5 Concept design

5.1 Overview

The concept design on which this environmental assessment is based on an initial functional layout developed as part of the design development process. It has been developed in response to design, community and environmental constraints, and in accordance with the principles of ecologically sustainable development. It also satisfies the project objectives outlined in **Chapter 2 – Strategic and project need.** It addresses and responds to all constraints and principles identified and established as part of this study. The concept design is intended to define a robust and buildable concept that provides:

> A definition of property acquisition requirements sufficient to allow acquisition to proceed.

> A clear description of the design principles, extent of impacts and impact mitigation requirements.

> A basis for estimating the cost of the proposed upgrade.

> A sound and clear basis for the later development of detailed designs to the standard required to support the construction contract.

Matters raised in representations to this environmental assessment could result in adjustments to the concept design, which would be included in the consideration of approval by the Minister for Planning.

The length of the proposed upgrade would be approximately 17 km starting at Ross Lane in Tintenbar and extending to the north to the existing Ewingsdale interchange, near the settlement of Ewingsdale (**Figure 5.1**). At Ross Lane, the proposed upgrade would connect to the north end of the Ballina bypass. Generally the proposed upgrade would be in close proximity to the existing highway corridor from Ross Lane to the Bangalow bypass. The existing highway would be maintained for local and regional traffic.

From near Bangalow, the proposed upgrade would diverge from the Bangalow bypass to the northeast through Tinderbox Creek valley. From there, the proposed upgrade would avoid the steep grades of St Helena Hill by way of a tunnel approximately 340 m long and 45 m below the ridge line. North of the tunnel, the proposed upgrade would be located immediately to the east of the existing highway before tying into the Ewingsdale interchange.

The general features of the proposed upgrade would be:

> Four-lane divided carriageways (two lanes in each direction), with a wide median allowing for the future addition of a third lane in each direction.

> Class M standard over the full length of the proposed upgrade. In accordance with the RTA's Pacific Highway Design Guidelines, 'Class M' projects are designed to 110 km/h (posted speed) freeway standard. This means a controlled access road with divided carriageways, no access for traffic between interchanges, grade separation at all intersections and alternative routes available for local traffic through the provision of service roads or local arterial road networks.

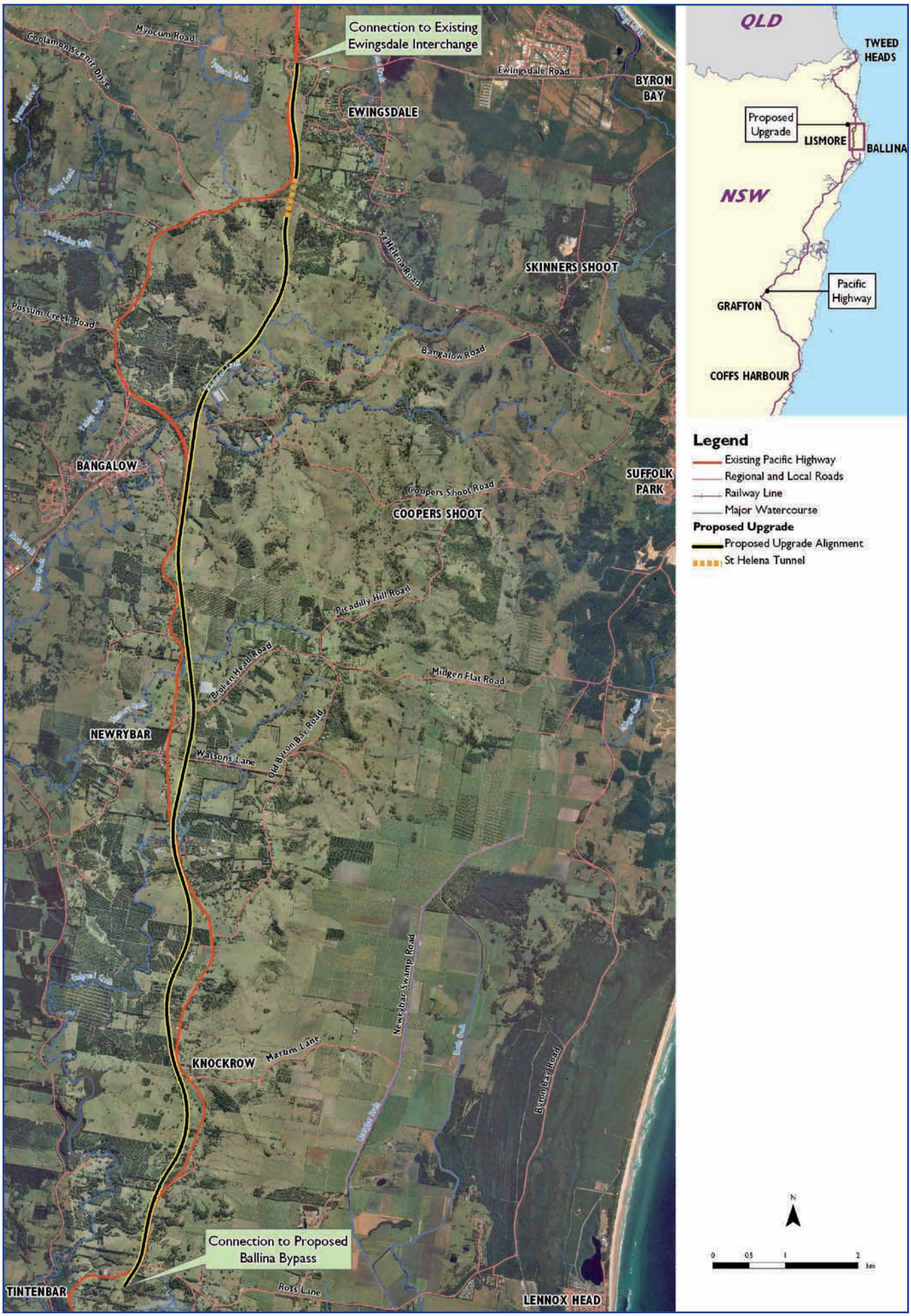
- Connection to the northern end of the Ballina bypass at the proposed Ross Lane interchange. A new northbound on-ramp and a new southbound off-ramp would be provided. The remainder of this interchange will be constructed as part of the Ballina bypass project.
- Upgrading of the existing Ewingsdale interchange to provide full access between the modified local and regional road network and the highway.
- A half interchange at Ivy Lane. North-facing ramps would provide access between the local road network and the proposed upgraded highway to the north.
- A half interchange at Bangalow. South-facing ramps would provide access between the local road network, including to Bangalow and Lismore, and the proposed upgrade to the south. This arrangement would replicate the arrangement with the existing Bangalow bypass which also has south-facing ramps only.
- Six twin bridges and four underpasses allowing roads and creeks to pass underneath the proposed upgrade. These would include twin bridges above Byron Creek and the existing Casino-Murwillumbah railway on the north side of Byron Creek.
- Two bridges carrying local roads over the proposed upgrade, one for Broken Head Road and one about 500 m north of Lawlers Lane providing access to several properties east of the upgrade. Protection screens would be provided on both bridges.
- Emergency u-turn and median crossovers at about 2.5 km intervals. These facilities incorporate lay-bys where vehicles could safely pull off the upgraded highway.
- A range of water quality management measures including intercept drains to divert clean water around the road reserve, landscape and vegetation treatments to assist in reducing water quality impacts and sediment basins to intercept run-off before discharging into the natural watercourses.
- Medians and outer verges, including safety barriers where required.
- Signage providing clear directions for traffic at the Ross Lane, Ivy Lane, Bangalow and Ewingsdale interchanges.
- Relatively flat gradients compared to the existing highway, with the maximum grade just south of Bangalow being approximately 5.4 percent over and approximately 700 m long section. There would also be a 4.4 percent grade over a 1.4 km section on the north side of the tunnel. An additional southbound climbing lane would be provided in both sections so that slow moving trucks would not be a significant safety hazard to other vehicles.
- The existing highway would be retained as a continuous road for local and regional traffic. It is further anticipated that between Ross Lane and Bangalow the existing highway would be handed over to the councils. Between Bangalow and Ewingsdale the existing highway would continue to function as a regional link between Lismore/ Bangalow and the north, and would be retained by RTA.
- Two significant diversions of the existing highway are proposed to retain it as a continuous local road. The first is just north of Emigrant Creek where the existing highway would be diverted underneath the bridge taking the proposed upgrade over Emigrant Creek. The other diversion is where the existing highway south of the Ewingsdale interchange is being diverted to a roundabout on the western side of the interchange.
- Additional local roads and property access would be provided including:
  - Safe access to all properties affected by the proposed upgrade, either directly to the existing highway or indirectly via a new local access road.

> New local roads as required to link the proposed interchanges with the existing highway and other local access roads.

> The proposed upgrade would incorporate twin parallel tunnels under St Helena ridge. The tunnels would each be about 340 m long and about 45 m below St Helena Road. One tunnel would be provided for each carriageway, separated by a rock pillar. The northbound tunnel would be 11.5 m wide between barriers, providing sufficient width for line marking as three lanes in each direction if required in the future. The southbound tunnel would be 12.5 m wide to incorporate the southbound climbing lane while still allowing 1 m wide shoulders on each side. In view of the additional southbound lane proposed initially, there is no provision for adding an additional lane to the southbound carriageway through the tunnel. The precise dimensions of the tunnel may be modified slightly during detailed design.

> Intersections and interchanges designed to achieve at least a level of service C, 20 years after opening for the 100th highest hourly volume (refer to **Section 13.3.2** for a description of level of service).

Figure 5.1 - Proposed upgrade alignment



5.2 Alignment

The proposed concept design alignment is described below and shown in detail in **Figure 5.2a-j.** Dimensions provided would be subject to refinement during detailed design.

The road corridor width for the concept design has been determined allowing a minimum of about 15 m between the edge of earthworks and the acquisition boundary. The width of the proposed road reserve is typically about 80 m where there are no cut or fill embankments required. The width increases (up to a maximum of about 250 m) with the scale of associated earthworks and where other elements such as interchanges are required.

5.2.1 Ross Lane to Emigrant Creek

The proposed upgrade commences at Ross Lane, connecting to the northern end of the Ballina bypass (**Figure 5.2a**). Between Ross Lane and Emigrant Creek the upgrade would generally be located in a corridor just west of the existing highway, varying from immediately adjacent to the existing highway to up to 500 m from the existing highway.

To allow the proposed upgrade to be constructed as close as possible to the existing highway the southbound off-ramp for the Ross Lane interchange would connect to the existing highway about 1 km north of Ross Lane. From here traffic would use the existing highway to access Ross Lane and Tintenbar.

Local access to the properties on the western side of the proposed upgrade would be maintained by constructing an access road parallel to the proposed upgrade. The access road would start from the Ross Lane interchange and extend about 1.2 km north providing access to seven properties.

The alignment keeps as close to the existing highway as possible, but would avoid the nearby Rous Water storage tank and treatment facilities (**Figure 5.2b**). Sufficient clearance has also been allowed for Rous Water to construct a proposed new storage tank adjacent to its existing facilities. Following the existing highway as closely as possible also reduces the impact on agricultural properties that generally extend to the west from the existing highway towards Emigrant Creek and Emigrant Creek dam.

South of Martins Lane, an underpass linked to the existing highway would provide access to properties on the western side of the proposed upgrade. From the underpass, the access road would extend about 400 m to the south and 2 km to the north. Properties east of the proposed upgrade would retain their access to Martins Lane west or to the existing highway.

From Martins Lane, the proposed upgrade would diverge to the west, avoiding any direct impact on Macadamia Castle and a cluster of residences adjacent to the existing highway (**Figure 5.2c**).

North of Macadamia Castle, the proposed upgrade would run parallel to and about 400 m west of the existing highway for a length of about 600 m and then, from Ivy Lane, would merge back onto a corridor immediately west of the existing highway.

At Ivy Lane, a half interchange with north-facing ramps is proposed. This would provide access between the local road network and the proposed upgrade to the north.

At Yarrenbool Place, about 250 m south of Hambly Lane, the proposed upgrade would cross an unnamed creek on twin bridge structures approximately 115-130 m long and then cross Emigrant Creek on twin bridges structures approximately 165-180 m long just north of Hambly Lane (**Figure 5.2d**).

Figure 5.2a - Proposed upgrade detail

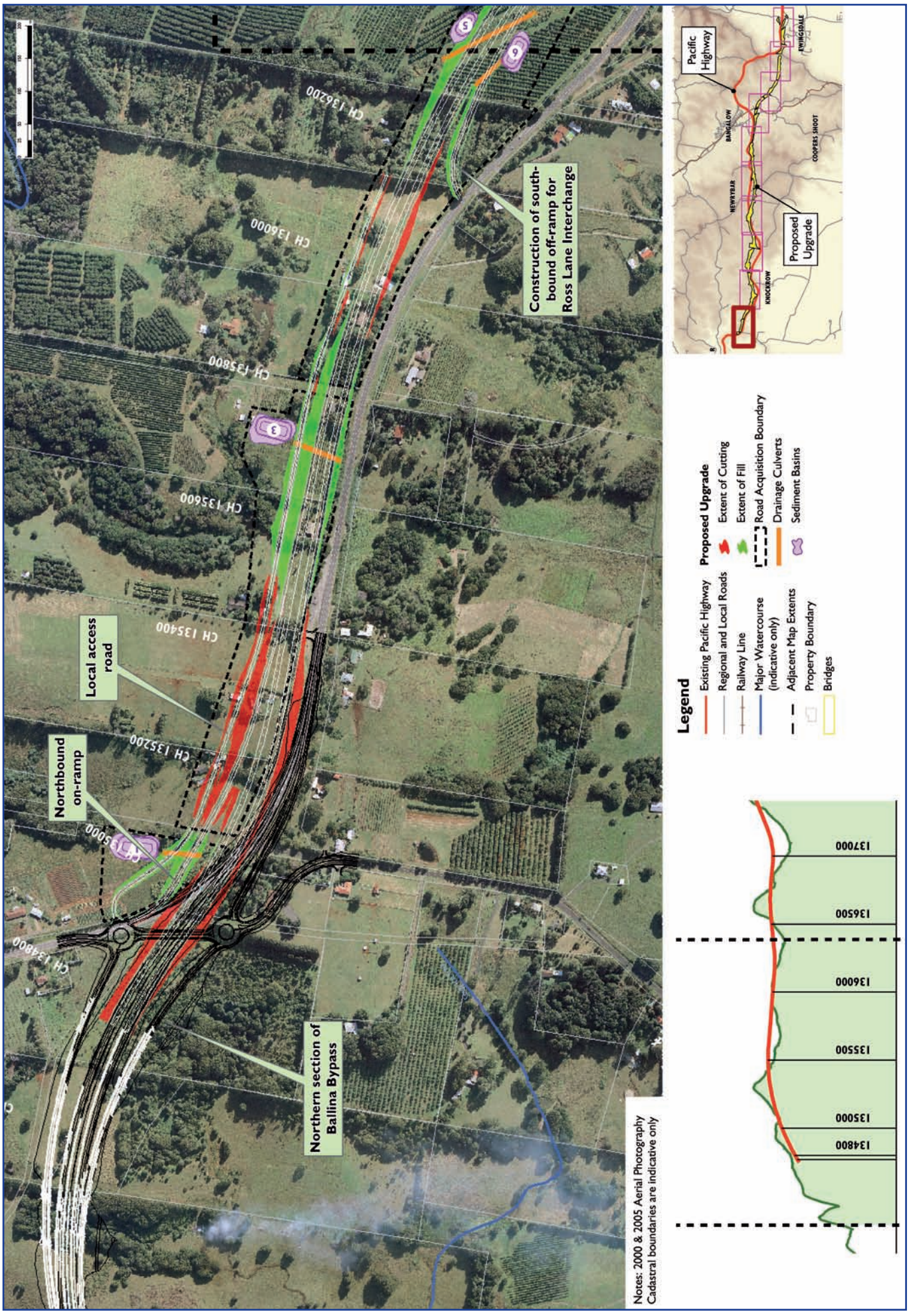


Figure 5.2b - Proposed upgrade detail

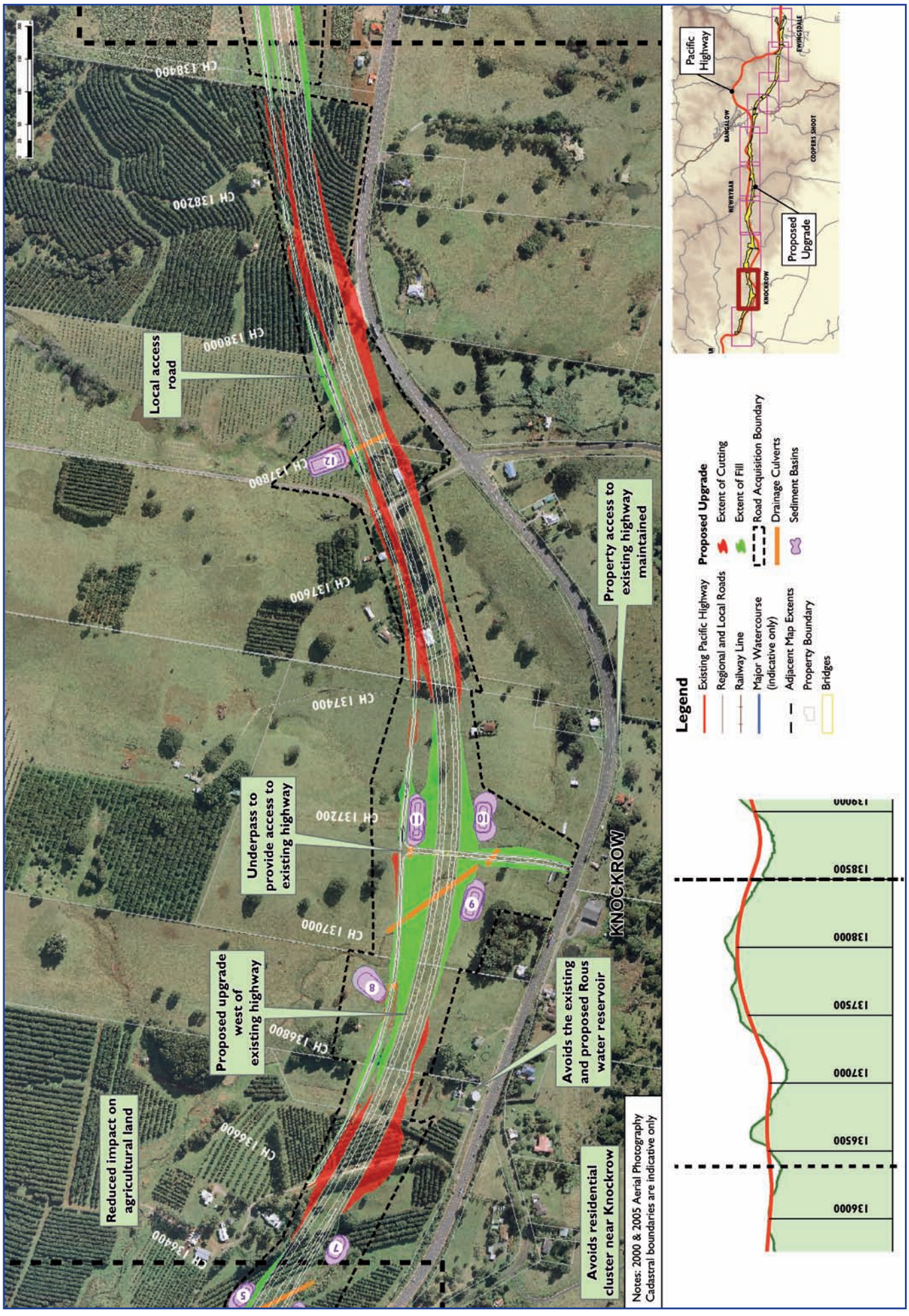
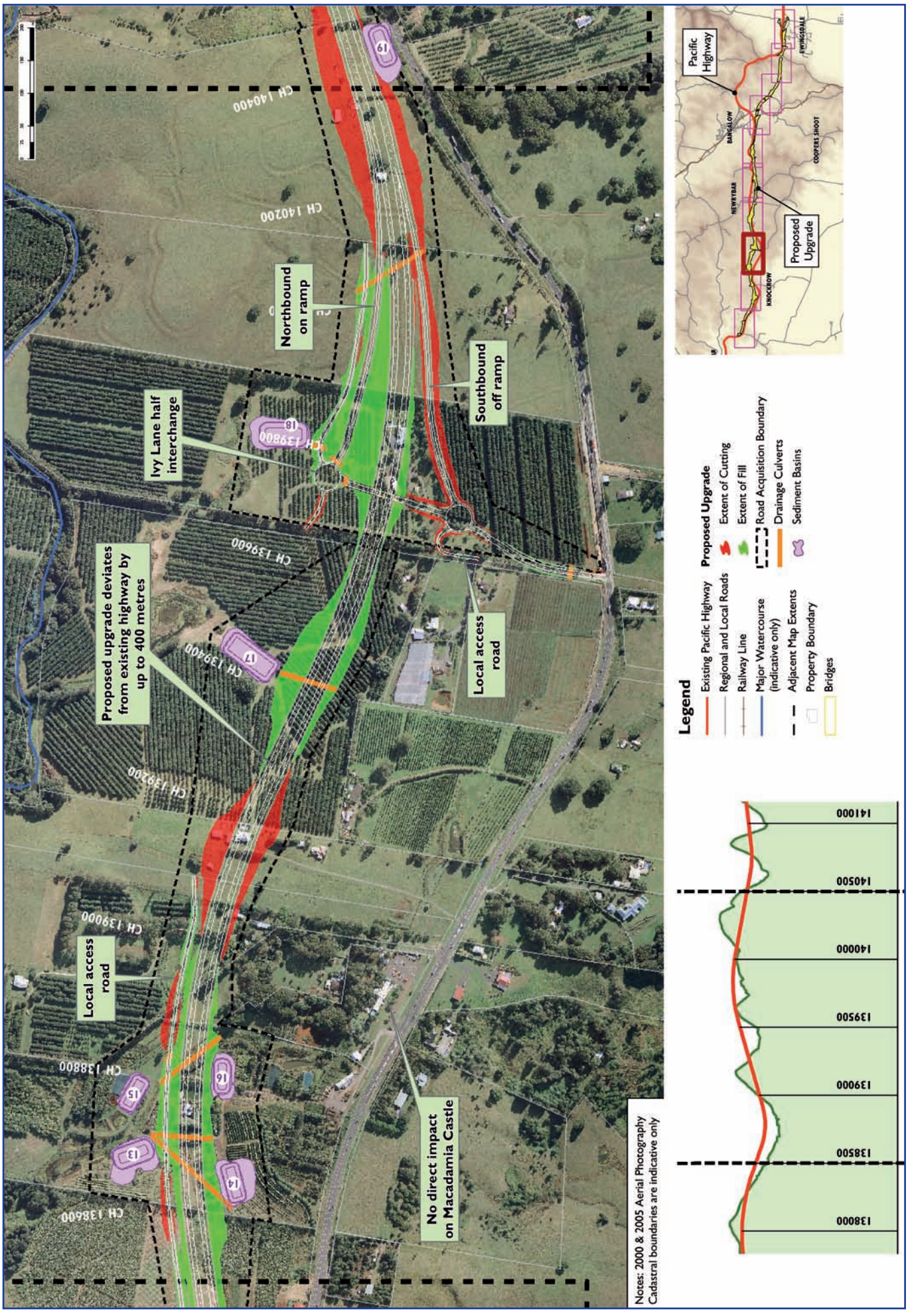


Figure 5.2c - Proposed upgrade detail



5.2.2 Emigrant Creek to Bangalow Road

Between Emigrant Creek and Bangalow Road, the proposed upgrade would generally be located in a corridor just east of the existing highway, varying from immediately adjacent to up to 400 m from the existing highway (**Figure 5.2d**).

About 200 m north of the Emigrant Creek crossing, the proposed upgrade would cross to the eastern side of the existing highway. The existing highway would be diverted underneath the proposed bridge taking the proposed upgrade over Emigrant Creek before reconnecting back onto the existing highway about 600 m south of Newrybar. The total length of the diversion would be about 750 m and would achieve an 80 km/h design speed.

After crossing to the eastern side of the existing highway the proposed upgrade would gradually diverge away from the existing highway. Between Watsons Lane and Broken Head Road the alignment would be parallel to, and about 300 m east of the existing highway as it passes Newrybar village.

An underpass would be provided to allow Watsons Lane traffic to pass underneath the proposed upgrade. A minimum of 4.8 m vertical clearance would be available for Watsons Lane traffic, consistent with RTA requirements for local roads.

North of Watsons Lane, the proposed upgrade would pass to the east of Newrybar Public School where a landscaped mound has been added between the proposed upgrade and the school to provide visual and noise mitigation (**Figure 5.2e**).

The proposed upgrade would pass underneath Broken Head Road in a cutting about 12 m deep. Broken Head Road would cross above the proposed upgrade on a bridge about 135 m long, providing continued access to Newrybar village, Newrybar Public School and the existing highway. The bridge would incorporate pedestrian and cyclist facilities for use by school students and Newrybar residents. There would be no provision for vehicular access between Broken Head Road and the proposed upgrade.

North of Broken Head Road, the alignment would move back towards the existing highway, crossing Skinners Creek on twin bridges about 185-195 m long before merging onto the start of the 9(a) proposed road reserve zone designated for highway usage.

There is no requirement for an access road on the eastern side for the most part through this section since all properties would retain access to Broken Head Road. All houses and properties to the west of the proposed upgrade would retain their access to Broken Head Road and to the existing highway.

For about 1.7 km north of Skinners Creek, the proposed upgrade would be just to the east of the existing highway and avoid the tight curves and steep grades of the existing highway.

Opposite Lawlers Lane, the proposed upgrade would climb to a crest that would form the highest point along the 17 km length (**Figure 5.2f**). It would reach an elevation of about 122 m above sea level, although this would still be about 13 m below the highest level of the existing highway in this section. About 300 m north of the crest, a bridge would be provided above the proposed upgraded to connect properties to the east with the existing highway.

From the crest of the hill and to the north of the local access bridge, the alignment would descend towards Bangalow with a grade of approximately 5.4 percent for a length of about

700 m. The descent would pass through a major cutting up to about 30 m deep and about 500 m long. An additional southbound climbing lane would be provided through this section so that slow moving trucks would not be a significant safety hazard to other vehicles. The additional southbound lane would be developed within the wide median, commencing near the connection to the Bangalow bypass and merging back to two lanes on the south side of the crest, just before the local access bridge. The reduced median width would require a median barrier for safety. The design would allow a third northbound lane to be added in the median in the future if required. In view of the additional southbound lane proposed initially, there is no provision for adding an additional lane to the southbound carriageway in the future.

The upgrade alignment would then connect to the southern end of the Bangalow bypass.

The northbound carriageway of the Bangalow bypass would be converted to a two-way local road while the southbound carriageway would become the northbound carriageway of the proposed upgrade (**Figure 5.2g**). A new southbound carriageway for the proposed upgrade would be constructed on the eastern side of the existing Bangalow bypass.

Through this section a local access road about 1.2 km long would be provided east of the proposed upgrade to provide access to two properties south of Bangalow Road.

At Bangalow, a half interchange with south-facing ramps is proposed. This arrangement would replicate the arrangement with the existing Bangalow bypass. The interchange would incorporate twin bridges above Bangalow Road, each about 60 m long. It would also provide access between the local road network, including Bangalow and Lismore, and the proposed upgrade to the south.

5.2.3 Bangalow Road to Ewingsdale

At Bangalow Road, the existing Bangalow bypass curves to the north-east and climbs steeply beside the Bangalow township. The proposed upgrade would continue in a northerly direction, crossing Byron Creek and the Casino-Murwillumbah railway on twin bridges, each about 180 -190 m long, before traversing Tinderbox Creek valley.

The section of the proposed upgrade through Tinderbox Creek valley to the St Helena Tunnel is about 3 km long (**Figure 5.2h**).

About 650 m north of the railway line at Bangalow, twin bridges approximately 145 m long would cross an unnamed tributary of Tinderbox Creek, reducing disturbance to riparian vegetation and the watercourse itself. Tinderbox Road would be realigned and diverted to pass under the twin bridges to maintain local access.

Through this section, there are several large cuttings into the hillside on the western side of the proposed upgrade to avoid any direct impact on Tinderbox Creek. On the eastern side, the proposed upgrade is quite close to the western edge of Tinderbox Creek at two locations. As a result, fill batters that are more steeply engineered are proposed at both locations rather than the normally slope-engineered batters to ensure that the earthworks do not extend into the flood zone of Tinderbox Creek.

The proposed upgrade would diverge to the north, away from Tinderbox Creek, about 1.5 km north of the railway line or about 1.5 km south of the tunnel under St Helena Hill (**Figure 5.2i**). Following a valley northwards and climbing towards the southern portal of the proposed tunnel, it would reach an elevation of about 91 m above sea level, well

below the elevation of 183 m above sea level that the existing highway reaches at the top of the St Helena ridge.

The proposed upgrade would pass under St Helena ridge through twin parallel tunnels, each about 340 m long and about 45 m below St Helena Road. The twin tunnels, one for each carriageway, would be separated by a rock pillar. The northbound tunnel would be 11.5 m wide between barriers, providing sufficient width for line marking as 3 lanes in each direction if required in the future. The southbound tunnel would be 12.5 m wide to incorporate the southbound climbing lane while still allowing 1 m wide shoulders on each side. In view of the proposed additional southbound lane, there is no provision for adding an additional lane to the southbound carriageway through the tunnel.

On the north side of St Helena Hill the tunnel would emerge just to the east of the existing highway, allowing the existing highway to be retained as a local road. Through to the Ewingsdale interchange, the proposed upgrade alignment would be as close as possible to the existing highway before merging onto and utilising the existing highway just south of the existing Ewingsdale interchange (**Figure 5.2j**). The grade would be 4.4 percent over a length of approximately 1.4 km. An additional southbound climbing lane would be provided through this section so that slow moving trucks would not be a significant safety hazard to other vehicles, particularly through the tunnel. The southbound lane would be developed on the outside by continuing the southbound on-ramp from the Ewingsdale interchange. The median width would not be reduced and no median barrier would be required, apart from the immediate approach to the tunnel portals. The climbing lane would not merge back to two lanes until about 800 m south of the tunnel. This would remove the need for vehicles to change lanes within the tunnel. South of Ewingsdale, a local access road would be provided on the eastern side of the proposed upgrade to maintain access to two properties.

Where the proposed upgrade passes the Ewingsdale residential area, it would be lower and slightly closer to Ewingsdale than the existing highway. A landscaped mound is proposed between Ewingsdale and the proposed upgrade to provide visual and noise mitigation. The mound would extend over a length of about 1 km, from the southern end of the closest houses in Ewingsdale almost through to the roundabout at Ewingsdale Road.

The existing Ewingsdale interchange would be retained but improved as part of the proposed upgrade. As the proposed upgrade merges onto the existing highway south of the interchange, the existing highway traffic would be diverted to the west onto a new connection road. A new roundabout would connect the existing highway traffic to the western side of the existing interchange. The existing northbound off-ramp, northbound on-ramp and southbound off-ramp would remain with minor modifications. A new direct southbound on-ramp is also proposed.

Figure 5.2d - Proposed upgrade detail

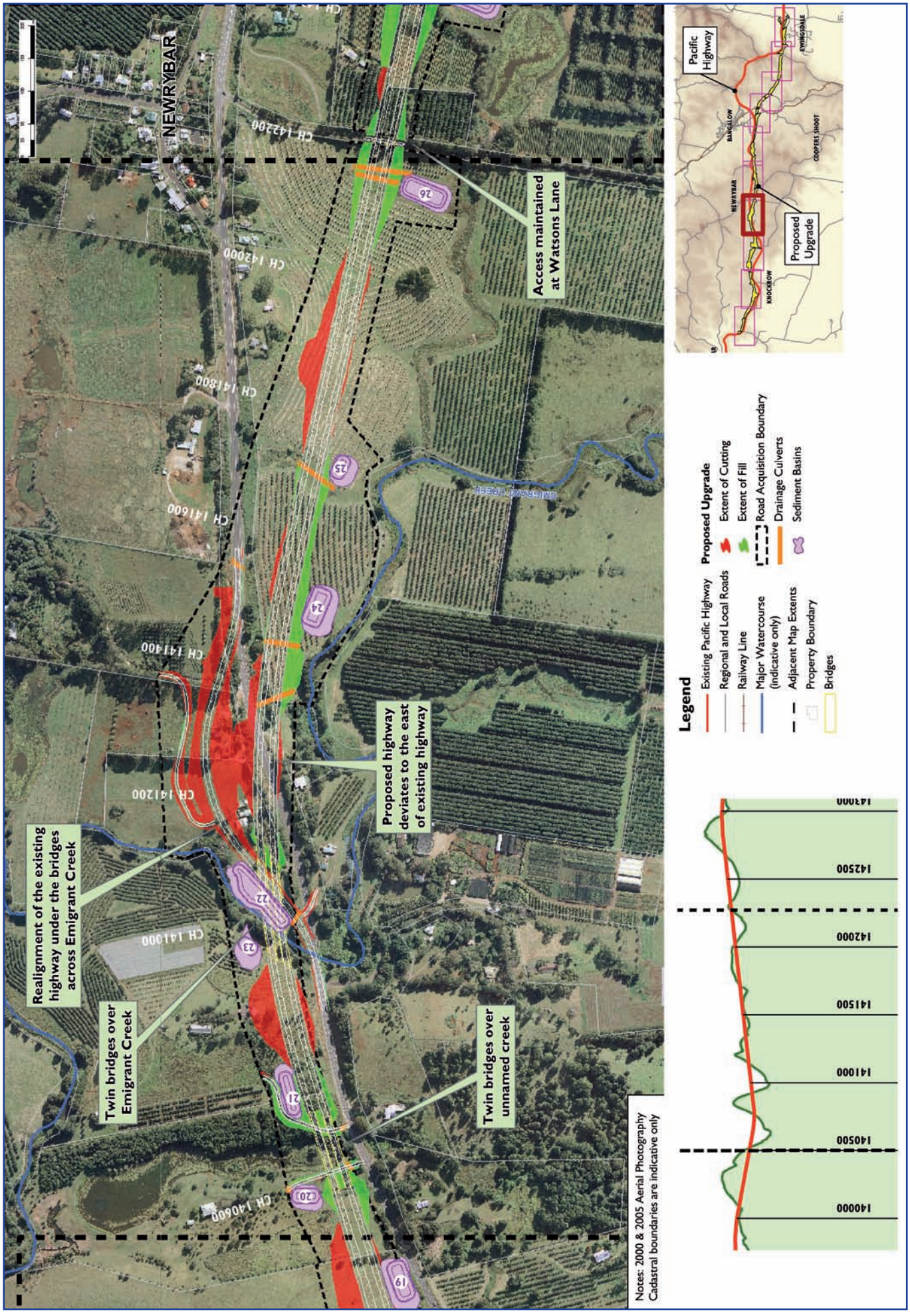


Figure 5.2e - Proposed upgrade detail

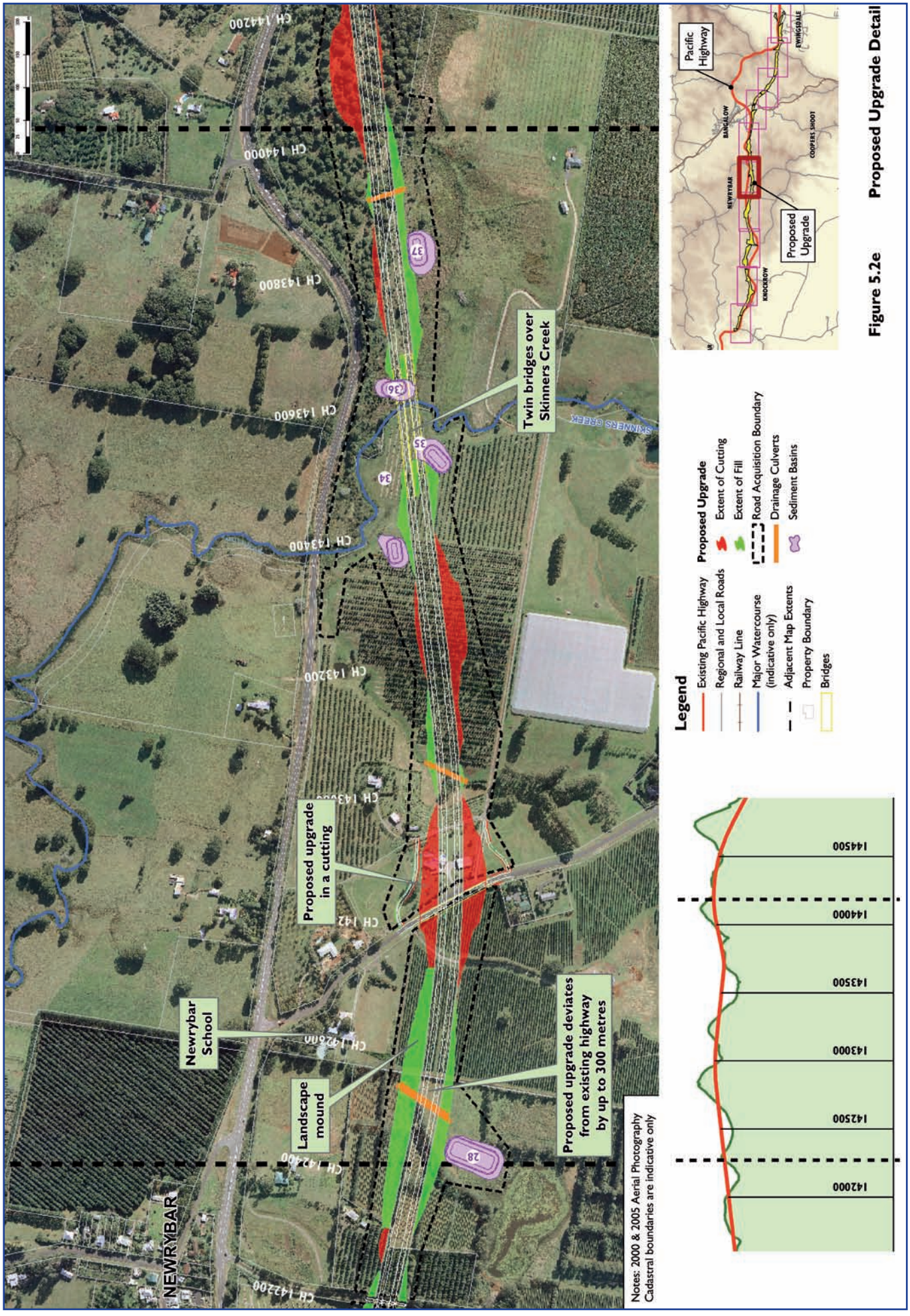


Figure 5.2f - Proposed upgrade detail

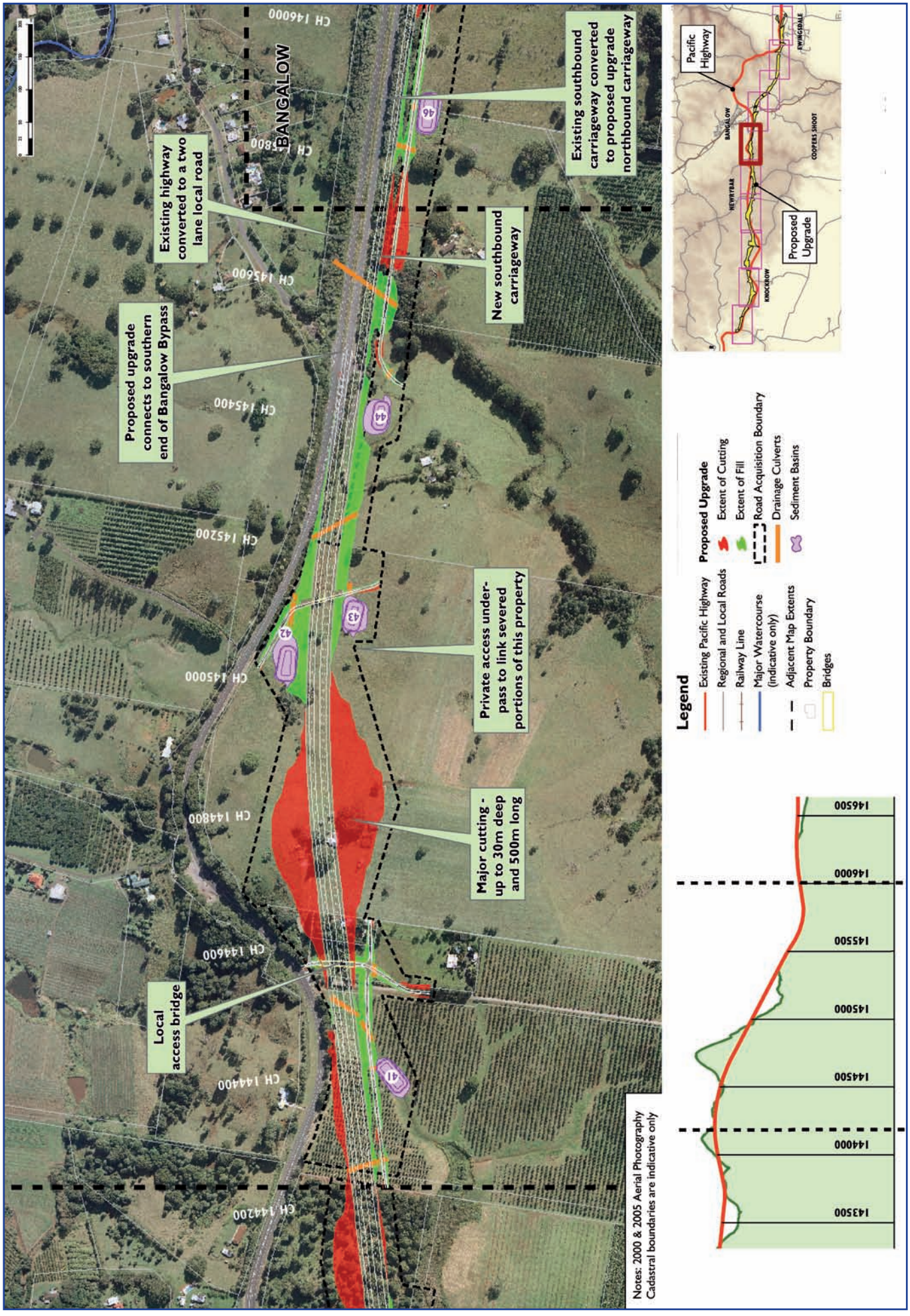


Figure 5.2g - Proposed upgrade detail

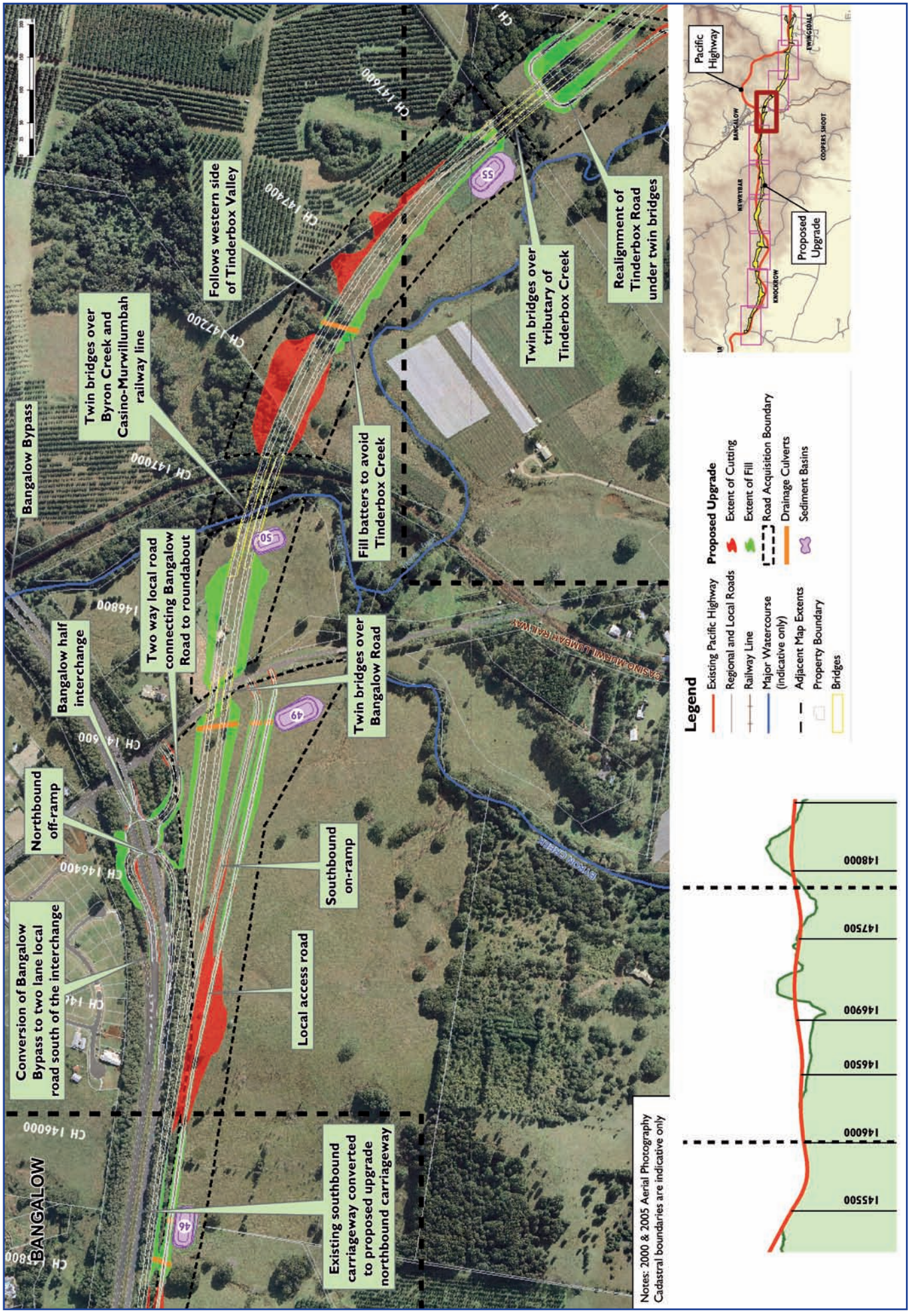


Figure 5.2h - Proposed upgrade detail

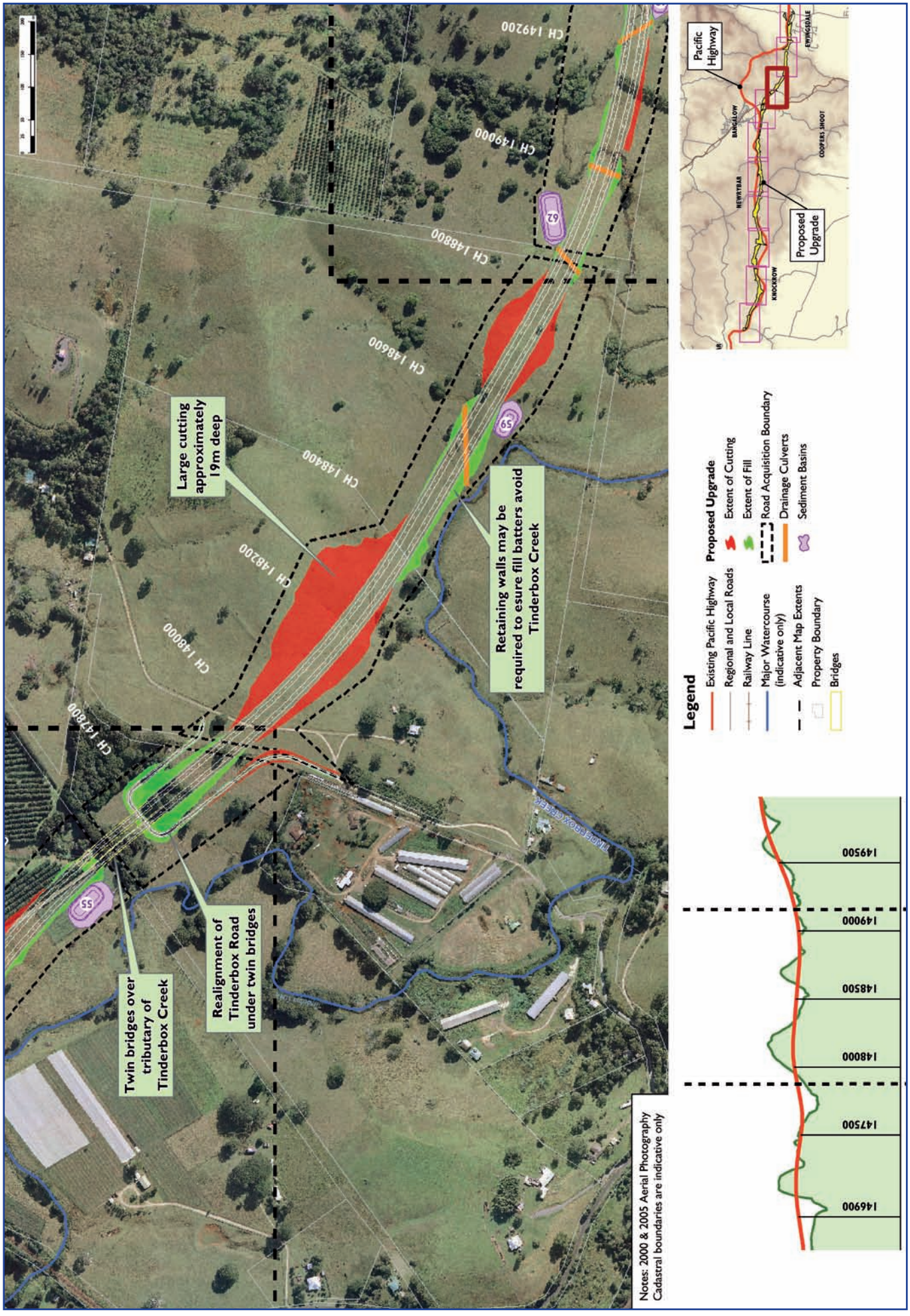


Figure 5.21 - Proposed upgrade detail

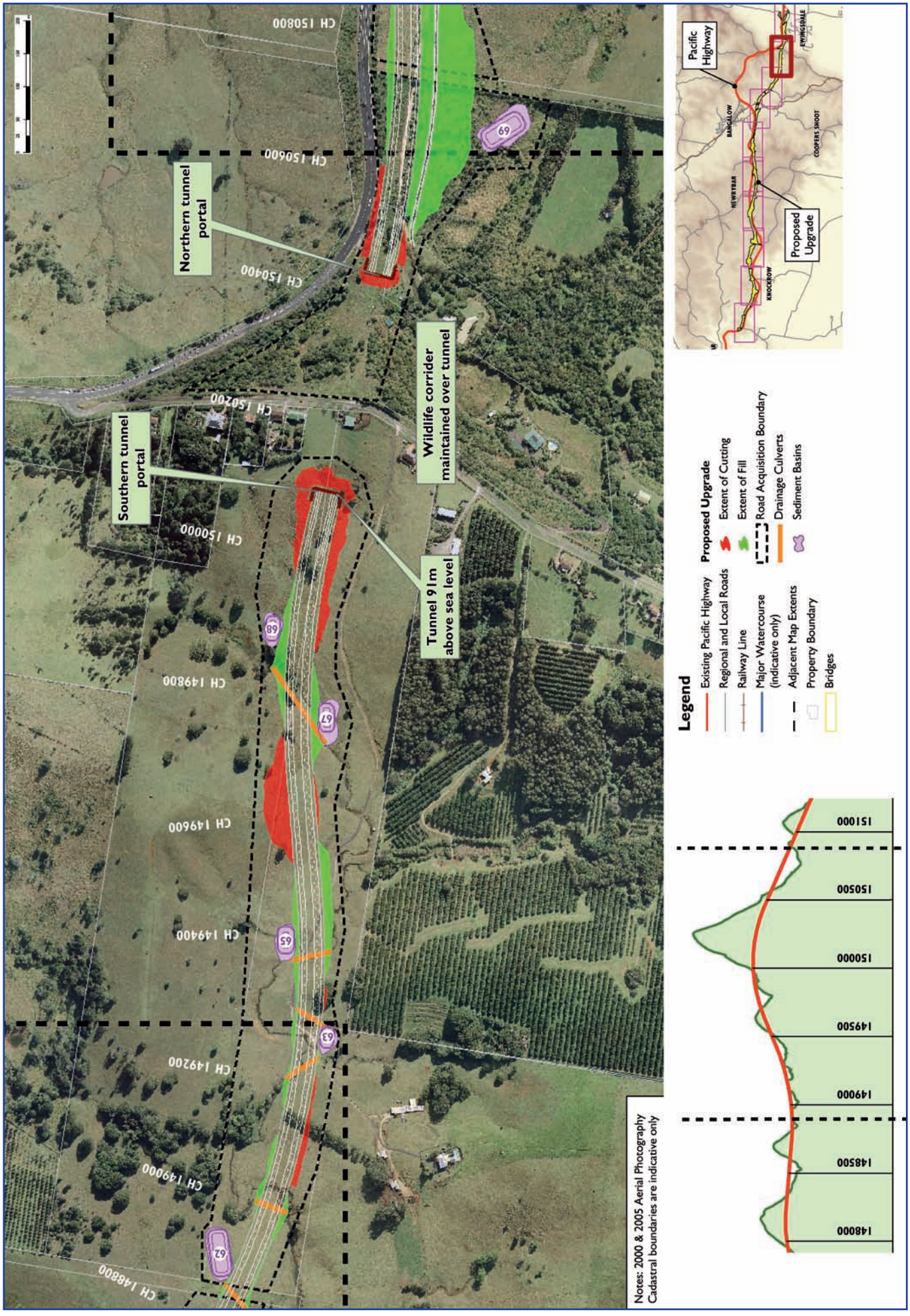
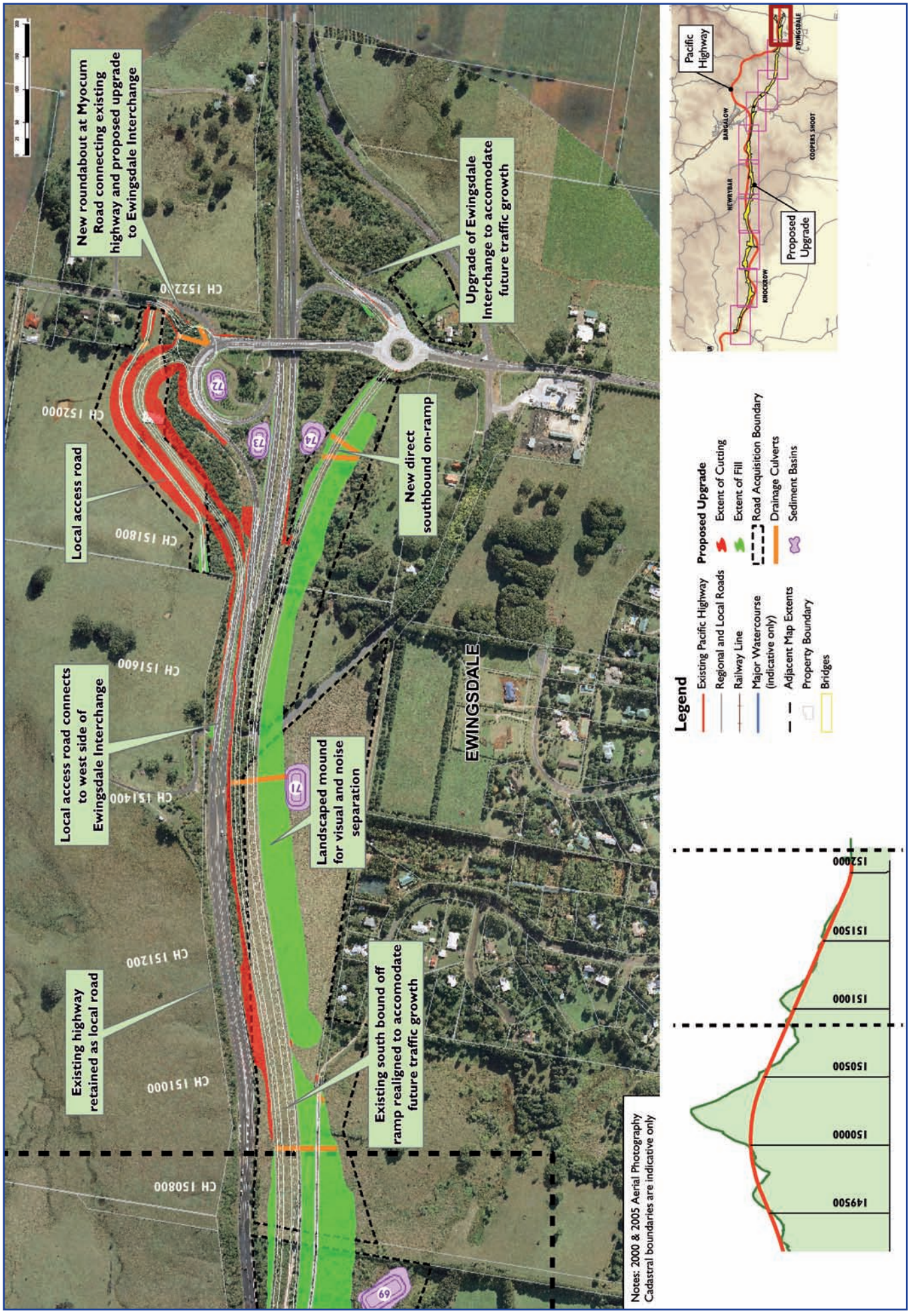


Figure 5.2j - Proposed upgrade detail



5.3 Interchanges and intersections

Full interchanges would be provided at Ross Lane and Ewingsdale and half interchanges would be provided at Ivy Lane (north facing ramps only) and at Bangalow Road (south facing ramps only).

The broader principles associated with access are provided in the *Tintenbar to Ewingsdale Strategic Access Report* (RTA 2008). This report includes a preliminary evaluation of a possible future southern Bangalow bypass that would allow traffic between Lismore/ Casino and the Pacific Highway to connect to the highway without travelling through Bangalow. While outside the scope of this project, it would be possible for a southern bypass of Bangalow to be connected to the proposed upgrade should it become justifiable in the future.

Description of the interchanges proposed as part of the upgrade is provided below. The concept designs presented in this section would be subject to refinement during detailed design.

5.3.1 Ross Lane interchange

The majority of the Ross Lane interchange (**Figure 5.3**) would be constructed as part of the Ballina bypass, including the overpass, the south-facing ramps, and temporary north-facing ramps connecting to the existing highway to the north. The Tintenbar to Ewingsdale upgrade would include:

> Refinement to the northbound on-ramp to connect to the proposed upgrade.

> Provision of a new southbound off-ramp. Due to space limitation and a preference to reduce the overall footprint of the combined road corridor, the southbound off-ramp would not connect directly to the roundabout on the east side of the interchange, but rather to the existing highway about 1.1 km north of the roundabout. The existing highway would remain open to local traffic and be two lanes, providing access to Ross Lane and Tintenbar.

5.3.2 Ivy Lane interchange

The layout of the Ivy Lane interchange is shown in **Figure 5.4**. It would allow for traffic movements between the local road network and the proposed upgrade to the north.

The interchange itself comprises a northbound on-ramp and a southbound off-ramp, connected to roundabouts on both sides of the proposed upgrade. The interchange would also be connected to the existing traffic network by a link road from the eastern roundabout back to Ivy Lane. The two roundabouts would be connected by an underpass that would also maintain access to properties on the western side of the proposed upgrade. The roundabout on the eastern side also has a local access road servicing properties on Ivy Lane.

The current Ivy Lane intersection with the existing highway would be retained, but would include a minor intersection upgrade in line with the increased traffic volumes. There is already a right turn deceleration lane for southbound traffic to turn right into Ivy lane. As part of these improvements, a northbound deceleration lane may be required for the existing highway south of the intersection, allowing northbound traffic on the existing highway to turn left at Ivy Lane.

Figure 5.3 - Ross Lane interchange

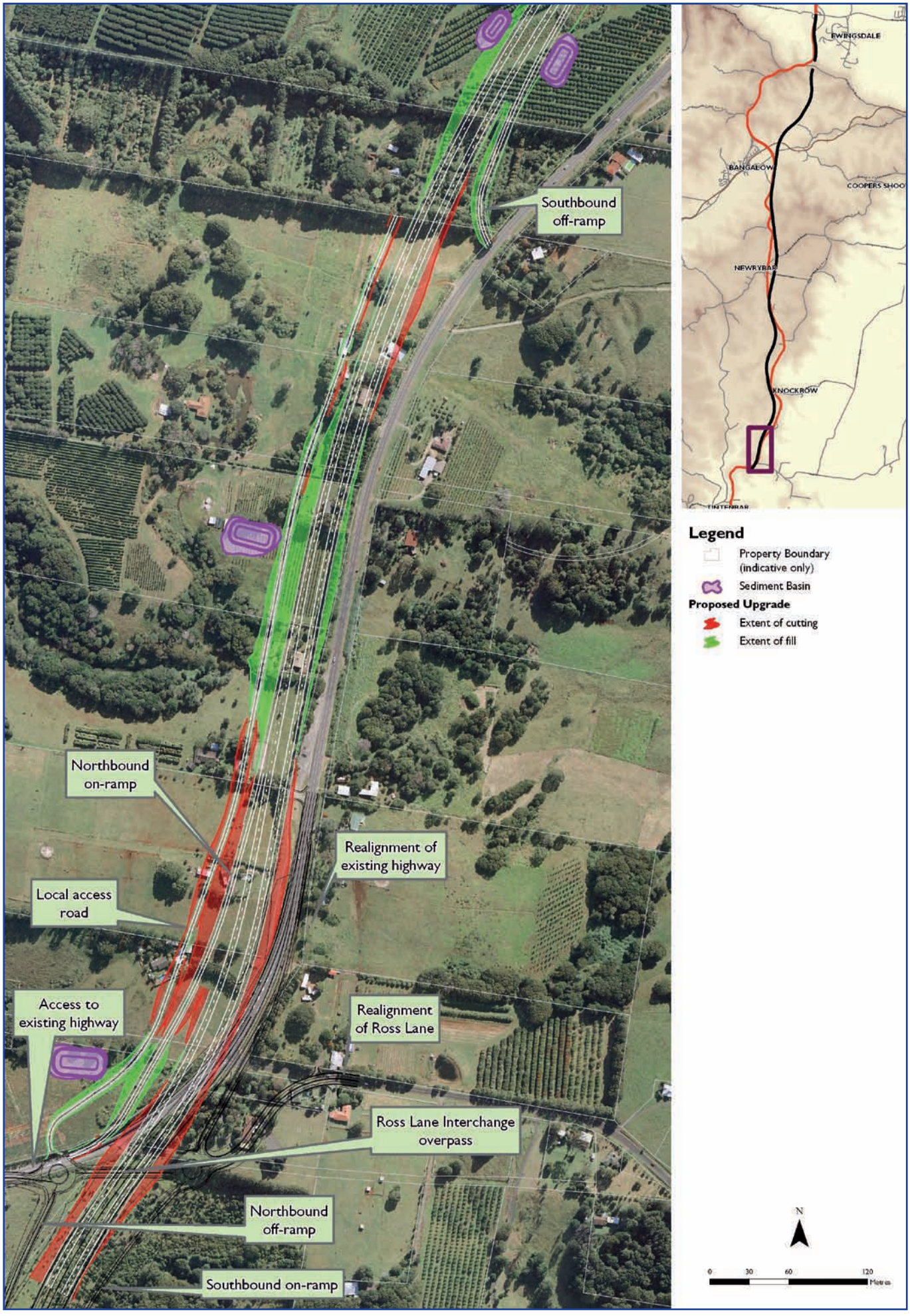
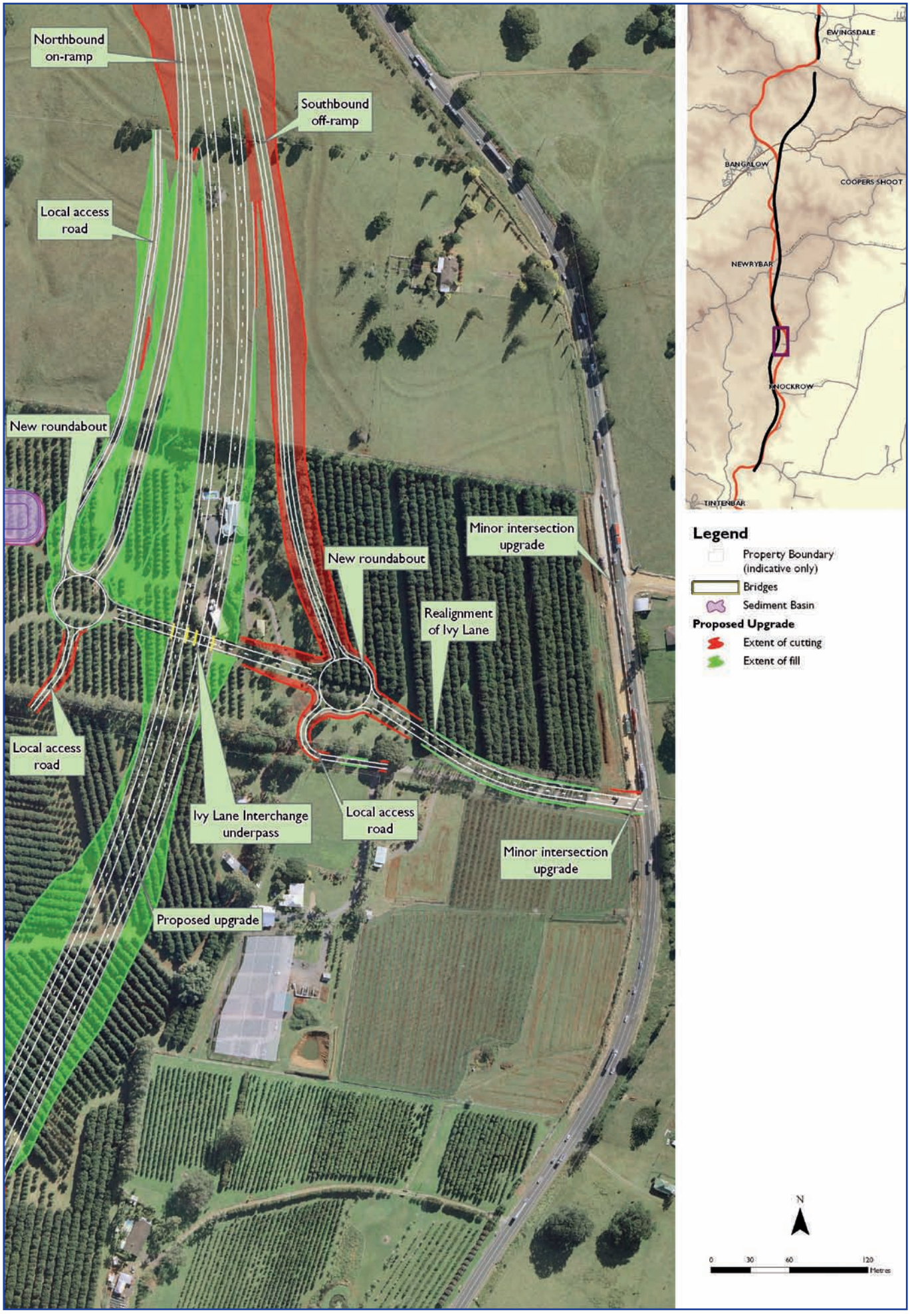


Figure 5.4 - Ivy Lane interchange



5.3.3 Bangalow interchange

The layout of the Bangalow interchange is shown in **Figure 5.5**. It would allow for traffic movements between the local/regional road network at Bangalow and the proposed upgrade to the south. This arrangement would replicate the existing arrangement with the Bangalow bypass at Bangalow Road.

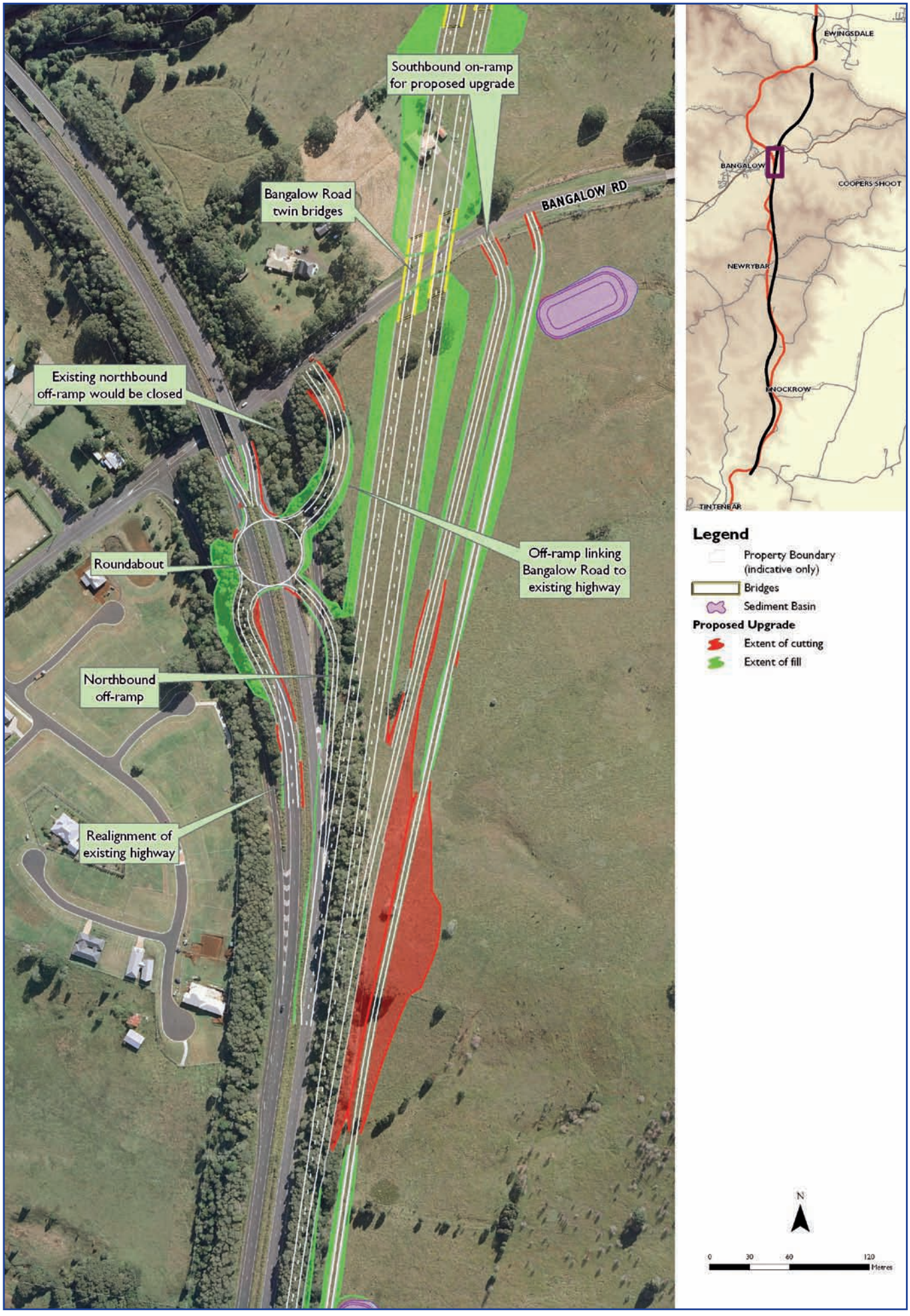
On the eastern side of the proposed upgrade, the interchange would comprise a southbound on-ramp which commences at Bangalow Road. A simple T-junction would be provided at the ramp intersection with Bangalow Road, just east of the proposed upgrade.

On the western side of the upgraded highway, the interchange layout is more complex because of the need to cater for traffic which would continue to use the existing highway to the south and the remaining section of the Bangalow bypass to the north. The northbound off-ramp would connect to a roundabout on the western side of the proposed upgrade, with a two-way road connecting the roundabout back to Bangalow Road. The existing highway, which remains open for local traffic to the south, would also connect to the roundabout, as would the remaining section of the Bangalow bypass to the north. The existing northbound off-ramp from the Bangalow bypass would be closed, this would be replaced by the short two-way road from the roundabout to Bangalow Road.

The proposed interchange layout would retain most of the existing infrastructure including bridges while allowing all traffic movements to and from the proposed upgrade to the south.

Traffic between the local/regional road network and the proposed upgrade to the north would continue to use the existing highway down St Helena Hill, connecting to the proposed upgrade via the Ewingsdale interchange.

Figure 5.5 - Bangalow interchange



5.3.4 Ewingsdale interchange

The existing Ewingsdale interchange would be retained but improved as part of the proposed upgrade. The proposed changes are shown in **Figure 5.6**. The modifications are required to connect the Bangalow/Lismore traffic using the existing highway to the proposed upgrade and the existing highway to the north. At the same time, the opportunity has been taken to incorporate other changes that would address issues with confusion/readability of the current layout and also to address some existing ramp design deficiencies.

The proposed upgrade would include the following changes to the western side of the existing interchange:

> Construction of a new roundabout.

> Relocation of the existing highway further to the west so that it can continue to provide a connection to Bangalow and Lismore. The relocated road would connect to the new roundabout.

> Slight change to the existing northbound off-ramp to diverge from the proposed upgrade rather than from the existing highway. The end of this ramp would also be modified so that it connects to the new roundabout.

> Retention of the existing looped northbound on-ramp. However, it would be modified slightly so that it leaves from the new roundabout on the western side.

> Connection of Myocum Road to the new roundabout.

The roundabout on the western side would also make provision for the addition of a new direct northbound on-ramp from the roundabout heading north-east. This is a future provision only and is not part of the proposed works in this environmental assessment.

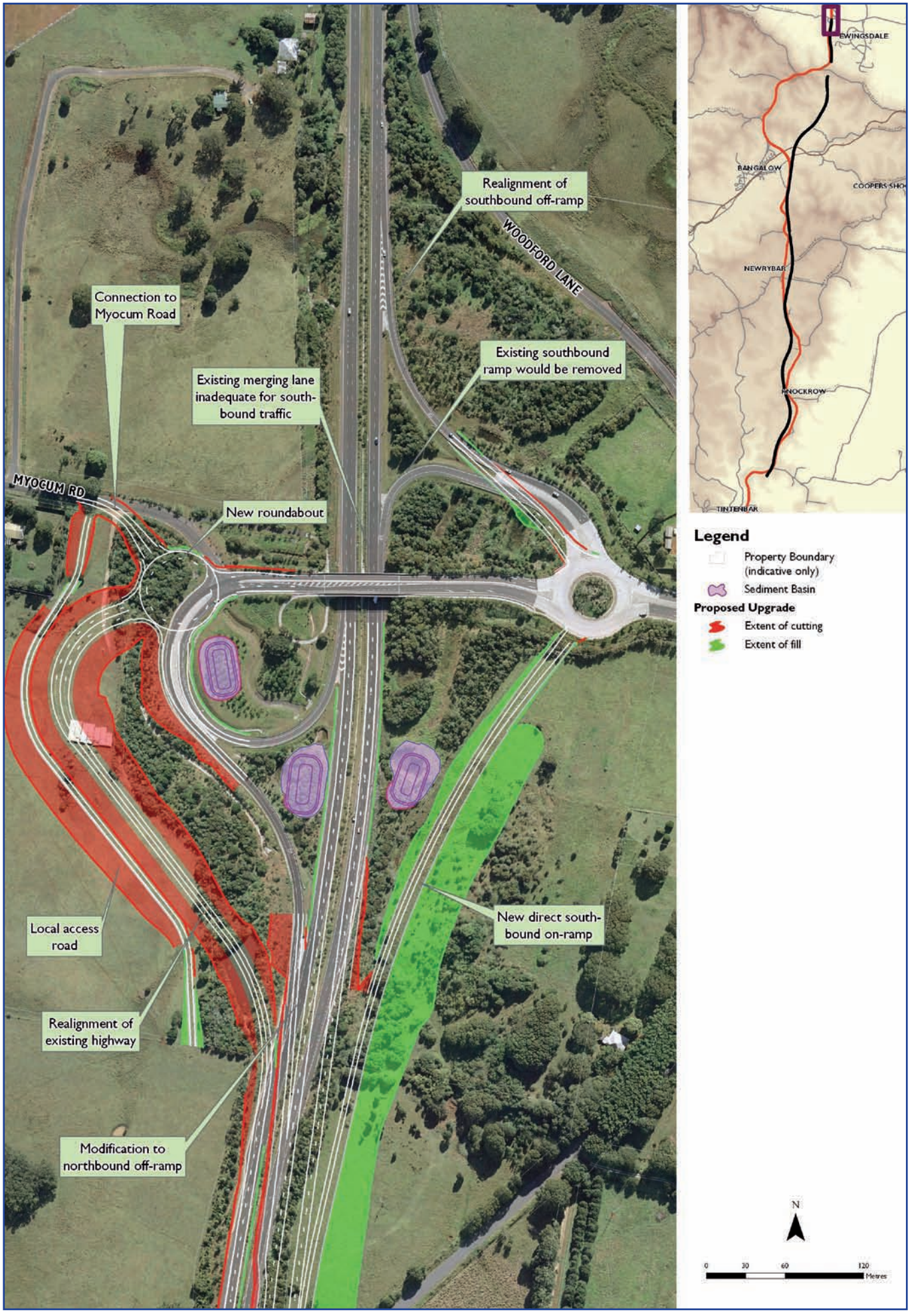
The proposed changes to the eastern side of the existing interchange are summarised below:

> A new direct southbound on-ramp would be provided. The existing loop ramp exits on the northern side of the roundabout to travel south and can be confusing to some users. In addition, the length of the acceleration lane onto the highway is insufficient because of the low speed (40 km/h) of the 40 m radius curve at the entry under the bridge. Removal of this on-ramp and replacement with a new direct ramp connected to the south side of the roundabout is therefore proposed.

> The existing southbound off-ramp would be retained but slightly re-aligned where it connects to the eastern roundabout.

The proposed layout allows for the future realignment of Woodford Lane so that it could be connected to the roundabout. The advantage would be the elimination of the existing at-grade intersection between Woodford Lane and Ewingsdale Road and its replacement with the safer roundabout layout. This is a future provision only and is not part of the proposed works in this environmental assessment.

Figure 5.6 - Ewingsdale interchange



5.4 Bridges and underpasses

5.4.1 Locations and general layouts

Bridge layouts have been developed to demonstrate that specific functional requirements can be achieved and to identify potential environmental impacts. As such, the designs are indicative and would be further refined during the detailed design phase of the project to maximise cost effectiveness, while also considering the proposed urban design principles.

Concept designs for bridge locations, preliminary bridge lengths and width and span arrangements have been developed considering:

> Geometric requirements for each carriageway, including sight distance widening on curved bridges.
> Constructability and construction sequencing.
> The visual impact on the surrounding area.
> Avoidance of piers in watercourse and riparian vegetation.
> Provision of adequate waterway capacity at waterways, with minimal increase to water levels upstream of the structure.
> Provision for fauna access under bridges through consideration of abutment and pier locations.
> The need to incorporate safety screens, hand rails and noise barriers, where required, as integral parts of the bridge balustrade.
> Provision of appropriate horizontal and vertical clearances to roads and railways.

There are six twin bridges and four underpasses carrying the proposed upgrade above roads and creeks. In the detail design phase the larger underpasses proposed could become twin bridges and, conversely, the smaller twin bridges could become underpasses, pending the structural assessments. There are also two bridges carrying local roads above the proposed upgrade. Indicative bridge and underpass details are summarised in **Table 5.1**. These could vary during detailed design.

Table 5.1 Bridge locations and lengths (indicative design)

	Northbound	Southbound
Highway bridges on proposed upgrade	Length (m)	Length (m)
Bridge over minor creek (Yarrenbool Place)	130	115
Bridge over Emigrant Creek	180	165
Bridge over Skinners Creek	195	185
Bridge over Bangalow Road	60	60
Bridge over Byron Creek & Casino- Murwillumbah railway	190	180
Bridge over tributary of Tinderbox Creek	145	145
Local road underpasses under the proposed upgrade	Length (m)	Width (m)
Martins Lane West	70	10.0
Ivy Lane	70	10.5
Watsons Lane	65	10.0
Private access underpass at Ch 145115.	65	11.0
Local road bridges above the proposed upgrade	Length (m)	Width (m)
Broken Head Road	135	10.0
Local access bridge at Ch 144550	60	8.0

Bridges would meet the following performance criteria:

> Meet RTA standards in terms of sight lines, structural performance and maintenance.
> Ensure that maximum flow velocity (in the 1 percent AEP event) does not cause scour.
> Allow future widening in the median with minimal additional ground disturbance.
> Address the *Urban And Landscape Design Strategic Concept* (described in **Chapter 18** and **Working Paper 11**, Landscape, urban design, and visual assessment).

5.4.2 Detailed bridge design

During the design process, the two most likely bridge design options were considered in developing layouts. These two broad options ensured that functional requirements could reasonably be achieved at each bridge location. The two broad bridge design options that were considered for each highway bridge site were:

> Option 1: Precast and prestressed (Super T) concrete superstructures.
> Option 2: Continuous variable span haunched steel trough superstructures.

Both bridge design options would have spill through abutments (with a batter slope of 2:1) and pilecaps below existing ground levels for visual enhancement.

Option 2 offers the potential for longer spans of up to about 57 m where necessary to meet functional requirements. Option 1 bridges would be limited to maximum spans of about 38 m but may have cost savings.

Bridge types would be reviewed during the detail design stage, possibly including bridge options beyond those listed above. The final choice of bridge type would be based on achievement of the above performance criteria and a balance between engineering, urban design, environmental and cost considerations.

5.5 Tunnels

A tunnel for each carriageway is proposed under the St Helena ridgeline. The main features of the tunnels are described below.

5.5.1 Tunnel geometric design

The proposed tunnels have a 4.4 percent approach grade on the north side. They would be approximately 340 m long and with a minimum 5.3 m vertical clearance.

The southbound and northbound tunnels would be similar in shape, except that the southbound tunnel would be 1 m wider.

The carriageway in the northbound tunnel would be 11.5 m wide between barriers, providing sufficient width for 3 lanes if required in the future.

The carriageway in the southbound tunnel would be 12.5 m wide to incorporate the southbound climbing lane while still allowing 1 m wide shoulders on each side.

The two tunnels would be separated by a rock pillar approximately 7.5 m wide.

Concrete barriers would be provided at the edge of the carriageways in each tunnel. Emergency walkways for pedestrians of 1 m wide by 2.1 m high would also be allowed beyond the concrete barriers. Additional headroom would be available above the required 5.3 m vertical clearance at the centre of each tunnel for tunnel services (for example, exhaust fans and wiring).

5.5.2 Tunnel structure and portals

Tunnel support measures along the tunnel were determined by assessment and evaluation of rock quality based on available geotechnical information. Five support classes were developed. Class 1 to 3 would comprise shotcrete and rock bolts of different configurations. Classes 4 and 5 would be likely to require additional support measures such as lattice girders.

The concept design has assumed that the tunnel would be tanked (sealed from groundwater intrusion). The exact nature of the waterproofing will be determined in final design and following further geotechnical investigation.

The tunnel support measures above would be supplemented by concrete lining for long term tunnel support.

The portals would be designed to comply with the RTA guidelines. Final treatment would take into account structural and urban design considerations.

5.5.3 Tunnel safety and servicing

Following a detailed risk assessment it is proposed that vehicles transporting dangerous goods, apart from those carrying Class 1 (explosives) and Class 2.1 (flammable gases), would be permitted to use the tunnel. The risk assessment also identified that appropriate fire control measures such as exhaust fans and a deluge system which should be installed in recognition of the usage by dangerous goods vehicles.

Traffic management and communication systems would be specified in the tunnel design to ensure the safety of tunnel users and personnel employed in tunnel maintenance and operations. A range of electronic equipment would be deployed to monitor and control traffic flows, transmit alarms, alert emergency and breakdown services and maintain contact between RTA traffic control operations, the tunnel control operations and the relevant emergency services.

Ventilation in the tunnel would occur through the piston effect of moving vehicles pushing air toward the respective exiting portals.

To provide appropriate levels of safety over the full range of operating conditions, facilities for traffic management and tunnel communications would be fully integrated into the systems installed to monitor and control the tunnel environment. System design would be related to the layout of the tunnel and its safety facilities i.e. emergency points and escape routes.

Monitoring of traffic and other activities would be achieved by combinations of closed circuit television (CCTV), CCTV alert and incident detection, and emergency telephones. Traffic would be controlled by fixed signs, variable message signs, matrix signals and portal/lane control signs according to specific needs. When hazards arise, variable signals would display appropriate warnings to slow or redirect traffic or warn of lane closures.

The RTA together with the various emergency services would develop controls to cover the operation of the tunnel on a day to day basis, execute planned maintenance, control tunnel traffic and respond to tunnel emergencies. There would be clear procedures and clearly defined responsibilities agreed and laid down between the tunnel stakeholders, with respect to traffic management and tunnel equipment, to ensure rapid and co-ordinated response to emergencies.

In the event of a tunnel closure, the existing highway would form an alternative route,

5.6 Pavements

A low noise wearing course (such as open-graded asphalt, stone mastic asphalt or low noise concrete) is proposed on all bridges as well as in the following sections as part of the noise management measures for the proposed upgrade:

> From about 300 m south of Newrybar (Ch 141750) to Skinners Creek (Ch 143650).
> From south of Bangalow (Ch 145200) to 750 m north of the proposed railway crossing at Bangalow (Ch 147800).
> From the northern portal of the tunnel through to the Ewingsdale interchange.

Further information on noise management is described in **Chapter 15 – Noise**.

In sections where a low noise wearing course is prescribed, the underlying pavement could be conventional flexible pavement, full depth asphalt or continuously reinforced concrete pavement. In other areas, the pavement could be conventional flexible pavement or full depth asphalt with a low noise wearing surface, or plain concrete pavement with a concrete surface.

The final decision on the type of pavement selected would be made during the detailed design phase of the project and would depend on total life costs (which includes construction and on-going maintenance costs), environmental impacts, material sourcing and constructability.

Pavement designs for intersections and local access roads may differ depending on traffic loads, and would be designed for a 20 year life. The pavement type would most likely be flexible pavement. Existing pavements would be used where possible, with minor rehabilitation and resurfacing carried out as required.

5.7 Emergency cross-overs and lay-by areas

The proposed upgrade has been designed to include a proposed outer shoulder width of 2.5 m. In addition, a 1.0 m wide dish gutter is provided adjacent to the outer edge of shoulder in areas of cut and fill. This would allow for vehicles to pull over at any location in the event of a sudden breakdown or other minor incidents, while retaining clearance to through-traffic. Across bridges, the shoulder width would be 2.5 m with no dish gutter. This would still be adequate for most vehicles to be able to stop clear of through traffic.

The only exception to the 2.5 m shoulder would be through the southbound tunnel where the outer shoulder width adjacent to the climbing lane would be 1 m wide. Traffic monitoring systems in the tunnel would allow the outside lane to be closed to traffic in the event of a breakdown in the tunnel.

To enhance clearances and safety, areas with localised shoulder widening (lay-bys) would also be provided at regular intervals of about 2.5 km in each direction, in conjunction with combined median cross-over/u-turn facilities. These facilities allow emergency vehicles to make u-turns and also allow traffic to be directed onto one carriageway if necessary due to accidents or maintenance. Lay-bys and emergency cross-overs would be provided on either side of the tunnel.

A number of additional lay-bys are proposed where maintenance access to sedimentation basins and bridge structures would be required from the proposed upgrade.

Rest area requirements were examined in accordance with the RTA's strategy for regularly spaced rest areas. No rest areas are proposed on the Tintenbar to Ewingsdale upgrade as based on current plans, adequate rest areas are provided and/or proposed to the north and south of this section of the Pacific Highway. Similarly there are currently no proposals for new service centres within the Tintenbar to Ewingsdale upgrade because of the proposed provision of service centres on other upgraded highway sections.

5.8 Lighting, fencing and signage

The proposed upgrade would generally be unlit, with the exception of interchanges, intersections and other areas where lighting is required for safety reasons, such as merging and diverging traffic streams. Lighting would also be provided inside the tunnel.

The lighting at the interchanges and on-off ramps would be designed based on luminance criteria in accordance with Category V3 in AS/NZS 1158.1 – ***Lighting for roads and public spaces***. The most energy efficient lighting technology would be favoured. Lighting design would take into account any potential light spill into nearby properties.

Fencing would be provided on both sides of the proposed upgrade to prevent pedestrian, livestock and wildlife access onto the road reserve. Concept design proposals for direction signs have been developed in accordance with standard RTA policy and would seek to direct motorists to the facilities and attractions available in and around the area. Road signage would be confirmed during the detailed design phase and would conform to

prevailing RTA practice at the time. Discussions would also be held with the Ballina and Byron Shire councils during the detailed design phase in relation to any particular signage requirements.

5.9 Cuts and fills

Fill slopes are generally proposed to be at a slope of 2:1 (horizontal to vertical). The slope may be reduced during detailed design where space permits and where there are maintenance advantages. Cut slopes would generally be 2H:1V but steeper in some of the deeper cuttings where the geotechnical investigations indicate sound material.

Generally, a minimum separation of about 15 m has been allowed between the edge of earthworks and the proposed acquisition boundary to provide access and some construction flexibility.

5.10 Drainage and water quality management

5.10.1 Drainage

The proposed upgrade would cross Emigrant Creek, Skinners Creek and Byron Creek. Twin bridges are proposed at each of these crossings, as well as over a tributary of Emigrant Creek and a tributary of Tinderbox Creek.

Bridge abutments on both sides of each creek crossing would generally be located to minimise scour velocities, impacts on flood behaviour and other key performance criteria listed in **Section 5.4**.

The impacts of the proposed upgrade on hydrology are discussed in detail in **Section 9 – Hydrology.**

The design of the proposed upgrade would generally allow the natural flow regimes to be maintained. Transverse culverts would be provided beneath the proposed upgrade to convey surface water runoff, and would be designed with sufficient capacity to convey the 1 percent AEP peak flow with minimal impact on highway function and on upstream or downstream flood levels.

Conceptual locations of cross-drainage culverts are indicated in **Figures 5.2a-j**. Culverts have in general been designed to follow the existing waterway alignment to minimise potential for bank erosion, which in some cases results in the culverts being set on a skewed alignment to the proposed upgrade. Appropriate scour protection would be provided on both upstream and downstream ends of all structures where increased velocities have the potential to cause scour. Design of scour protection measures would be undertaken during the detailed design phase based on peak inlet/outlet velocity and is dependent on the characteristics of the culvert flows. Typically, a headwall and apron would be sufficient to protect against scour when the outlet velocities are low. However, watercourses with high velocity flows may require devices to slow the flow at the culvert entry or outlet and protect the stream bed.

Agreed culverts and scour protection would also be designed (during the detailed design phase) to be fish-friendly and fauna-friendly in accordance with relevant Department of Primary Industries Fisheries guidelines.

Runoff from above the proposed upgrade would be collected in a catch drain at the top of cuttings, or a toe drain at the bottom of the batter, and diverted to an existing watercourse or proposed culvert location.

The highway pavement drainage system would be designed during the detailed design stage to cater for run-off from the pavement surface, cut batters and the median of the proposed upgrade.

Bridge deck drainage systems would be devised during the detailed design phase of the project to discharge to the highway pavement drainage system and avoid direct discharge into the watercourse. It is anticipated that piped drainage in the bridge superstructure would provide adequate drainage of surface water from the bridges.

5.10.2 Water quality management

A broad water quality management strategy has been developed for the proposed upgrade. The strategy includes a number of measures to improve water quality running off the proposed upgrade before it enters the local creek system. It also acknowledges differing sensitivities in receiving waters, particularly the high level of sensitivity associated with the close proximity of Emigrant Creek dam, which is part of Rous Water's water supply network.

The most important element of the strategy (both during construction and operation) is a system of sediment basins. Sediment basins work by holding runoff for a period of time to allow suspended solids to be removed from the water and deposited on the floor of the basins. Some sediment basins incorporate additional measures to remove various pollutants. It is proposed to treat virtually all runoff from the proposed upgrade within the Emigrant Creek dam catchment through sediment basins before it is discharged. Outside the Emigrant Creek dam catchment, most runoff would be contained and treated in sediment basins, however runoff from a small proportion of the proposed upgrade would not enter sediment basins. Instead, alternative methods of treatment would be implemented during detailed design. These may include sediment fences (amongst other measures) during construction, while the proposed landscape treatments would be likely to adequately filter this relatively small amount of runoff during operation. Additional details on treatment during construction and operation are provided below.

Construction phase

Erosion and sedimentation controls would be designed in accordance with *Managing Urban Stormwater – Soils and Construction* (Landcom 2004) and the draft DECC document *Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction*. Sediment basins have been sized on the basis that soils likely to be disturbed by the proposed upgrade are generally fine, but non-dispersive (based on geotechnical investigations undertaken to date). Basin sizing allows for capture of runoff from all disturbed areas. During the development of the detail design a specialist soil conservation consultant would be engaged to assist in the development of specific soil and sediment control measures and strategies.

Operational phase

Outside the Emigrant Creek dam drinking water catchment area, construction phase basins would generally be converted to provide an operational water quality function. The basins would serve to treat both day-to-day runoff from the road, and have adequate capacity to contain a major accidental spill from a traffic accident.

Any construction phase basins not retained during the operation phase would be removed once the vegetation in the catchment area has established and water quality has stabilised. Following removal, disturbed areas would be revegetated.

Within the Emigrant Creek dam drinking water catchment area, all construction-phase sediment basins would be converted to water quality basins utilising sand filters for the operation phase. These would also treat day-to-day runoff from the road, and have adequate capacity to contain a major accidental spill from a traffic accident. The basins would be dry basins with treatment achieved through a combination of gross pollutant traps, sand filter media and permeable piping.

Basins in the Emigrant Creek dam catchment would require regular maintenance in the form of cleaning and clearing the gross pollutant traps. The sand filters themselves would require little maintenance, with the sand needing to be replaced only in the event of a spill. The basins outside the Emigrant Creek dam catchment would have a low maintenance requirement consisting of general landscape maintenance and repairs in the case of damage or spills.

5.11 Noise attenuation

As discussed in **Chapter 15 - Noise and vibration,** a traffic noise assessment was undertaken for the proposed upgrade. Based on this assessment, locations requiring noise attenuation have been identified. These are:

> Ewingsdale.
> Clover Hill Estate, Bangalow.
> Newrybar Public School.

The specific method of noise attenuation would be identified during detailed design based on functional, urban design and cost factors. Options would include earth mounds, noise walls, individual architectural treatment of homes, and the use of low noise pavement surfaces.

5.12 Local transport network

A number of regional roads connect with the existing highway between Ross Lane and Ewingsdale, providing east-west access both locally and regionally. These are:

> Ross Lane (regional road 7735) east to Lennox Head and The Coast Road.
> Bangalow Road (main road 65) west to Lismore.
> Ewingsdale Road (main road 545) east to Byron Bay.

In addition to these routes, a number of local roads join the existing highway and provide access to the local communities. These roads carry significantly lower volumes of traffic.

Following the construction of the proposed upgrade, the existing Pacific Highway would fulfil a regional road function, providing a continuous alternative route for local and regional traffic accessing the surrounding local road network. The proposed upgrade would maintain the existing connectivity between houses, villages, towns and community facilities through the provision of local road underpasses or overpasses as well as service roads for properties affected by the proposed upgrade.

It is anticipated that ownership and maintenance of the existing highway would be transferred to the respective councils (Ballina and Byron). This would however be subject to negotiation and agreement. Ownership and maintenance of the proposed upgrade, including associated infrastructure and interchanges within the proposed road reserve, would be the responsibility of the RTA. The precise limits of responsibility between the RTA (for the proposed upgrade) and the councils (for the existing highway) would be defined after project approval and before handover. At this stage the detailed design would be sufficiently developed so that the interface between the new work and the existing road network could be accurately determined.

Further details on the local road network and future traffic conditions can be found in **Chapter 13 – Traffic,** while a strategic overview of access arrangements can be found in the *Strategic Access Report* (RTA 2008). This includes an evaluation of a possible future southern Bangalow bypass (which is outside the scope of this project).

5.13 Pedestrians and cyclists

No specific provision would be made for pedestrians and cyclists on the proposed upgrade. The Broken Head Road overpass would however include a pedestrian/cycle lane or path.

5.14 Services relocations

The following major services relocations would be required:

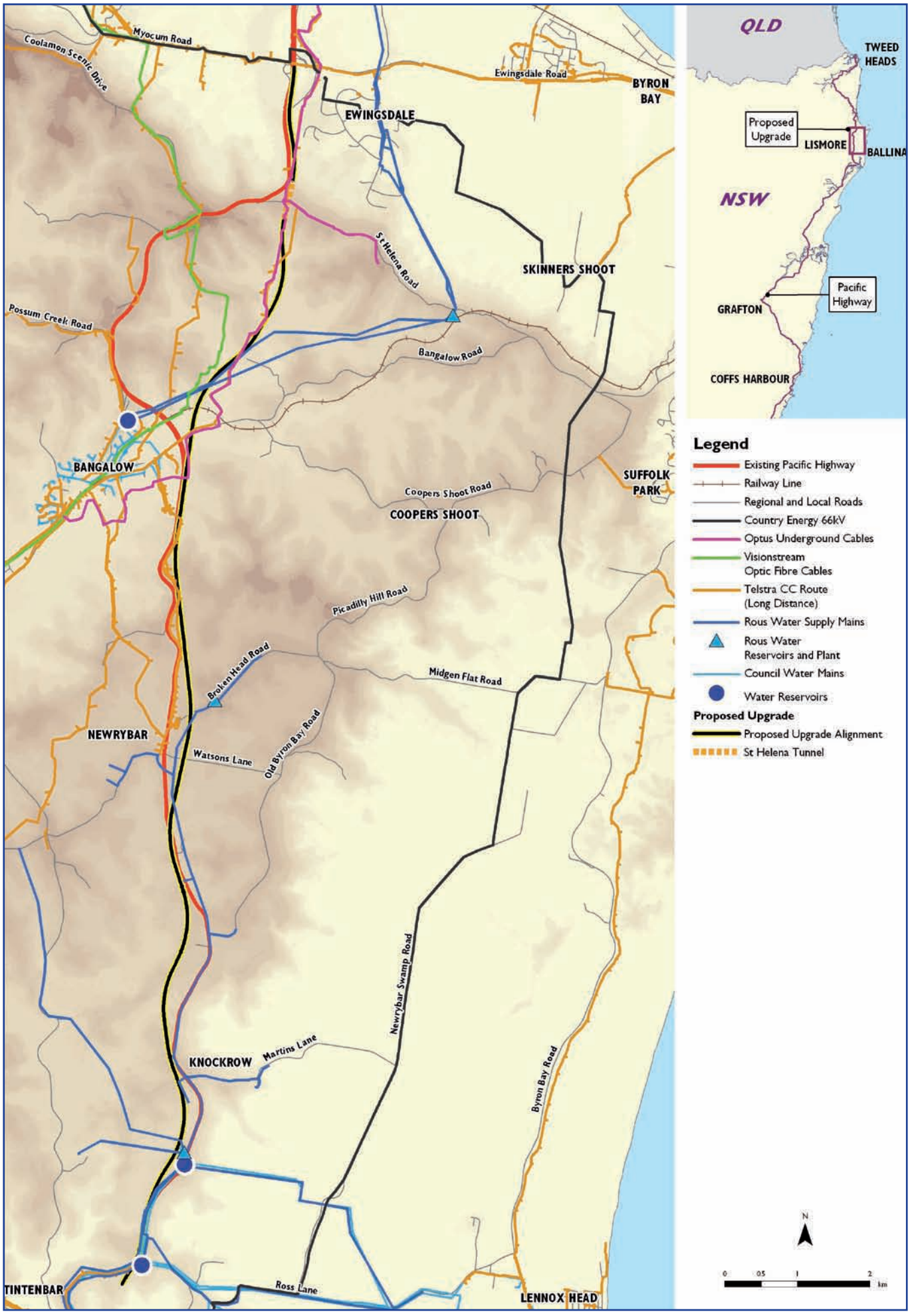
- Telstra fibre optic cables and coaxial cables, generally following the existing highway and also Tinderbox Creek valley.
- Visionstream fibre optic cables from Bangalow to Ewingsdale, following the Tinderbox Creek valley.
- Optus fibre optic cables from Bangalow to Ewingsdale, following Tinderbox Creek valley and also east along St Helena Road.
- Rous Water 600 mm diameter trunk water supply mains from Emigrant Creek dam to the treatment plant and reservoir at Knockrow, from Rocky Creek dam to the same reservoir at Knockrow, and also east from Bangalow along the Byron Creek valley

There are also smaller distribution water mains owned by Rous Water and the councils which may be affected as follows:

- A 375 mm diameter water main that follows the existing highway south of Knockrow. Ballina Shire Council also has an existing water supply main beside the existing highway south of Knockrow.
- An existing 100 mm diameter distribution main on the eastern side of the existing highway between Knockrow and Broken Head Road.
- An existing 100 mm diameter distribution main along Broken Head Road.

The location of major existing services is shown in **Figure 5.7**. Service would generally be relocated outside the road reserve. Location would be identified in the detailed design in association with the utility provider.

Figure 5.7 Major existing services



5.15 Urban and landscape design

Urban and landscape design have been fundamental to the route selection and engineering design of the proposed upgrade. An urban and landscape concept plan has been prepared for the proposed upgrade (described further in **Chapter 18 - Visual amenity and urban design** and fully detailed in *Working Paper 11 – Urban Design, Landscape and Visual Assessment*). Urban and landscape design principles and the overall response are shown in **Table 5.2** below with reference to the objectives of the Pacific Highway Urban Design Framework. Cross sections indicating typical landscape treatments are shown in **Figure 5.8, Figure 5.9** and **Figure 5.10.**

Table 5.2 - Urban and landscape design principles

Pacific Highway urban design framework objective	Discussion and project response	Key urban and landscape design principles
Objective 1: **Provide a flowing road alignment that is responsive and integrated with the landscape.** Applying to road alignment decisions as well as the road design, the alignment should flow and respond to the shape of the landform and patterns of natural and farmed vegetation cover.	Urban and landscape design objectives and principles to address issues of flowing alignment and responsiveness to the shape of the landform were developed during the route selection process for the proposed upgrade and have influenced the development of the concept design for the proposed upgrade. However, this remains an important issue to address during future detailed design stages.	Shape cuttings to correspond to natural landforms. Revegetate cuttings and embankments to maintain the character of undulating green hills against the horizon line.
	The natural and farmed vegetation cover along the proposed Tintenbar to Ewingsdale upgrade is one of the major features of the study area, as well as a key factor in the area's highly scenic character. Responding to the existing landscape character is an objective of particular importance for the proposed upgrade.	Protect significant stands of roadside vegetation. If retention is not possible reinstate plantings in nearby locations. Design roadside plantings to reflect adjoining landscape and vegetation patterns in order to integrate the road landscape, create a varied sequence of views and enclosure and reduce the linear effect of the upgraded highway. Design landscape plantings to correspond to existing species.

Table 5.2 (cont)

Pacific Highway urban design framework objective	Discussion and project response	Key urban and landscape design principles
Objective 2: **Provide a well vegetated, natural road reserve.** A road corridor in the lush forested landscape of the north east coast of NSW should be well-vegetated in the interest of road user enjoyment, landscape integration and biodiversity protection and recovery.	This objective is similar to Objective 1 with regard to the need to integrate the road corridor with the existing landscape character.	Reduce the visibility of the proposed upgrade from townships, farms and homesteads. Reduce the visibility of the proposed upgrade from the local road system. Ensure that key prominent cuttings are vegetated as much as feasible.
	The revegetation of the road corridor to enhance the natural environment and mitigate against the impacts on existing native stands of vegetation is an important ecological objective.	Undertake ecological restoration in areas of lowland rainforest and riparian areas where they remain within the road reserve. Select plant species to maximise wildlife habitat connectivity, particularly under creek crossings.
Objective 3: **Provide an enjoyable interesting highway with varied views and vistas of the landscape and pleasant restful places to stop.** The Pacific Highway is a long road, it takes a considerable time to drive and there is a tendency for drivers to make long duration journeys. Consequently the drive should be an enjoyable and memorable road user experience. This will help shorten the perception of the journey and keep drivers alert.	The provision of an enjoyable and interesting highway experience with varied views and vistas was considered during the route selection process and formed an integral component of route selection. It has further informed the development of the "Urban and Landscape Design Concept" outlined in ***Working Paper 11 - Urban design, landscape and visual assessment.*** The identified key design principles should guide further design development.	Maintain and protect key vistas and long-distance views and maximise the potential for views to existing landmarks and other prominent features. Vary the degree of enclosure and openness along the upgraded highway, to provide visual interest and enjoyment and reduce the potential for driver fatigue. Maintain a diverse and scenic driving experience along the existing highway alignment.
Objective 4: **Value the communities and towns along the road.** It is important to ensure the road upgrade is considerate of the towns and communities along the route. This can be achieved through sensitive planning of the road alignment to avoid visual and noise impacts. However this is not always possible and in some cases it is of value to have a close relationship between the road and community.	Issues of noise and visual impact on local towns and communities have been considered during the route selection process. The "Urban and Landscape Design Concept" contained in this working paper further addresses theses issues. Detailed design principles for the design of noise barriers are provided in the section called "Urban Design Elements" in ***Working Paper 11 - Urban design, landscape and visual assessment.***	Preserve the small scale character of the existing highway and other local roads. Reduce areas of wide uninterrupted areas of pavement.

Table 5.2 (cont)

Pacific Highway urban design framework objective	Discussion and project response	Key urban and landscape design principles
Objective 4 (cont): It should not be forgotten that the local vernacular of farms, field boundaries, local roads, established businesses and residences is an important cultural aspect of the landscape and the journey.	Reducing the visual impact of the proposed upgrade is an important aspect of valuing towns and communities along the proposed upgrade who value the high visual quality of the study area. As discussed earlier in this working paper, the area's high scenic and lifestyle values are some of the main reasons people chose to live in and visit the area.	Reduce the visual effect of the vertical dimension of infrastructure elements associated with the proposed upgrade including bridges, cuttings, embankments and noise barriers.
Objective 5: **Provide consistency-with-variety in road elements.** Where appropriate consistent road design and road furniture will help unify the highway and reduce the perception of clutter. This will allow the road user to better appreciate the passing landscape. It will also make the driving experience simpler and more comfortable. Conversely, a road, which is inspired by the character and distinctiveness of the local context, will add variety to the journey and help keep drivers interested and aware.	A discussion on appropriate road design and road furniture, including design principles, is provided in the section on "Urban Design Elements" in ***Working Paper 11 - Urban design, landscape and visual assessment.***	
Objective 6 **Provide a simplified and unobtrusive road design.** The road design should be as simple as possible, refined to the basic elements of road and bridge with all other details designed out, simplified or hidden.	Road design formed an integral component of the route selection process for the proposed upgrade. The design of the proposed upgrade represents the result of a collaborative effort of the project team, incorporating engineering and urban design constraints as well as the constraints identified by other specialist consultants on the project team. This objective is further addressed through the recommendations of the "urban and landscape design concept" in ***Working Paper 11 - Urban design, landscape and visual assessment*** which provides detailed design principles for the further development of the road urban design elements to guide the design development stages. Simplifying the road design will also make it easier for the motorist to enjoy the surrounding landscape, to appreciate local landmarks and thereby assist in orientation.	Develop a simple and robust design aesthetic appropriate to highway infrastructure.

Figure 5.8 Cross section of proposed upgrade showing landscape treatment (at Knockrow - chainage 135600)

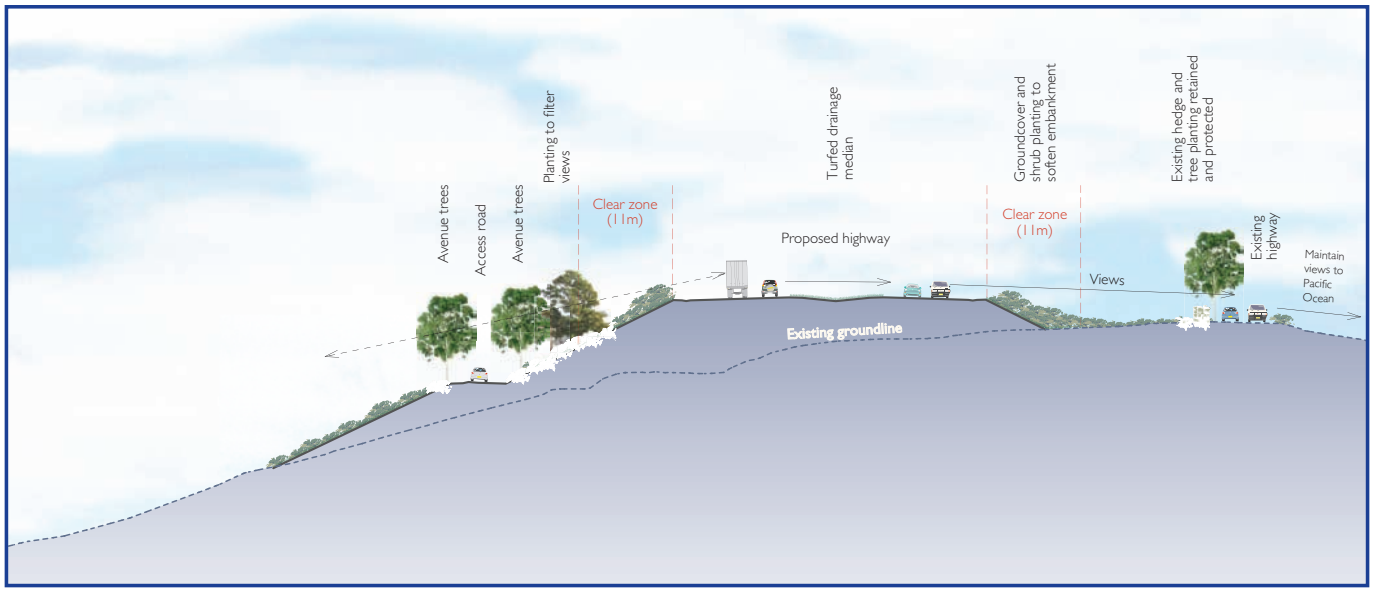


Figure 5.9 Cross section of proposed upgrade showing landscape treatment (at Knockrow – chainage 137100)

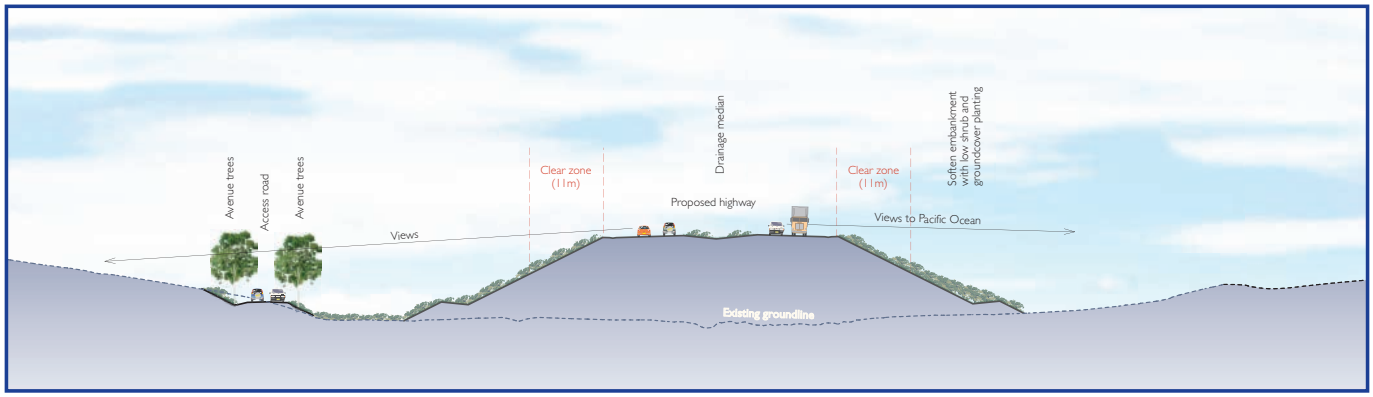
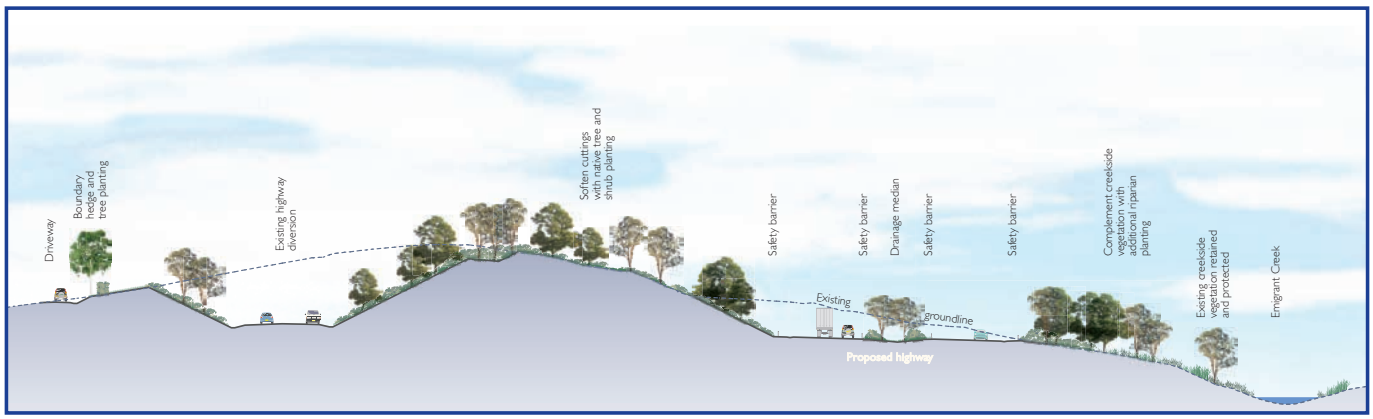


Figure 5.10 Cross section of proposed upgrade showing landscape treatment (south of Newrybar – chainage 141,300)



5.16 Land acquisition

The road corridor width for the proposed upgrade has been determined allowing a minimum of about 15 m between the edge of earthworks and the acquisition boundary. The width of the proposed road reserve is typically about 80 m where there are no cut or fill embankments required. The width increases (up to a maximum of about 250 m) with the scale of associated earthworks and where other elements such as interchanges are required.

The proposed upgrade's dual carriageways would be accommodated within this reserve, together with road embankments, landscaping, noise barriers, water quality control measures, fencing and other environmental mitigation measures.

The proposed road reserve boundary is shown in **Figure 5.2a-j.** Minor adjustments in the road reserve and associated fencing may be made to this boundary during detailed design.

Land within this corridor would be acquired in accordance with the *Land Acquisition* (*Just Terms Compensation*) Act 1991. Each acquisition would be considered on its individual merit. A copy of the RTA's Land Acquisition Policy is provided in **Appendix B**. A remnant land strategy has been developed for allotments incorporating part of the road reserve, but including land excess to the RTA's requirements (refer to *Working Paper 7 – Land use and property)*.