6. Concept design

6.1 Highway design

6.1.1 Overview

The concept design for the proposed upgrade has been developed in response to design, community and environmental constraints, and to satisfy the design objectives, principles and criteria outlined in Section 5.2.

The proposed upgrade includes the following key features:

- Four-lane divided carriageways, with provision for upgrade to six lanes.
- Access control over the full length of the proposed upgrade.
- An alignment that is integrated as much as possible with the existing terrain and landscape, while meeting safety and performance requirements.
- Effective advance signage for exits to Kempsey and Crescent Head, Frederickton and South West Rocks, and Eungai and Stuarts Point.
- Full access, grade-separated interchanges south of Kempsey, north-east of Frederickton, and at Stuarts Point Road.
- Use of the existing Pacific Highway as the southern and northern entrances to Kempsey.
- Full bridging of the Macleay River and partial bridging of the Macleay River floodplain.
- 1-in-100 year flood immunity for the proposed upgrade with the exception of the Macleay River floodplain, where the road embankment would be above the 1-in-20 year flood level.
- Rest area facilities for both the northbound and southbound traffic south of Barraganyatti near Cooks Lane to service heavy vehicles and tourist traffic.
- Median U-turn facilities for emergency service vehicles only, and general use U-turn facilities along the alignment.
- Safe median and outer roadside verges, including appropriate safety barrier protection where required.
- Reconnection of local road and property access and maintenance of pedestrian access where required.
- Stock and machinery access for local agricultural properties where required.
- Relatively flat gradients, with the main climb at Barraganyatti at approximately 3.5% over 400 metres.
- Water quality swales and basins to protect sensitive receiving waters.
- Slim lines and other architecturally designed elements for bridges.
- Throw-over protective screens on all highway overpass bridges.

6.1.2 Alignment

The concept design of the proposed upgrade, including horizontal and vertical alignment is shown in Figures 6-1a to 6-1s.

The proposed upgrade starts at the existing Pacific Highway dual carriageway south of Kempsey and proceeds north along the existing alignment for approximately 1,400 metres. From there it moves to the east crossing over the North Coast Railway, Transgrid 132 kilovolt electricity corridor and Patersons Lane.

The alignment then moves north-east, towards hills located south-east of Kempsey, on an embankment approximately 10 metres high. At the southern edge of the hills, the alignment moves north before crossing through a saddle between two peaks.

Moving north on a down-grade away from the hills, the alignment passes over Bingis Lane, and crosses Crescent Head Road approximately 1 metre above the existing road level. Bingis Lane passes under the proposed upgrade. Crescent Head Road would be re-graded and slightly realigned to pass over the proposed upgrade. The Bruces Lane intersection would be adjusted to improve sight distance and avoid conflict with the new bridge over the upgrade on Crescent Head Road. North of Crescent Head Road, the proposed alignment follows the ridgeline in a north-easterly direction. At Pola Creek, the alignment intersects the creek at approximately 90 degrees to minimise bridging and disturbance to the riparian zone (the part of the watershed immediately adjacent to the stream channel).

North of Pola Creek, the alignment rises toward the ridge at Inches Road. Inches Road would be realigned to span over the proposed upgrade. North of Inches Road, the alignment crosses Old Station Road 1 metre above the existing road level. Old Station Road would be re-graded to pass over the proposed upgrade.

From Old Station Road the alignment turns north, continuing straight across the floodplain. It crosses Red Hill Lane and McKays Lane, before curving to the north-west to cross South West Rocks Road, Ferry Lane and the Macleay River. This alignment was selected to minimise severance of agricultural properties. Ferry Lane (west) would be reconnected to South West Rocks Road adjacent to the floodplain bridge.

The vertical alignment is typically flat across the floodplain, with a minimum height of 3.6 metres. A high point occurs at the bridge over the Macleay River, where a clearance of 9.1 metres above mean high tide level is provided in accordance with navigation requirements for this location. North of the proposed Macleay River bridge, the alignment remains on an embankment up to 6 metres high across the floodplain as far as the ridge north-east of Frederickton. The Frederickton interchange is located on the top of this ridge.

North-west of the Frederickton interchange, the alignment passes between the Frederickton Golf Course and the Frederickton sewage treatment works and on to Raymonds Lane. Raymonds Lane (north) would be cut and reconnected to Mill Lane. From Raymonds Lane, the alignment moves north through a small cutting then out onto flood-prone land at the western edge of a wetland listed under *SEPP No. 14 – Coastal Wetlands.* Here the alignment rises slightly across Mill Lane to Seashore Lane. The proposed upgrade passes under Mill Lane, and Seashore Lane (north) would be reconnected to Mill Lane.

Moving north from Seashore Lane, the alignment crosses under Kemps Access Road, Collombatti Creek and the Seven Oaks drain at right angles to optimise bridge configurations and provide clearance for access. The embankment would be a minimum of 5.5 metres high at Collombatti Creek and 2.2 metres high across the floodplain.

The alignment moves north-west to skirt around an area of bushland supporting threatened species habitat south of Seven Hills Road. A cutting approximately 10 metres deep would be located south of Seven Hills Road. The proposed upgrade passes over Seven Hills Road with bridging extended to provide fauna passage between areas of high quality habitat.

North of Seven Hills Road, the alignment crosses a floodway on embankment with minor bridging and passes within 30 metres of the North Coast Railway. From there, it curves away to the east, crossing several ridge lines and onto another floodway with an embankment height of 4 to 5 metres.

The alignment then moves north-east across another series of minor ridges and valleys to Cooks Lane. Cooks Lane would be bridged over the proposed upgrade, which is in a 7 metre deep cutting. Rest areas for both heavy vehicles and cars would be provided on the northbound and southbound carriageways just to the south of Cooks Lane.

At Cooks Lane the alignment swings north, running to the west of a Transgrid utility easement. The proposed upgrade crosses Hill Lane and Nirvana Way before joining the alignment of the existing Pacific Highway 600 metres south of Barraganyatti Hut Road. Both Hill Lane and Nirvana Way would be closed. Future access to the fire trails west of Hill Lane would be via Barraganyatti Hut Road. Access to Nirvana Way would be reinstated via a western service road from Barraganyatti Hut Road. Barraganyatti Hut Road would be connected to the Stuarts Point Road interchange by an overbridge and a service road on the eastern side of the proposed upgrade.

The proposed upgrade then generally follows the corridor of the existing Pacific Highway from this point to the end of the upgrade.

At Stuarts Point Road, a full interchange is proposed to provide access to the proposed upgrade from Eungai Rail and Stuarts Point Road. North of Stuarts Point Road, the alignment connects to the existing dual carriageways at the North Coast Railway. Access to the northern end of Station Street at Eungai Rail would be retained as a left-in, left-out access point for the present.

Typical cross-sections for the proposed upgrade are illustrated in Figure 6-2.

Figure 6-1a **Horizontal and vertical route alignment**

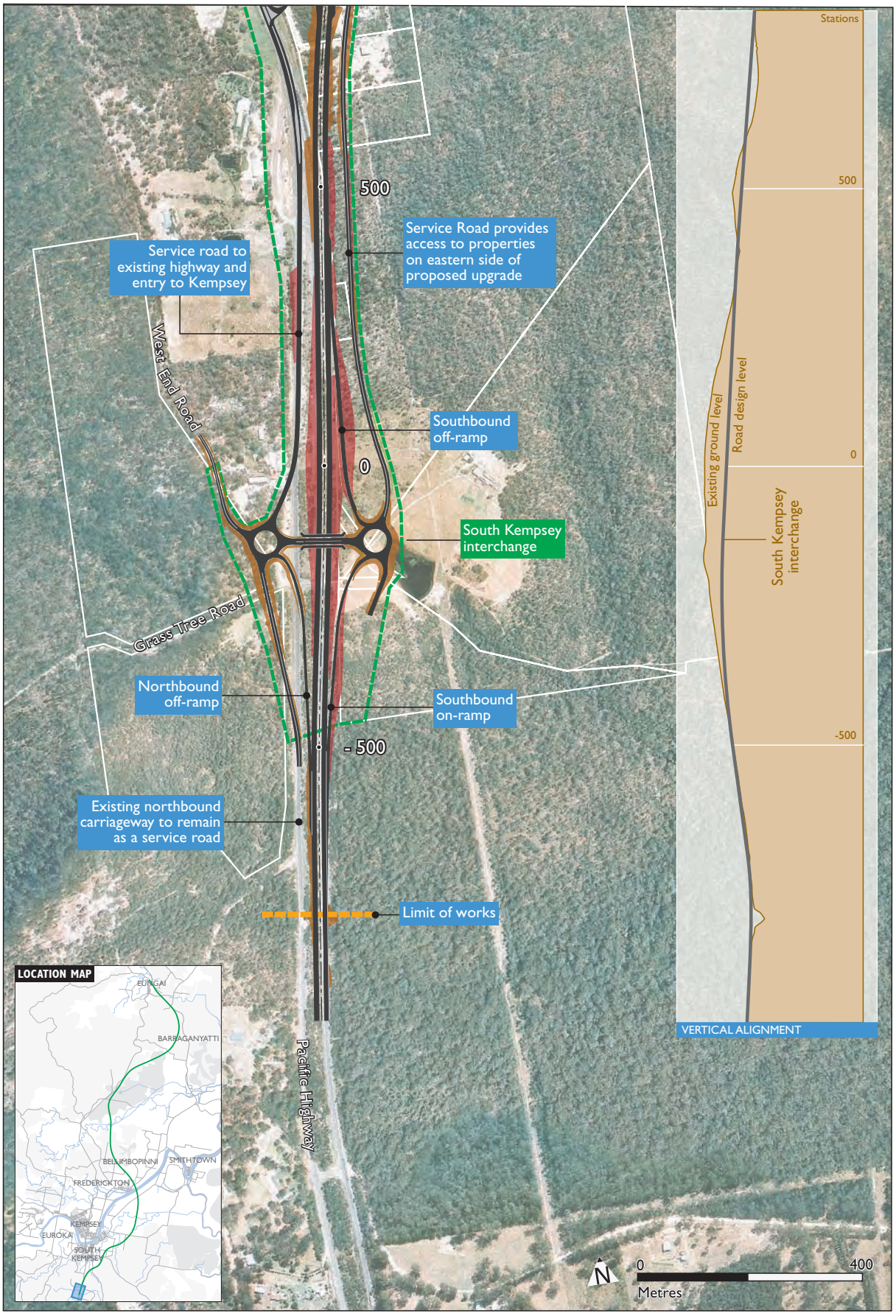
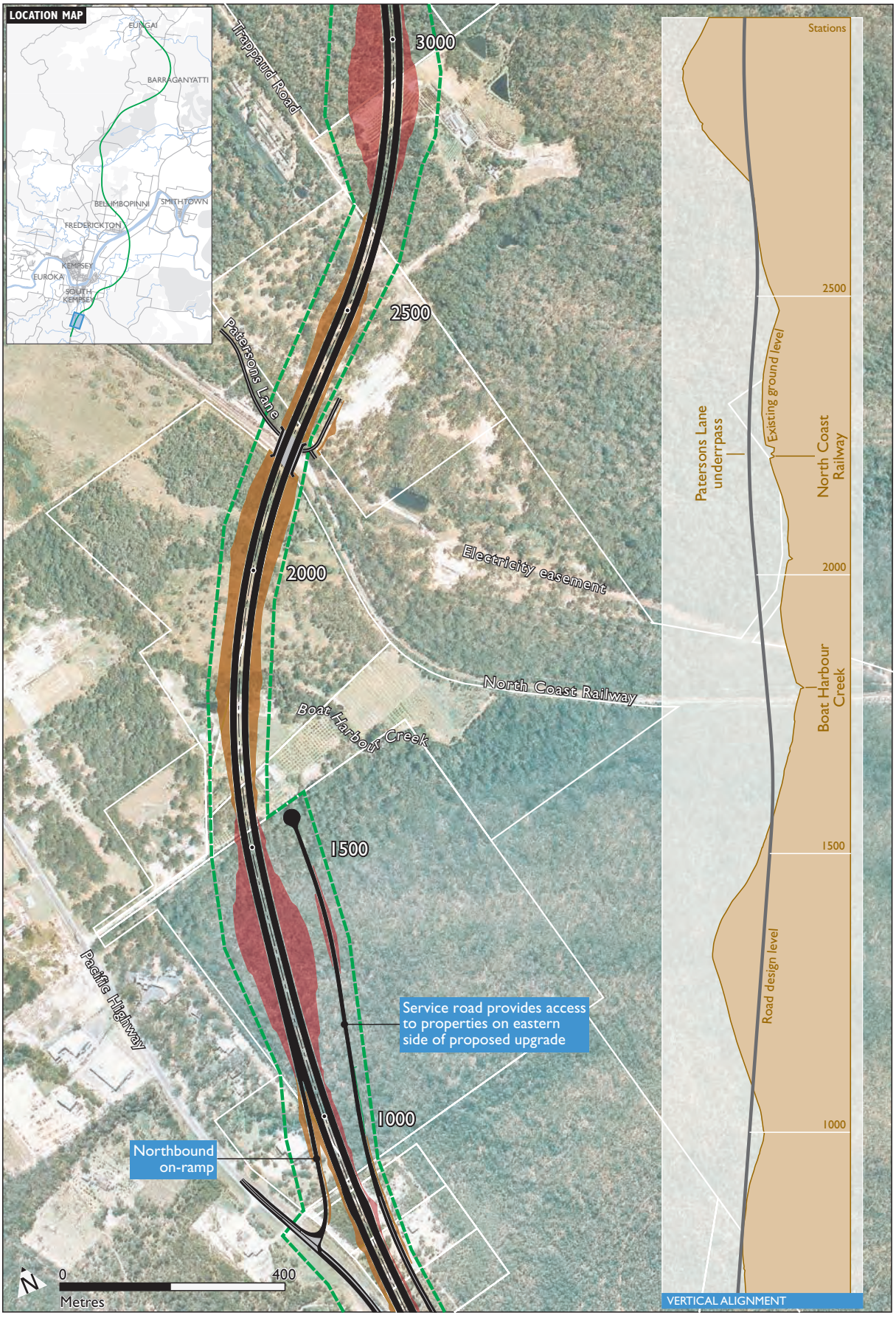


Figure 6-1b **Horizontal and vertical route alignment**



Two-lane road carriageway
Road embankment
Road cutting
Bridges
Property boundary
Road corridor
500 Station in metres

Figure 6-1c **Horizontal and vertical route alignment**

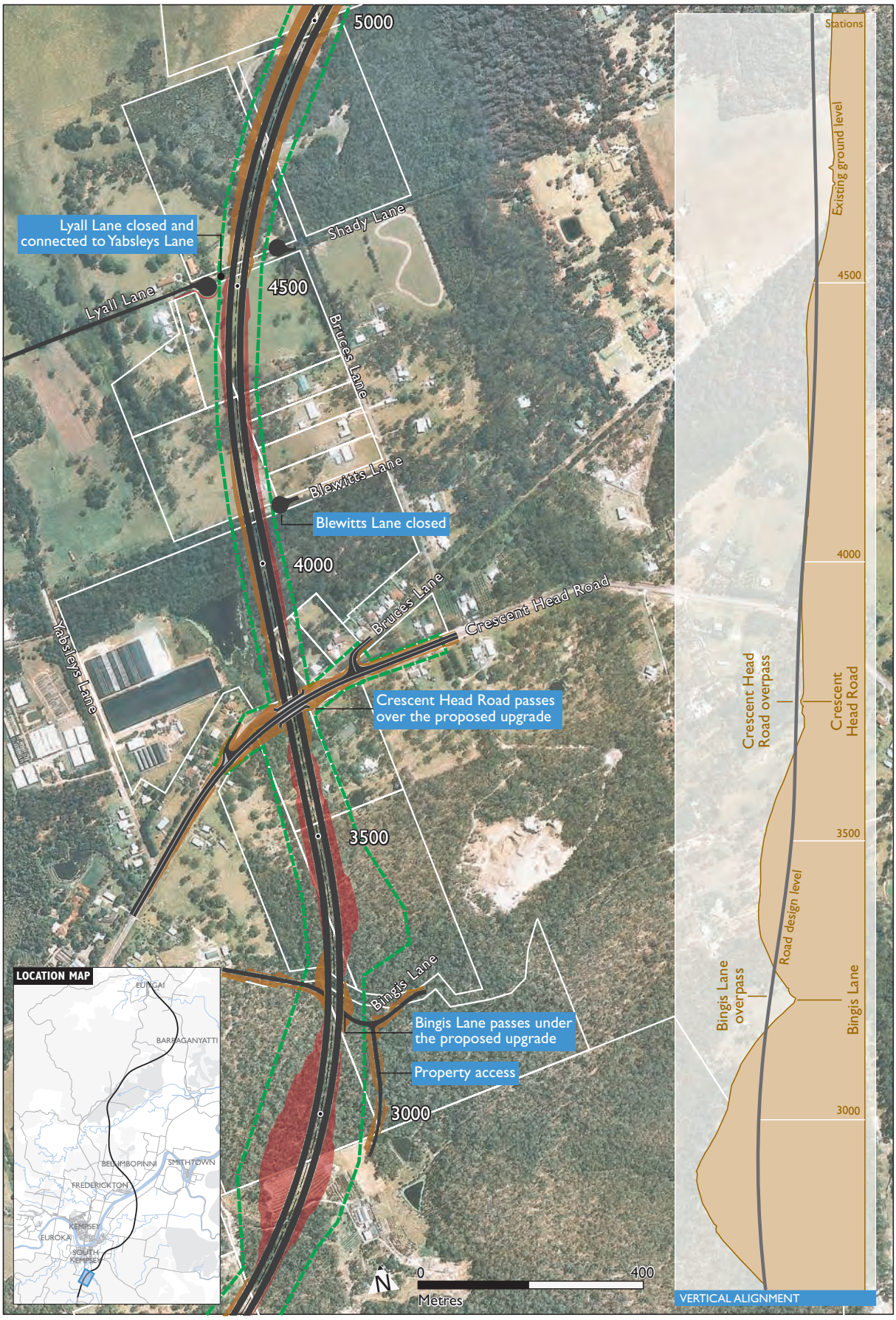


Figure 6-1d **Horizontal and vertical route alignment**

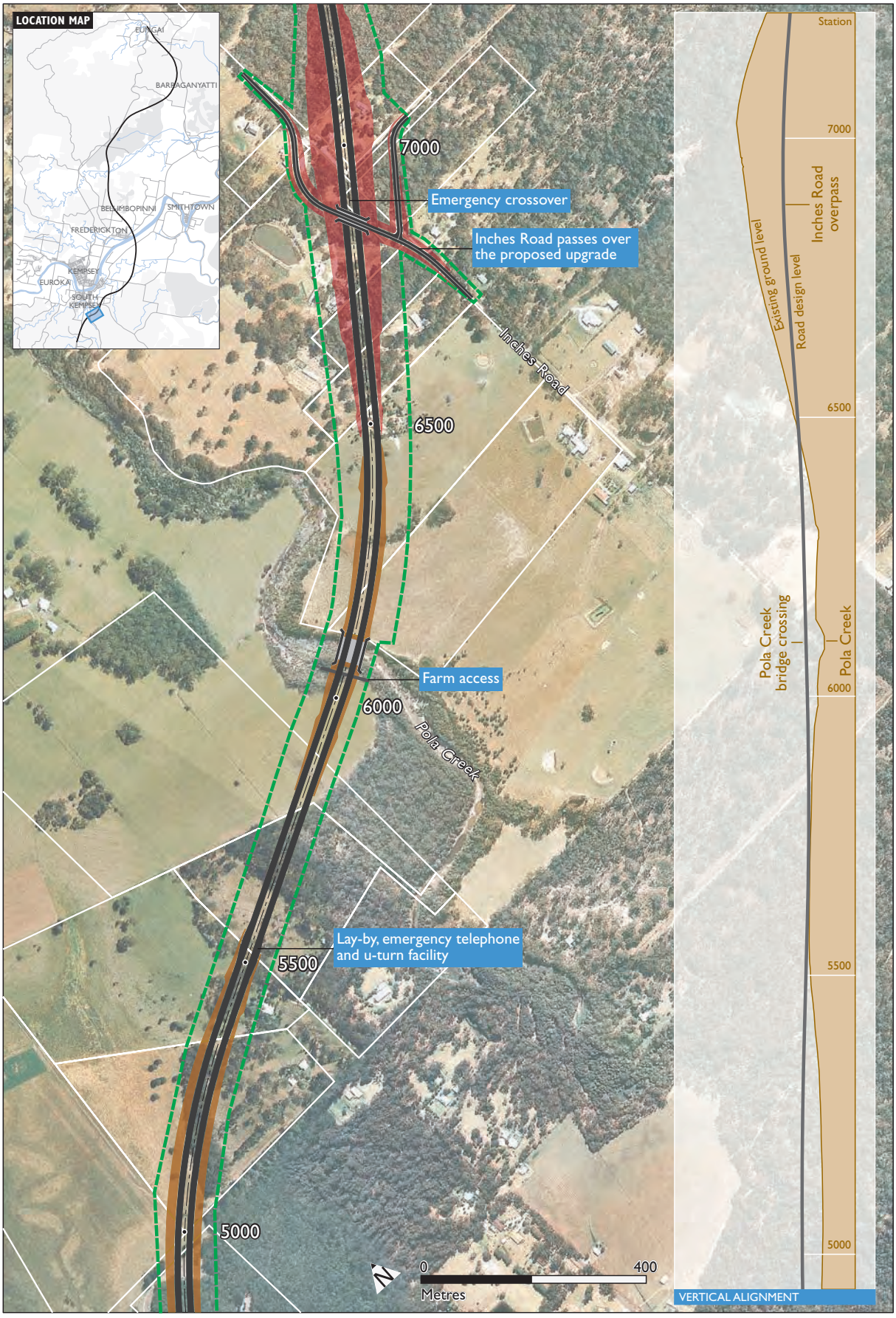


Figure 6-1e **Horizontal and vertical route alignment**

Figure 6-1f **Horizontal and vertical route alignment**

Figure 6-1g **Horizontal and vertical route alignment**

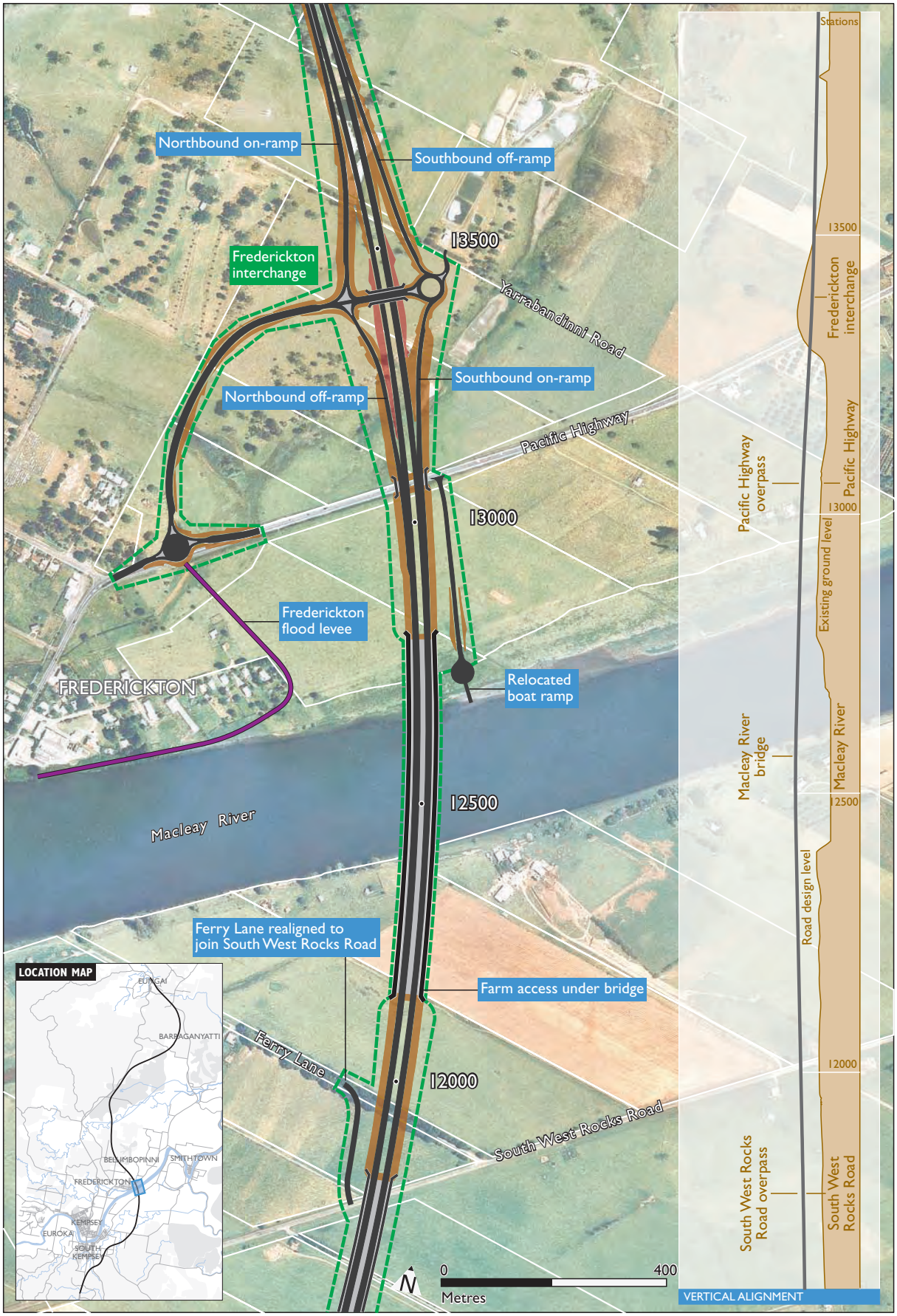


Figure 6-1h **Horizontal and vertical route alignment**

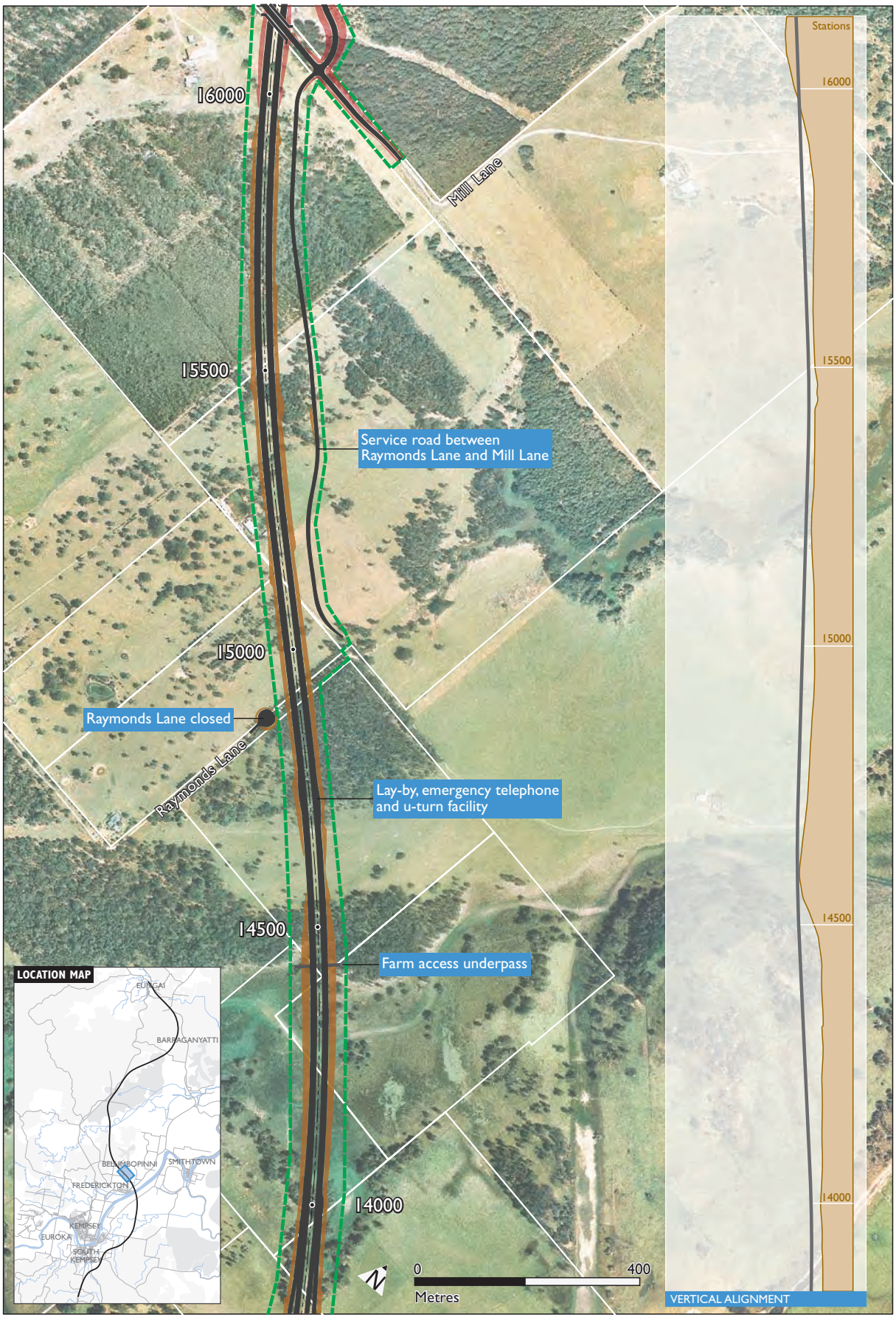


Figure 6-1i **Horizontal and vertical route alignment**

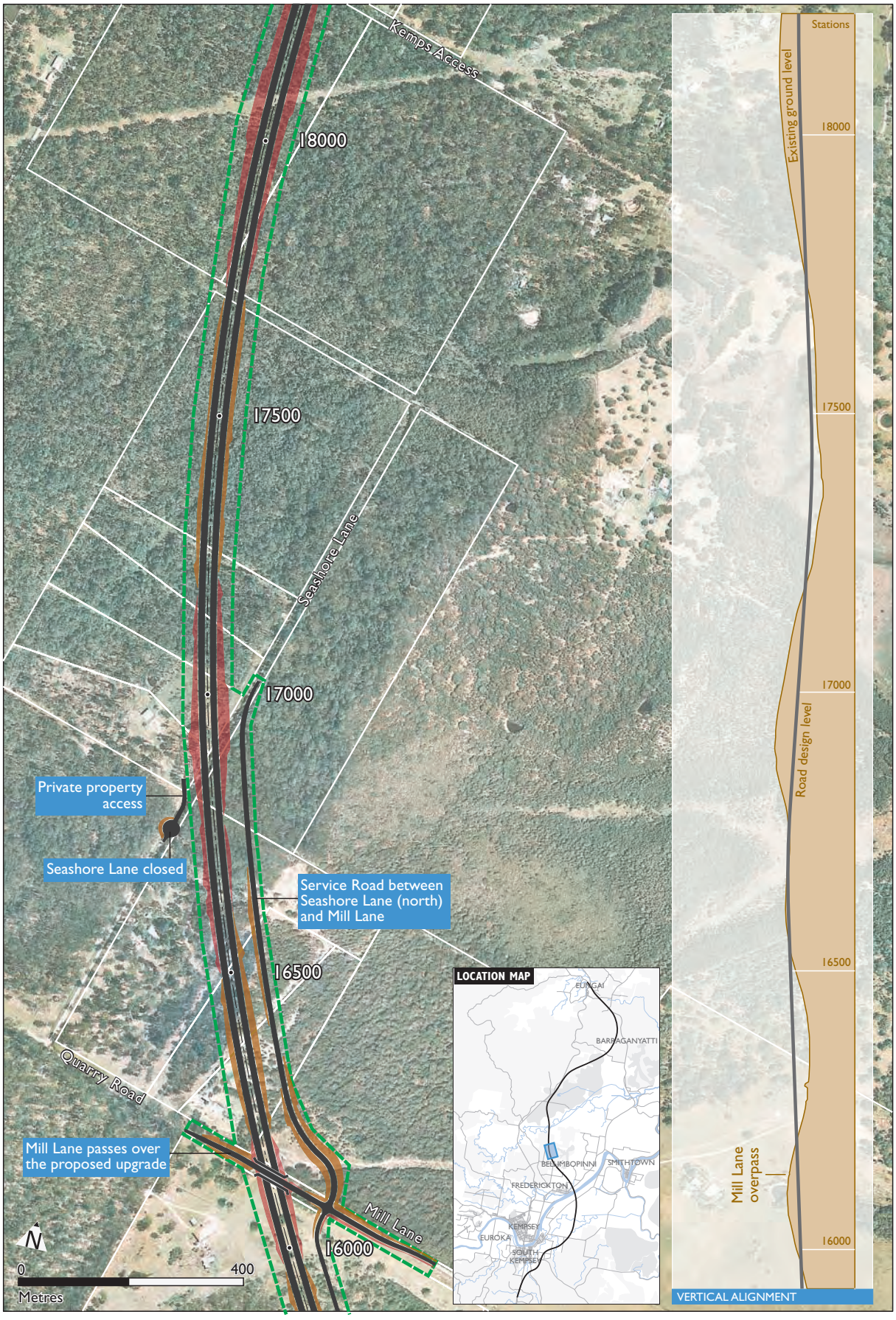


Figure 6-1j **Horizontal and vertical route alignment**

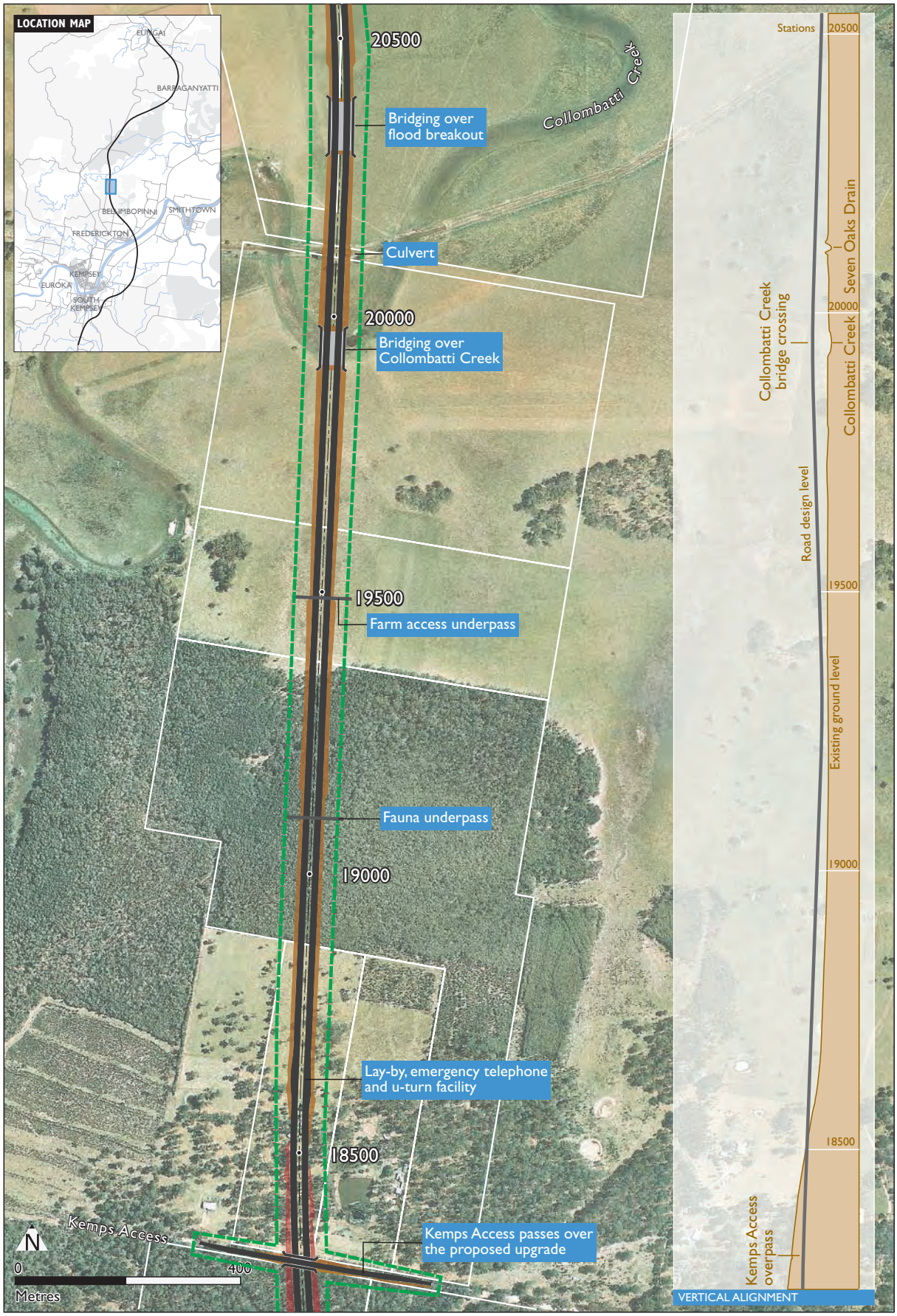


Figure 6-1k **Horizontal and vertical route alignment**

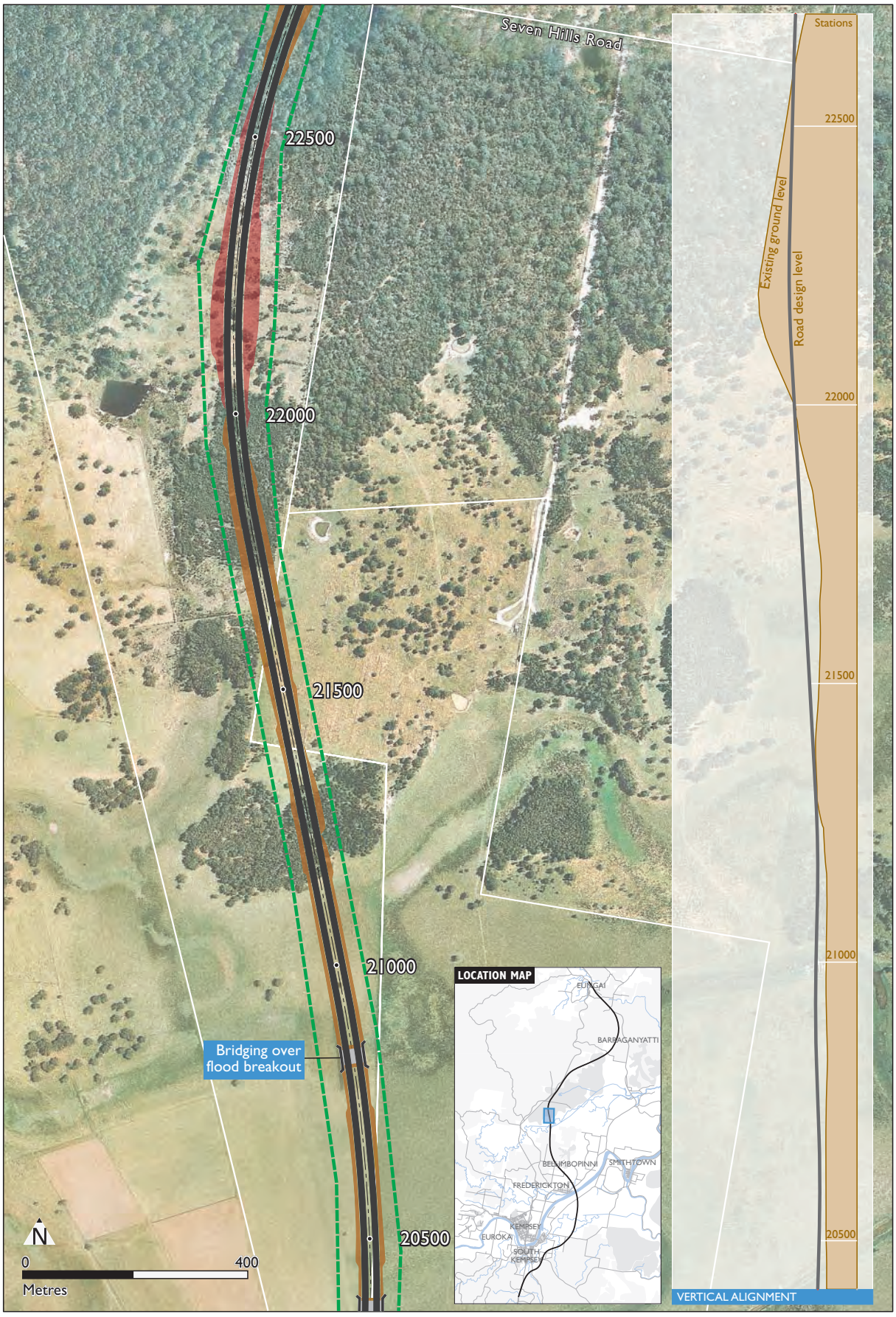


Figure 6-11 **Horizontal and vertical route alignment**

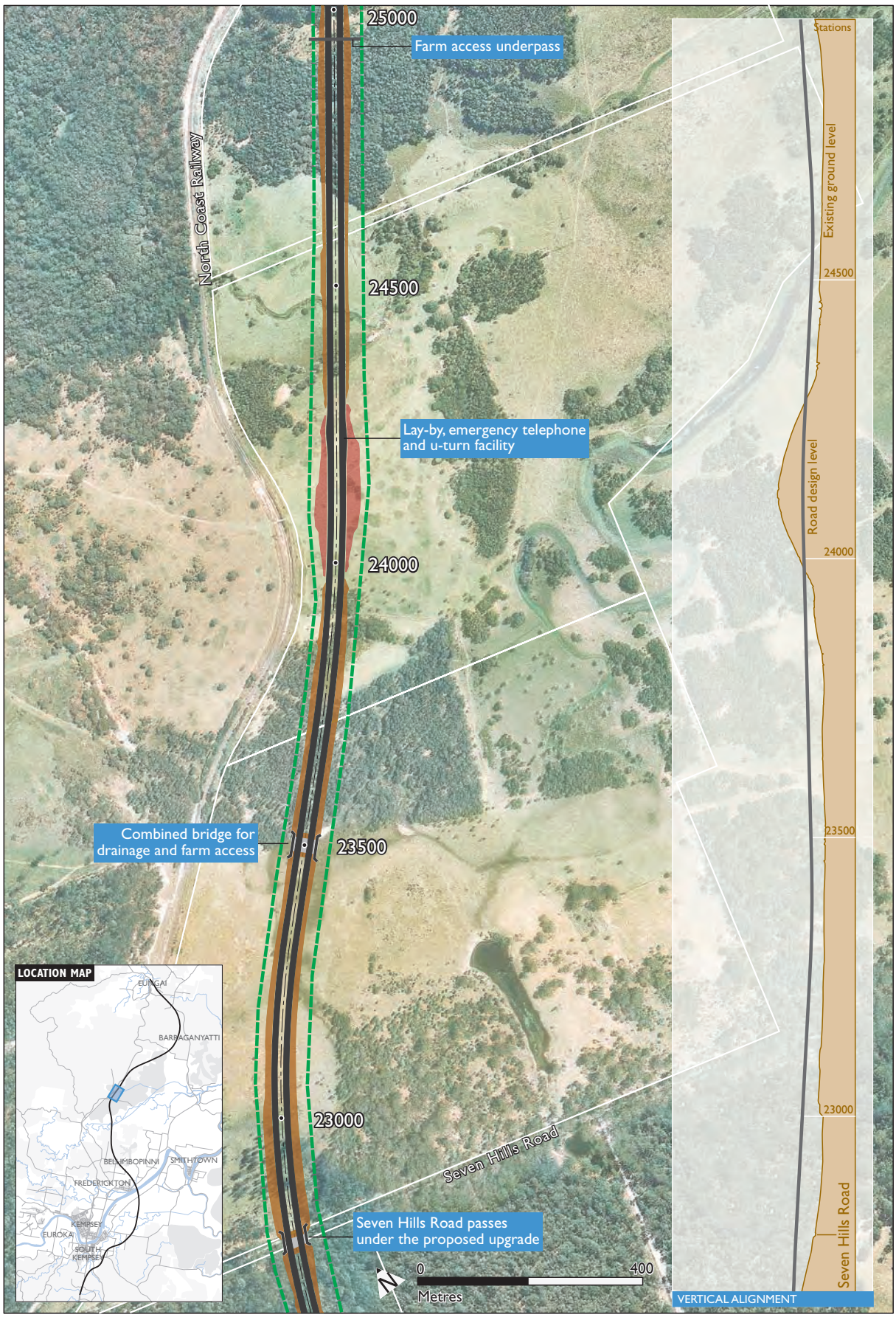


Figure 6-1m **Horizontal and vertical route alignment**

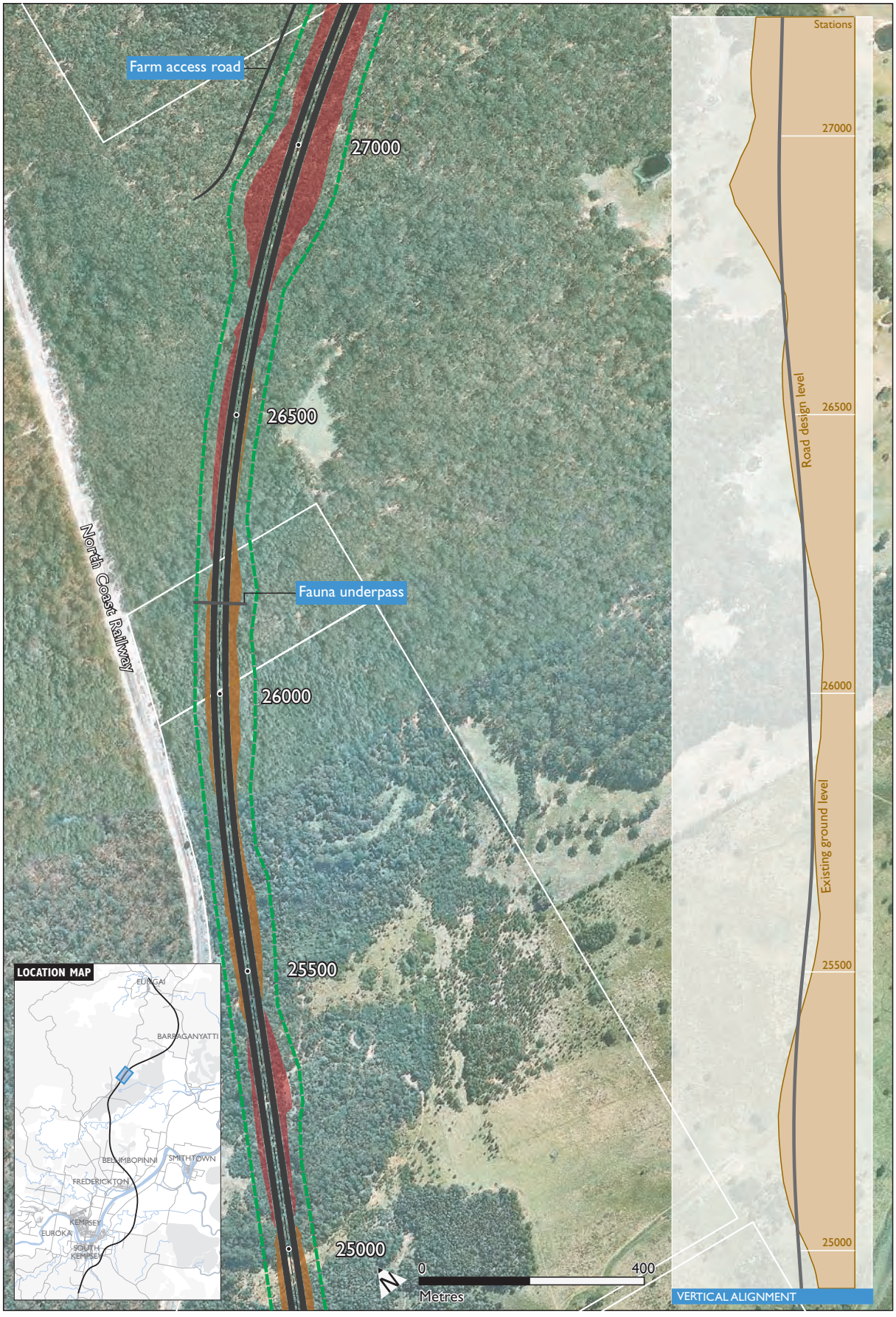


Figure 6-1n **Horizontal and vertical route alignment**

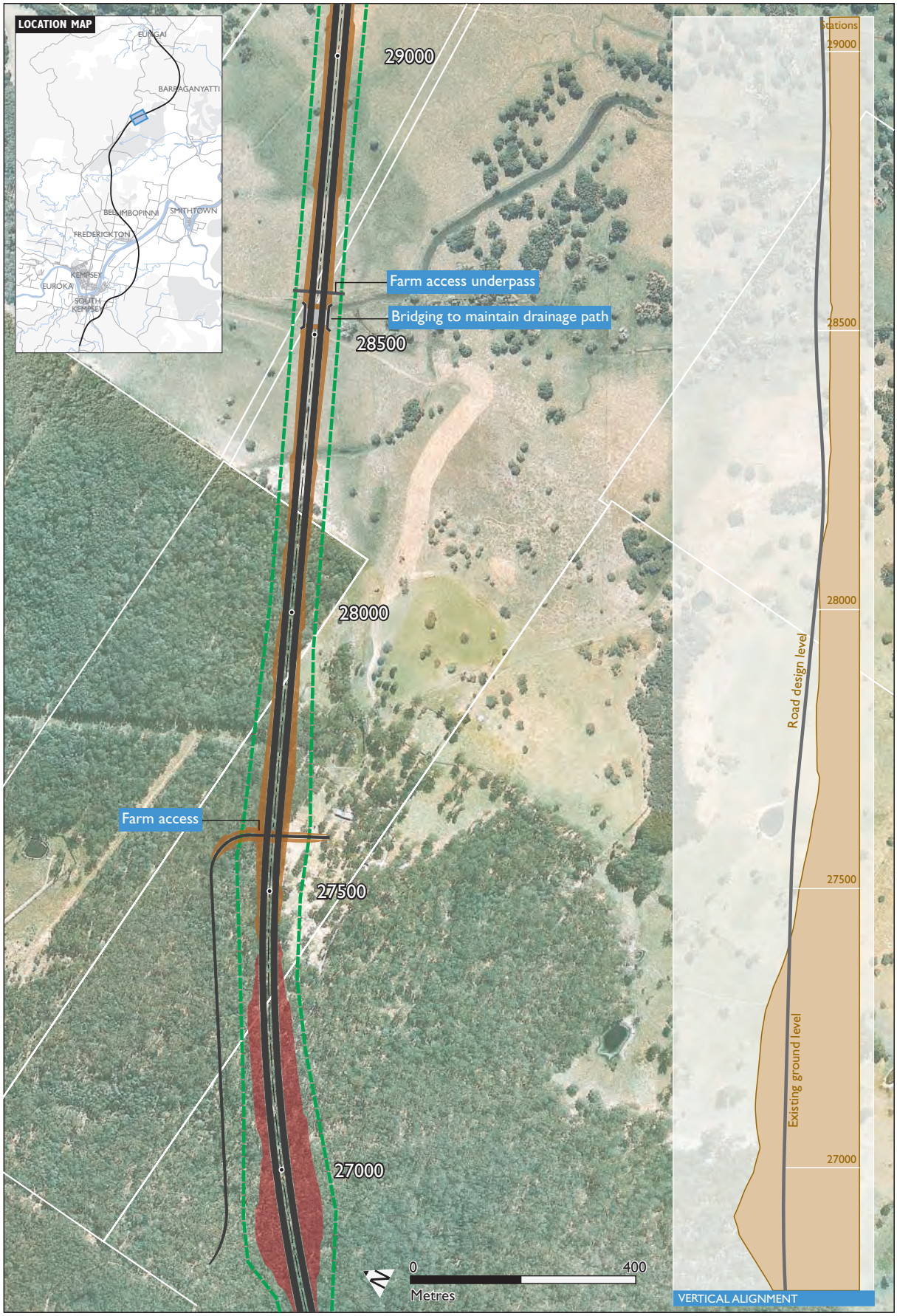


Figure 6-1o **Horizontal and vertical route alignment**

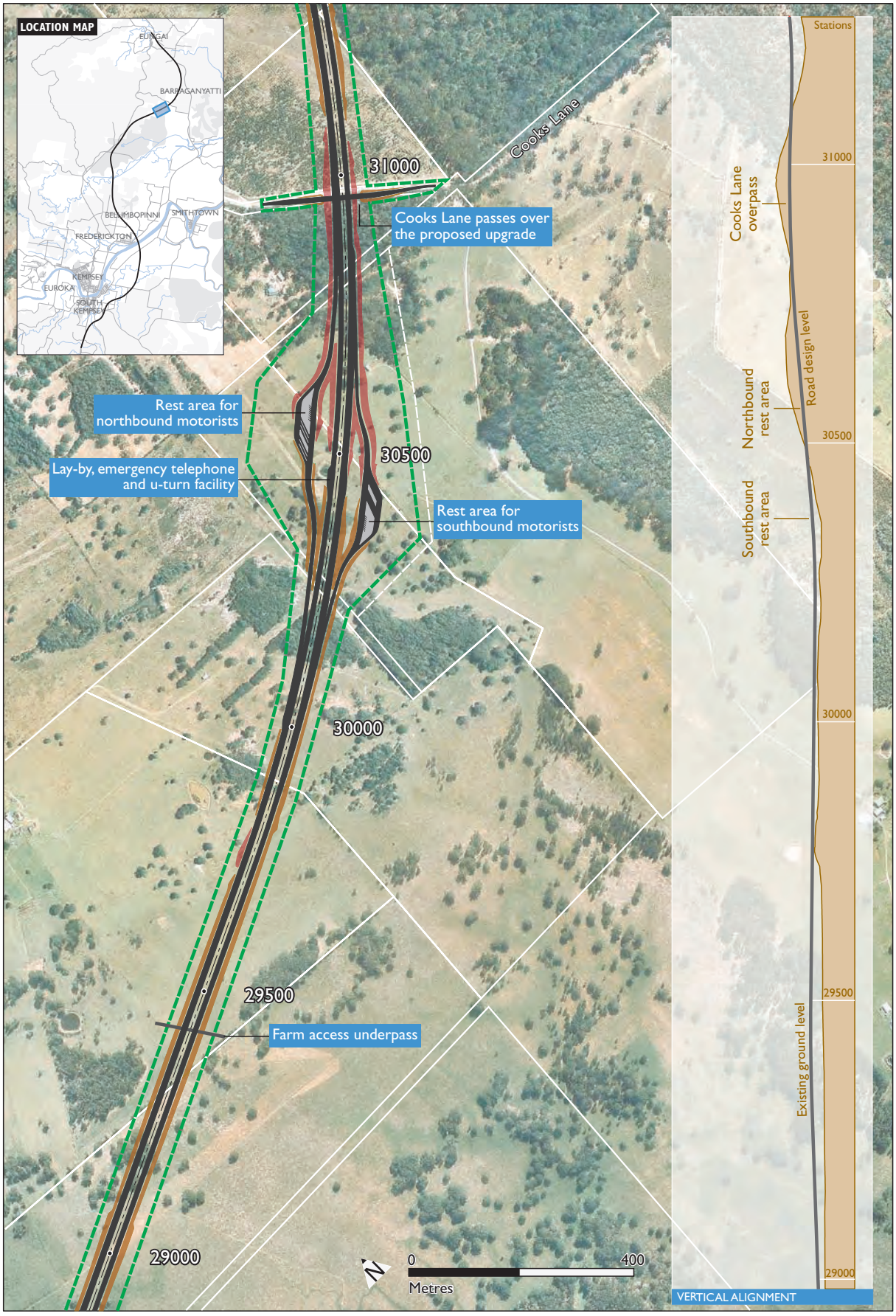


Figure 6-1p **Horizontal and vertical route alignment**

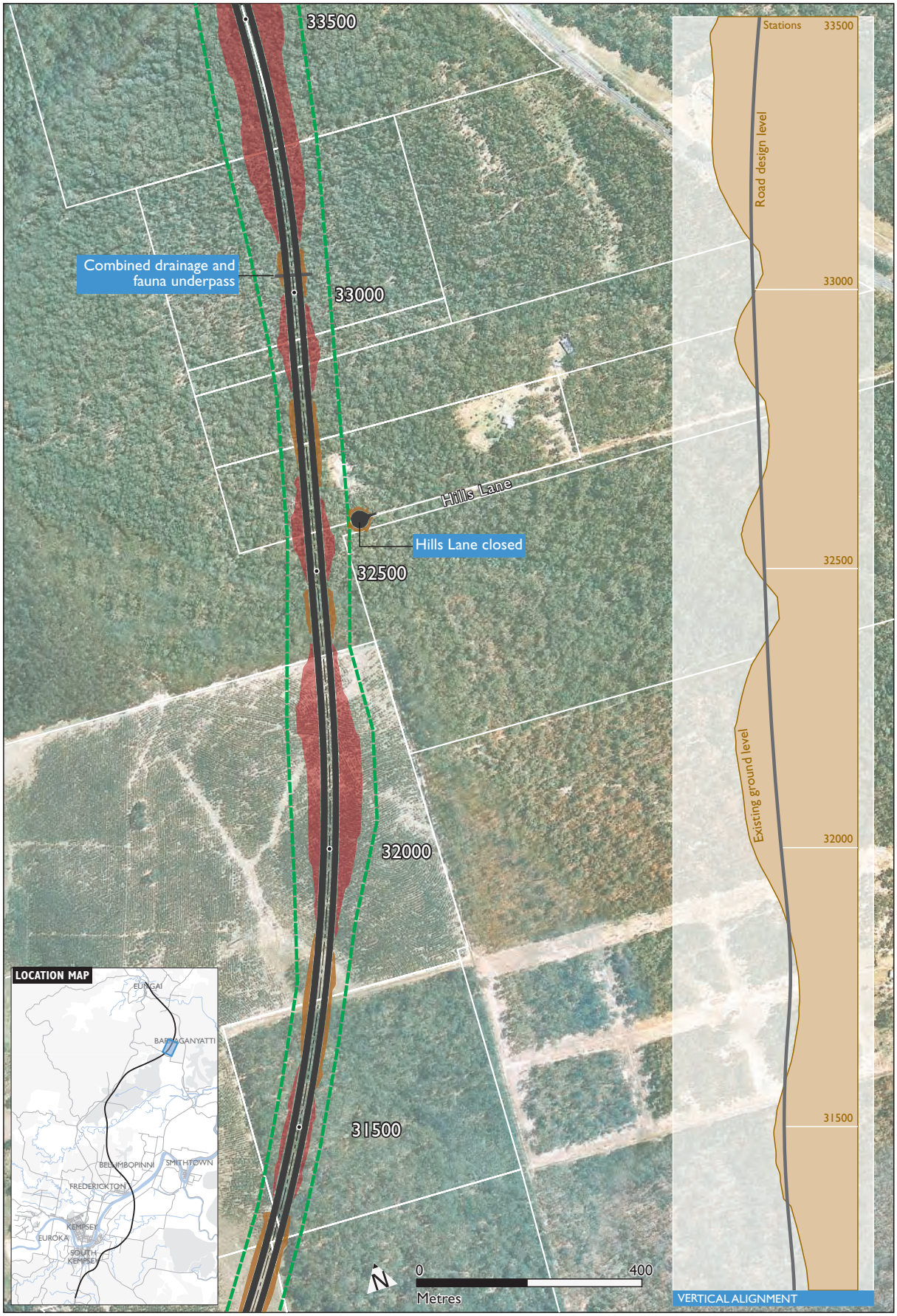


Figure 6-1q **Horizontal and vertical route alignment**

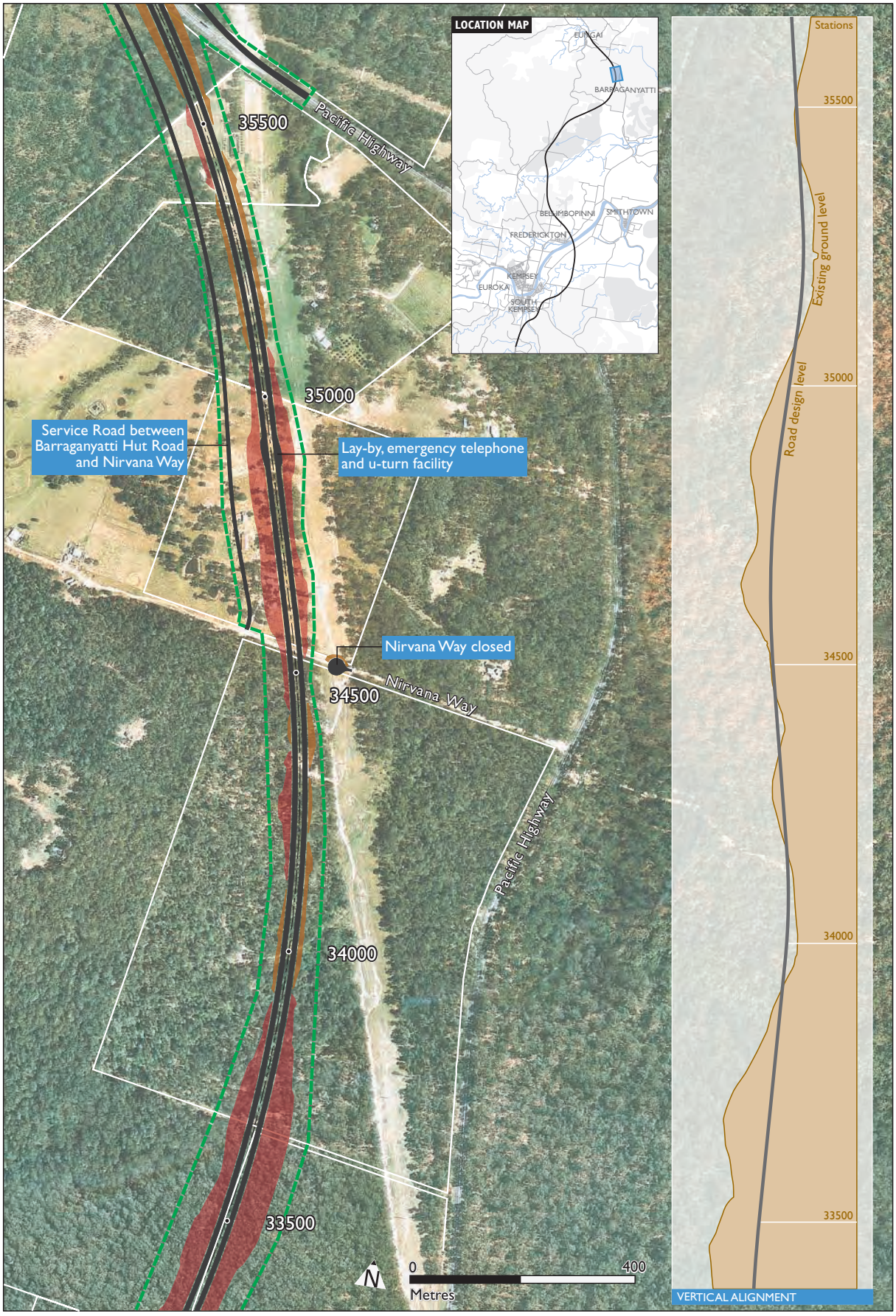


Figure 6-1r **Horizontal and vertical route alignment**

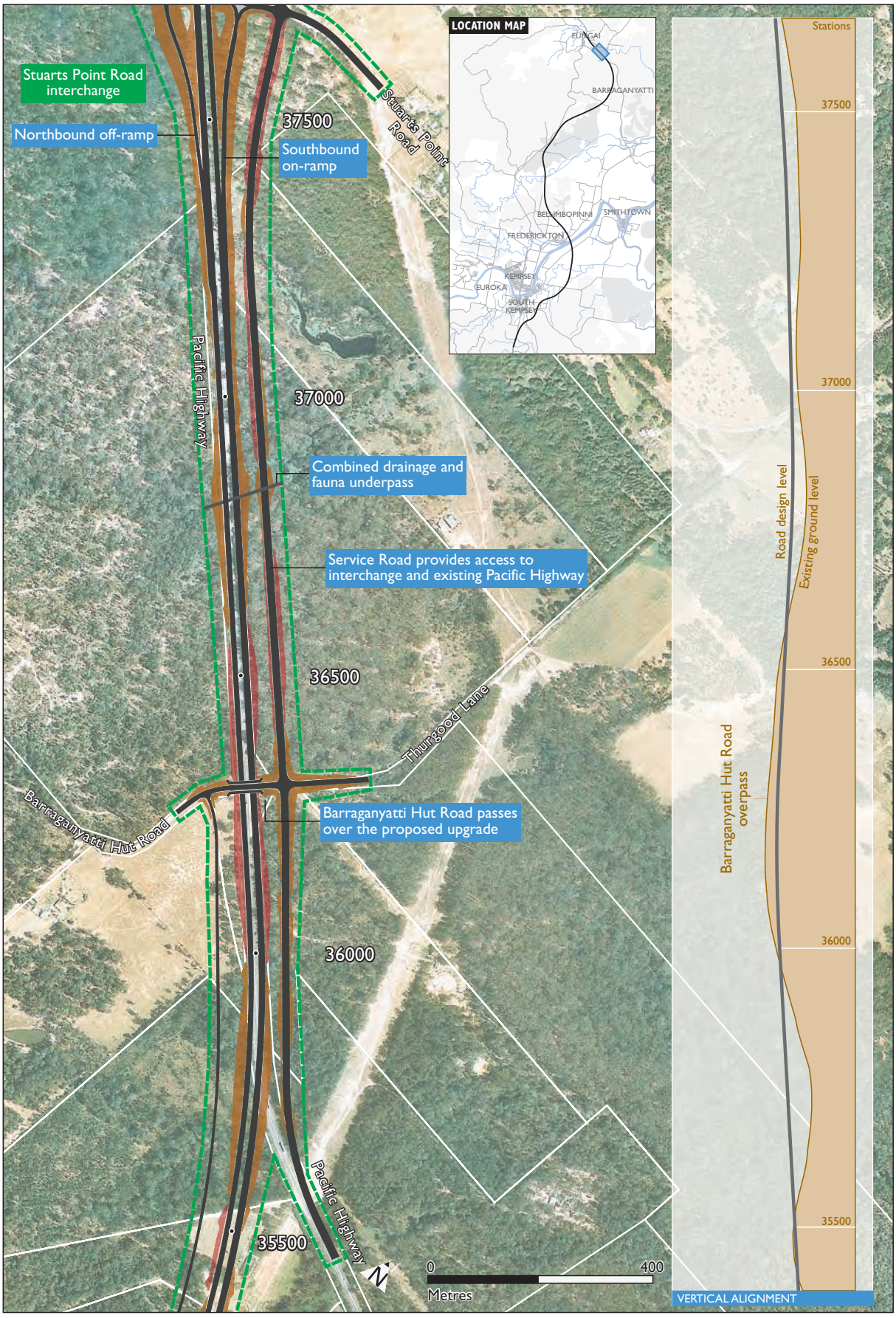


Figure 6-1s **Horizontal and vertical route alignment**

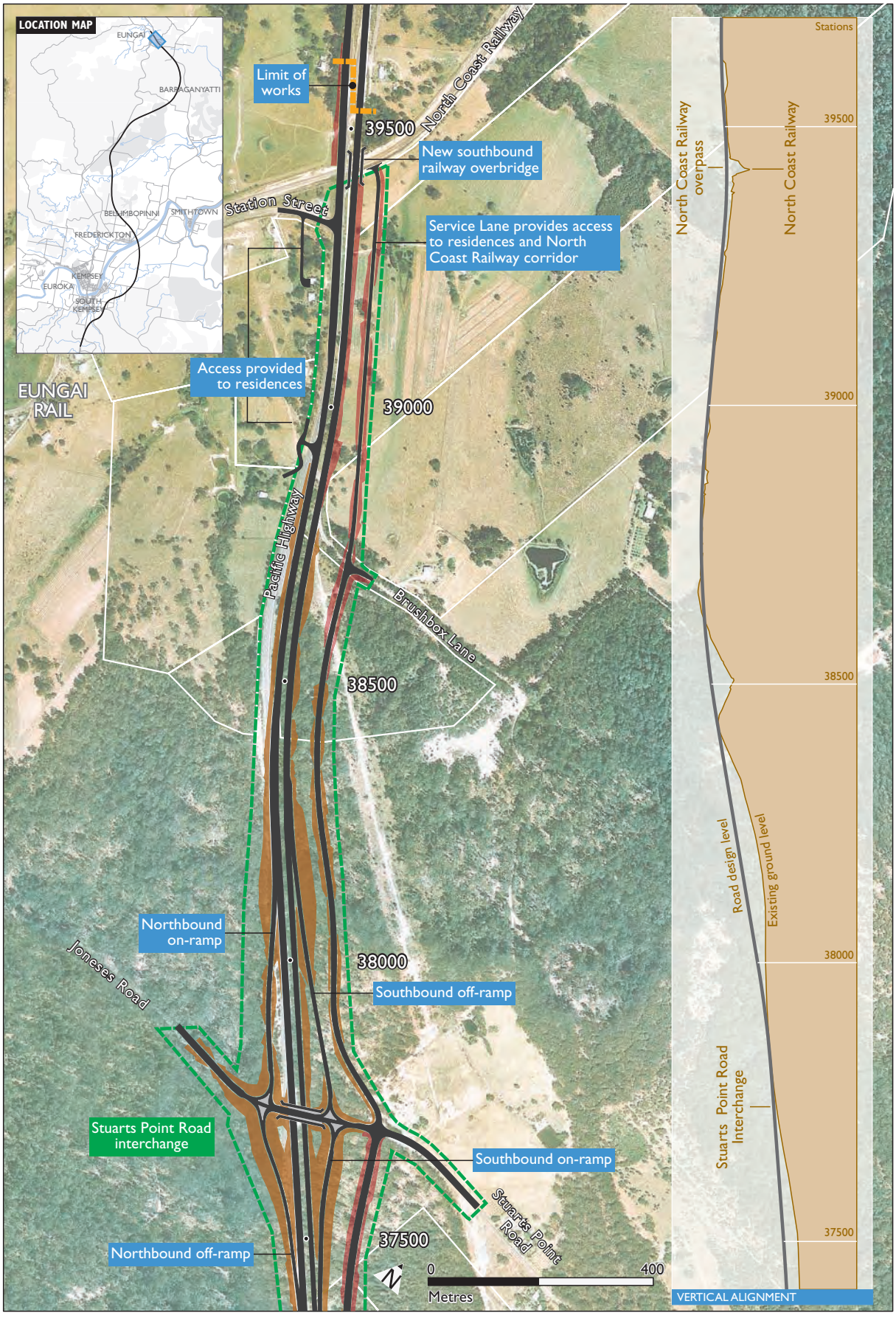
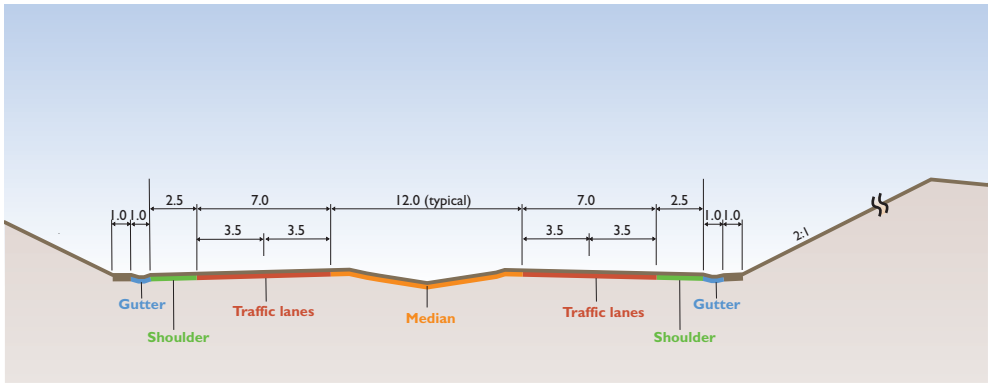
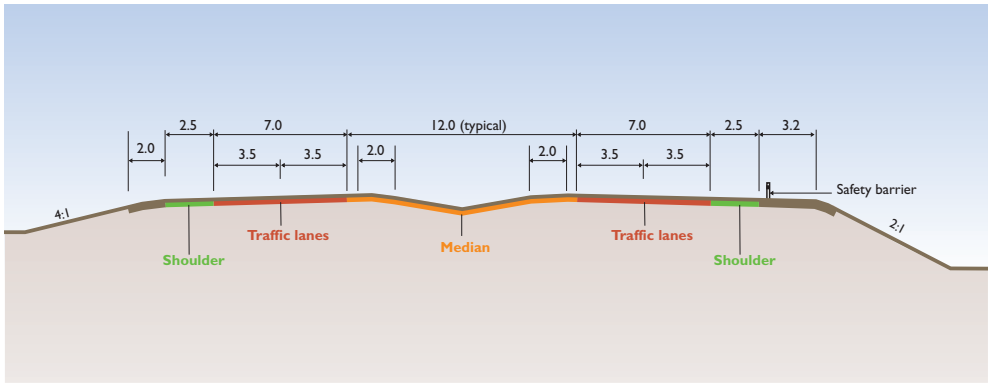


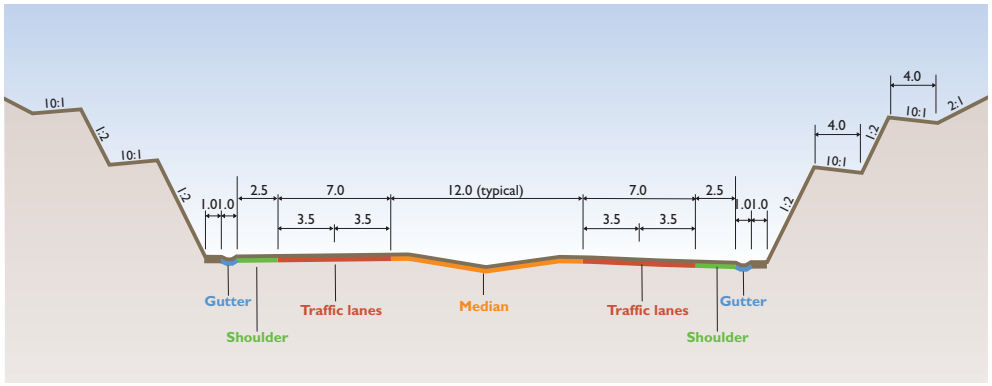
Figure 6-2 **Typical cross-sections**



Cross-section of excavation



Cross-section of an embankment



Note: Values in metres

Cross-section of major cut

6.1.3 Interchanges and intersections

Interchange locations and configurations are shown in Figure 6-1a to 6-1s and are described below.

South Kempsey interchange

The South Kempsey interchange would be located on the ridge south of the South Kempsey industrial area, to maximise visibility from the proposed upgrade and provide a visual 'gateway' to Kempsey from the south. The interchange would also comprise the entrance to the Macleay Valley and Crescent Head.

As shown in Figure 6-1a, the South Kempsey interchange has a modified full diamond configuration, providing access to the Pacific Highway from the north and south. Both southbound ramps and the northbound off-ramp would connect to the overpass bridge at the interchange. The northbound on-ramp is located approximately 1,000 metres north of the bridge, due to site constraints and to improve access to the proposed upgrade from the South Kempsey area.

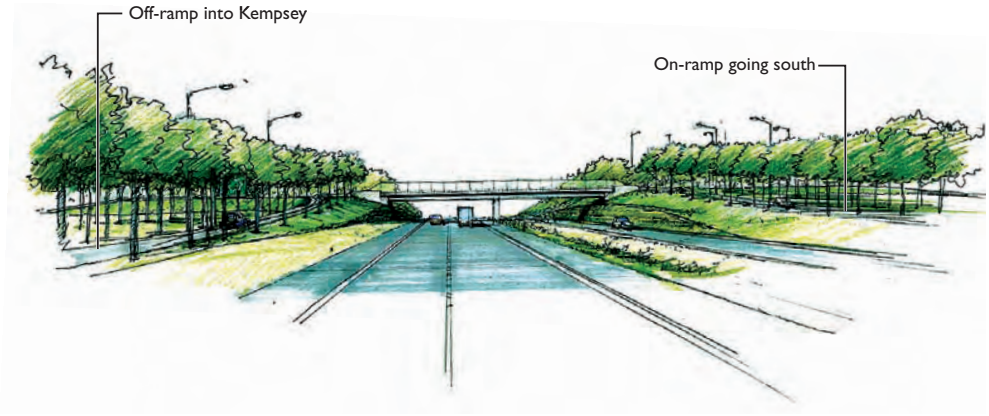
A service road would be constructed on the western side of the proposed upgrade to connect the interchange to the existing Pacific Highway. A service road would also be constructed on the eastern side providing access to potential future commercial/industrial land. To cater for potential future uses on adjoining land, the South Kempsey interchange has been designed to accommodate heavy vehicles (B-doubles).

The area surrounding the South Kempsey interchange has been considered as a location for a potential highway service centre. A highway service centre does not form part of this proposal.

A photo-illustration of the proposed South Kempsey interchange and the highway looking south is provided in Figure 6-3. A perspective drawing of the South Kempsey interchange from a driver's view is shown in Figure 6-4.

Figure 6-3 **Photo-illustration of the proposed South Kempsey interchange (looking south)**

Figure 6-4 **Perspective drawing of the proposed South Kempsey interchange (looking north)**



Frederickton interchange

The Frederickton interchange is located north-east of the Frederickton Golf Course, as shown in Figure 6-1g. The interchange comprises the main access point for Frederickton, Smithtown, Gladstone and South West Rocks. It is located on a ridge to the east of Frederickton to provide a 100-year flood-free access from Frederickton to the north. A photo-illustration of the proposed Frederickton interchange is provided in Figure 6-5.

The proposed interchange comprises a full diamond configuration, providing access to the proposed upgrade from the north and south.

Access to the interchange is provided via a single two-way service road connecting to the existing Pacific Highway north of Frederickton on the south-western side of the interchange.

Figure 6-5 **Photo-illustration of the proposed upgrade at Frederickton (looking west)**

Stuarts Point Road interchange

The Stuarts Point Road interchange forms an important connection to the proposed upgrade for communities at Eungai Rail, Stuarts Point and South West Rocks – refer Figure 6-1s. The interchange is a full diamond configuration, providing access to the Pacific Highway from the north and south.

A service road connecting the existing Pacific Highway, Barraganyatti Hut Road and the southern end of Thurgood Lane with the interchange would be constructed parallel to the proposed upgrade. This service road connects the interchange to the communities of South West Rocks and Frederickton via the existing Pacific Highway.

A photo-illustration of the proposed Stuarts Point Road interchange and the highway looking south is provided in Figure 6-6.

Figure 6-6 **Photo-illustration of the proposed Stuarts Point Road interchange (looking south)**

Station Street left-in/left-out

A left-in, left-out intersection would be constructed at the current intersection of the Pacific Highway and Station Street to provide safe and convenient northbound access for residents of Eungai Rail. Residents travelling from Eungai Rail south to Kempsey would access the proposed upgrade via Jones Road, which connects to the Stuarts Point Road interchange. The proposed Station Street access arrangement would need to be reviewed in the future, probably at the same time as the existing at-grade intersections on the highway to the north of the proposed upgrade are re-evaluated.

U-turn and crossover facilities

Emergency U-turn and crossover facilities would be provided at regular intervals along the proposed upgrade, as illustrated in Figure 6-1a to 6-1s. Vehicles would also be able to use interchanges for U-turn movements or for emergency crossovers.

6.1.4 Structures

The structure designs have been developed to meet specific functional requirements. As such, the designs are indicative and would be further refined during the detailed design phase of the project to maximise the cost-effectiveness of solutions in the context of urban design principles.

The detailed design of bridges would be guided by the following principles developed specifically for the project:

- All bridges should belong to the same design family and should be considered as part of the suite of unified elements.
- Bridges should be of similar design to those in adjoining upgrade sections of the Pacific Highway.
- Bridges should assist in the comprehension of access for road users, with the South Kempsey interchange providing an opportunity to identify the entrance to the town for highway users.
- Piers for bridges over the highway should be integrated with the overall design of the structure. This may be through the use of a column without headstocks or wall type columns.
- Generally, spill through 'open' abutments finished in local stone laid over a blinding slab should be employed.
- Safety screens, hand rails and noise barriers, where required, should be designed as integral parts of the bridge balustrade.
- Bridge parapets should be constructed of concrete and double steel rails. Drainage pipes on bridges should be concealed.

Cross-sections of indicative bridge configurations are illustrated in Figure 6-7.

Macleay River bridges

The Macleay River bridges would be parallel structures approximately 658 metres long, crossing the 300 metre wide Macleay River and the adjoining Macleay River floodplain. Key features of an indicative bridge design are provided in Table 6-1.

Table 6-1 Key features of the Macleay River bridges

Feature	Value/dimension
Spans	50 metres
Length	658.0 metres
Vertical clearance	9.1 metres to mean high tide
Lane width	3.5 metres (x 2 lanes) per bridge
Pedestrian facilities	No
Bicycle facilities	On paved shoulder

Note: *These values/dimensions would be subject to refinement during detailed design.*

A possible/indicative bridge design may involve a concrete box girder type structure, with main spans approximately 50 metres long, a substructure consisting of piers (possibly constructed of three columns) and abutments supported on bored piles.

The location and lengths of the bridges have been chosen to optimise hydraulic efficiency and to span a buried cliff located on the northern bank of the Macleay River.

The width of each bridge would be 11.5 metres between kerbs to accommodate a future third lane. In the case of the indicative bridges illustrated, the additional width has been allowed for in the superstructure because a box girder structure cannot be easily widened.

The height of the bridge has been set to allow recreational boat access along the Macleay River. The minimum clearance required by NSW Maritime Authority is 9.1 metres above mean high tide level.

Floodplain bridging

The Macleay River floodplain would be crossed by the proposed upgrade for a length of approximately 4 kilometres. Indicative features of the proposed floodplain bridge structures, based on the current design, are described in Table 6-2.

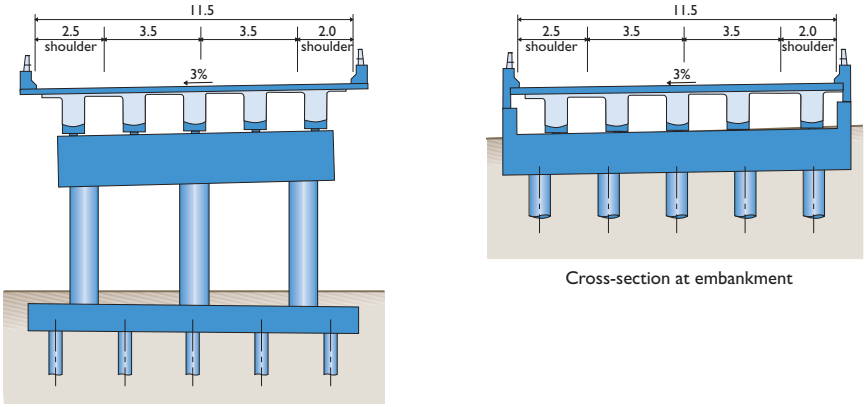
Table 6-2 Key features of the floodplain bridges

Feature	Bridge – Station 9600 to Station 10300	Bridge – Station 11038 to Station 11830
Spans	30 metres	30 metres
Length	700 metres	792 metres
Vertical clearance	500 millimetres to the 100 year ARI flood level	500 millimetres to the 100 year ARI flood level
Lane width	3.5 metres (x 2 lanes each bridge)	3.5 metres (x 2 lanes each bridge)
Pedestrian facilities	No	No
Bicycle facilities	On paved shoulder 2.5 metres	On paved shoulder 2.5 metres

Note: *These values/dimensions would be subject to refinement during detailed design.*
ARI – Average Recurrence Interval (refer Glossary for definition)

The design of the floodplain bridges would be finalised during the detailed design stage. A Super-tee girder type structure is one option proposed for the floodplain bridges. Drainage would be installed beneath the deck to allow water to drain off the bridges. Water collected would be treated prior to release into waterways.

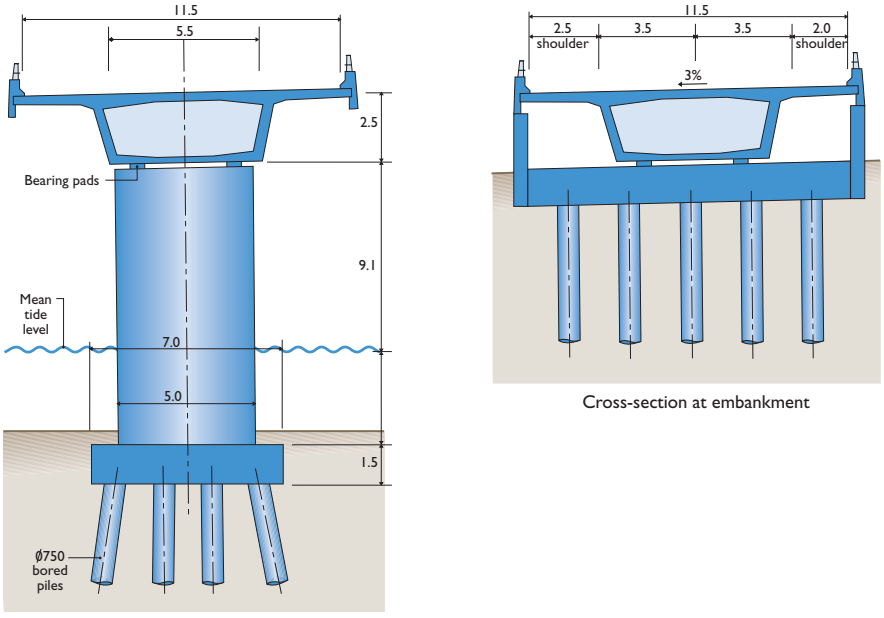
Figure 6-7 Typical bridge cross-sections



Cross-section at pier

Cross-section at embankment

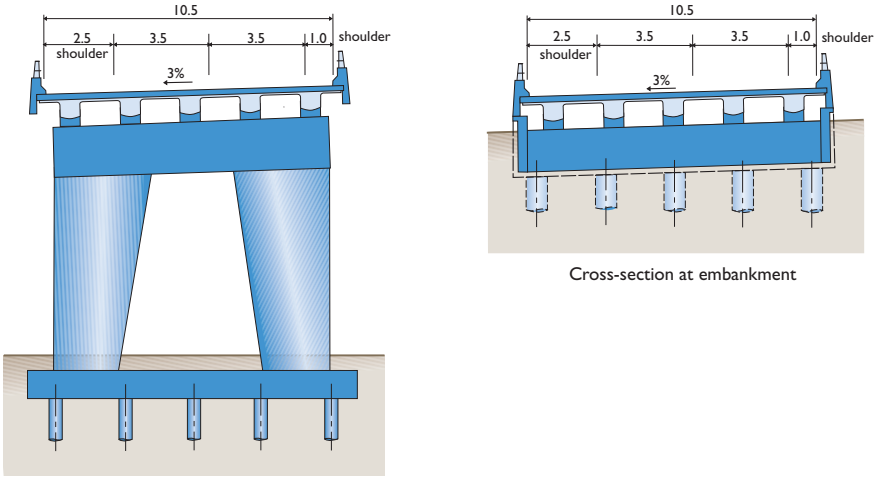
Bridge section - floodplain



Cross-section at pier

Cross-section at embankment

Bridge section - Macleay River bridge



Cross-section at pier

Cross-section at embankment

Bridge section - typical

A photo-illustration of the proposed floodplain bridges is provided in Figure 6-8.

Figure 6-8 **Photo-illustration of the proposed floodplain bridging at Frogmore (looking west)**

Interchange bridges

Two-span overbridges are proposed at all three of the interchanges. Indicative features of the bridge design are provided in Table 6-3.

Table 6-3 **Key features of a typical interchange bridge**

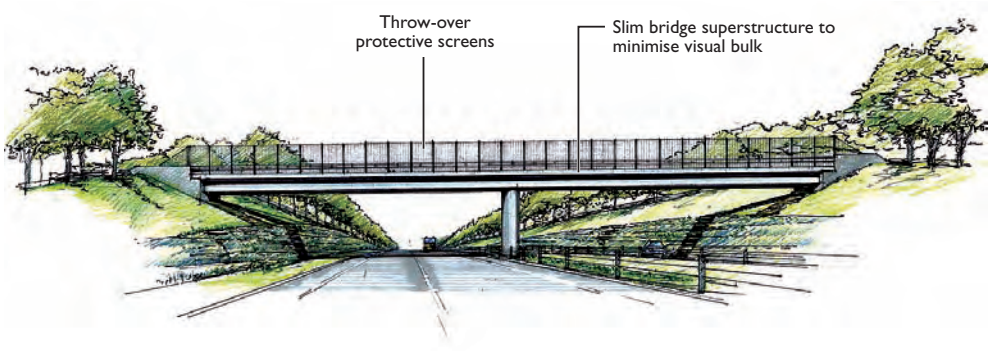
Feature	Value/Dimension
Spans	2
Length	60 to 70 metres
Vertical clearance	5.3 metres (minimum)
Lane width	3.25 to 3.5 metres (x 2 lanes)
Pedestrian facilities	1.8 metre footpath (as required)
Bicycle facilities	On paved shoulder (as required)

Note: *These values/dimensions would be subject to refinement during detailed design.*

Throw-over protective screens would also be used where pedestrian access is provided.

A perspective drawing of the indicative South Kempsey interchange bridge is shown in Figure 6-9.

Figure 6-9 **Perspective drawing of typical interchange bridge**



A summary of all interchange bridges along the proposed upgrade is provided in Table 6-4.

Table 6-4 **Location of interchange bridge structures**

Location (Station)	Bridge	Bridge form	Minimum functional requirement	Total bridge length (metres)
-150	South Kempsey interchange	Overpass	Span the proposed upgrade	70
13400	Frederickton interchange	Overpass	Span the proposed upgrade	65
37680-37720	Stuarts Point Road interchange	Overpass	Span the proposed upgrade	65

Note: *These values/dimensions would be subject to refinement during detailed design.*

Overpass, underpass and waterway bridges

Two-span overbridges are proposed at local road overpasses. Key features of the bridge designs are provided in Table 6-5 and illustrated in Figure 6-9. The typical dimensions of the waterway bridges would differ from the overpass bridges as they have varying design requirements.

Table 6-5 **Key features of a typical overpass bridge**

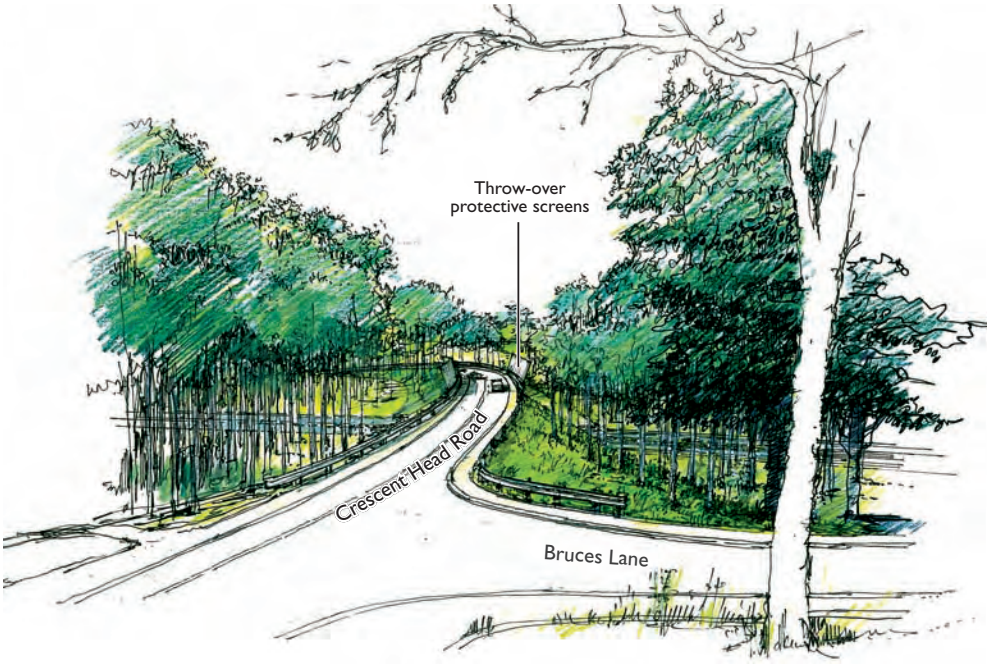
Feature	Value/Dimension
Spans	2
Length	60 to 70 metres
Vertical clearance	5.3 metres (minimum)
Lane width	3.25 to 3.5 metres (x 2 lanes)
Pedestrian facilities	1.8-metre footpath (as required)
Bicycle facilities	On paved shoulder

Note: *These values/dimensions are subject to refinement during detailed design.*

Super-tee girders are likely to be adopted for the two spans, varying in length from 30 to 37 metres. The substructure would comprise piles and pile caps or pad footings, depending on geotechnical conditions. A large tapered blade would most likely be used at the centre pier.

Throw-over protective screens would also be used where pedestrian access is provided or may be available. A perspective drawing of the proposed upgrade at Crescent Head Road overpass (with throw-over protective screens) is shown in Figure 6-10.

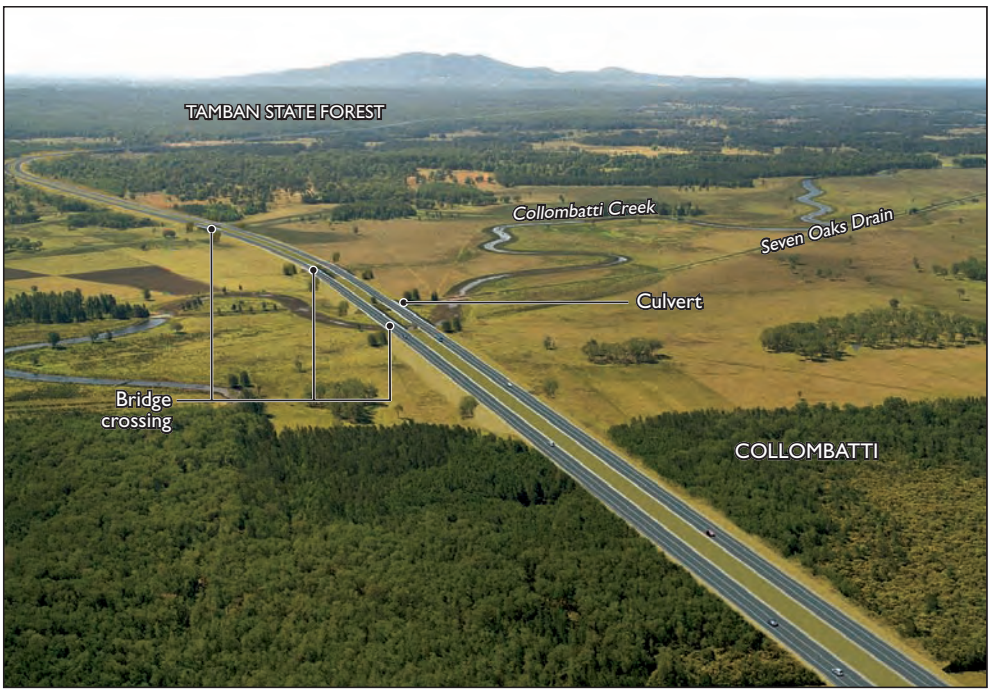
Figure 6-10 **Perspective drawing of the proposed Crescent Head Road overpass (looking west)**



The Mill Lane and Kemps Access overpasses would provide stock passage across the proposed upgrade (refer Figure 15-3). Discussions with local farmers indicated that cattle do not readily cross bridges if they can see the road below. As a result these overpass bridges would be fitted with two metre-high sight screens.

Underpass bridges would be constructed to provide vehicle access under the proposed upgrade and waterway bridges would be constructed to pass over existing watercourses. A photo-illustration of proposed waterway crossings at Collombatti Creek is shown in Figure 6-11.

Figure 6-11 **Photo-illustration of the proposed upgrade at Collombatti Creek (looking north)**



The typical underpass bridge types for the proposed upgrade would consist of either a super-tee or precast concrete plank superstructure with either piled or pad footings, as appropriate. Abutments would typically be spill-through, where room permits, or reinforced soil abutments where the bridge span needs to be minimised.

A summary of all minor bridges along the proposed upgrade is provided in Table 6-6.

Table 6-6 **Location of minor bridge structures**

Location (Station)	Bridge	Bridge form	Minimum functional requirement	Total bridge length (metres)
2209 – 2257	North Coast Railway & Patersons Lane	Railway underpass	Twin bridge to span the North Coast Railway Line and a realigned Patersons Lane	48
3188 – 3202	Bingis Lane	Road underpass	Twin underbridge to allow the proposed upgrade to span Bingis Lane	14
440 – 506	Crescent Head Road	Overpass	Span the proposed upgrade	66
6100 – 6160	Pola Creek	Water crossing	Provide the required waterway area	60
312 – 382	Inches Road	Overpass	Span the proposed upgrade	70
247 – 317	Old Station Road	Overpass	Span the proposed upgrade	70
132 – 214	Mill Lane	Overpass	Span the proposed upgrade	74
100 – 164	Kemps Access	Overpass	Span the proposed upgrade	64
19908 – 19988	Collombatti Creek	Water crossing	Provide the required waterway area	81
20295 – 20395	Waterway overflow	Water crossing	Provide the required waterway area	100
20803 – 20857	Waterway overflow	Water crossing	Provide the required waterway area	54
22762 – 22804	Seven Hills Road	Underpass	Twin bridges to span Seven Hills Road and to provide 2 metre wide fauna crossing	42
23474 – 23517	Waterway	Waterway crossing	Provide the required waterway area and provide stock and tractor access	43
28513 – 28558	Floodway & cattle access	Water crossing	Provide the required waterway area and provide stock and tractor access	45
94 – 159	Cooks Lane	Overpass	Span the proposed upgrade	65
104 – 164	Barraganyatti Hut Road/Thurgood Lane	Overpass	Span the proposed upgrade	62
287 – 321	Eungai Rail bridge	Rail overpass	Span the railway line	34

Note: *These bridge structures would be subject to refinement during detailed design.*

Other structures

Three types of retaining structures would be required along the proposed upgrade. The first is a soil nail wall that would be constructed on the western side of the South Kempsey interchange between the proposed upgrade and the service road (Station (-20) to Station 145).

The second type of wall is a reinforced soil wall, which would be used to construct vertical bridge abutments. Vertical bridge abutments are used to minimise back spans on bridges and hence the overall length of the bridge.

The third type of wall, a reinforced concrete retaining wall, would be used at the Frederickton levee (refer Section 6.2.2). This wall would be used where there is insufficient room to construct an earth structure and would only constitute part of the overall levee structure. The wall foundation would either be piles or pad footings. Additional geotechnical investigation would be carried out during detailed design to determine positioning for effective design.

Sign supports would be constructed from galvanised steel hollow sections. These would be bolted to either a piled or pad footing. Additional geotechnical investigation would be carried out during detailed design to determine the specific details of appropriate locations.

A number of structures are planned to minimise potential barriers to the movement of various fauna populations as a result of the proposed upgrade. Fauna passage would be achieved by the inclusion of purpose-built structures, while other structures would be multi-purpose (i.e. for both drainage and fauna passage). The location and description of these structures is shown in Section 11.4. The report *Technical Report 2 - Supplementary Ecological Assessment* (NSW Roads and Traffic Authority 2006a) and Chapter 11 – *Biodiversity* describe fauna movements in more detail.

Details on noise barriers are provided in Section 6.3.

6.1.5 Pavements

Proposed upgrade main alignment

Heavy-duty low-maintenance pavements, designed for a 40-year life, are proposed for the proposed upgrade. The structural pavement would be determined during the detailed design phase, but would be either concrete, deep-lift asphalt or a composite pavement.

A low-noise pavement is proposed close to sensitive receivers, where required, as detailed in Section 16.5. This type of pavement is predicted to reduce noise generated from the pavement by 2 to 4dBA when compared to standard pavements. It is proposed that a noise-reducing pavement is used through areas of closely spaced residences between Station 3500 and Station 5700.

Through rock cuttings where the pavement is at or below the water table, a drainage blanket would be provided beneath the selected material.

Interchange ramps

Interchange ramp pavements would typically be constructed of either deep lift asphalt or composite pavements designed for a 40-year life, with the wearing course replaced at regular intervals.

Local roads

Flexible pavements for intersections and local roads would be designed for a 20-year life. Pavement designs for each local road may differ depending on traffic loads. As most of the local roads carry very low traffic volumes, a standard local road pavement has been adopted for the concept design.

The pavement would extend the full width of the road formation (including shoulders).

6.1.6 Rest areas and emergency lay-by areas

The proposed outer shoulder widths would enable most vehicles to pull over at any location in the event of a sudden breakdown or other minor incidents, while retaining clearance to through-traffic. However, to enhance clearances and safety, localised shoulder widening is to be considered at the detailed design stage.

Lay-by areas would be required on both northbound and southbound carriageways at around 5 kilometre intervals to provide for emergency truck stopping bays and passenger vehicle lay-bys. The exact location of lay-by areas would be defined during detailed design.

Rest areas would be located approximately 500 metres south of Cooks Lane. Separate rest areas would be provided for each carriageway. Each rest area would ultimately provide parking for up to 20 B-double trucks, eight cars, and some vehicles towing trailers or caravans. Each of the rest areas may initially provide for up to 10 B-doubles. Space would be provided for additional parking as required in the future. Typical facilities would include toilet facilities, shaded areas and picnic tables.

The locations of the rest areas and emergency lay-by areas are shown in Figures 6-1a to 6-1s.

6.1.7 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 converging and diverging traffic streams.

The areas where lighting is required are as follows:

- South Kempsey interchange.
- Frederickton interchange.
- Stuarts Point Road interchange.
- Station Street left-in/left-out.
- Vehicle rest area.
- The underside of the Macleay River bridge.

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*. Lighting suitable for car park areas would be used for the vehicle rest area. Waterway lighting on the Macleay River bridge would be installed in accordance with NSW Maritime Authority requirements. This lighting would not be visible to motorists. The design of lighting would also consider potential visual impacts on adjacent landholders. Mitigation measures to reduce the potential impacts associated with light spill into adjacent residential areas include shielding provided by the existing, or planted, vegetation.

In all cases, where technically and economically feasible, the most energy efficient lighting technology would be used.

Fencing would be provided on both sides of the proposed upgrade to prevent pedestrian and livestock access onto the road reserve. Fauna fencing would also be provided at various locations where populations of native fauna have been identified. The fauna fencing would direct animals toward underpasses that allow safe crossing of the carriageways. Further details on fauna fencing are provided in Section 11.4 and illustrated in Figure 11-5.

Road signage would be determined during the detailed design phase and would conform to prevailing RTA practice. Discussions would be held with the Kempsey and Nambucca Shire councils during the detailed design phase in relation to any particular signage requirements. The signage would seek to alert motorists to the facilities and attractions available in and around the Macleay Valley, in particular in Kempsey.

6.1.8 Geotechnical issues

A geotechnical investigation has been completed to provide information for the completion of the concept design. Two unpublished reports have been prepared based on the geotechnical investigations: a *Geotechnical Investigation Report* and a *Geotechnical Design Report* (NSW Roads and Traffic Authority 2005 and 2007d). Further details on geology and soils are provided in Chapter 12 – *Geology and soils*.

In summary, over the southern portion of the proposed upgrade, the underlying rock is generally moderately resistant and less susceptible to erosion than in the northern portion, where more ground movement has contributed to a deeper weathering profile and reduced rock strength.

Quaternary sediments are widespread in low-lying areas, mainly associated with East Kempsey wetland, Macleay River floodplain and Collombatti Creek floodplain.

The proposed alignment crosses large areas of soft soils, particularly over the floodplain where the alignment would be on fill. The soft soils are of variable depth and overlie residual soils and weathered rock. Alluvial deposits extend in some areas (Macleay River floodplain) to depths in excess of 30 metres.

Further detailed geotechnical studies would be undertaken during detailed design to identify the extent and specific properties of the soft soils and to precisely determine the extent of surcharge and duration of loading required for embankment construction. Further discussion on impacts on geotechnical impacts is provided in Chapter 12 – *Geology and soils*.

6.2 Flood protection and drainage

The proposed upgrade would cross the Macleay River floodplain and other low-lying areas, resulting in changes to flooding behaviour and drainage patterns. The impacts of the proposed upgrade on hydrology are discussed in detail in Chapter 10 – *Hydrology and water management*. The following features have been incorporated into the design of the proposed upgrade to reduce the impacts of changes to flood behaviour, drainage and water quality.

6.2.1 Flooding controls

The proposed upgrade would increase water levels and the duration of inundation during and after flood events in some areas on the Macleay River floodplain. To protect homes and farms during flood events, it is proposed to provide site-specific measures to address flood impacts arising from the proposed upgrade. These measures may include amongst others, the raising of houses, construction of protective levees and provision of stock mounds to provide high ground for cattle.

Although these flood mitigation measures would require further consultation with the land owners, it is currently anticipated, based on available data, that approximately 30 houses would be raised and around 20 stock mounds constructed.

6.2.2 Frederickton levee

To protect properties on the western bank of the Macleay River at Frederickton, a flood levee would be constructed as part of the proposed upgrade. The levee would be approximately 1,070 metres long, running parallel to the Macleay River from the Macleay River Hotel to the end of Lawson Street and wrapping around to the existing Pacific Highway, as illustrated in Figure 6-1g and Figure 6-5. The levee would protect residential dwellings, the Macleay River Hotel and other commercial premises from flood waters.

The levee would be approximately 2 metres in height (above current ground level) to protect properties from flood inundation in a 100 year ARI flood. Where land permits, the levee would be an earth structure, with batter slopes typically at 4(horizontal):1(vertical). Where there is insufficient land to construct an earth structure, a concrete wall would be constructed. Floodgates on existing watercourses would ensure that drainage through the levee is maintained.

The proposed levee would be constructed prior to the commencement of earthworks on the Macleay River floodplain. A landscaping strategy has been developed to ensure that the visual impact of the proposed levee is reduced and that, where possible, views across the Macleay River are maintained. This is outlined in Sections 6.6 and 19.5.

Typical sections of the proposed Frederickton levee are provided in Figure 6-12.

The proposed levee would require the removal of an existing recreational boat ramp at the site of the old ferry crossing next to the former dairy factory buildings. A new site for the ramp has been identified to the east of the proposed Macleay River bridge. This location has been identified as a site that could be used by the construction contractor during the construction of the proposed new bridges over the Macleay River. Access would be provided via a short service road off the existing Pacific Highway. Ample parking would be available for trailers and cars. The construction of the boat ramp would increase the overall footprint of the proposed upgrade.

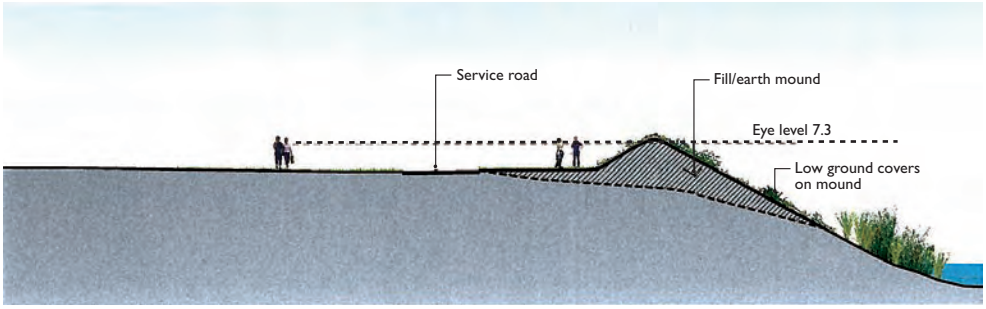
What is ARI?

ARI (Average Recurrence Interval) is the long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years.

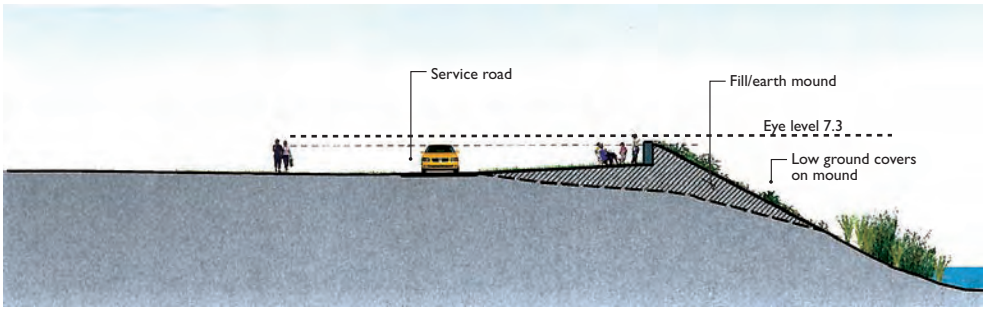
ARI is another way of expressing the likelihood of occurrence of a flood event (Department of Natural Resources 2005).

Photo: The Macleay River during March 2001 floods.

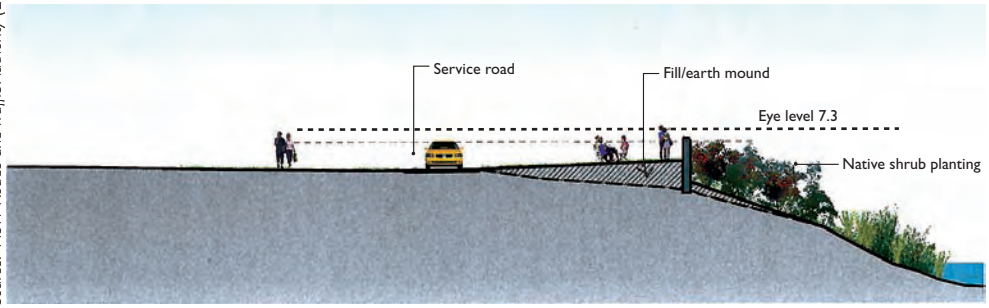
Figure 6-12 **Typical sections and perspective drawing – Frederickton flood levee**



Earth bank levee



Earth bank/wall levee



Wall levee

Source: NSW Roads and Traffic Authority (2006d)

Perspective drawing

6.2.3 Cross drainage and highway drainage

Cross culverts would be provided to convey run-off from upslope catchments beneath the proposed upgrade. The cross culverts would maintain natural flow regimes and existing flow paths.

Cross culverts have been designed with adequate capacity to convey the 1-in-100 year average recurrence interval (ARI) storm with:

- No flow on at least one carriageway of the proposed upgrade.
- Minimal increase to water levels upstream of the structure.
- Minimal disruption to the natural hydrological regime through the diversion of flow onto the adjoining catchment.

Where possible, culverts would accommodate terrestrial fauna movement. Culverts and scour protection would also be designed to be fish-friendly where aquatic habitats exist.

Culverts would be sized to ensure peak water levels upstream of the structure meet the road flood immunity requirements. A target water level was selected for each culvert location based on existing water levels, the impact of increased water levels on the upstream catchment, and the level at which water would spill onto the carriageway, other roads or into an adjoining catchment.

Appropriate scour protection would be installed upstream and downstream of all structures that have the potential to cause scour. The selection of appropriate scour protection depends 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, streams with high velocity flows may require devices to slow the flow prior to entry to the culvert and protect the stream bed.

Run-off from catchments upslope of the proposed upgrade would be collected in a batter drain and directed along the top or bottom of the batter to an existing watercourse or proposed culvert location.

The highway stormwater drainage system has been designed to cater for run-off from the pavement surface, cut batters and the depressed median of the proposed upgrade.

Bridge deck drainage systems would be devised during the detailed design phase of the project. It is anticipated that piped drainage in the bridge superstructure would provide adequate drainage of surface water.

6.2.4 Water quality controls

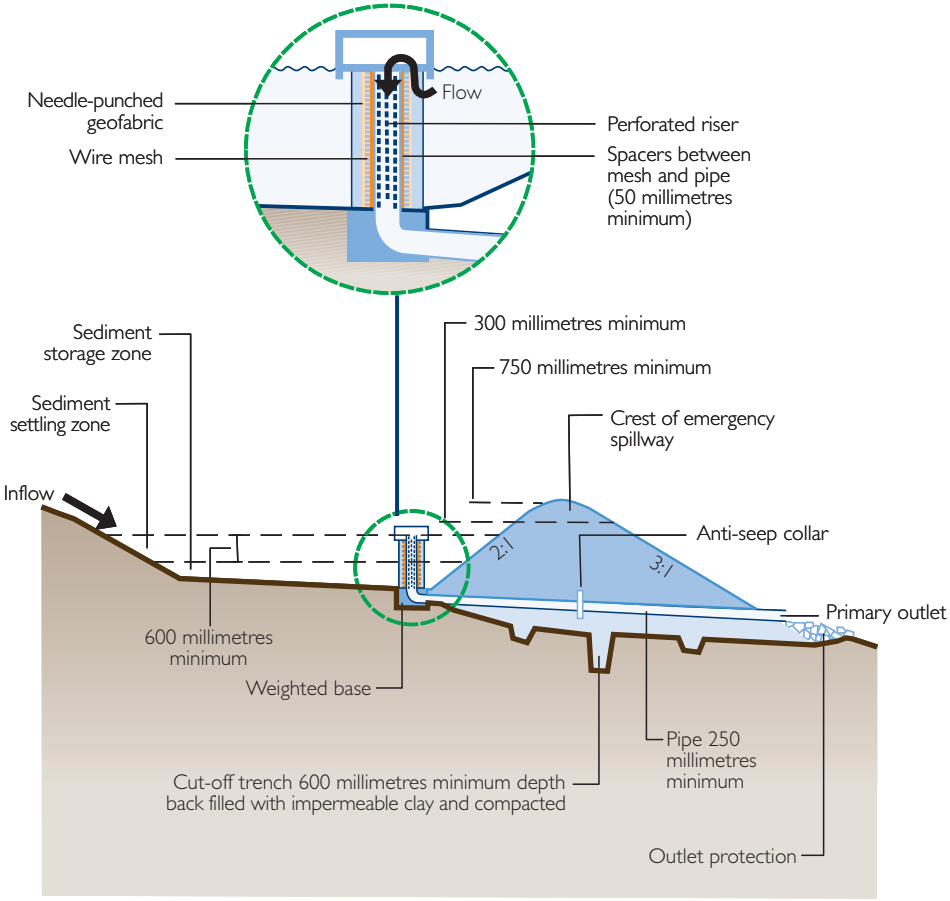
Sedimentation basins

Sedimentation basins would be constructed at various locations along the proposed upgrade. The location of these sedimentation basins would be determined following the completion of the detailed design phase of the project and as part of a site assessment by a qualified soil conservationist. The sedimentation basins would be constructed prior to the commencement of bulk earthworks, where practicable, and where site access permits. The basins have been sized in accordance with *Managing Urban Stormwater – Soil and Construction* (Landcom 2006) assuming fine, dispersive soils in all locations. In all other locations (i.e. smaller catchments) sediment fences would be constructed to intercept flow and retain the sediment during construction.

After completion of the proposed upgrade, selected sedimentation basins established during the construction phase would be retained as spill containment basins for the treatment of stormwater run-off from the road surface during operation.

An example of a sedimentation basin is illustrated in Figure 6-13. The location of sedimentation basins are illustrated in Figure 7-1 in Chapter 7 - *Detailed design and construction of the proposed upgrade.*

Figure 6-13 **Example of a sedimentation basin**



Spill containment basins

The management of spills from highway accidents would be addressed using a combination of grass-lined drains and spill containment basins (described above). Typically spill containment basins would be provided near sensitive receiving waters.

Where the proposed upgrade passes through areas that are not considered environmentally sensitive, no spill containment has been proposed.

The proposed locations of spill containment basins are shown in Figures 6-1a to 6-1s. The location and number of spill containment basins would be refined during the preparation of the detailed design.

6.3 Noise attenuation

As explained in Chapter 16 – *Noise and vibration,* approximately 116 residences identified in Figure 16-1 would be potentially noise affected as a result of the proposed upgrade. Around 75% of these are currently unexposed, or exposed to only low levels of existing road traffic noise.

For residences and other sensitive receivers that would experience noise levels above the relevant Department of Environment and Climate Change noise goals, various noise treatments would be applied to the proposed upgrade. These include using low-noise pavement or constructing noise barriers. Both of these options are expensive and are generally only used where a sufficient number of properties are grouped together to make these measures cost-effective. Where properties are sparsely located, architectural treatments of the residences would be considered.

Mitigation measures would most likely involve application of one or more of the available measures, including low-noise pavements, noise barriers and architectural treatments in combination to reduce the impacts of highway-related noise.

Further discussion on the location and use of noise barriers and other noise treatments is provided in Chapter 16 – *Noise and vibration*. The potential location of noise barriers is shown in Figure 16-15. An example of a noise barrier is shown in Figure 16-14.

6.4 Local transport network

Changes to the local road network, including changes to local access and pedestrian and cycle networks are described in Chapter 14 – *Traffic, transportation and access*.

6.5 Services

6.5.1 Relocation of existing services

Relocation of some existing services would be required. The services identified for relocation include water, electricity and communications. No sewer or gas mains have been identified as requiring relocation.

A summary of the major service relocations is provided in Table 6-7. Some additional minor relocations have also been identified, but these are not listed. A review of service relocations would be undertaken during the detailed design phase of the project.

Table 6-7 **Major service relocations**

Station	Description	Provider	Proposed treatment
0 – 800	Sydney to Brisbane fibre optic cable – perpendicular across existing highway then diagonal across alignment	Telstra	Relocate
2250	66 kilovolt overhead cable – regional parallel to the North Coast Railway	Transgrid	Install 2 x 23 metre (approx) poles and restring over or under highway overpass
3750	Low/11/33 kilovolt overhead cable – northern side of Crescent Head Road	Transgrid	Relocate underground north of Crescent Head Road
3750	Crescent Head Road 150 millimetre diameter pipe (AC)	Kempsey Shire Council	Relocate to the northern side of the Crescent Head Road realignment
3750	Telstra P100 & A100 – parallel to Crescent Head Road (south side)	Telstra	Relocate to south side of realigned Crescent Head Road
3750	Telstra copper cable – parallel to Crescent Head Road (north side)	Telstra	Relocate to north side of realigned Crescent Head Road
6950	Telstra P100 & P20 – Inches Road	Telstra	Relocate to the proposed Inches Road alignment and connect to bridge across proposed upgrade
7000	100 millimetre diameter pipe (UPVC) –Inches Road	Kempsey Shire Council	Relocate to new Inches Road alignment (cross proposed upgrade on the proposed bridge)
7550	200 millimetre diameter (UPVC) – Old Station Road	Kempsey Shire Council	Relocate to the southern side of Old Station Road and upgrade to ductile pipe
7550	11/33 kilovolt overhead cable – Old Station Road	Country Energy	Relocate underground north of Old Station Road
11780	11 kilovolt overhead cable – South West Rocks Road	Country Energy	Relocate 50 metres underground
13060	11 kilovolt overhead cable – existing Pacific Highway	Country Energy	Relocate 50 metres underground
13730	Transgrid overhead cable – Regional connection	Transgrid	Raise towers and cables to provide 12 metre clearance to the proposed upgrade
13730	132 kilovolt Transgrid overhead cable	Transgrid	Raise cables to provide clearance to proposed upgrade
14640	33 kilovolt overhead cable – adjacent to Raymonds Lane	Country Energy	Relocate underground
33700	Telstra 6 pair direct buried – crosses through major cutting	Telstra	Reconnect from Nirvana Way
35800	Telstra 10 pair direct buried – crosses diagonal across proposed upgrade and service road	Telstra	Protect
38600 – 39600	P63 VisionStream cable	VisionStream	Relocate to eastern side of proposed Upgrade
38700 – 39300	Telstra P50 – Parallel to east side	Telstra	Relocate to edge of batter
38900 – 39300	Telstra P50 – Parallel to west side	Telstra	Relocate to edge of batter

Note: *Proposed treatments for service relocations would be subject to refinement during the detailed design phase.*

6.5.2 Provision for new services

No dedicated corridor would be provided along the proposed upgrade for external utility services. The proposed alignment is tightly constrained and widths have been kept to a minimum to reduce the footprint of the proposed upgrade and associated impacts. A range of services currently follow the existing Pacific Highway alignment, local roads and other easements. It is, therefore, proposed that any future utility services would generally continue to use the existing utility corridor spaces.

Services required (either short or long-term) for operation of the proposed upgrade would include power for lighting and traffic information systems, and communications cabling. It is proposed that conduits for all of these services would be located within the shoulder of the road, with provision made for compatibility or conversion requirements for the ultimate six-lane configuration.

6.6 Concept urban and landscape design

6.6.1 Urban and landscape design strategy

The upgrading of the Pacific Highway is governed by a series of objectives that cover development in general, and others that deal with urban design outcomes. These are established in the Pacific Highway Urban Design Framework (NSW Roads and Traffic Authority 2005a) as follows:

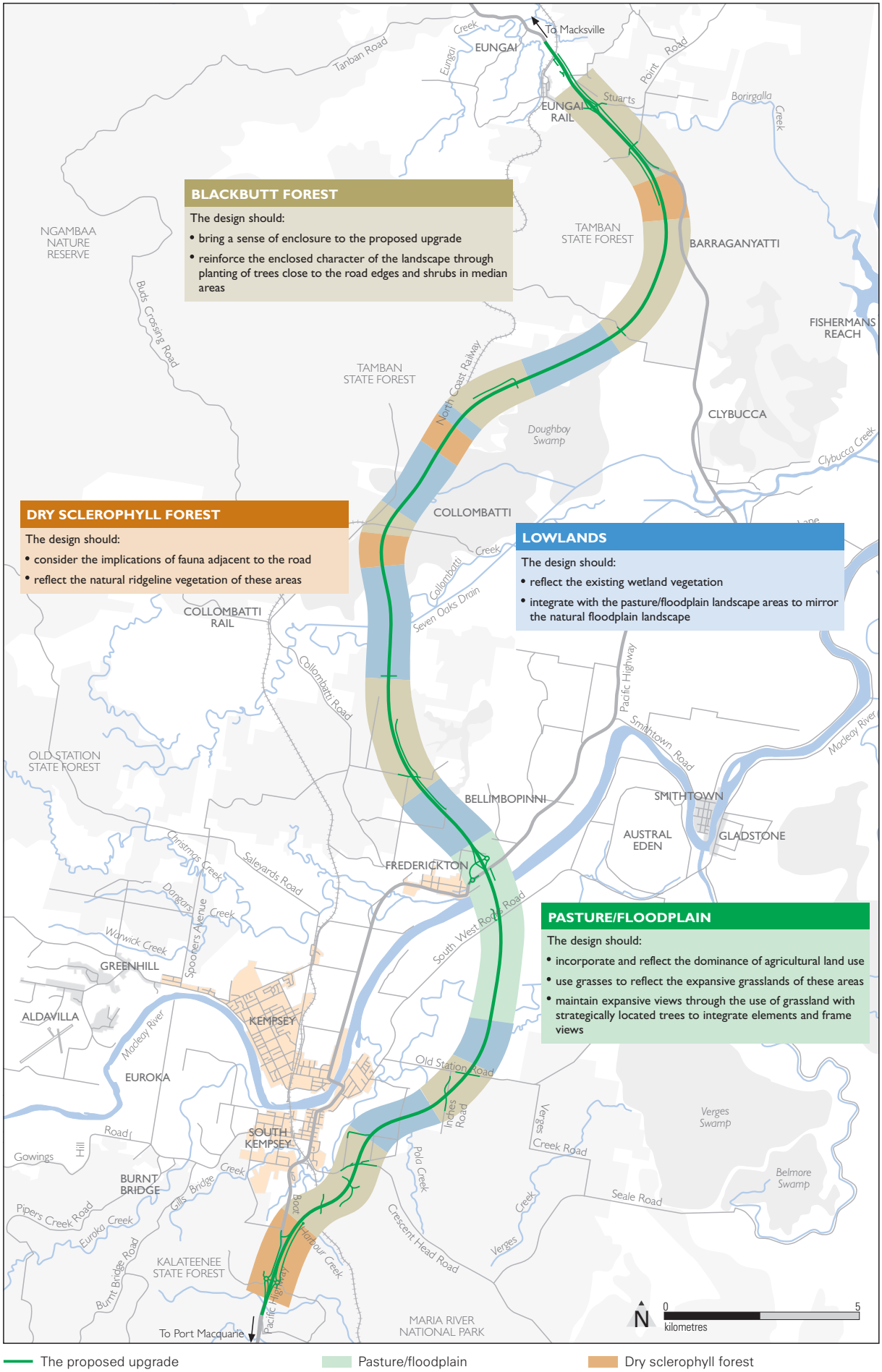
- Provide a flowing road alignment that is responsive to, and integrated with, the landscape.
- Provide a well vegetated, natural road reserve.
- Provide an enjoyable, interesting highway, with varied views and vistas of the landscape and pleasant restful places to stop.
- Value the communities and towns along the road.
- Provide consistency-with-variety in road elements.
- Provide a simplified and unobtrusive road design.

Key elements of the urban and landscape design strategy of the proposed upgrade include:

- Creating an entrance landmark by locating the South Kempsey interchange near a crest and using themed planting to provide a visual statement upon entering the Macleay Valley and the town of Kempsey.
- Reducing visual impacts on the Macleay River floodplain by minimising lengths of embankment and using quality, slim-lined bridging.
- Integrating the proposed upgrade with topographical features, for example, using topography to reduce impacts on views and adjusting carriageway levels to reduce the height of cuttings and retaining walls.
- Incorporating consistent, quality road structures, such as bridges, to achieve a high design standard and visual symmetry.
- Maintaining views across the Macleay River and floodplain to reinforce the context of the riverside towns of Kempsey and Frederickton and rural surrounds.
- Adopting different planting regimes to integrate with the various landscape character types and enhance the sense of progressing through different zones of a broader landscape.

The landscape strategy is illustrated in Figure 6-14. The urban and landscape concept plan is detailed in Section 19.5 and illustrated in Figures 19-4a to 19-4f and 19-5.

Figure 6-14 Landscape design strategy



6.7 Establishing the corridor

6.7.1 Road corridor requirements

The road corridor width for the proposed upgrade would vary considerably. At the interchanges, the road would be approximately 250 metres wide, while where there are high embankments or deep cuttings, it would be approximately 150 metres wide. However, at other locations, where the road is at ground level, the width would generally be reduced to between 90 and 100 metres to minimise the extent of property acquisition.

The highway'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 road corridor boundary is shown in Figures 6-1a to 6-1s.

Land within this corridor would be acquired in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. In addition, during negotiations with property owners, consideration would be given to additional acquisition to overcome difficulties of severed access to sections of isolated land. Each acquisition would be considered on its individual merit. A copy of the RTA's Land Acquisition Policy is provided in Appendix E.

Further information of property acquisition and property impacts is provided in Chapter 15 – *Land use and property*.