1	**0.5**
RB2	-15.0	13.9	3.4	2.7	-1.0	5.1	**-5.0**

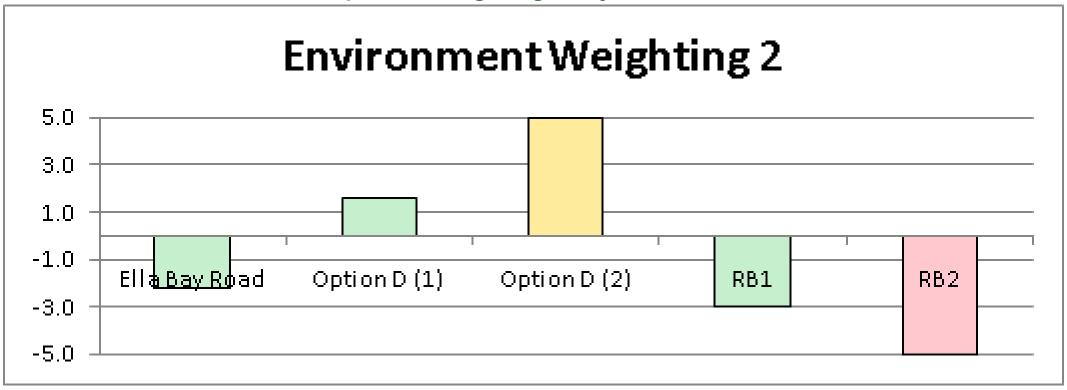
Table 26 – Weighting Environment x3 MCA results

Attribute Scores	Environmental	Cassowary	Transport	Social	cost	Total	Weighted Total
Weighting	**1**	**6**	**1**	**1**	**1**		
Ella Bay Road	3.4	-30.0	2.3	5.0	5.0	-14.4	**-5.0**
Option D (1)	1.8	29.0	4.6	3.6	-5.0	30.0	**4.3**
Option D (2)	3.1	30.0	5.0	4.3	-4.9	33.5	**5.0**
RB1	5.0	20.2	-5.0	-5.0	-0.3	19.5	**2.1**
RB2	-5.0	27.9	3.4	2.7	-1.0	30.1	**4.3**

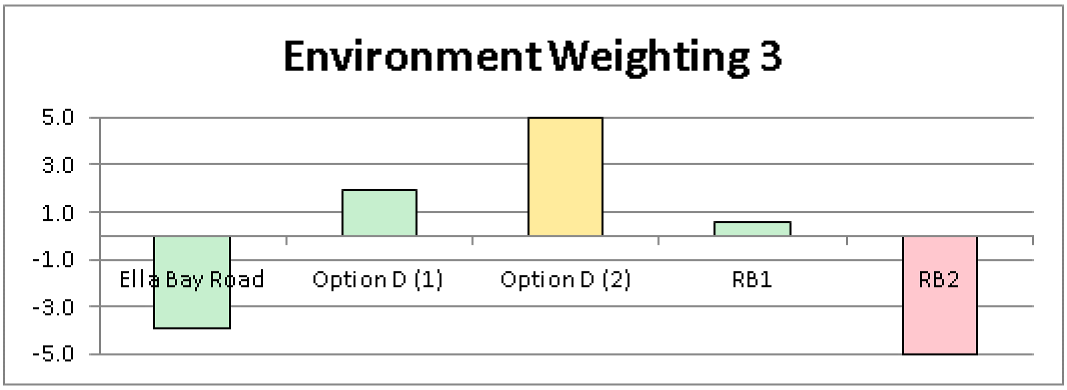
Table 27 – Weighting Cassowary x6 MCA results



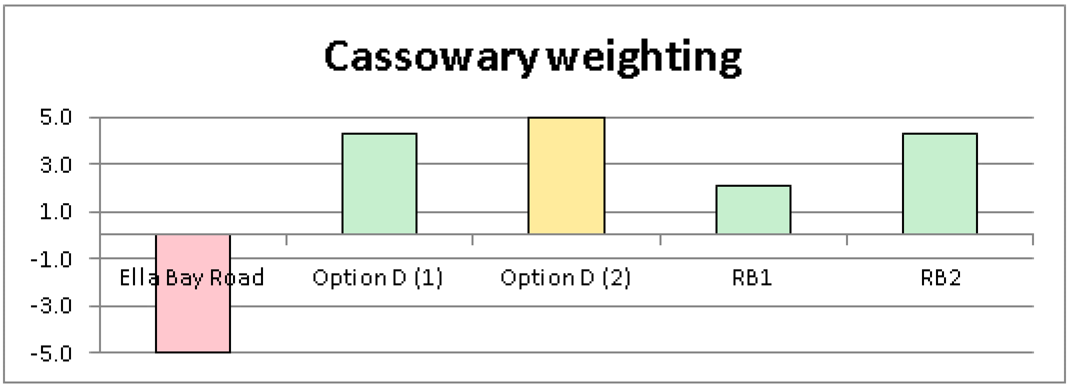
Graph 15 - Weighting Unity MCA results



Graph 16 - Weighting Environment 2 MCA results



Graph 17 - Weighting Environment 3 MCA results



Graph 18 - Weighting Cassowary 6 MCA results

6. Results Analysis.

The Supplementary EIS evaluated the MCA of various route options for Ella Bay and Flying Fish Point Bypass based on the feedback from Flying Fish Point residents in submissions following the EIS. The comments from the community focussed on two main concerns

- In particular that environmental values especially cassowaries be protected; and
- The traffic impacts in terms of pollution, accidents and noise be limited

The post SEIS submission from DEWHA and WTMA focussed on inclusion and evaluation of specific parts of the alignment to include the reserve to the north of Flying Fish Point based on the concern of habitat isolation for cassowaries. This MCA has evaluated the options with reference to environment, social, traffic, cost and impact to cassowaries.

This MCA focussed more directly on impact to cassowaries and the attribute E4 has been elevated to one of the main categories and the individual components of E4 weighted to emphasise respective impacts. Additionally a sensitivity analysis has been applied directly to environmental and cassowary categories both combined and separately for impact to cassowaries. The weighting of elements for E4 impact to cassowaries has been weighted x3 & x6 (Loss of access to habitat, risk of mortality, respectively) for the attribute and then the attribute/criteria has been further weighted x6.

The overall highest scoring option including sensitivity weighting was option D(2).

Summarising option D(2) and RB2;

Environment

Option D(2) scored highly in maintaining the existing vegetation with the least clearing, however D(2) did not allow improvement of flora and fauna connectivity and scored poorest in this attribute. The current Ella Bay road has been in operation since early 1900's and has incrementally caused isolation of flora and fauna over the more than century of use. Stanton (2009b) reported that Ella Bay Road had less severe edge effects than a newly created road due to its narrowness and long establishment. The quantity of clearing for D(2) is 127m² over a road length of 722m with the largest area of clearing required for the construction bypass road for the fauna underpass (Bridge 1). Some fauna has continued connectivity through the low traffic numbers over the dirt road. The addition of mitigation of a cassowary underpass (Bridge 1) with revegetation and a macropod sized fauna underpass will most likely continue to allow this connectivity.

Option RB2 scored poorly in this attribute due to the extensive clearing but scored close to highest on fauna and flora connectivity. The road alignment for RB2 would be located in the north of the 7.3.25 RE adjacent to a feather palm grove adjacent to the low point of the reserve swamp. The alignment clearing would encounter large mature trees 15m to 40m high (Stanton 2009b) and is vegetated with predominately cassowary food source wetland species (Buosi 2009a). The listed *Endiandra globosa* (rare, NCA) is a prominent canopy and shrub species and similarly, *Rourea brachiandra* (Rare, NCA) are present through the reserve and would likely be subject to clearing.

Cassowaries

This attribute is the most significant environmental issue for evaluation of the reserve. The major anthropogenic effects on cassowaries are loss of habitat and mortality from road strike and dog attack. This habitat has been rated as moderate by Moore (Moore 2007a) and high quality by Buosi (NRA 2009) both based on the reserve holding the only source of water during the dry season. However the reserve was found to be dry during the water survey of 2009 (Ella Bay 2009).

Option D(2) scored highly in maintaining the vegetation balance and improving the risk of cassowary mortality, however did not score highly in access to habitat. The proposed fauna underpass (Bridge 1) was weighed at 0.5, however given that there is evidence of cassowaries using similar bridges (EBSR Volume 6.1h *Cassowary Underpass Survey 2008 2009*) and the access to the reserve is at reasonably defined crossings there is a high likelihood that the underpass will be effective. Further mitigation will be provided by utilising one way cassowary escape gates (EBSR Volume 6.1i, *Cassowary Gate Trial*) to minimise the risk of cassowaries remaining trapped on the road if in the unlikely event the birds access the road. With the implementation of these measures, it is believed that habitat connectivity will not be adversely affected.

Option RB2 performs highest with regards to minimising cassowary impact. The reserve would be accessible to the cassowaries however the loss of 8% of the reserve habitat to cassowaries with clearing for the road detracts from this option. If the MCA was to only consider cassowaries then option RB2 would be the preferred option.

Social and Transport

Option D(2) performed highest in both of these categories due to the directness of alignment, safety, distance from residents with regards to operational noise, construction impacts and the minimal change in the existing road visuals. Option D(2) scored highest in all the attributes except two related to construction impact, T7 which was due to construction traffic and S4 which was the impact of construction where the do nothing comparison to the existing Ella Bay Road swamped all other rankings.

Option RB2 performed moderately in all attributes and would be workable solution providing only moderate disruption to local residents, except for a large number of trucks travelling through Flying Fish Point to deliver fill.

Cost

In the comparison option D(2) was the second highest cost option, with the major cost being the construction of the fauna bridge at 70% of the total cost for this section.

While RB2 was some $700,000 cheaper no allowance had been made in this comparison for the increased cost to:

- Provide a fauna bridge to allow cassowary access to the beach area. This would increase the cost of RB2 by $1.2m (as per the SEIS MCA); and
- Elevate the road to the minimum height of 5 mAHD that has been included in the design for the alignment of the road from Alice Street roundabout to Ella Bay. This would increase the cost by $550,000.

In the MCA comparison Option RB2 was not fully costed and compared with the same properties as that of Options D (1&2). The total cost of RB2 with the same features as Options D (1&2) would increase the total cost to $2.784m. RB2 was compared in the MCA to a different specification as option D (1&2), as it could be argued that the inclusion of the fauna bridge and increase in height were not essential requirements.

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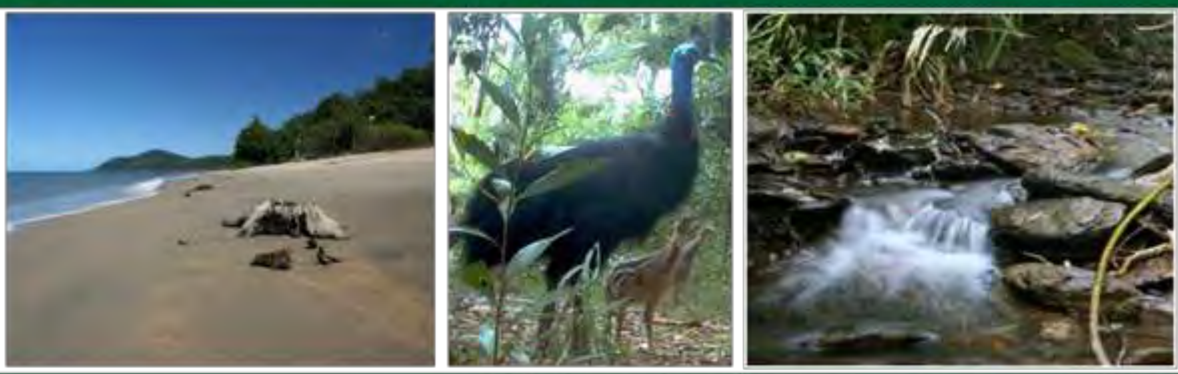
Appendix 3: Revision to Road Usage Demographics for Ella Bay Road

APPENDIX 3

Revision to Road Usage Demographics for Ella Bay Road

Ref. University of South Australia Report to DEWHA 2008

August 2010 Revision 1



Executive Summary

This report is a revision of the demographic data and traffic generation for the Ella Bay Integrated Resort Development. The review used a revised project staging and generated residential and tourism occupancy rates from analysis of similar resort/residential developments with data from the Australian Bureau of Statistics Census 2006. The Ella Bay resort and residential demographics was built up from reference to Palm Cove and Port Douglas demographics.

The report also reviewed demographic and traffic generation data from a review by the University of South Australia (UniSA) - Institute for Sustainable Systems and Technologies by request of DEWHA in mid 2008 (Yue, Stazic, Zhang, & Perkin, 2008).

The majority of generated data confirmed and was in agreement within ±10% with the information provided in the EIS and SEIS. Exceptions were the number of construction workers was revised down from 990 to a peak of 440 workers. The maximum construction traffic would be greater with an increase from 220 to 284 trips/day (two-way).

This review did not agree with data generated by the UniSA in particular the demographic and traffic comparison to Flying Fish Point, the use of Institute of Transportation Engineers (ITE) data without consideration of the seasonal aspects of the Wet Tropics instead of Queensland Main Roads data generated from Queensland resorts and the proportion of international tourists all of which change the road use demographics.

Description	Revised Data	EIS & SEIS	UniSA
Population			
Maximum	3,304	3,044	
Nominal	2,856	2,539	
Residents			
Maximum	1,274	1,404	
Nominal	1,102	1,404	
Visitors			
Maximum	2,030	1,640	
Nominal	1,754	1,135	
Staff			
Maximum	1042	1240 (760)**	
Nominal	802	930	
Construction workforce			
Maximum	404	990	990
Nominal	355		
Traffic generation			
Maximum t/d	4,138	3,990	4,312
Nominal t/d	2,800	2,570	
AADT	3,134	3,000	4,312
Max Construction traffic	284	220	220

** EIS Sec A6.5 and Sec A6.6.

Contents

Tables

Figures

1. Introduction

This report revises the demographics for the Ella Bay Integrated Resort Development for the purposes of road design. The revision is in response to a third party review by the University of South Australia - Institute for Sustainable Systems and Technologies by request of DEWHA in mid 2008 (Yue, Stazic, Zhang, & Perkin, 2008). This revision is based on a revised project staging forecast, and revised residential and tourism occupancy rates from analysis of similar developments with data from the Australian Bureau of Statistics Census 2006.

The Generation of road traffic data was based on;

- Appendix 3A of the Department of Transport and Main Roads' "Road Planning and Design Manual";
- The Road and Traffic Authority's (RTA) "Guide to Traffic Generating Developments";
- The Institute of Transportation Engineers' "Trip Generation" manual; and
- "Resort Traffic Surveys" prepared by Eppell Consulting for the Department of Main Roads.

2. Ella Bay Demographics

To determine the road usage patterns, the demographics for the construction and occupancy staging and the completed development occupancy have been revised. The development occupancy staging has been based on comparison to similar neighbouring residential/resort communities from two (2) locations and compared to the neighbouring village of Flying Fish Point which was used by UniSA as the basis of the demographic calculations (refer to Figure 2.1).

- Palm Cove (90 km North of Ella Bay).
- Port Douglas (124 km North of Ella Bay).
- Flying Fish Point (3.5 km South of Ella Bay).

Palm Cove is situated 26 km (about 26 minutes) to the north from the centre of Cairns and is an extended Cairns City suburb with a large proportion of the residents commuting to Cairns for employment.

Port Douglas is situated 67 km (about 1 hour 20 minutes) north from centre of Cairns, and is a resort focussed destination with a marina and two golf courses. It has a town centre and is more self-contained than Palm Cove.

Flying Fish Point immediately south of Ella Bay is a small village community with one shop, one caravan park, one school and no other facilities with very little local employment and the majority of employment in Innisfail.

The population profile of the communities in terms of building type, population differs from that of Ella Bay:

- Ella Bay has 1,400 dwellings with a mix of 860 apartment units and 540 residential lots;
- Palm Cove has 1,579 dwellings total with 1,168 apartments (inc semi-detached) and 344 separate residential homes;
- Port Douglas has 2,192 dwellings total with 1,783 apartments (inc semi-detached) and 198 separate residential dwellings; and
- Flying Fish Point has 351 dwellings total with 268 separate residential dwellings, and a caravan park comprising the majority of remainder of 70 sites and units.

Of particular note to this comparison is the timing of the 2006 ABS Census. It was conducted on 8th August 2006 which corresponds to the Tropical North QLD's peak holiday season of June to October during the dry season and coolest period of the year and represents a high occupancy period. For the sixteen (16) days prior to the census there was no recorded rainfall in the area (Bureau of Meteorology (2009)) which would indicate optimum holiday conditions.

Figure 2:1 Relationship of Ella Bay to other major resort based towns.

Data Description

Table 2.2 presents the ABS data for Palm Cove, Port Douglas and Flying Fish Point. Demographics for Ella Bay have been interpolated and are presented in the three (3) adjoining columns:

- Prediction based on Palm Cove comparison. This data has been developed by taking the relevant ratios from the Palm Cove data and adjusting for the total number of dwellings and ratio of residential to units;
- Nominal adjusted for lot/unit ratio. This data has been prepared by taking the total number of occupants at 2.04 persons/dwelling and an occupancy ratio of 72% based on Palm Cove. The number of residents and visitors has been interpolated from the ratio of residents to visitors from the ratio of residential dwellings to overall dwellings. The motor vehicle ownership and usage have been prepared from interpolating the data and adjusting for the eco concept of Ella Bay through buses, walking, bicycles and buggies; and
- Maximum adjusted for lot/unit ratio. This data has been prepared taking the total number of occupants at 2.36 persons/dwelling and an occupancy ratio of 92% based on Flying Fish Point. The number of residents and visitors has been interpolated from the ratio of residents to visitors from the ratio of residential dwellings to overall dwellings.

The data has been grouped by Population Total, Dwellings Total, Dwelling Composition, Motorcars Total, Employed Workforce, Transport to Work and Resident Population Distribution.

- **Population Total** data groups all the individuals at the locations, including visitors. The percentage distribution for each category is calculated to the total.
- **Dwellings Total** data identifies all the available dwellings in the area, occupied and unoccupied and if visitor only dwellings (resort). The occupancy ratio is calculated with respect to the total.
- **Dwelling Composition** data identifies the breakdown between the different types of dwellings within the location occupied and unoccupied. The *Other Dwellings* data comprises caravans and camping, which will not feature at Ella Bay. The *Person per Dwelling* ratio was calculated by dividing the total available dwellings by the population total, in order to predict Ella Bay's population by combining it with the occupancy rate.
- **Motorcars Total** data are all "cars" counted within location including visitors and residents, the Motorcar Ratio is based on the whole population number including visitors.
- **Employed Workforce (residents)** data is for residents of the location only, visitors were not included.
- **Transport to Work** data is the breakdown of how residents stated their method of travel to work.
- **Resident Population Distribution** was issued by the ABS in actual numbers and percentages were calculated.

Population

The data interpolated for Ella Bay population has provided a range based on nominal dry season occupancy. The school holidays of July and September would increase the occupancy during these periods over the nominal occupancy to the maximum occupancy. The nominal occupancy would be 2,856 occupants and the maximum 3,304 occupants. While the Ella Bay maximum has been based on the nominal Flying Fish Point ABS census data the increase over Palm Cove data is considerable and reflects that Flying Fish Point is not a holiday destination and the occupancy at the time of the census is close to maximum. To generate the maximum population the Occupancy Ratio increased from 72% to 92% and the Ratio of persons per total dwelling has increased from 2.04 to 2.36.

The population (visitor vs resident) breakdown has been based on the lot adjusted Palm Cove data and is indicative of Ella Bay numbers. Visitors in this context mean that the visitors principal place of residence is not at Ella Bay accounting for both visitors (international and domestic) and holiday houses.

Predicted Ella Bay Population	Nominal	Maximum	EIS & SEIS Nominal	EIS & SEIS Maximum
Total Population	2,856	3,304	2,539	3,044
Residents	1,102	1,274	1,404	1,404
Visitors	1,754	2,030	1,135	1,640

Table 2.1 Comparison of Predicted Population.

By comparison the estimated total population reported in the EIS (EIS Volume 2 – pp. 5,6 / February 2007) is approximately 10% less and in a slightly different ratio between residents to visitors. In the EIS a nominal figure was not calculated and the total of permanent residents of 1404 from 540 dwellings is based on an occupancy ratio of 2.6 persons per total occupied dwelling.

The nominal and maximum visitor numbers based on the 2006 census figures indicate a 20% greater number of visitors than the EIS and SEIS calculations.

Census Data (2006)	Palm Cove	Port Douglas	FFP	Prediction based on Palm Cove comparison	Nominal adjusted for lot/unit ratio	Maximum adjusted for lot/unit ratio
Population Total	3,217	4955	829	2852	2856	3304
Residents	1,141	879	657	998	1102	1274
Resident ratio	35%	18%	79%	35%	39%	39%
Visitors	1224	2477	152	1084	1040	1204
Visitors ratio	38%	50%	18%	38%	35%	35%
OS Visitors	852	1599	20	742	714	826
OS Visitors ratio	26%	32%	2%	26%	25%	25%

Dwellings				Occupancy based on Palm Cove	Occupancy based on Palm Cove, Ratio probable	Occupancy based on FFP, Ratio on max
Dwellings Total	1,579	2,192	351	1400	1400	1400
Occupied dwellings (incl.visitors)	1,130	1,556	324	1002	1002	1288
Unoccupied Dwellings	449	636	27	398	398	112
Occupancy Ratio	72%	71%	92%	72%	72%	92%
Dwelling Composition						
Separate house	344	198	268	540	540	540
Semi-detached	148	576	10			
Apartment	1020	1207	15	860	860	860
Other dwellings	67	211	58			
Ratio Per Person total Dwelling	2.04	2.26	2.36	2.04	2.04	2.36

Motor Vehicle usage				Based on Palm Cove	Based on eco, bus, local work	Based on FFP
Motorcars total	1131	1558	324	1003	898	1291
Cars Residents only	548	407	265	479	510	514
Motorcar Ratio (residents %)	0.48	0.46	0.40	0.48	0.46	0.40

Employment & Transport				Based on Palm Cove	Based on greater local employment	Based on FFP
Employed Workforce (residents)	627	599	344	549	585	667
proportion of residents working	55%	68%	52%	55%	60%	52%
Transport to Work				Based on Palm Cove	Based on eco, bus, walk	Based on FFP
Bus	21	7	8	18	53	16
Car, as driver	342	164	217	299	132	421
Car, as passenger	28	37	40	24	33	78
Motorbike/scooter	10	8	0	9	13	0
Bicycle	12	57	5	10	66	10
Other	14	25	4	12	0	8
Walked only	99	152	15	87	165	29
Worked from home	34	64	15	30	119	29
No work	67	85	40	59	79	78

Resident Population Distribution				Based on Palm Cove	Based on mean & lot/unit	Based on FFP
0-14	11%	7%	21%	11%	14%	21%
15-29	18%	25%	14%	18%	18%	14%
30-44	25%	25%	22%	25%	25%	22%
45-59	27%	25%	26%	27%	25%	26%
60+	19%	17%	17%	19%	18%	17%

Table 2.2 Ella Bay Demographics Prediction.

Population Age Distribution

The resident population age distribution has been adjusted for the lot/unit ratio based on Palm Cove. The age profile generated based on Flying Fish Point would not be consistent with the resort, lifestyle and socio economic target market for Ella Bay, while the Port Douglas age distribution reflects the greater tourism focussed destination where 82% of the total population are visitors. (Visitors plus Overseas Visitors).

Resident Population Distribution	Nominal
0-14	14%
15-29	18%
30-44	25%
45-59	25%
60+	18%

Table 2.3 Population Age Distributions.

The population age distribution reflects a significantly lower number of young children than Flying Fish Point which is consistent with the projected lower occupancy ratio pre dwelling meaning that there are less children per dwelling.

Profile of Operations Staff

The operational staff numbers were calculated in the EIS Sec A6.6 as 760 staff working at Ella Bay, including the resort staff, operation of the golf course and retail precincts and support facilities.

The operational staff numbers were calculated in the EIS sec A6.5 as 930-1240 staff based on 1.2 – 1.6 staff/fully serviced occupied room with 860 rooms (ie apartments only) at 90% design occupancy. This staff ratio has been calculated from the 1989 Resorts Traffic Report.

The assumption that all the rooms will be fully serviced at the highest resort standard is not correct. A proportion of the units will be unserviced and partially serviced units, without restaurants and without daily house cleaning. For this analysis it has been assumed that 60% of the units will be fully serviced and that there is 90% occupancy.

Table 2.4 presents a range of staff numbers based on unit type and residential lots at 90% occupancy. The range of nominal to maximum has been based on the 1.2 – 1.6 staff/fully serviced unit. The resort staff ratios include all staff including gardeners, chefs etc.

To allow for the unserviced and partially serviced units which would be self-contained, owner occupied, holiday or permanent rental with a lower service factor; a 0.2 staff per unit which equates to 8 hours per week of staff time has been used.

To allow for staff employed by residents; a 0.1 staff per lot which equates to 4 hours per week of staff time has been used.

The staff for the non dwelling based infrastructure such as school, research centre, shops and other have been included as a total of total of 50 nominal and 80 for peak season (school 12, research centre 20, laundry 8, shops 20 and other 20.)

	Resort units	Staff @ staff/unit ratios 1.2/1.6	Unserviced Units	Staff for Unserviced units @ 0.2/unit	Staff for home lots @ 0.1/lot	Staff of shops, schools, etc	Total staff based on max. Ratio and 90%
Nominal	526	631	334	67	54	50	802
Maximum	526	842	334	67	54	80	1042

Table 2.4 Total Staff based on Ratio of Unit type and residential lots at 90% occupancy.

The projected staff numbers range from 802 to 1042, which is consistent with the demographic report in the EIS Appendix A6.6.

Motor Vehicles

The number of motor vehicles (**Motorcars Total**) has been based on the Palm Cove data with adjustment for the lot/unit ratio. This is also a relevant comparison for the workforce as the distance from Palm Cove to Cairns and Ella Bay to Innisfail are 26km and 12km respectively, representing similar geographic proximity for a mobile workforce.

The goal at Ella Bay is to increase the environmental usage of transport and given the shorter distance and encouragement to work from within Ella Bay there is likely to be an increase in "bus" to work portion, cycle, buggies and working from home numbers.

Palm Cove 26 km (about 26 minutes) north from the centre of Cairns is considered a Cairns City suburb and therefore subject to a higher level of possible car commuting to Cairns for work, leisure and supplies. ABS data shows that Palm Cove's vehicle ratio is 0.48 vehicles per resident, and 54% of the resident work force (30% of total resident population) identified "Car as driver" as transport to work method.

Port Douglas is 67 km (about 1 hour 20 minutes) north from centre of Cairns, ABS data states that 27% of the resident work force (18% of total resident population) identified "Car as a driver" as their method of transport to work. This indicates that the Port Douglas workforce is more internal to the area and the workforces do not drive outside to Cairns for employment.

3. Staging

The staging plan for the development has been revised from that presented in the EIS and the SEIS. The major change is that there is a more evenly spread development pace, starting in the north and moving south and then towards the west. Refer to Figure 3:1. The EIS (EIS section *3.2.1 Staging)* planned staging focussed on construction of the village centre as an initial stage followed by development of the northern and western residential and resort precincts. This compressed the construction timetable and increased the peak numbers of construction workforce.

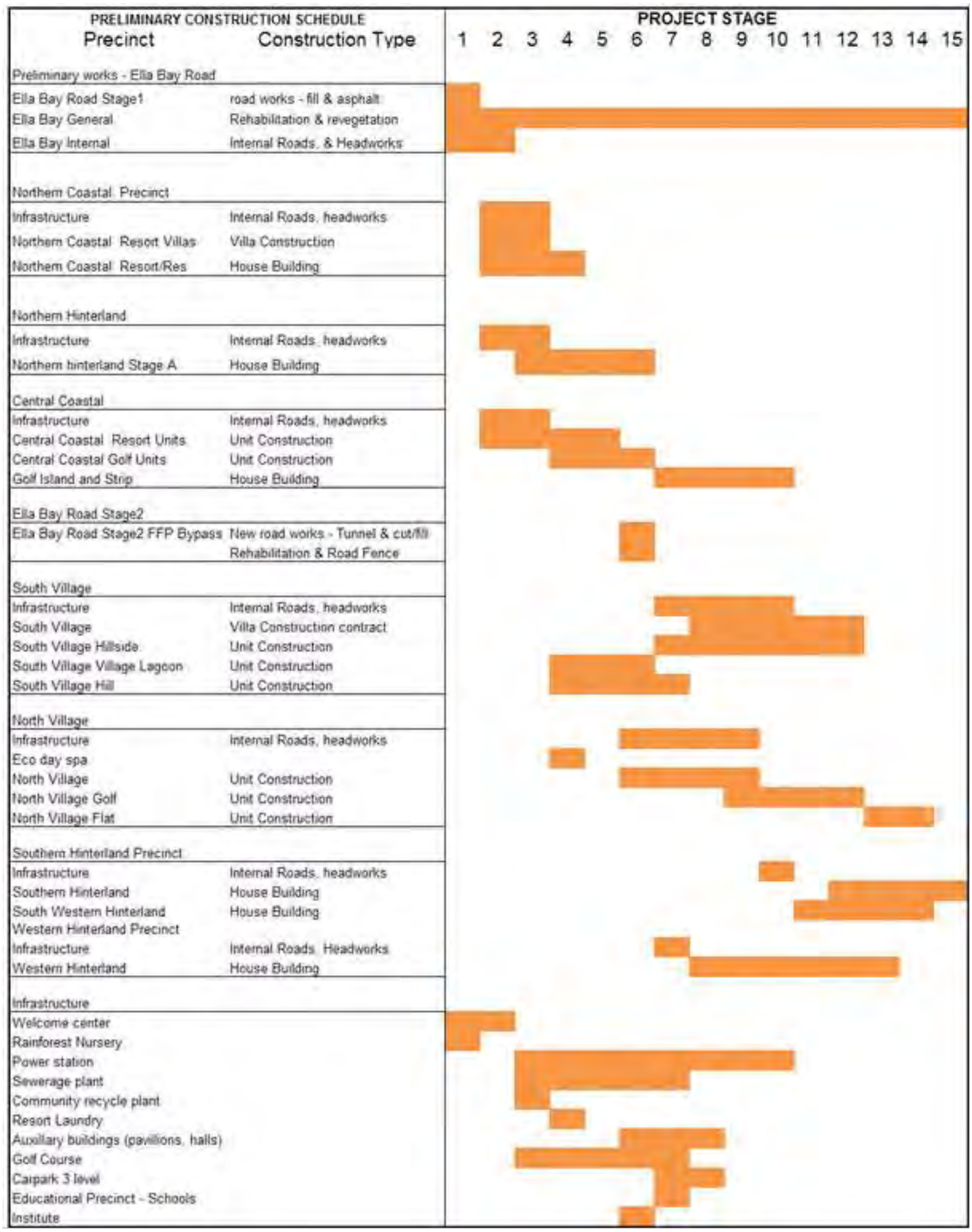


Figure 3:1 Revised Staging Plan.

Construction Workforce

The construction workforce was calculated in the EIS Appendix A6.6 based on the economic staging of the project as an average of 990 positions required each year for a ten year project. The numbers were obtained by applying a 40% factor to the estimated full-time equivalent (FTE) jobs obtained from 5.1 full-time equivalent jobs created for every $1 million in turnover (Urban Development Institute of Australia, Queensland Division 2).

A more recent and extensive analysis of the full-time employment per $million by industry type and project value (Department of Environment and Resource Management (DERM), 2009) reports this figure as being between 3.2 and 4.3 FTE for housing (apartments) and 4.1 to 5.1 FTE for major road construction per $million. Given the value and mix of construction the nominal figure for total FTE has been interpolated to be 4.5 FTE for road works and 3.5 FTE for housing and infrastructure per $million. Applying a site based ratio to these figures of 80% for road works and 75% for housing and infrastructure, produces a site based construction workforce of 3.6 FTE/$m and 2.6 FTE/$m respectively. The other part of the percentage is for off-site based design, procurement, project management and contractors profit.

The Ella Bay Demographics Prediction (Table 2:2) shows the site based manning has been adjusted for construction restrictions during the wet season. Construction tasks that would create erosion and sediment runoff will be restricted to dry season only. For the purposes of this assessment a worst case scenario has been adopted where all civils and early construction have been listed as dry season only. This graph has taken the impact of the weather literally but most buildings would be staged such that internal construction and fit out would occur in the wet season ready for occupancy in the following dry season.

The maximum workforce is expected to be 404 in year 8.

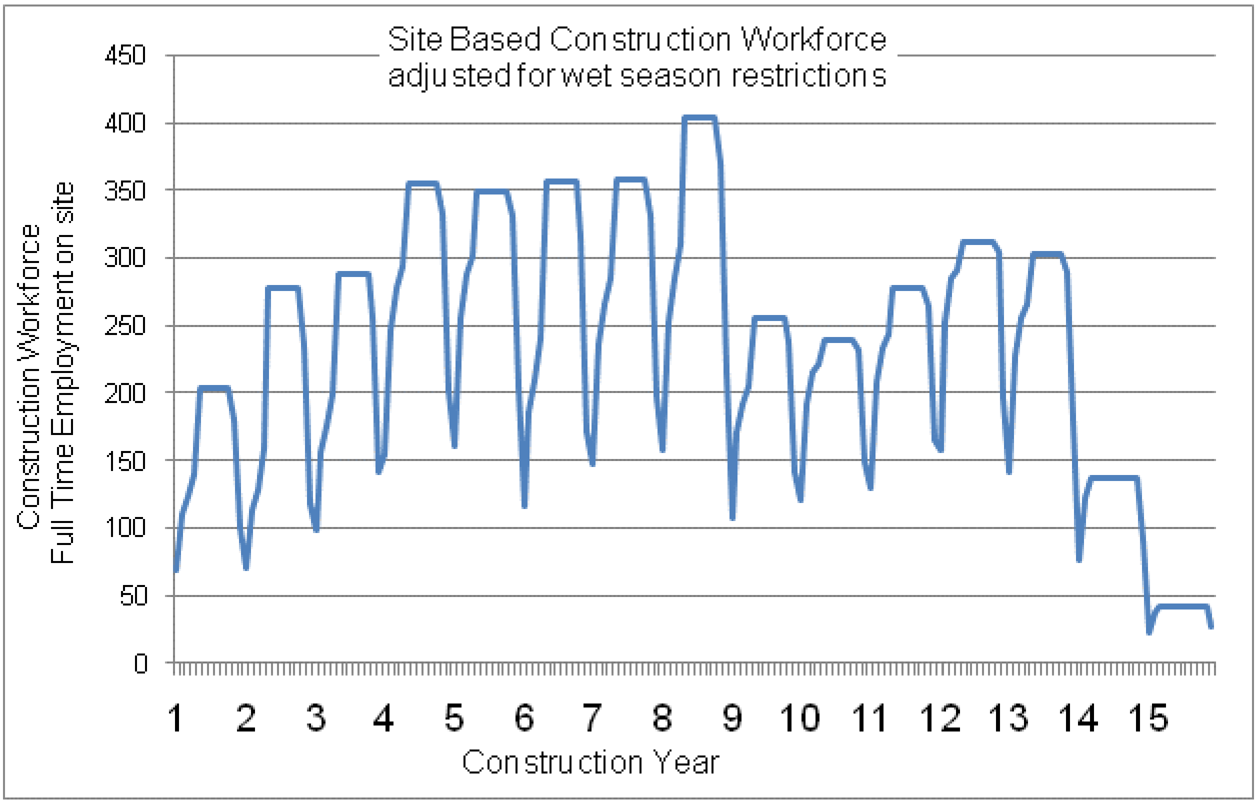


Figure 3:2 Construction workforce numbers showing seasonal variation.

Population Growth during Construction Period

The population growth of the community and the resorts will be a function of the completion date of the construction of each building group and precinct. The revised staging has reduced the rate of growth of the community. The number of residents and visitors has been based on the nominal 2.04 and 72% occupancy, based on data from Table 2.2 and Table 2.4.

	Dwellings Dwelling numbers derived from construction schedule				Nominal Occupants Number of residents/year based on construction starts @ 2.04 plus 1 year				
Year	House	Resort	Units	Total	House	Resort	Unit	Total	Cum. Total
1									
2									
3		58		58					
4	58			58		118		118	118
5	74			74	118			118	237
6	76	80		156	151			151	388
7		84		84	155	163		318	706
8	62	133		195		171		171	877
9	39	8	78	125	126	271		398	1275
10	60	55		115	80	16	159	255	1530
11			139	139	122	112		235	1765
12			117	117			284	284	2048
13	27	54		81			239	239	2287
14	78	54		132	55	110		165	2452
15	66			66	159	110		269	2721
16					135			135	2856
	540	526	334	1400	1102	1102	681	2856	

Table 3.1 Population growth during the construction period.

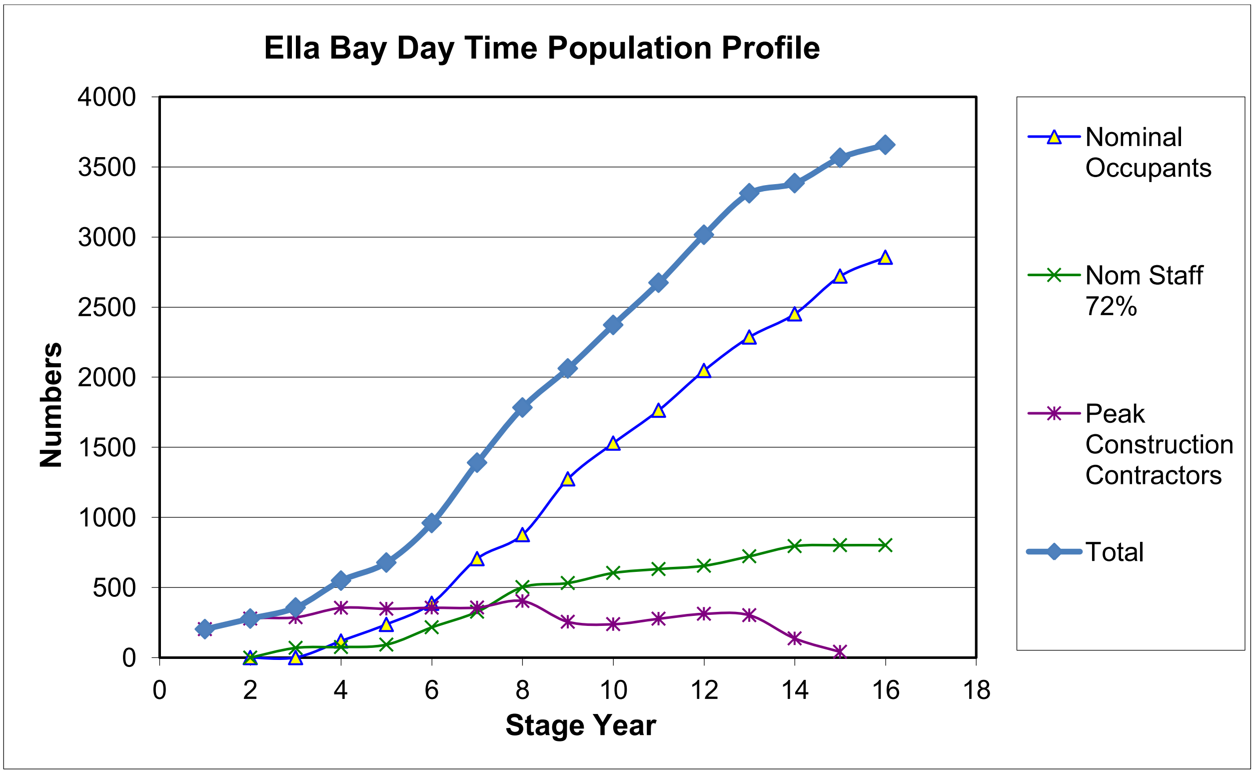


Figure 3:3 Total day time population during construction period including construction workforce and staff based on peak construction workforce and nominal occupancy and staffing.

4. Traffic Prediction

The UniSA report in Chapter 4 develops trip generation estimates from a number of sources and data. The following section analyses these assumptions. Heading sections are from the UniSA report.

Trip Generation Estimates Based on Current Flying Fish Point Trip Rates and the SEIS estimates

The UniSA report has an error in the analysis of existing trip generation based on Flying Fish Point demographics from the 2006 census. The error is in the establishment of the population and number of buildings. The UniSA report has excluded visitors from the dwelling demographics. This has underestimated the number of dwellings and population in Flying Fish Point. All road users are included in the road survey which means that the number of trips per occupied dwellings has been underestimated. Note (a) from Appendix B:

"(a) Excludes 'Visitors only' and 'Other not classifiable' households. "

Description	UniSA report	Ella Bay Analysis
Number of dwellings	267[a]	324 [c]
Number of Dwellings excluding the south of Coconuts	217[b]	254[d]
Modified traffic AADT	1540	1540
Number of trips per occupied dwelling	7.1	6.1

- [a] total from UniSA report Appendix B – dwelling structure note a
- [b] From UniSA report Section 4.1 – (Flying fish Point + Coconut North of Palm Av.)
- [c] Includes visitors
- [d] Includes visitors – (Flying fish Point + Coconut North of Palm Av.)

Table 4.1 Traffic analysis of Flying Fish Point.

Flying Fish Point is also a tourist destination that has relatively no tourist accommodation yet receives a high number of day tourists that have been included in the road traffic count but cannot be isolated from the demographic analysis. Day tourists and sightseers would be covered in the resort base of the Ella Bay analysis.

The Employment and Transport demographics for Permanent Residents from Table 2.2 (2006 Census) has been compared as a percentage for Palm Cove, Port Douglas and Flying Fish Point in Table 4.2 below. The census statistics for *Car, as driver* show that for the resort/residential communities the number of single occupant drivers was much lower than that of Flying Fish Point.

Comparison of the Port Douglas demographics for **Transport to Work** *Car as driver* to that of Flying Fish Point shows that:

- A greater percentage of Port Douglas permanent residents are working 68% compared to 52%, this is also reinforced by the age analysis where there are one third of the residents are children under 14 years compared to Flying Fish Point;
- Only 27% of the working residents drive to work compared to 63% for Flying Fish Point; and
- This is despite Port Douglas having a higher percentage of car ownership 46% to Flying Fish Point 40%.

The result is that for resort/residential community of Port Douglas a greater number of permanent residents work, reducing the traffic from non work related permanent resident traffic and of the workers there is half the amount of car usage for transport to work. What is not able to be determined is the proportion of "drive to work" which is internal within Port Douglas. A similar trend is shown with the Palm Cove Data but to a lesser degree.

	Palm Cove	Port Douglas	FFP
Proportion of residents working	55%	68%	52%
Bus	3%	1%	2%
Car, as driver	55%	27%	63%
Car, as passenger	4%	6%	12%
Motorbike/scooter	2%	1%	0%
Bicycle	2%	10%	1%
Other	2%	4%	1%
Walked only	16%	25%	4%
Worked from home	5%	11%	4%
No work	11%	14%	12%

Table 4.2 Employment and Transport Demographics for Permanent Residents as a percentage.

The importance of this is that the comparison of a small township such as Flying Fish Point to a resort/residential community is not an appropriate comparison to extrapolate trip numbers. Given that the permanent residents of similar resort/residential communities can be demonstrated to utilise cars less, (although having a higher ownership of cars) indicates that the sustainability goal of reducing car usage which is one of the themes of Ella Bay Development is achievable.

Trip Generation Estimates Based on ITE – "Trip Generation" Information

The relevant design guidelines for traffic generation rates for Queensland roads (DTMR, 2010) (refer to Table 4.3) provide a range of 6 to 10 t/d based on a number of different studies. Flying Fish Point is at the bottom of this range at 6.1 t/d including day tourism. The UniSA report uses US derived data from ITE at 6.59 t/d (ITE, 2002)

Description	Peak Rate	Daily Rate	Unit	Source
Detached	0.85	9	Dwelling	RTA, 2002
	0.8	6-10	Dwelling	QT
	N/A	9.6	Dwelling	AMCORD
	N/A	10	Dwelling	Qld Sts
Medium Density		4-6.5	Dwelling	RTA
	N/A	5.9	Dwelling	AMCORD
	N/A	6	Dwelling	Qld Sts
High Density	0.4	3-6	Dwelling	QT
	0.29	N/A	Dwelling	RTA
	N/A	4.2	Dwelling	AMCORD

Table 4.3 Traffic Generation rates - residential dwellings from Qld RDPM.

The use of buggies for internal trips proposed at Ella Bay Development, which has been successfully used in similar resort/residential communities such as Hamilton Island and Sanctuary Cove has not been considered in the analysis by the UniSA. Comparable buggy usage trip statistics are not available, however anecdotal evidence is that the usage of buggies by residents for internal trips is as high in these communities as that of cars but leads to more frequent use of internal shops, restaurants, schools, and resources. The buggies with their low speed and open sides will provide a more social experience.

UniSA nominates a figure of 25% for internal trips, Ella Bay Developments believes that this figure should be 50% for internal trips with nearly all of these trips generated by buggy. The development will include restaurants, bars, gymnasiums, sporting fields, pools, shops, school and other resources which are the main generators of additional non work related traffic.

Based on the preceding it is most likely that the number of trips per day for each permanent residence would be 6.0 including internal trip generation by buggies and that the 50% of the trips will be internal.

Description	Trips per day	For 540 Residential Units
UniSA	2,402	Based on 6.59 t/d ITE and 25% internal
Ella Bay Developments	1,620	Based on 6.0 t/d and 50% internal

Table 4.4 Residential external trips per day.

The EIS analysis of resort precincts has been based of typical Queensland resorts (Eppell Consulting , 1989) such as Iwasaki and Port Douglas. Of note with this data is that it is applied to individual resorts and not to the resort precincts and does not include internal trips. The seasonal change in the Wet Tropics produces a defined peak season and an off season during the Wet. The EIS data has been adjusted to produce a range of high to low season to produce an Average Annual Daily Traffic or AADT value. The range in data between high and low season is from 80% to 100% in the dry months to 20% to 40% in the wet season (Figure 4.1)

The UniSA trip generation has been based on ITE data which has been obtained from surveying USA resorts and averaging all of the results. As the UniSA report states:

"The ITE – "Trip generation" contains average weekday, weekend and peak period trip generation rates for variety of land uses."

Using the revised demographic data from Table 2.2 and Table 2.4 and the Queensland based resort survey.

	UniSA		Ella Bay maximum		Ella Bay LowSeaon	
Component	trips per day	ITE data	trips per day	Eppell consulting based on peak occupancy	trips per day	Eppell Consulting based on nominal occupancy
Resort Precinct	1,757	Based on 860 units @ 8.17 trips 75% internal	1161	Based on 860 units @ 90% occupancy 1.5 v/d occupied room	647	Based on 860 units @ 50% occupancy 1.5 v/d occupied room
Residential	2402	Based on 540 houses 6.59 trips 25% internal	1620	Based on 540 houses 6.0 t/d and 50% internal	1166	Based on 540 houses at 72% occupancy 6.0 t/d and 50% internal
Staff		included	834	Based on 1042 staff at 0.8v/ staff [a]	557	Based on 50% occupancy staff at 0.8v/ staff
Service vehicles		included	280	Based on EIS, peak holiday time	140	Based on 50% EIS
Bus coaches		included	180	0.2vpd 860 rooms 90% occupancy plus	100	0.2vpd 860 rooms 50% occupancy plus

	UniSA		Ella Bay maximum		Ella Bay LowSeaon	
				20 for staff		20 for staff
Golf Course	65			Included in resort		Included in resort
International School	79	Based on 0.9 trips per student 50% internal	36	Based on 0.9 trips per student 75% internal [c]	36	Based on 0.9 trips per student 75% internal [b]
Research Centre	10	Based on ITE	10	Based on ITE	10	Based on ITE
Total	4,312		4,138		2656	

- [a] adjusted from Eppell consulting data for greater use of bussing as parking will be restricted for staff.
- [b] the school will be primarily for internal students.

Table 4.5 Comparison of trip data.

The EIS data provided a range of 2,570 to 3,990 for two-way traffic movement with an AADT of 3,000. This analysis produced an AADT of 3,314 while the UniSA produced an AADT of 4,312. The analysis of the seasonal variation was based on data from (Eppell Consulting , 1989) (EIS Appendix A6.5). The average, traffic flows to/from the resort are expected to peak during the dry season months and school holiday periods (July to October). Significantly lower volumes are expected during wet season and non-school holiday times (February to May).

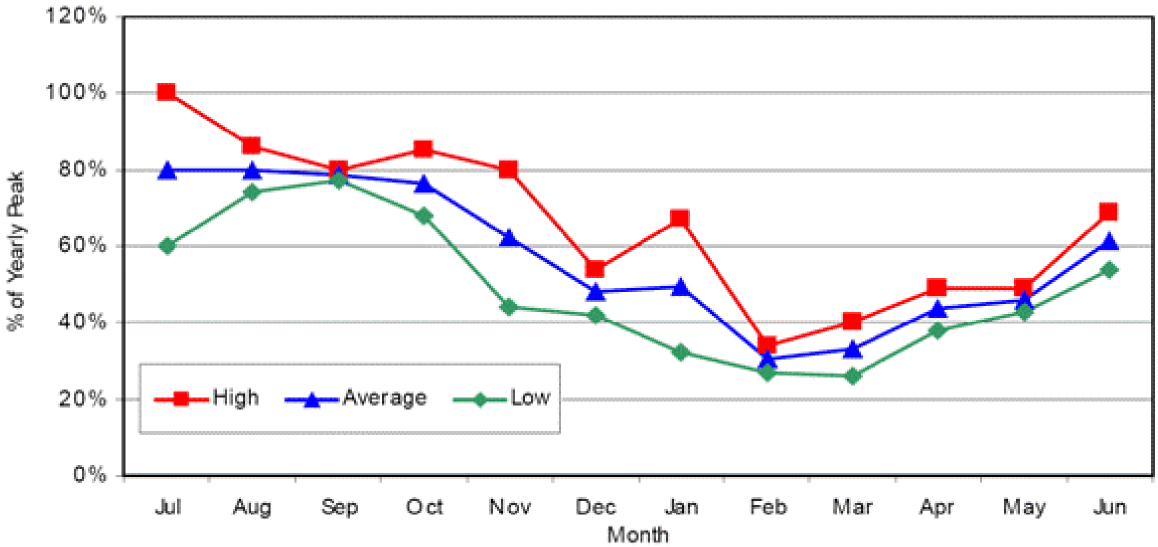


Figure 4:1 Monthly variation of occupancy. (EIS Appendix A6.5.)

Description	EIS	UniSA	Revised Ella Bay
Trips/day for high season	3,990	4,312	4,138
Trips/day for low season	2,570		2,800
AADT	3,000	4,312	3,134

Table 4.6 AADT comparison.

There is significant difference between the UniSA AADT data and that produced by the EIS and this report. The major difference is in the residential traffic numbers external to the development and the treatment of the low season based on the seasonal change in the Wet Tropics.

The UniSA report ignores the Eppell Consulting data which is Queensland based and that buggies will be used for internal trips.

Construction Work Traffic

The construction workforce has been revised in Figure 3.2 with a maximum of 404 workers in year 8 and an average of 355 workers for years 4 to 7 inclusive.

The analysis in the EIS and in the UniSA report generated data of 220 trips/day for construction vehicles. There will be two intense periods of vehicle movements during:

- The stage 1 road construction; and
- The peak resort construction stage in year 8.

The use of the Catelan Road Compound during the stage 1 road construction will reduce the traffic movements through Flying Fish Point and along Ella Bay Road 208 trips/day. The peak resort construction period will generate traffic of 284 trips/day. The construction traffic is a small component of the overall traffic generation.

Traffic Generation	To Catelan Road	To Site Two way	Basis
Employee Light Vehicles	150	40	15 management and tech staff in/out plus business trips. Use bus.
Site Visitors	20	10	Restricted to High occupancy Vehicles 5/HOV
Bus	25 (East)	50	250 workers ave 10/bus
Truck Deliveries - Fuel	2	4	Delivery to Seahaven compound
Truck Deliveries - Parts	2	4	Delivery to Seahaven compound
Truck Deliveries – Bulk Materials	40	80	2 deliveries/day/$m road works (peak)
Other Deliveries	10	16	80% direct delivery
Small to Medium Trucks	10	4	Contents marshalled at compound
Total traffic movements per day	468	208	

Table 4.7 Road Construction traffic movements Year 2. (HOV = High Occupancy Vehicles)

Traffic Generation	To Site Two way	Basis
Employee Light Vehicles	150	10 management and tech staff in/out plus business trips plus 25 trades plus 30 employee HOV
Site Visitors	10	Restricted to High occupancy Vehicles 5/HOV
Bus	40	200 workers ave 10/bus
Truck Deliveries - Fuel	2	Delivery to Ella Bay compound LPG for generators and diesel for offroad construction vehicles
Truck Deliveries - Parts	4	Delivery to Ella Bay compound
Truck Deliveries – Bulk Materials	4	2 deliveries/day/$m works
Truck Deliveries – articulated	30	Housing and resort construction materials 15/day for housing and resort
Small to Medium Trucks	40	Housing and resort construction materials 20 dwellings 1/day/dwelling
Total traffic movements per day	284	

Table 4.8 Road Construction traffic movements Year 8. (HOV = High Occupancy Vehicles)

Traffic Build-up

The maximum traffic profile over the construction period (Figure 4.2) has been based on the peak seasonal construction manning and maximum occupancy. Occupancy has been assumed to be at the maximum in the year after construction or residential lot completion. The low season traffic profile which would be experienced during the wet season months of February and March has also been included to show the seasonal traffic variation.

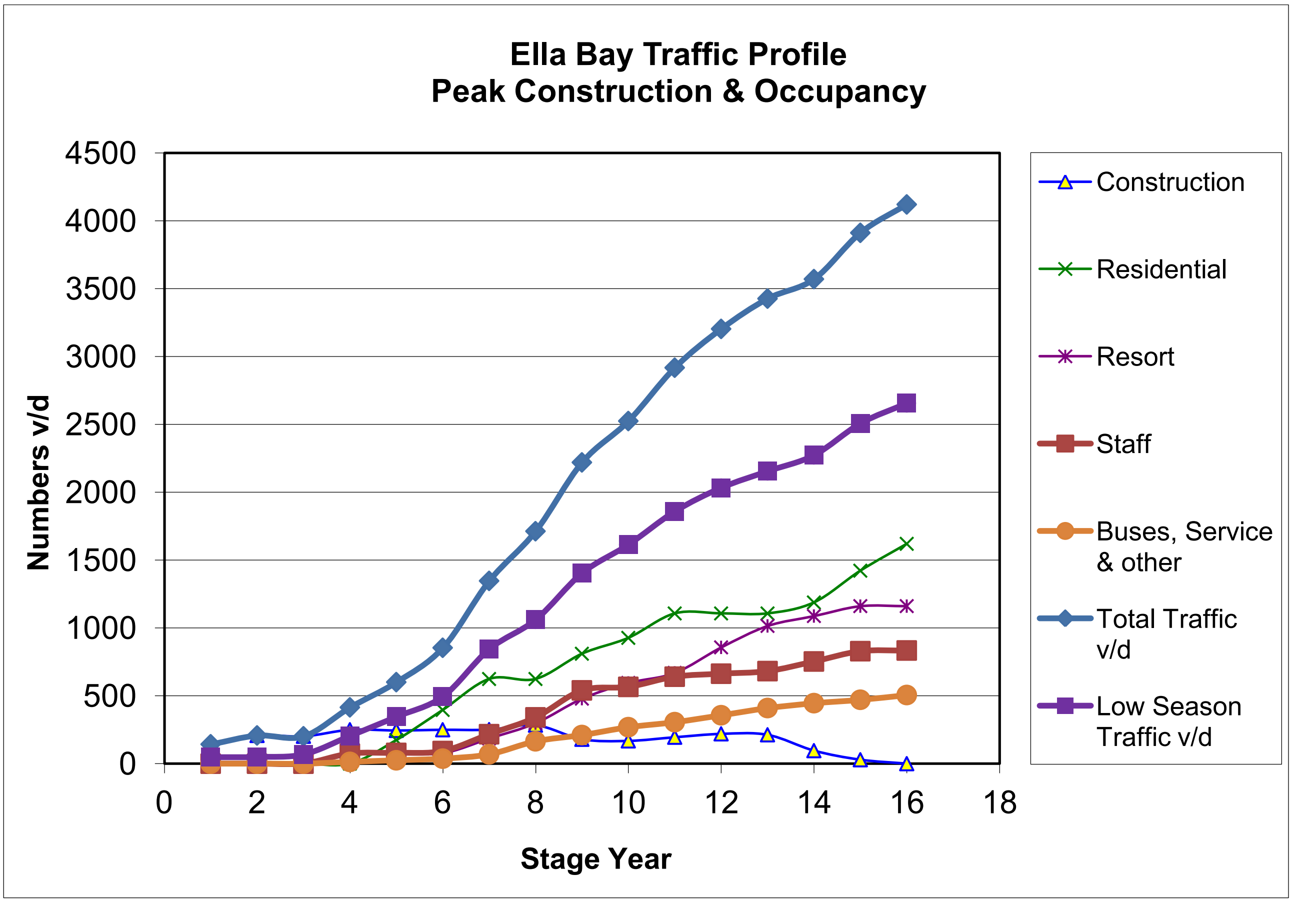


Figure 4:2 Maximum traffic profiles during the construction period including peak construction traffic and maximum occupancy and staffing.

5. Discussion

The Ella Bay occupancy data has been reviewed based on data from the ABS 2006 census with reference to the demographics of Palm Cove and Port Douglas and is in close agreement with the data provided within the EIS and SEIS. The revised project staging plan has provided a more gradual occupancy increase.

The road usage data has been revised based on the occupancy and is in close agreement with data provided within the EIS and SEIS.

There were a number of specific areas where the data generated was not in agreement with the review by the University of South Australia - Institute for Sustainable Systems and Technologies. These were

- The demographic and traffic comparison to Flying Fish Point;
- Recognition of the seasonal variability of Far North Queensland tourism market; and
- The calculation of internal trips within the resort.

The comparison to Flying Fish Point with regards to population demographics was not valid based on the type and socio-economic of the resort and residential occupancy of Ella Bay. The more comparable demographics of the resort communities of Palm Cove and Port Douglas produced significantly different ratios of visitors to residents.

The use of the Institute of Transportation Engineers (ITE) data by UniSA without consideration of the seasonal aspects of the Wet Tropics instead of Queensland Main Roads data generated from Queensland resorts produced a much higher AADT. The extreme seasonal fluctuation in tourism numbers in Far North Queensland is a problem for resort operators. The weather impacts from cyclones, the wet season plus the high temperature and humidity reduces the desirability of the area to international and domestic visitors. While the Queensland Main Roads report is a dated 1988 report compared to the up to date ITE report, the fluctuation in occupancy is still valid.

The calculation of internal trips for permanent residents is an area where there are few comparable developments that could provide data. The UniSA report assumes 25% internal trips where as this report uses 50%. The large difference has been derived from the style of self contained community that is included in the Ella Bay Development. The infrastructure will include restaurants, bars, gymnasiums, sporting fields, pools, shops, school, church and other resources which are the main generators of additional non work related traffic. The commercial area will contain offices and shops. The permanent resident demographics are comparable to a self contained satellite suburb or small town.

Additionally not included in any of the road usage data is that Ella Bay is a development based on environmental sustainability, and the ethics of a person who chose to be a permanent resident or visitor would include minimisation of carbon footprint from transport.

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Appendix 4: Road Safety Audit of Ella Bay Road

Ella Bay Road ch1400m to ch2600m

Functional Geometric Design

Road Safety Audit Report

Ella Bay Pty Ltd

21 December 2010

EXECUTIVE SUMMARY

Road Safety Audits Pty Ltd has been engaged by Ella Bay Pty Ltd to conduct this functional design stage road safety audit report for Ella Bay Road ch 1400m to 2600m. It is an existing unsealed road with very low volumes. This area is within the World Heritage Area Zone C.

The purpose of this audit is to focus solely on the geometry for the pavement width comprising traffic lanes and the shoulders/bicycle lanes. More general issues such as signs, line marking, physical hazards and safety barriers are not included in this report.

The audit found that a wider pavement width is necessary to achieve a minimum but reasonable level of safety.

DOCUMENT ISSUE

Filename	Date	Revision	Lead Auditor	Contact
RSA-538	21 December 2010	1	Theo Niakolas	Peter Harris
RSA-538	1 April 2011	2	Theo Niakolas	Peter Harris

CONTENTS

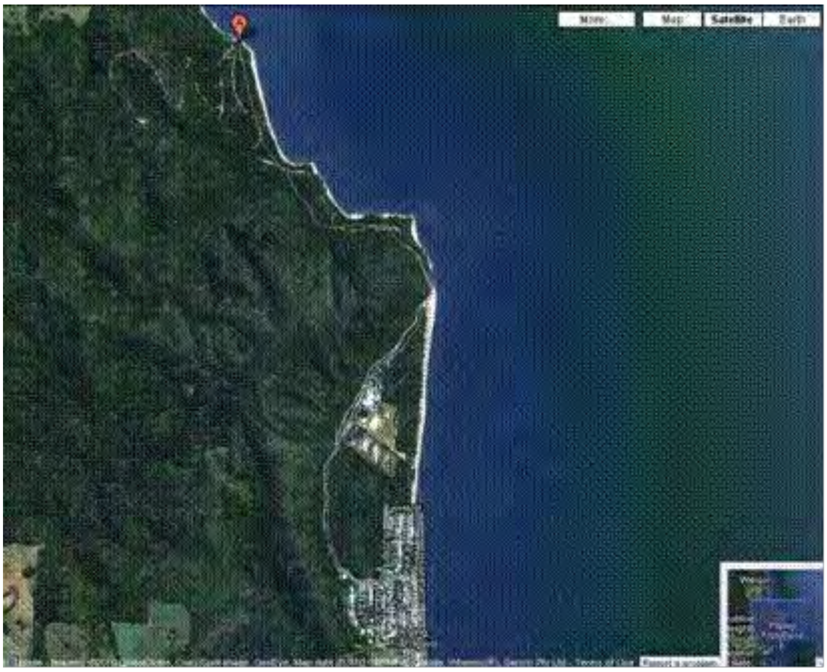
1. PROJECT DESCRIPTION AND AUDIT SCOPE

A functional design stage road safety audit of a section of Ella Bay Road was conducted at the request of Ella Bay Pty Ltd. This audit is intended to assist Ella Bay Pty Ltd as part of the Ella Bay Integrated Resort Development Approval process.

This audit was initiated with an email briefing from Rod Lamb of Ella Bay Pty/Ltd to Peter Harris of RSA P/L. After this, there were several phone discussions about the project, and a personal meeting (14/12/10) to discuss finer details.

As part of the development, Ella Bay Road is to be reconstructed between Flying Fish Point and Ella Bay. However, at this stage of the project, the critical information required for the approval process is the degree of vegetation clearing within chainages 1400-2600m (World Heritage Area Zone B). From a road safety perspective, driver sight distance and curve coordination are the main aspects that affect road width and potential clearing. Accordingly, it was determined that this particular audit would focus solely on the geometric aspects of the road between these chainages. The 'road' consists of the through lanes and shoulder/bicycle lanes. Other topics normally covered in a road safety audit may be picked up at a later date when more details of the design are set in place.

A site inspection was not conducted for this audit given that the audit is limited to geometric details only which are fully discernable from the road design plans.



Ella Bay – 88km South of Cairns, Queensland. Image Courtesy of Google Images

2. SUPPORTING MATERIAL TO FACILITATE AUDIT

The following information was supplied to facilitate the audit:

- Email brief from Rod Lamb dated 3 December 2010.
- Ella Bay Road Design and Environmental Management Report (August 2010 Revision 1).
- Overall Layout Plan EBR1CE-PD02 Revision A.
- Longitudinal Section EBR1CE-PD07 Revision A.
- Road Layout Sheets 1-22 dated 31/3/10 with various layers including sight line checks, pavement markings, signs, degree of clearing, table drains, safety barrier, and so on.
- Spreadsheet with design comments.
- Revision B of Road Layout plans 1-22, dated 25/3/11

3. AUDIT TEAM

The road safety audit team consisted of Peter Harris and Theo Niakolas. Peter Harris is an accredited Senior Road Safety Auditor under QMR Senior Road Safety Auditor register.

4. METHODOLOGY

The audit was carried out in accordance with "Austroads Guide to Road Safety, Part 6: Road Safety Audit 2009" guidelines.

The purpose of the audit is to raise issues/deficiencies from a road safety perspective, and while it may do so at times, the purpose of the report is not to point out compliance with standards. However, the following guides were used to facilitate the audit:

Austroads Guide to Road Safety 2009 'Road Safety Audit' Austroads
Guide to Road Safety 2009 'Barriers and Hazards' Austroads Guide
to Traffic Management 2009
Austroads Guide to Road Design 2009
Queensland MUTCD and RPDM AS
1742.2 2009

5. AUDIT FINDINGS

Important Information Forming Basis of Audit

- This design audit focuses only on the proposed alignment between chainages 1400m and 2600m.
- Only geometric design issues affecting the road are covered in this audit, not other potential issues such as signs, line marking and physical hazards. For the purpose of this audit, the 'road' is the through lanes and shoulders.
- It is understood that the proposed alignment and extent of works have been designed to minimise the construction footprint and hence the effects on flora and fauna.
- It is understood that the maximum posted speed limit proposed for Ella Bay Road will be 60km/h.
- The predicted traffic volumes are 3134 vpd, with approximately 5% being commercial vehicles, including medium and heavy trucks. It is understood that the B-doubles and larger trucks will be prohibited.
- A bicycle route will be incorporated as part of Ella Bay Road with the expectation that cyclists will use the shoulder.
- Predominantly, the current proposal is to provide 3.5m wide lanes with 1.5m width shoulders. Localised bend widening is proposed between chainages 2040m to 2110m, and 2370m to 2420m.

Design Rationale

From a road safety audit perspective, key fundamental requirements that must be met are:-

- Accessibility, including emergency response capabilities
- Speed control
- Road user requirements

The road users in this case are understood to comprise:-

- Passenger vehicles
- 25m semi trailers
- Motorcyclists
- Bicycle riders
- Tourists
- Bus operators

Audit Findings

5.1 Cross Section

Due to the terrain and curvilinear nature of the road, proper horizontal and vertical geometry integration is difficult without major engineering works. However, given the likely traffic volumes, it is considered that the road cross sectional requirements must accommodate a semi trailer without encroachment onto opposing lanes. It is also important to ensure that a cyclist can traverse the road without passenger vehicle encroachment into the bicycle lane.

Additionally, the road lends itself to visual ('sight-seeing') opportunities whilst driving. This opportunity, although aesthetically pleasing, is likely to make the driving navigation task for motorists more hazardous. For example, a two second glance sideways at the ocean when travelling at 50km/h can lead to significant lane 'wandering'. Three metre wide lanes allow no room for error under normal circumstances, let alone for the Ella Bay Road alignment. The revised widths will alleviate the risk of wandering.

It is appreciated that the speed limit is low and that having narrowing lanes in some circumstances may help slow traffic down. However, this outcome is not guaranteed in this particular road environment. Also, this design aspect is well superseded by other more critical issues.

The below cross sectional proposals will alleviate some of the sight distance / co-ordination issues, however, appropriate warning signage and other signs/devices will still need to be incorporated.

It is strongly suggested that the following cross sectional properties be adopted as a general minimum:-

- Where road geometry is straight and with radii greater than 120m; provide lane widths of 3.50m wide, with 1.5m wide sealed shoulders. (Recommendation adopted in Revision B)
- Where horizontal geometry incorporates radii between 80m and 119m; provide lane widths of 3.50m, plus 2.0m wide sealed shoulders.
- Where horizontal geometry incorporates radii between 60m and 79m; provide lane widths of 3.70m wide plus 2.3m wide sealed shoulders. (Recommendation adopted in Revision B)

o Where the horizontal geometry incorporates radii smaller than 60m, these need to be given special attention on an individual basis. They are considered to be similar to intersection manoeuvres and will require speed shedding warning devices.

Although the lane and shoulder widths proposed above are not considered overly generous, they will still provide:-

- Reasonable sight distance opportunity to motorists,
- A safer environment for cyclists,
- Reduced likelihood of head on type crashes,
- A safer passage around a broken down passenger vehicle, and,
- A road environment in which major emergency response activities can be more readily conducted (It is understood that Ella Bay Road is the only means of access for the current community and future increased community).

5.2 Parking Areas

It is suggested that where the proposed parking is nominated between chainages 1610m-1640m and 2000m-2110m, that the north bound lane be widened to accommodate vehicles propped to turn right into the parking look-out area. The parking bay clear offset as proposed is supported as this enables reversing out of parking bays without encroachment into the south bound through lane. (this recommendation has been adopted).

5.3 Painted Islands

It is suggested that the diagonal pavement markings as proposed at chainages 2400m and 2070m be replaced with a central line, with the width distributed to shoulder/lane widening instead (these markings could be traversed by motorists simultaneously creating head on crash potential). (this recommendation has been adopted).

5.4 Rough Surface

Where it is proposed to provide a roughened road at cassowary crossings, caution must be exercised to ensure that both motorcyclists and cyclists are not destabilised negotiating such surfaces.

5.5 Superelevation

Positive superelevation should be provided at all curves. However, for the whole road, it is strongly suggested that at least positive 3% superelevation be provided for all radii less than 150m.

5.6 Stormwater Flow Depths

It is suggested that over-pavement stormwater runoff flow depths be less than 4mm. Also particular attention to swale drain capacity should be made to ensure that Ella Bay Road is not cut off due to water over road for events up to an ARI of at least 50 years; given that it is the only access to the development.

6. SUMMARY AND CONCLUSION

The original cross-section was found to be too narrow. The revised plans have incorporated most of the recommended actions whereby wider lanes and shoulders have been provided.

The audit has been carried out in accordance with Austroads Guide to Road Safety Road Safety Audit 2009 and has examined the site as set out in sections 1.0 and 2.0. A written response should be made to all of the audit findings.

Responses to audit findings are generally not required by the auditor, and the auditor does not change the audit findings or sign off on the responses. However, the responses can be fed back to the auditor for knowledge and possible use on future audits for this project.

The audit has attempted to balance the safety needs of all road users within the site/design constraints. As per Austroads guidelines, the suggestions provided have attempted to be realistic/feasible and commensurate with the actual risk posed.

Agreement to the suggestions does not eliminate risk, but reduces risks to levels generally tolerated by the road authority and current practice. Although it attempts to raise all safety deficiencies, this is generally not practicable due to limited knowledge of the site and its potential operation. It is suggested that road safety initiative and judgement is also practiced by the project team.

Peter Harris
Senior Road Safety Auditor

Theo Niakolas
Senior Designer

Appendix 5: Revegetation Planting List

Revegetation Planting List

As each stage or partial stage of works is completed, revegetation and ground treatment will take place as soon as possible. In most cases this will be completed within one week of a completion of the embankment, drain or earthworks.

					Table Drain				
					Straight Road or Outside of Curve		Inside of Curve		
Species	Common Name	Form	Height	Cassowary Food	Road batter to drain, and low flow drain invert (lined with jute)	High flow drain invert (lined with geofabric or rock).	Road batter to drain	Drain invert low flow (lined with jute)	Drain invert (lined with geofabric or rock).
Centella asiatica	Pennywort	Herb	0.2	n	Y	Y	Y	Y	Y
Cylosorus interruptus	Willdenow's maiden fern	Fern	1	n	Y	Y	Y	Y	Y
Lindsaea ensifolia subsp. ensifolia	Fern	Fern	0.5	n	Y	Y	Y	Y	Y
Oplismenus aemulus	Beard Grass	Grass	1	n	Y	Y	Y	Y	Y
Oplismenus compositus	Creeping Beard Grass	Grass	1	n	Y	Y	Y	Y	Y
Scirpodendron ghaeri	Sedge	Sedge	1.5	n	Y	Y	Y	Y	Y
Dianella caerulea var. vannata	Blue Flax Lilly	Forb	1.8	n	Y	Y			
Gahnia aspera	Sword Sedge	Forb	1.5	n	Y	Y	Y		
Nephrolepis obliterata	Sword Fern	Fern	1	n	Y	Y	Y		Y
Blechnum cartilagineum	Gristle fern	Fern	1.5	n	Y			Y	
Nephrolepis hirsutula	Fern	Fern	1	n	Y		Y	Y	
Bowenia spectabilis	Zamia Fern	Cycad	2	n	Y				
Dryaria rigidula	Basket Fern	Fern	1.5	n	Y				
Hibbertia scandens	Climbing Guinea Flower	Vine	0.5	n	Y		Y		
Hypolytrum nemorum	Mini-Pandan Sedge	Sedge	2	n	Y		Y		
Lomandra hytrix	mat-rush	Forb	1.5	n		Y		Y	Y

Bioretention swales

					Bioretention swales			
					Straight Road or Outside of Curve		Inside of Curve	
Species	Common Name	Form	Height	Cassowary Food	Road batter to swale	Bioretention swale	Road batter to swale	Bioretention swale
Centella asiatica	Pennywort	Herb	0.2	n	Y	Y	Y	Y
Cylosorus interruptus	Willdenow's maiden fern	Fern	1	n	Y	Y	Y	Y
Lindsaea ensifolia subsp. ensifolia	Fern	Fern	0.5	n	Y		Y	Y
Oplismenus aemulus	Beard Grass	Grass	1	n	Y		Y	Y
Oplismenus compositus	Creeping Beard Grass	Grass	1	n	Y		Y	Y
Scirpodendron ghaeri	Sedge	Sedge	1.5	n	Y	Y	Y	Y
Dianella caerulea var. vannata	Blue Flax Lilly	Forb	1.8	n	Y			
Gahnia aspera	Sword Sedge	Forb	1.5	n	Y	Y	Y	
Nephrolepis obliterata	Sword Fern	Fern	1	n	Y	Y	Y	
Blechnum cartilagineum	Gristle fern	Fern	1.5	n	Y	Y		Y
Nephrolepis hirsutula	Fern	Fern	1	n	Y	Y	Y	Y
Bowenia spectabilis	Zamia Fern	Cycad	2	n	Y			
Dryaria rigidula	Basket Fern	Fern	1.5	n	Y	Y		
Hibbertia scandens	Climbing Guinea Flower	Vine	0.5	n	Y		Y	
Hypolytrum nemorum	Mini-Pandan Sedge	Sedge	2	n	Y	Y	Y	
Lomandra hytrix	mat-rush	Forb	1.5	n		Y		Y

					Edge Closure	
					Straight Road or Outside of Curve	Inside of Curve
Species	Common Name	Form	Height	Cassowary Food	Embankment & edge closure	Embankment & edge closure
Alyxia ruscifolia	Chain fruit	Shrub	2	n		Y
Aristolochia acuminata	Native dutchmans pipe vine	Vine	0.5	n		Y
Blechnum cartilagineum	Gristle fern	Fern	1.5	n	Y	Y
Bowenia spectabilis	Zamia Fern	Cycad	2	n	Y	Y
Carrisa ovata	currant bush	Shrub	4	n	Y	Y
Centella asiatica	Pennywort	Herb	0.2	n		Y
Commersonia bartramia	Brown Kurrajong	Tree	25	n	Y	
Cordyline manners-suttoniae	Giant Palm Liliy	Shrub	5	n	Y	Y
Cyathea rebeccae	Black Tree Fern	Fern	7	n	Y	
Dianella caerulea var. vannata	Blue Flax Lilly	Forb	1.8	n		Y
Dryaria rigidula	Basket Fern	Fern	1.5	n		Y
Entada rheedii	Matchbox bean vine	Vine	0.5	n		Y
Epipremum pinnatum	Native monstera	Vine	1	n	Y	Y
Eupomatia laurina	Copper laurel, Bolwarra,	Shrub	2-5	n	Y	Y
Ficus oppositta	Sand paper fig	Small Tree	10	n	Y	
Freyinetia excelsa	Slender Climbing Pandan	Vine	0.5	y	Y	Y
Gahnia aspera	Sword Sedge	Forb	1.5	n	Y	Y
Glochidion sumatranum	Buttonwood - Cheese Tree/Sumac	Tree	25	n	Y	
Hibbertia scandens	Climbing Guinea Flower	Vine	0.5	n	Y	Y
Hoy australe	Wax flower vined	Vine	0.5	n	Y	
Ipomoea pes-caprae	Goats- foot morning glory	Vine	0.5	n	Y	
Lepidozamia hopei	Zamia cycad	Cycad	18	y		Y
Lindsaea ensifolia subsp. ensifolia	Fern	Fern	0.5	n		Y
Mallotus discolor	Yellow Kamala	Tree	17	n	Y	
Melastoma malabathricum subsp. malabathricum	Blue Tongue	Shrub	3	n	Y	Y
Melicope elleryana	Corkwood	Tree	35	n	Y	

					Edge Closure	
					Straight Road or Outside of Curve	Inside of Curve
Species	Common Name	Form	Height	Cassowary Food	Embankment & edge closure	Embankment & edge closure
Merremia peltata		Vine	0.5	n		Y
Millettia pinnata	Pongamia	Tree	20	n	Y	
Myrsine porosa	Mutton Wood	Small Tree	2-10	n	Y	
Pandanus solmslaubachii	Swamp Pandanus	Small Tree	20	y	Y	
Pandanus tectorius	Beach Pandanus	Small Tree	12	y	Y	
Sarcopteryx martyana		Small Tree	20	n	Y	
Schefflera actinophylla	Umbrella Tree	Tree	25	n	Y	
Tabernaemontana orientalis	Eastern Gondola Bush	Shrub	8	n	Y	
Tabernaemontana pandacaqui	Banana Bush	Shrub	4	n		Y
Timonius timon		Small Tree	20	n	Y	
Vigna marina	Vigna	Vine	0.5	n	Y	

					Fauna Underpass			
					All			
Species	Common Name	Form	Height	Cassowary Food	Fauna culverts (exit) and Cassowary escape gates.	Underneath bridges for visual corridor	Adjacent to bridges and along riparian areas	Swales, adjacent and below the bridges
Oplismenus compositus	Creeping Beard Grass	Grass	1	n	Y	Y	Y	Y
Blechnum cartilagineum	Gristle Fern	Fern	1.5	n	Y	Y		Y
Centella asiatica	Pennywort	Herb	0.2	n	Y	Y		Y
Nephrolepis obliterata	Sword Fern	Fern	1	n	Y	Y		Y
Oplismenus aemulus	Beard Grass	Grass	1	n	Y	Y		Y
Dryaria quercifolia	Epiphyic Fern -Oak Leaf Fern	Fern	0.5	n	Y	Y		
Hibbertia scandens	Climbing Guinea Flower	Vine	0.5	n	Y	Y		
Lindsaea ensifolia subsp.Ensifolia		Fern	0.5	n	Y			Y
Aristolochia acuminata	Native Dutchmans Pipe Vine	Vine	0.5	n	Y			
Entada rheedii	Matchbox Bean Vine	Vine	0.5	n	Y			
Alpinia caerulea	Native Ginger	Shrub	4	y		Y	Y	Y
Ardisia brevipedata	Rambling Spearflower	Shrub	3	y		Y	Y	Y
Cordyline cannifolia	Palm Liliy	Shrub	2	y		Y	Y	Y
Dianella caerulea var. vannata	Blue Flax Lilly	Forb	1.8	n		Y	Y	Y
Musa banksii	Native Banana	Small Tree	6	y		Y	Y	Y
Piper nove-hollandiae	Native Pepper	Vine	0.5	y		Y	Y	Y
Davidsonia pruriens	Davidson's Plum	Tree	6	y		Y	Y	
Adiantum hispidulum	Rough Maidenhair Fern	Fern	0.3	n		Y		Y
Angiopteris evecta	King Fern	Fern	5	n		Y		Y
Bowenia spectabilis	Zamia Fern	Cycad	2	n		Y		Y
Cordyline manners-suttoniae	Giant Palm Liliy	Shrub	5	y		Y		Y
Freyinetia excelsa	Slender Climbing Pandan	Vine	0.5	y		Y		Y
Freyinetia scandens	Climbing Pandan	Vine	0.5	n		Y		Y
Alyxia ruscifolia	Chain Fruit	Shrub	2	n		Y		
Carrisa ovata	Currant Bush	Shrub	4	n		Y		
Cycas media	Qld Cycad	Cycad	3	y		Y		
Dryaria rigidula	Basket Fern	Fern	1.5	n		Y		
Epipremum pinnatum	Native Monstera	Vine	1	n		Y		
Eupomatia laurina	Copper Laurel, Bolwarra,	Shrub	2-5	n		Y		

					Fauna Underpass			
					All			
Species	Common Name	Form	Height	Cassowary Food	Fauna culverts (exit) and Cassowary escape gates.	Underneath bridges for visual corridor	Adjacent to bridges and along riparian areas	Swales, adjacent and below the bridges
Macklinaya confusa	Blue Umbrella	Shrub	6	y		Y		
Scaevola taccadala	Sea Lettuce Tree	Shrub	3	y		Y		
Tabernaemontana pandacaqui	Banana Bush	Shrub	4	n		Y		
Hornstedtia scottiana	Native Cardamom Ginger/Lilly	Herb	4	y			Y	Y
Acronychia acronychioides	White Aspen	Tree	25	y			Y	
Archontrophenix alexandrae	Alexandra Palm	Palm	30	y			Y	
Atractocarpus fitzalanii	Native Gardenia	Tree	20	y			Y	
Chionanthus ramiflorus	Native Olive	Small Tree	20	y			Y	
Ficus drupacea	Drube Fig	Tree	20	y			Y	
Ficus obliqua	Small Leafed Fig	Tree	50	y			Y	
Hydriastele wendlandiana	Cat-O-Nine-Tails	palm	26	y			Y	
Lepidozamia hopei	Zamia Cycad	Cycad	18	y			Y	
Licuala ramsayii	Cairns Fan Palm	Palm	20	y			Y	
Litsea leefeana	Bollywood	Tree	30	y			Y	
Neolitsea dealbata	Grey Bollywood	Tree	15	y			Y	
Pandanus monticola	Scrub Breadfruit	Small Tree	10	y			Y	
Phaleria clerodendron	Scented Daphne	Small Tree	10	y			Y	
Podocarpus grayae	Plum Pine	Tree	30	y			Y	
Polyscias australianum	Ivory Basswood	Tree	15	y			Y	
Polyscias elegans	Celerywood	Tree	30	y			Y	
Pouteria chartacea	Dugulla	Tree	12	y			Y	
Pytosperma elegans	Solitaire Palm	Palm	15	y			Y	
Cyathea rebeccae	Black Tree Fern	Fern	7	n				Y
Cylosorus interruptus	Willdenow's Maiden Fern	Fern	1	n				Y
Hypolytrum nemorum	Mini-Pandan Sedge	Sedge	2	n				Y
Nephrolepis hirsutula	Fern	Fern	1	n				Y

					Vegetated gabions and embankments					
					Inside Of Curve West of road	Straight road or outside of corner	Straight road or outside of corner	Eastern Side of road	Heath Point park	
Species	Common Name	Form	Height	Cassowary Food	Low gabions and batters <2m.	Low batters and gabions	Steep batters, rock fall netting	Adjacent to low wall gabions.	Top of gabion	In front of gabion
Acacia sp.		Tree	5-15	n		Y				
Acronychia laevis	Hard Aspen	Small Tree	12	n		Y				
Adiantum hispidulum	Rough Maidenhair Fern	Fern	0.3	n	Y		Y	Y		
Allocasuarina litoralis	Black Sheoak	Tree	8	n		Y				
Angiopteris evecta	King Fern	Fern	5	n		Y				
Aristolochia acuminata	Native Dutchmans Pipe Vine	Vine	0.5	n	Y		Y	Y		
Blechnum cartilagineum	Gristle Fern	Fern	1.5	n	Y		Y	Y		
Bowenia spectabilis	Zamia Fern	Cycad	2	n	Y		Y	Y		
Calophyllum inophylum	Beach Calophyllum	Tree	30	Y						Y
Centella asiatica	Pennywort	Herb	0.2	n	Y		Y	Y		
Colubrina asiatica	Beach Berry Bush	Shrub	0.5-10	n						Y
Commersonia bartramia	Brown Kurrajong	Tree	25	n		Y				
Cordyline manners-suttoniae	Giant Palm Liliy	Shrub	5	y		Y				
Crinum pendunculatum	River Lilly	Forb	2	n					Y	
Cyathea rebeccae	Black Tree Fern	Fern	7	n		Y				
Cyclophyllum multiflorum	Canthium	Tree	15	n						Y
Dianella caerulea var. vannata	Blue Flax Lilly	Forb	1.8	n	Y		Y	Y		
Dryaria quercifolia	Oak Leaf Fern	Fern	0.5	n	Y		Y	Y		
Dryaria rigidula	Basket Fern	Fern	1.5	n	Y		Y	Y		
Dryaria rigidula	Basket Fern	Fern	1.5	n		Y				
Drypetes deplanchei	Yellow Tulipwood	Tree	25	n		Y				
Entada rheedii	Matchbox Bean Vine	Vine	0.5	n	Y		Y	Y		
Epipremum pinnatum	Native Monstera	Vine	1	n	Y		Y	Y		
Eupomatia laurina	Copper Laurel, Bolwarra,	Shrub	2-5	n		Y				
Ficus oppositta	Sand Paper Fig	Small Tree	10	y		Y				
Freyinetia excelsa	Slender Climbing Pandan	Vine	0.5	y		Y				
Freyinetia scandens	Climbing Pandan	Vine	0.5	y		Y				

					Vegetated gabions and embankments					
					Inside Of Curve West of road	Straight road or outside of corner	Straight road or outside of corner	Eastern Side of road	Heath Point park	
Species	Common Name	Form	Height	Cassowary Food	Low gabions and batters <2m.	Low batters and gabions	Steep batters, rock fall netting	Adjacent to low wall gabions.	Top of gabion	In front of gabion
Gahnia aspera	Sword Sedge	Forb	1.5	n		Y				
Glochidion lobocarpum	Pin Flower Tree	Small Tree	9	n		Y				
Guioa acutifolia	Glossy Tamarind	Tree	20	n						Y
Hibbertia scandens	Climbing Guinea Flower	Vine	0.5	n						Y
Hibiscus tiiaceous	Coast Cottonwood, Hibiscus	Tree	12	N						Y
Hoy australe	Wax Flower Vined	Vine	0.5	n	Y		Y	Y		
Hoy australe	Wax Flower Vined	Vine	0.5	n					Y	
Hoy australe	Wax Flower Vined	Vine	0.5	n						Y
Ipomoea pes-caprae	Goats- Foot Morning Glory	Vine	0.5	n	Y		Y	Y		
Ipomoea pes-caprae	Goats- Foot Morning Glory	Vine	0.5	n					Y	
Lindsaea ensifolia subsp. ensifolia	Fern	Fern	0.5	n		Y				
Lithomyrtus obtusa	Beach Myrtella	Shrub	2.5	N						Y
Lophostemon suaveolens	Swamp Mahogany	Tree	20	n		Y				
Macaranga inamoena	Buff Macaranga	Tree	10	n		Y				
Macaranga subdentata	Needle Bark	Tree	15	n		Y				
Macaranga tanarius	Macaranga	Tree	28	n		Y				
Macklinaya confusa	Blue Umbrella	Shrub	6	y		Y				
Mallotus discolor	Yellow Kamala	Tree	17	n		Y				
Melastoma malabathricum subsp. malabathricum	Blue Tongue	Shrub	3	n		Y				
Merremia peltata		Vine	0.5	n	Y		Y	Y		
Millettia pinnata	Pongamia	Tree	20	n		Y				
Myrsine porosa	Mutton Wood	Small Tree	2-10	n		Y				
Nephrolepis obliterata	Sword Fern	Fern	1	n	Y		Y	Y		
Oplismenus compositus	Creeping Beard Grass	Grass	1	n	Y		Y	Y		
Pandanus tectorius	Beach Pandanus	Small Tree	12	y						Y
Pittosporum ferrugineum	Rusty Pittosporum	Tree	20	n		Y				

					Vegetated gabions and embankments					
					Inside Of Curve West of road	Straight road or outside of corner	Straight road or outside of corner	Eastern Side of road	Heath Point park	
Species	Common Name	Form	Height	Cassowary Food	Low gabions and batters <2m.	Low batters and gabions	Steep batters, rock fall netting	Adjacent to low wall gabions.	Top of gabion	In front of gabion
Pittosporum revolutum	Yellow Pittosporum	Shrub	6	n		Y				
Polyscias murrayi	Pencil Cedar	Tree	30	n		Y				
Rubus queenslandicus	Rose Leaf Bramble	Vine	1.5	y	Y		Y	Y		
Sarcopteryx martyana		Small Tree	20	n		Y				
Scaevola taccadala	Sea Lettuce Tree	Shrub	3	y						Y
Schefflera actinophylla	Umbrella Tree	Tree	25	n		Y				
Sophora tomentosa	Silver Bush	Shrub	5	n						Y
Sporobulus virginicus	Sand Couch	Grass	1	n						Y
Syzigium forte	White Apple	Tree	25	Y						Y
Tabernaemontana orientalis	Eastern Gondola Bush	Shrub	8	n						Y
Tabernaemontana pandacaqui	Banana Bush	Shrub	4	n		Y				
Terminalia arenicola	Brown Almond, Brown Damson	Tree	10	Y						Y
Terminalia catappa	Indian Almond, Beach Almond	Tree	15	Y						Y
Terminalia muelleri	Mueller's Tamarind	Tree	18	Y						Y
Thespesia populnea	Tulip Tree	Tree	10	n						Y
Timonius timon		Small Tree	20	n		Y				
Trema orientalis	Poison Peach	Small Tree	30	n		Y				
Vigna marina	Vigna	Vine	0.5	n	Y		Y	Y		
Vigna marina	Vigna	Vine	0.5	n					Y	
Wikstroemia indica	Tie Bush	Shrub	4	n						Y

Appendix 6: Noise Report

ASK Consulting Engineers Pty Ltd
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December 24, 2010

Ella Bay
12 Browning Street
SOUTH BRISBANE 4101
Attention: Rod Lamb

Dear Rod,

Re: Noise associated with Ella Bay Road Traffic

ASK Consulting Engineers was commissioned by Ella Bay to prepare an analysis dealing with the noise impact of the Ella Bay Road upgrade onto Zone B World Heritage Area.

1 Introduction

Ella Bay is proposing to upgrade Ella Bay Road at Ella Bay to a 6m wide dense graded asphalt seal. This road is currently unsealed.

The road is located in the vicinity of Zone B World Heritage Area (WHA). Distances from the road to the WHA range from 31m to 100m.

The Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) has commented that *vehicular noise has been found to penetrate over 100m into the rainforest at levels that may contribute to the degradation of habitat for fauna*. This comment is understood to be based on the Kuranda Range Road Study.

This letter uses the 100m distance for the 2003 Kuranda Range Road Study and attempts to find distances from the proposed Ella Bay Road at which the predicted road traffic noise levels are similar to those at 100m from the Kuranda Range Road.

2 Road Traffic Parameters

A comparison of the predicted road traffic noise levels for the Kuranda Range Road and Ella Bay Road has been carried out using the parameters indicated in Table 2.1.

Table 2.1 Road Traffic Parameters Used in Noise Models

Parameter	Kuranda Range Road*	Ella Bay Road
Traffic volume (AADT)	6,125	3,000 - 4,000
Percentage heavy vehicles	7.3	5.0
Speed Limit (km/hr)	80	60
Road Surface	SMA (stone mastic asphalt)	DGA (dense graded asphalt)

* Data obtained from Table 1.1 in ASK report 2867R (2004)

3 Road Traffic Noise Model

The noise model used is the PEN (Propagation of Environmental Noise) model. This model contains algorithms to enable application of the CORTN88 noise model and predicts noise levels in terms of L_{10}(18 hour) and/or L_{10}(1 hour).

The L_{10} is the noise level exceeded 10% of the time, the L_{10}(1 hour) is the noise level exceeded 10% of the time in 1 hour (i.e. 6 minutes), and the L_{10}(18 hour) is the arithmetic average of the 18 L_{10}(1 hour) noise levels between 6am and midnight.

4 Assumptions

For the Kuranda Range Road the average incline of approximately 3.9% has been incorporated into the noise model. It has further been assumed that the 2003 Kuranda Range Road comprises a 2 lane road with each traffic lane being 3.5m wide.

Ella Bay Road has been taken to comprise a 2-lane road with 3.5m wide lanes with a 1.0% incline.

5 Road Traffic Noise Predictions

The geometry of the roads and the input data as per Table 2.1 result in the noise levels due to the Kuranda Range Road being higher by approximately 7 dB(A) when compared to those resulting from Ella Bay Road at the same distance from the edge of the nearest traffic lane.

Therefore it has been calculated that the L_{10}(18 hour) noise level at 100m from the Kuranda Range Road in 2003 is approximately equal to the noise level at 33.5m and 40m from Ella Bay Road for traffic flows of 3,000 vehicles per day 4,000 vehicles per day respectively.

Please contact the undersigned if you wish to discuss this further.

Yours faithfully

ASK Consulting Engineers Pty Ltd

Frits Kamst

Director

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December 14, 2010

Ella Bay
12 Browning Street
SOUTH BRISBANE 4101
Attention: Rod Lamb

Dear Rod,

Re: Noise associated with Ella Bay Road Traffic

ASK Consulting Engineers was commissioned by Ella Bay to prepare an analysis dealing with the noise impact of the Ella Bay Road upgrade onto Zone B World Heritage Area.

1 Introduction

Ella Bay is proposing to upgrade Ella Bay Road at Ella Bay to a 7m wide dense graded asphalt seal. This road is currently unsealed.

The road is located in the vicinity of Zone B World Heritage Area (WHA). Distances from the road to the WHA range from 31m to 100m.

The Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) has commented that *vehicular noise has been found to penetrate over 100m into the rainforest at levels that may contribute to the degradation of habitat for fauna*. This comment is understood to be based on the Kuranda Range Road Study.

This letter uses the 100m distance for the 2003 Kuranda Range Road Study and attempts to find distances from the proposed Ella Bay Road at which the predicted road traffic noise levels are similar to those at 100m from the Kuranda Range Road.

2 Road Traffic Parameters

A comparison of the predicted road traffic noise levels for the Kuranda Range Road and Ella Bay Road has been carried out using the parameters indicated in Table 2.1.

Table 2.1 Road Traffic Parameters Used in Noise Models

Parameter	Kuranda Range Road*	Ella Bay Road
Traffic volume (AADT)	48,200	3,000 - 4,000
Percentage heavy vehicles	7	5.
Speed Limit (km/hr)	80	60
Road Surface	SMA (stone mastic asphalt)	DGA (dense graded asphalt)

* Data obtained from Table 1.1 in ASK report 2867R (2004)

3 Road Traffic Noise Model

The noise model used is the PEN (Propagation of Environmental Noise) model. This model contains algorithms to enable application of the CORTN88 noise model and predicts noise levels in terms of L_{10}(18 hour) and/or L_{10}(1 hour).

The L_{10} is the noise level exceeded 10% of the time, the L_{10}(1 hour) is the noise level exceeded 10% of the time in 1 hour (i.e. 6 minutes), and the L_{10}(18 hour) is the arithmetic average of the 18 L_{10}(1 hour) noise levels between 6am and midnight.

4 Assumptions

For simplicity it has been assumed that both the roads and the surrounding topography are the same.

It has further been assumed that the Kuranda Range Road is a 4 lane median separated road, with each traffic lane being 3.5m wide and a 5m median strip..

Ella Bay Road has been taken to comprise a 2-lane road with 3.5m wide lanes.

5 Road Traffic Noise Predictions

The geometry of the roads and the input data as per Table 2.1 result in the noise levels due to the Kuranda Range being higher by approximately 14 dB(A) when compared to those resulting from Ella Bay Road.

Therefore it has been calculated that the L10(18 hour) noise level at 100m from Kuranda Range Road is approximately equal to the noise level at 10m from Ella Bay Road.

As the proposed road is more than 100m from the WHA it is considered that a noise barrier is not required.

Please contact the undersigned if you wish to discuss this further.

Yours faithfully

ASK Consulting Engineers Pty Ltd

Frits Kamst

Director