

Chapter 8 - Description of short listed route options

Not used

8.0 Description of short listed route options

The four sections of the study area were used to facilitate analysis and assessment of route options. The short listed route options are described below, section by section. Following the public display and consultation process, detailed comparison and evaluation of these route options will be carried out in the next phase of the project. Route options are all described in a north to south direction.

The RTA is committed to provide certain facilities as part of this upgrade. However, as these facilities do not affect the assessment and selection of feasible options they are not included in the descriptions below. Such features include provisions for pedestrians and cyclists, RTA stockpiles, interchanges, intersections, storm water sedimentation and detention facilities.

Of more significance are rest area facilities for heavy vehicles. The RTA is committed to providing a heavy vehicle rest area in the northbound and southbound directions as part of the upgrade. Potential locations have been selected for heavy vehicle rest areas based on the RTA publication "*Rest Area Best Practice Design Guide*" 2004. Currently three sites have been identified. These sites are shown in **Figure 7.4**.

Site selection criteria for the heavy vehicle rest areas include:

- Downhill exit grade (and preferable uphill entry grade).
- Remote from dwellings.
- Level site for sleeping (or readily levelled).
- Pleasant outlook and surrounds.

In addition to these criteria, sites have been selected on potentially disused sections of the highway corridor which have sufficient area for ablution facilities and parking for 10 B-Double trucks.

Following the description of the options (in **Section 8.6**) is a summary of the Stage 1 Road Safety Audit which has been carried out on the preliminary concept design.

8.1 Section A (Mount Pleasant to south Gerringong)

8.1.1 Overview

Only one route option is included in the short list to be considered further i.e. an upgrade of the existing alignment. The Red route will make good use of the existing road reserve. As the upgrade is to include physical separation of the opposing carriageways the design will include careful consideration of an appropriate access and intersection strategy¹³. The Red route is shown in **Figure 8.1**.

8.1.2 Alignment (road safety / efficiency)

The horizontal alignment is relatively good however the existing and relatively steep grade of approximately eight per cent would remain. Further detailed analysis will consider the provision of a climbing lane for the northbound direction. Particular attention will be paid to providing appropriate measures to manage the potential for higher speeds on the relatively steep down grades in the southbound direction. This will also be considered as part of the road safety strategy.

8.1.3 Regional and local economic development

8.1.3.1 General

The steep lengths of the existing highway along the red route already has a northbound climbing lane (i.e. three lanes in total). Therefore the increase in width required to provide two lanes in each direction plus a potential northbound climbing lane will be no greater than where no climbing lane is required. This means the Red route will have minimal impact on regional and local development and is consistent with local and state planning policies.

A controlled access strategy will be implemented. Although not all properties and local roads will maintain direct access to the highway, safe access will be provided which may include provision of service roads. Access to and from the town of Gerringong will be assessed in detail separately from the route options development process and will take into account feedback from the community regarding access requirements and possible intersection locations.

8.1.3.2 Planning and legislation

The existing road reserve is zoned a combination of Arterial Road and 9(a) Arterial Road Widening under the Kiama Local Environmental Plan. Adjoining land to the west is zoned 1(a) Rural 'A'. These zones do not preclude the upgrade of Princes Highway as such works would be permissible with development consent. However, development in the Rural 1(a) zone should minimise the fragmentation of rural land of prime crop and pasture potential, and strip acquisition along the Red route is consistent with this.

It should be noted that under the 7(b) Environmental Protection (wetlands) zone road works are prohibited under Kiama Local Environmental Plan. Land to the north of Gerringong on the eastern side of the existing Princes Highway is currently zoned 7(b). Should the upgrade works encroach into the 7(b) zone, there may be significant statutory planning constraints on those works.

8.1.3.3 Land use and property impacts

Widening will be required for the construction of the Red route, but the impacts of property acquisition and severance will be minimised generally by widening on one side of the existing highway. Careful consideration will be given to the dairies and the vineyard to the west of the existing highway. Additional land along the existing highway corridor adjacent to Gerringong has been designated as road. A highway upgrade along the Red Route is likely to meet community expectations.

8.1.4 Environmental impacts

8.1.4.1 Water quality

Impacts on water quality are minimised by upgrading the existing highway. Some existing drainage structures may need to be augmented to achieve flood immunity but there are no major waterway crossings required for this route. Water quality management of Werri Lagoon and associated State Environmental Planning Policy 14 Wetland will need to be considered in detail prior to construction and operation and will be assessed as part of the environmental assessment for the preferred route.

8.1.4.2 Terrestrial ecology

The Red route will have minimal impact on terrestrial ecology. Little or no clearing of vegetation with conservation significance will be required and little or no significant habitat occurs adjacent to the existing highway in this section.

¹³ Appropriate access to Gerringong is particularly important and is being examined separately from the route option development process as access does not affect the choice of alignment in this case.

8.1.4.3 Aquatic ecology

The Red route will have little or no impact on aquatic ecology. No major waterway crossings are required and aquatic habitat impacts will be minimal. There may be some augmentation of drainage structures which will not have a significant impact on sensitive aquatic habitats (although this will be further assessed during the environmental assessment of the preferred route).

8.1.4.4 Heritage

There will be minimal impact on cultural heritage values. The area immediately surrounding the existing highway has low archaeological sensitivity. There are no European heritage items or significant Aboriginal archaeological deposits recorded in the vicinity of the existing highway in Section A that would be adversely impacted on by an upgrade of the existing alignment.

8.1.5 Community impacts

8.1.5.1 Community issues

Community issues surrounding the Red route relate primarily to access. It is fair to report that the community at large are uncomfortable with the present arrangement of the Fern Street intersection.

Although not directly affecting choice of route options at this stage, the location and form of access is very important to the continued social and business well being of Gerringong. Access to Gerringong will be assessed in detail during the next phase of the project once a preferred route has been identified and will take into account feedback from the community.

8.1.5.2 Noise and vibration

The Red route follows the existing road corridor and is not likely to cause a significant change in the noise environment for the overall community. However, there may be some increase in noise levels for receivers immediately adjacent to the highway as the road will need to be widened and may move it closer to some receivers. The overall community may experience a minor increase in noise levels if the posted traffic speeds are increased.

8.1.5.3 Urban design, landscape and visual amenity

In the north the Red route will have a visual impact as the route descends the high ground from Mount Pleasant and crosses Omega Flat. Reinforcement of the openness of the landscape is appropriate where expansive views of pastureland from the highway are desirable. Ocean and pastoral views will be maintained on the descent from Mount Pleasant.

As this route is based on an upgrade of the existing highway, the long term impact could be expected to be similar to that of the existing highway. However as it will be a wider formation and appear "new" immediately following completion the impact will be greater. The eastern edge of the "new" corridor provides the opportunity for cultural landscape plantings to define the western edge of Gerringong.

By upgrading the existing highway many of the urban design objectives can be satisfied as both the natural and cultural landscape context has evolved within this corridor for some time. The key urban design initiatives of this route option will:

- Protect and enhance the heritage and cultural values of this section of the corridor, by limiting the increased footprint of the highway corridor.
- Respect and respond to the Gerringong township by providing safe and improved access.

- Integrate the enjoyment of the existing journey by maintaining the strong visual connections to the ocean, hinterland and mountains beyond while also passing through the unique Omega Flat area adjacent to Werri Lagoon.

The urban and landscape design of this section will have a mixture of rural and semi-urban highway characteristics. There is likely to be a grade separated interchange with a relatively significant overbridge structure. Effort will be required to ensure that this does not have an inappropriate urban "feel". Careful integration of these elements will ensure that the existing landscape patterns and form that dictate the current experiences will not be adversely impacted by the upgrade works.

8.1.6 Engineering

8.1.6.1 Structures

Apart from an interchange bridge, no significant structures are required for the Red route.

8.1.6.2 Ground conditions

Widening of the existing road corridor will be required. Depending on the optimum balance in terms of land use and acquisition, sections of fill and cut earthworks will be required. Some lengths of existing cut slopes exhibit minor instability. Sections of retaining features such as soil nails and rock bolts are may be required. Underlying rock in some areas has been classified as "very high strength" rock. Some cuttings along this route may require blasting.

The Omega Flat area comprises estuarine soils with high probability of soft soils and acid sulphate soils.

8.1.6.3 Flooding and drainage

At the southern extent i.e. in the low lying areas immediately south of Gerringong, the existing highway is prone to occasional flooding. Pursuant to the design requirements as discussed in **Chapter 6** the upgrade is required to be flood immune. The level of the existing highway will need to be raised in some areas and reconstruction and or widening of existing transverse drainage structures may be necessary.

8.1.6.4 Major public utilities

Major public utilities in this area comprise fibre optic cables, the Eastern Gas Pipeline and the Sydney Water Corporation water main. This route crosses the water main at two locations between Rose Valley Road and Fern Street, however this will not present any particular design or construction difficulties.

8.1.6.5 Earthworks

Two discrete portions exist in this section. To the north, earthworks comprise short lengths of relatively low fill embankments and shallow cut excavations. Rock won from cuttings will provide a valuable source of fill construction materials in the southern portion. The southern portion, traversing Omega Flat, has typical floodplain characteristics. Preliminary geotechnical investigations indicate that soft soil treatments will be required to manage long term settlements. These could include mini-piles, preloading and surcharging with wick drains. The presence of acid sulphate soils requires particular consideration in relation to project risk.

Adjacent to Burnett Street at the north of Gerringong, the alignment passes through cutting to a maximum depth of seven metres and an approximate length of 400 m.

8.1.7 Value for money - cost, constructability and project risk

Concept cost estimates are presented in **Chapter 9**.

This option is relatively straightforward in terms of upgrading a highway. Construction will be able to proceed with at least one lane in each direction in operation at all times controlled by construction speed zones. Careful attention will need to be given to maintain the safety of existing junctions at Fern Street and Belinda Street during construction.

Generally this route poses no unusual construction risks. However there are time and cost risks associated with construction over soft and acid sulphate soils at Omega Flat.

8.2 Section B (south Gerringong to north Berry)

8.2.1 Overview

Three options emerged as performing markedly better than others in the long list of route options i.e. the Pink route, Green route and Yellow route (refer **Figures 8.2, 8.3 and 8.4**).

They share a common starting point on the existing highway south of Gerringong and terminate between Gembrook Lane and Tindalls Lane, again on the existing highway alignment. All three cross Broughton Creek.

The Pink route generally follows the existing highway corridor except for a 3.5 km length around and south-east of Foxground where the existing alignment is significantly sub-standard for the proposed design speed.

The current alignment of the existing highway is well below the standard for the upgrade, requiring reconstruction of the existing highway as well as the provision of additional lanes.

The Green route shares the same alignment as the Pink route for approximately two thirds of Section B. This route diverges from the existing highway near Toolijooa Road and passes under the Toolijooa ridge line at the "north saddle" in tunnel (approximately 350 m in length). The route emerges in the Broughton Creek floodplain and curves south-west and south before crossing Broughton Creek three times and rejoining the existing highway just north of Austral Park Road.

The Yellow route follows the railway line south of Gerringong. After approximately 4.5 km, the route sweeps west around the hill at Toolijooa and to the north-west of Harley Hill. The route passes under the "south saddle" ridge in tunnel (approximately 350 m in length). The route follows a relatively straight alignment before crossing Broughton Creek and rejoining the existing highway at the same location as the Pink and green routes.

8.2.2 Alignment (road safety / efficiency)

The alignment of the Pink route is appropriate for a posted speed of 100 km/h. At Foxground the vertical grade is in the order of eight per cent and the horizontal curve transitions from a radius of approximately 1200 m to 900 m. To ensure an acceptable level of road safety, careful consideration would be given to the horizontal curve transition, the superelevation and the need for a climbing lane at this location together with appropriate measures to manage potential high downhill speeds.

The Green route is the same as the above apart from the more direct alignment taken through the hillside and over the Broughton Creek floodplain. The vertical grade achieved by tunnelling through the hillside, in the order of one per cent, is significantly easier than the Pink route, resulting in greater efficiency and safety. The maximum grade of the Green route is six per cent in a section that is common with the Pink route.

The Yellow route is generally very good in terms of both horizontal and vertical alignment. It provides a maximum vertical grade of four per cent at the eastern approach to the tunnel and with few horizontal curves, results in a highly efficient route.

8.2.3 Regional and local economic development

8.2.3.1 General

The Pink and the Green route largely follow the existing highway until they reach the Foxground area, where they diverge. Both routes partially sever rural allotments. There are some direct impacts on rural dwellings associated with the Pink route at the Toolijooa Road junction where it diverges from the existing highway.

Generally the Pink and Green routes promote the reuse of existing resources by utilising the existing highway for most of their length. The Green route has some additional costs associated with the length of tunnel through the Toolijooa ridge line, but the construction of this length of tunnel would also be beneficial in terms of reduced land take and severance as well as reduced impact on ecological resources.

The Yellow route largely follows the railway line for much of its length, which has the advantage of minimising land acquisition and severance and also offers opportunities for co-location with existing infrastructure for some of its length. The construction of the tunnel in the Yellow route also offers some mitigation of land use impacts by reducing land take and severance, but has a direct impact on an existing organic farm. This potential impact would be assessed in more detail through the value management process prior to the selection of the preferred route.

8.2.3.2 Planning and legislation

All three routes in Section B pass largely through land zoned as 1(a) Rural under both the Kiama and the Shoalhaven Local Environmental Plans. The road is permissible with consent under both Local Environmental Plan zonings.

The Yellow route has the potential to impact on a potential future development in the form of a caravan park in the Toolijooa area. At the time of writing, a Development Application has been submitted to Kiama Council and an assessment and determination has not been released. This development application, as with others in the study area will be monitored during subsequent stages of the project.

8.2.3.3 Land use and property impacts

The Pink and Green routes have a lesser impact on property severance and land acquisition generally as they follow more of the existing alignment than the Yellow route. However there may be some acquisition required for small lot rural residential properties fronting the existing highway in order to upgrade the existing alignment to meet the required road design standards. Of the two routes, the Green route would have a slightly lesser impact in terms of direct property acquisition because it incorporates a section of tunnel through the Toolijooa ridge.

There are also direct property impacts associated with both routes as they diverge from the existing alignment. The Pink route would also require a larger footprint than the Green route to incorporate the large cutting and embankment required to negotiate the steep terrain to the west of Toolijooa ridge.

The two large dairy farms that are already severed by the South Coast railway corridor will be further severed by the Yellow route as it traverses the low lying land. The route also severs large and small property holdings as it diverges from the railway and rejoins the existing highway at Austral Park Road. The land severed by the Yellow route is predominantly Class 2 agricultural land and used largely for dairy farming. As the Yellow route emerges from the southern portal of the tunnel under the Toolijooa ridge, it has a significant severance impact on an organic farm.

This farm is registered with the Organic Growers of Australia. Further review will be carried out to ascertain the continuing viability of the farm. The route would also require measures to preserve amenity in some nearby dwellings.

Additional land use impacts associated with the Yellow route includes interference with the existing Sydney Water Irrigation System located between the existing highway and the South Coast railway line. This will require careful planning and consideration should this route be taken forward as the preferred route.

8.2.4 Environmental impacts

8.2.4.1 Water quality

The Pink, Green and Yellow routes all cross the Crooked River. The Pink and Green routes cross Broughton Creek three times. The Yellow route crosses Broughton Creek once.

The Yellow route however traverses significantly lower lying land than the Pink and Green routes and would be more prone to flooding both during construction and operation. This would require careful design consideration, especially given the proximity of the Crooked River wetland area on the eastern side of the railway, which supports an area of high significance Estuarine Fringe Forest.

8.2.4.2 Terrestrial ecology

Significant ecological impacts associated with a route passing across Toolijooa ridge are largely negated by the Green route as in tunnel it passes under a significant area of Endangered Ecological Community and some significant populations of known threatened species. There would however be some minor impact caused by earthworks required at the northern portal of the tunnel. Compensatory planting would ameliorate the impact.

Both the Pink and Green routes would have marginal impact on patches of native vegetation and corridor values. The Pink route would have some impact on a small patch of low significance vegetation to the west of Toolijooa ridge. Both the Pink and Green routes would avoid a known area of highly significant vegetation located adjacent to the existing highway on the western side at Foxground.

The Yellow route would have a minor impact on native vegetation as it passes along the railway line for much of its length, but would impact on some degraded vegetation adjoining a large patch of Endangered Ecological Community to the south of Toolijooa ridge.

As discussed in **Section 5.1.4.8** wildlife corridors exist in the study area and the Pink, Green and Yellow routes would all have some impact on fauna species in these corridor habitats and elsewhere.

8.2.4.3 Aquatic ecology

The Pink and Green routes require three crossings of Broughton Creek and other significant waterways that will require careful design management.

The Yellow route has a minor impact on aquatic ecology requiring one crossing of Broughton Creek. The Yellow route does traverse significantly low lying land in the vicinity of the Crooked River wetland area on the eastern side of the railway.

8.2.4.4 Heritage

All routes run in proximity to the archaeologically sensitive Toolijooa ridge, which has Indigenous heritage implications. The routes largely avoid European heritage sites. The Yellow route has a likelihood of disturbing a known, recorded archaeological site to the south of Toolijooa ridge. The Pink and Green routes have the potential to impact an Aboriginal battleground at Broughton Creek flats.

The bridge carrying the existing highway over Broughton Creek is heritage listed. The Pink route has the potential to impact this.

8.2.5 Community impacts

8.2.5.1 Community issues

The Pink and Green routes follow the existing highway for much of their length. As with any route comprising upgrading of the existing highway, community issues include provision of safe and convenient access. Severance of land area in the Broughton Creek floodplain is a concern as is property acquisition which will be necessary along widened sections of the existing highway. The Green route will have a marginally reduced degree of community impact as severance is reduced through use of a tunnel.

The Yellow route follows the existing railway corridor in the northern part of Section B. For much of this length community and social issues are of relatively low impact as dwellings and farms are sparse. Around Toolijooa however, impacts will be significant. Impacts include land acquisition, severance, expansion of currently lightly used transport corridor, access into a relatively undisturbed rural community, access and significantly increased noise and visual intrusion. Between the community of Toolijooa and where the upgrade meets the existing highway at Austral Park Road, the impacts include significant land acquisition, severance and impacts on farm use.

8.2.5.2 Noise and vibration

As the Pink route largely follows the existing highway it would have the least change to current noise patterns. Although the Green route passes further away from the total number of receivers, the relative impact is significant as it would bring noise closer to receivers which currently enjoy relative quiet. As the Yellow route is a new alignment it would have significant impact on receivers currently far from the highway. Residences adjacent to the existing highway would enjoy a reduction in noise with the Green and Pink routes. However, as the existing highway would remain operational, they would be impacted by some noise from more than one direction.

8.2.5.3 Urban design, landscape and visual amenity

The alignment of the Pink route stays close to the existing Princes Highway alignment which is highly responsive to the natural varied and sloped terrain in this area. The Pink route would traverse areas of slope that average between 20 - 30%, with some areas greater than 30%.

The upgrade objectives require a broad scale flowing alignment to meet safety and design speed criteria. This results in a significant cut embankment on the northern slope of the Toolijooa ridge in an area of high visibility. Large cut embankments in the order of 30 m deep and 900 m long in such areas may appear to be visually unbalanced with the natural landform.

The Pink route will clearly address some of the urban design objectives, but at the same time will provide a challenge in relation to other objectives. While the alignment flows to some extent the large cutting will not easily integrate with the natural landform and may not visually support the natural systems and ecology of the corridor.

Maintaining an alignment within the existing highway corridor will help to protect the heritage and cultural values of the corridor by reducing land severance and avoiding areas of significant habitat.

The Green route provides a similar flowing alignment to that of the Pink route but the integration of a tunnel will significantly reduce the visual impact to the ridgeline and protects the natural ecology and cultural values of the corridor. A cutting would still be required to accommodate the south bound portal that is otherwise associated with the cutting required by the Pink route.

The Green route option consistently addresses and satisfies the urban design objectives for the upgrade. While there is no precedent in the area to date for vehicular tunnels, the tunnel required for the Green route would to some degree be consistent with existing tunnels utilised by the South Coast railway line at numerous locations.

The Yellow route utilises the established infrastructure corridor of the existing railway line. This co-existence of railway and highway has already been established along the western edge of Gerringong. In assessing this route against the urban design criteria, the majority of the objectives are satisfied in varying degrees.

The alignment responds to the cultural and landscape context of the area and, by nature it is integrated with the surrounding flat plain at the northern end of the route.

The straight and flat alignment along a two to three metre high embankment adjacent to the railway line provides the motorist with an expansive view of the surrounding pastures and wetlands to the east and Toolijooa ridge to the west.

As the route turns west the alignment is more responsive to the rolling terrain of Toolijooa ridge. The incorporation of the tunnel reduces the scale of earthworks that would be associated with a large cut and protects the natural ecological and cultural values of the Toolijooa area.

The visual impact of the northern part of the Yellow route on nearby residents at Toolijooa and Harley Hill is significant.

The alignment of the Pink, Green and Yellow routes are the same once they reach Austral Park Road and generally follow the existing highway alignment until the start of Section C. A large cutting will be required for all routes in this area due to the close proximity of the existing highway alignment to the lower slopes of the escarpment. Urban design mitigation measures would be considered as the design evolves to minimise the visual impact of this cutting.

8.2.6 Engineering

8.2.6.1 Structures

The Pink route requires bridge structures over the Crooked River and three crossings of Broughton Creek. These crossings should be relatively straightforward and the alignment should suit standard bridge design and construction methods.

The Green route requires the same structures as the Pink route. Both the Green and the Yellow routes require a tunnel of approximately 350 m in length. Preliminary geotechnical investigations indicate that underlying rock is fine grained sandstone of high strength. This readily lends itself to modern tunnelling techniques such as a road header. Both routes would most likely require twin tunnels, each carrying one direction of traffic.

The Yellow route also requires bridge structures over the Crooked River and Broughton Creek. Again, the route alignment lends itself to accommodating relatively straightforward bridge designs.

8.2.6.2 Ground conditions

Alluvial material and acid sulphate soils are likely to be encountered in low lying areas, requiring careful treatment.

The Pink route crosses the floodplain of Crooked River and although information available indicates mostly alluvial material exists there is a possibility of acid sulphate soils being present. Immediately further south, the Pink route climbs to higher ground (i.e. away from the low lying and soft soil conditions) and requires cuttings producing relatively good quality earthwork materials. The route passes Foxground in a combination of embankments and cuttings. Alluvial and acid sulphate soils are likely to be encountered in the Broughton Creek floodplain before better ground conditions are met along the bottom of the ridges leading towards the southern end of this section.

The Green route is as per the Pink route except for the large fill embankment leading up to the tunnel through the north saddle of the Toolijooa ridge. As discussed above, the underlying bedrock is relatively well suited to tunnelling.

The Yellow route crosses the floodplain of the Crooked River and low lying areas of Toolijooa adjacent to the railway line. Estuarine soils, which are likely to be soft and contain acid sulphate, occur over much of the Yellow route adjacent to the railway line. The Yellow route diverges from the railway line and into more favourable soil conditions before heading into a tunnel through the "south saddle" of Toolijooa ridge. Initial investigations indicate that the underlying bedrock at the location is relatively well suited to tunnelling.

Upon exiting the tunnel, the Yellow route encounters similar conditions to those of the Pink and Green routes.

8.2.6.3 Flooding and drainage

The low lying areas are all flood prone and suitable treatments are required to deal with the affects. These include raising the finished road level above the required flood immunity level and providing adequate cross drainage.

Each of the water courses encountered along these routes would require bridges or culverts to meet flood mitigation requirements. The Yellow route crosses significant lengths of floodplain and would require many transverse drainage structures to ensure no adverse flooding affects are created by the upgrade.

8.2.6.4 Major public utilities

Major public utilities in this section comprise fibre optic cables and the Eastern Gas Pipeline.

In the north close to the southern extent of Gerringong, both the Pink and Green routes cross the Eastern Gas Pipeline and the Optus fibre optic cable. Both of these crossings can be accommodated in embankment with protective structures over the services as necessary. The Yellow route crosses the Eastern Gas Pipeline three times. (Once close to Crooked River and once close to Sharpes Lane. The tunnel through the "south saddle" passes under the Eastern Gas Pipeline.

In the south and close to Austral Park Road, the Pink, Green and Yellow routes follow the existing highway alignment and close to the alignment of the Optus fibre optic cable. This cable may require relocation and/or protection. The Pink, Green and Yellow routes all involve a crossing of the Eastern Gas Pipeline in embankment close to Tindalls Lane. This is in the vicinity of an existing crossing by the highway and would involve similar construction and protection techniques.

8.2.6.5 Earthworks

The majority of the lengths of the Pink and Green routes involve upgrading the existing highway. This would include widening for the most part. For areas which are sub-standard in terms of horizontal and or vertical alignment, reconstruction may be the only solution.

The most significant feature of the Pink route is a large cutting commencing at the property or area called Kellyong just north of the existing Foxground junction. This cutting is approximately 900 m long and has a maximum depth of 27 m.

The tunnel in the Green route reduces significant earthwork features.

The Pink, Green and Yellow routes achieve a balance between cut and fill earthworks material.

8.2.7 Value for money - cost, constructability and project risk

Concept cost estimates are presented in **Chapter 9**.

The Pink route is the longest of the three, but would be the least costly. Both the Green and Yellow routes would incur additional cost for similar lengths of tunnel, however the Yellow route would be more costly overall because of the need to address extensive soft soil foundations.

The Pink and the Green routes follow the existing sub-standard alignment for much of their length. These routes would require significant traffic management as the existing highway is widened and reconstructed. Tunnelling on the Green and Yellow routes presents a different set of risks to those encountered in open excavation. Preliminary geotechnical investigations indicate the rock likely to be encountered is suitable for tunnelling under current design and construction techniques.

A significant length of the Yellow route comprises off-line construction and therefore presents the best scenario for traffic delay and disruption. Due to the presence of soft soils and acid sulphate soils, timely construction methods would have to be employed to manage short and long term settlement. As this route is off-line, preloading and or surcharging could proceed with minimal effect on traffic which could continue to use the existing highway. A disadvantage would be that relatively long sections of new work would remain incomplete (i.e. without a pavement) until all the settlement was achieved. Due to the long settlement times required for the soft soils, the delay on opening could be lengthy.

8.3 Section C (Berry Township)

8.3.1 Overview

The Blue and Orange routes are shown on **Figures 8.5 and 8.6** respectively.

The Blue route departs from the existing highway alignment at Tindalls Lane, continuing west before turning south to rejoin the existing highway alignment at Kangaroo Valley Road. The Blue route requires bridge crossings of Broughton Mill, Connollys and Bundewallah creeks. It also crosses Woodhill Mountain and Bong Bong Roads. It is proposed that both these roads remain operational and pass either over or under the upgrade.

The longitudinal profile of the Blue route gently undulates with a relatively minor amount of earthworks to provide flood immunity.

From Tindalls Lane the Orange route generally follows the existing highway corridor for 2.5 km before descending the southern slopes of the ridge. The route then swings to the west via a right hand curve to follow an alignment parallel to North Street within a gazetted road corridor. As with the Blue route, the Orange route crosses Woodhill Mountain Road and Broughton Mill Creek.

At the western end of North Street, the Orange route turns to the south-west and rejoins the existing alignment just south of Kangaroo Valley Road.

Both options cross Kangaroo Valley Road in cutting providing the opportunity for Kangaroo Valley Road to cross the highway upgrade on an overbridge.

South of Kangaroo Valley Road the routes are identical and involve upgrading of the existing highway to the end of Section C at Croziers Road. Upgrading this section of the highway to the appropriate geometric and safety standards requires the current road alignment to be "smoothed out" in places with new embankments and cuttings.

8.3.2 Alignment (road safety / efficiency)

The Blue route provides a high quality alignment and therefore provides an efficient solution and would perform well in terms of road safety. The Orange route also provides good alignment qualities. The tighter curves on the town approaches provide a more urban highway characteristic.

8.3.3 Regional and local economic development

8.3.3.1 General

Both routes have the potential to cause community severance by creating a physical barrier between the existing township of Berry and future residential growth to the west of Berry along Kangaroo Valley Road. Careful design, incorporating an overbridge, would be required to maintain connectivity between the town centre and the future planned residential development to the west of Berry.

The Orange route includes existing road widening provisions to the north of Berry adjacent to North Street. Between the residential areas, the sportsground and the park at the eastern end of North Street access will need to be resolved. The Orange route is in accordance with current and planned land use in that it makes use of an existing road corridor immediately north of North Street. To a certain degree this route has been expected by the community for some time, due to the gazettal of the corridor, subsequent purchase of significant sections by the RTA and a previous assessment of a Berry bypass.

8.3.3.2 Planning and legislation

The road is permissible with consent along both routes in Section C, with the Orange route utilising existing road widening provisions to the north of Berry along the North Street corridor.

8.3.3.3 Land use and property impacts

The Blue route severs an existing vineyard and several large and small agricultural lots of Class 2, 3 and 4 to the north and west of Berry. For much of its length, the Blue route does not match existing property boundaries, which increases the impacts of severance caused by land acquisition.

Of the two routes proposed to bypass Berry, the Orange route has a lesser impact in terms of land use and property impacts because it utilises more of the existing highway reserve. Where it diverts from the existing alignment, it runs largely along a gazetted road corridor.

8.3.4 Environmental impacts

8.3.4.1 Water quality

The Blue route requires three major waterway crossings to the north of Berry and water quality management would need to be considered in detail if the route progresses to concept design.

The Orange route would have a lesser impact on water quality in that waterway crossings are fewer, but a significant structure would also be required for the Orange route to cross Broughton Mill Creek and Woodhill Mountain Road in the vicinity of Pullman Street, to the north of Berry. Potential impact on water quality would be a significant issue for both routes in Section C. Precautions and mitigation measures would be considered in a water quality management strategy to be developed for the design, construction and operation phases of the upgrade.

8.3.4.2 Terrestrial ecology

Both routes have a marginal impact on a patch of moderate significance vegetation along the western side of the existing highway near Tindalls Lane. The Blue route would require more vegetation clearance and impact on more riparian vegetation than the Orange route.

8.3.4.3 Aquatic ecology

The Blue and Orange routes both require major waterway crossings to the north of Berry potentially impacting on aquatic ecology and riparian stability. Of the two routes, the Blue route would have a greater impact, affecting more riparian vegetation and potentially more, higher quality aquatic habitat as it requires additional waterway crossings to the Orange route. This is not considered significant and impacts for both routes could be managed to environmentally acceptable standards.

8.3.4.4 Heritage

The Orange route has a potential to impact the Pullman Street and Tannery Lane European heritage precinct immediately to the north of Berry.

The Blue route has a lesser impact on heritage than the Orange route. Although the Blue route is located close to three known Aboriginal archaeological sites recorded during the construction of the Eastern Gas Pipeline, these sites can be avoided while finalising the route.

8.3.5 Community impacts

8.3.5.1 Community issues

Community issues for the Blue route include the crossing of areas of rural agricultural land and community severance. As Woodhill Mountain Road and Bong Bong Road remain operational community severance is likely to be visual in nature as access would be unaffected.

Interchange locations to the south of Berry would be the same for either route. It is envisaged that comprehensive access would be provided via a grade separated half interchange at Kangaroo Valley Road.

The Orange route will require significantly less land acquisition although visual intrusion will be greater for the Orange route as this option is likely to require a considerable length of noise mitigation features along the North Street corridor. These are expected to be of strong interest to the North Street community.

Both routes remove through traffic from the heart of Berry and hence the associated negative impacts such as road safety and air and noise pollution. Both routes therefore provide significant improvements to Berry as a whole.

8.3.5.2 Noise and vibration

The overall noise impact of the Blue route would be beneficial to the larger urban community. As the overall number of dwellings affected by noise is less than the existing road, the net effect is considered positive. However there will be a significant impact to the smaller rural community adjacent to the route. The positive benefit assumes that noise mitigation is included where required.

The Orange route which runs adjacent to town would still require noise mitigation measures, particularly along North Street.

Notwithstanding this, both routes provide significant benefits to Berry as a whole as through traffic is removed from the centre of the town.

8.3.5.3 Urban design, landscape and visual amenity

The Blue route has medium visual impact and will require some cut to accommodate the alignment however, it is furthest from the town which provides the best opportunity for mitigation e.g. vegetative screening and/or independently graded carriageways may facilitate the long term integration of the route with its surroundings. The Blue route will provide some viewing opportunities of Berry for the driver, which would support local economic objectives, as well as expansive views west to the escarpment and south to Coolangatta Mountain. The ocean is generally screened from view by the narrow ridge that runs toward the eastern edge of Berry. The alignment of the Blue route provides a generous sweep around the north side of Berry following the valley that runs up to Broughton Vale.

Careful design would be required to protect the natural ecology and cultural values of the corridor as a number of bridge crossings would be required as the route bypasses Berry and introduces a new visual entity in an otherwise greenfield area. The broad sweeping alignment across a generally flat area facilitates integration with the existing landscape context and provides a safe and enjoyable journey for the motorist.

The Orange route has the least visual impact as it follows the existing highway alignment and the North Street corridor. Distant views are afforded as it descends the ridge separating Broughton Creek from Broughton Mill Creek. Subtle curves with large radii provide variety, flow and integration with the existing landscape.

By upgrading the existing highway alignment many of the urban design objectives can be satisfied as both the natural and cultural landscape contexts have evolved within this corridor for some time. Upgrading the existing corridor aids in protecting and enhancing the heritage and cultural values of the area by limiting the increased footprint of the highway.

The alignment of the Orange route is flowing and responsive to the subtle nuances of the natural landscape. An enjoyable journey would be provided for the motorist with visual connections to the coast and plains to the east and the hinterland and mountains to the south and south-west.

The portion of the Orange route that bypasses Berry along North Street is immediately adjacent to the township and careful consideration of pedestrian circulation and connectivity would need to be considered in the context of the urban design objectives at future design stages. It is likely that due to the more "urban" alignment and potential for more noise mitigation features, the Orange route would have a semi-urban "feel" along North Street.

The location of access to and from Berry requires careful consideration and will be carried out as part of the route selection process. It is likely that full or half grade separated interchanges would be considered. A northern interchange for the Blue route would be located further from Berry than for the Orange route. Impact for both would therefore be different.

8.3.6 Engineering

8.3.6.1 Structures

Both routes cross existing roads and creeks. The Blue route has an alignment which lends itself to relatively straightforward bridge designs.

Both routes are likely to incorporate grade separated interchanges to the north and south side of Berry. The northern interchange for the Blue route is likely to be located close to Tindalls Lane whereas for the Orange route it is likely to be located at Pullman Street. The interchange arrangements of both routes at the south of Berry are likely to involve a crossing under Kangaroo Valley Road. The Orange route interchange at Pullman Street would require a significant bridge structure at the north of Berry to cross Broughton Mill Creek and Woodhill Mountain Road. This bridge will be in the order of 300 m long and have a maximum height above the existing ground of 10 m. The bridge would span the existing highway (envisaged to be maintained to provide local access), Broughton Mill Creek and Woodhill Mountain Road. Being a significant structure relatively close to the northern entrance to Berry, considerable care will be necessary to develop a slender and unobtrusive design.

The bridge required at Kangaroo Valley Road would be relatively simple as the upgrade would be in a five metre deep cutting.

8.3.6.2 Ground conditions

The ground conditions encountered by these routes are generally favourable. Preliminary geotechnical investigations indicate that there is a low risk of encountering acid sulphate soils as the Blue route traverses the Broughton Mill Creek floodplain.

8.3.6.3 Flooding and drainage

The main characteristic of Section C with regards to flooding and drainage is the traverse of the Broughton Mill and Bundewallah Creek floodplains. The northern part of both routes is located in flood immune areas. As the Blue route descends into the floodplains the heights of embankments are governed by the flood levels. Careful consideration will be given during future more detailed studies into flood detention measures which may bring benefits to the town during flood events e.g. transverse drainage structures may be sized to control the flow from upstream and therefore manage the rate of flooding downstream and potentially reduce the probability of creeks overtopping. The Orange route in particular has the potential to provide this benefit in regard to Town Creeks and Bundewallah Creek, however this would require close examination later in the study process.

8.3.6.4 Major public utilities

The major public utilities present in Section C comprise the Eastern Gas Pipeline, Optus and Telstra fibre optic cables and the 132 kV electricity transmission line.

Neither the Blue nor the Orange route encounters any of the major public utilities. To the north of this section, the Eastern Gas Pipeline and the Optus cable meet up with and follow the 132 kV transmission line corridor to the south. The Telstra cable is to the south of Berry and follows the line of the railway.

8.3.6.5 Earthworks

As discussed above, in the northern or eastern parts of this section the routes are either close to the existing ground level or require cuttings with the exception of a significant cutting and embankment just to the south of Tindalls Lane. The Blue route requires a 400 m long cutting with a maximum depth of seven metres. To establish a suitable vertical alignment, fill embankments are required for several hundred metres either side of this cutting. As the routes descend and cross the floodplain, embankments are required to provide appropriate flood immunity. Preliminary geotechnical studies suggest that the majority of soil and rock encountered in Section C would provide a good material for road building. Although it is likely that some soft soil conditions would be encountered, at this stage, acid sulphate soil is not considered to be a significant risk. Soft soil conditions, as with the other sections would require appropriate treatments e.g. preloading and surcharging.

8.3.7 Value for money - cost, constructability and project risk

Concept cost estimates are presented in **Chapter 9**.

The Orange route which includes the North Street corridor is significantly less costly than the Blue route. This is attributable in part due acquisition of some of the land along the North Street corridor following gazettal in the late 1960's. Land to be acquired as part of the Blue route is estimated to be particularly costly.

The Orange route presents most complications with regards to traffic delay and disruption as it involves a significant length of upgrading of the existing highway. There are no apparent issues which make the Orange route particularly difficult in terms of construction. The Blue route is off-line and would be relatively easy to construct. Similar to the Yellow route in Section B, the Blue route traverses areas of soft soil and as it is off-line, suitable ground treatments could be implemented which would have minimal impact on traffic usage in the interim.

8.4 Section B/C (south Gerringong to south Berry)

8.4.1 Overview

Of several routes assessed which traverse Sections B and C, only one was short listed. This route is identified as the Brown route. It runs along the western side of the railway line from Gerringong to Berry. It then heads west from the David Berry Hospital and crosses the existing highway, Broughton Mill Creek and Woodhill Mountain Road. It continues west along the North Street corridor and from Kangaroo Valley Road it follows the existing highway to Croziers Road. The Brown route is shown in **Figure 8.7**.

8.4.2 Alignment (road safety / efficiency)

The brown route is generally good in terms of both horizontal and vertical alignment. The section which follows the railway line is very good. The road alignment of the approach to Berry from the north is good. The road will have an urban feel as it passes Berry along the North Street corridor and around the western end of Berry before following the existing highway.

This route presents a high level of efficiency. As with all options, the Brown route exhibits a high standard of road alignment. However, as it is relatively long and generally straight, its road safety qualities are marginally reduced.

8.4.3 Regional and local economic development

8.4.3.1 General

Between Gerringong and Berry the Brown route follows the railway line which has the advantage of minimising land acquisition and severance and also offers opportunities for co-location with existing infrastructure.

As with the Orange route, the Brown route includes existing road widening provisions to the west of Berry adjacent to North Street, but requires a new access to a park and sportsground along the North Street corridor. The Orange route is in accordance with current and planned land use in that it makes use of an existing road corridor immediately north of North Street. To a certain degree this route has been expected by the community for some time, due to the gazettal of the corridor, subsequent purchase of significant sections by the RTA and a previous assessment of a Berry bypass.

8.4.3.2 Planning and legislation

Between Gerringong and Berry the Brown route passes largely through land zoned as 1(a) Rural under both the Kiama and the Shoalhaven Local Environmental Plans and is permissible with consent under both Local Environmental Plan zonings.

The Brown route has the potential to impact on a potential future development in the form of a caravan park in the Toolijooa area. At the time of writing, a Development Application has been submitted to Kiama Council and an assessment and determination has not been released. This development application, as with others in the study area will be monitored during subsequent stages of the project.

Around Berry this route is permissible with consent; the route utilises the existing road widening provisions along the North Street corridor.

8.4.3.3 Land use and property impacts

The two dairy farms that are already severed by the South Coast railway corridor will be further severed by the Brown route as it traverses the low lying land. The land severed by the Brown route is predominantly Class 2 agricultural land and used largely for dairy farming.

Additional land use impacts associated with the Brown route includes interference with the existing Sydney Water Effluent Re-use Irrigation Scheme located between the existing highway and the South Coast railway line. This will require careful planning and consideration should this route be taken forward as the preferred route.

The route is in accordance with current and planned land use in that it utilises the road widening designation along the North Street corridor.

It would be vital to carefully consider measures to minimise impact or preserve the amenity of dwellings close to the route. Of particular importance are the sections of new alignment e.g. Toolijooa and Harley Hill.

8.4.4 Environmental impacts

8.4.4.1 Water quality

Similar to the Pink, Green and Yellow routes, the Brown route requires a crossing of Crooked River. It crosses both Broughton Creek and Broughton Mill Creek once. As the Brown route traverses the lower lying land along the length of the railway between Gerringong and Berry it would be prone to flooding both during construction and operation. This would require careful design consideration, especially given the proximity of the Crooked River wetland area on the eastern side of the railway, which supports an area of high significance Estuarine Fringe Forest.

A significant structure would be required for the Brown route to cross Broughton Mill Creek and Woodhill Mountain Road in the vicinity of Pullman Street, to the north of Berry. This would require careful design to ensure that potential impacts on water quality are minimised. This would be ensured through development and implementation of a water quality management plan.

8.4.4.2 Terrestrial ecology

Between Gerringong and Berry the Brown route would have a minimal impact on native vegetation as it passes along the railway line. It would however impact on an area of Endangered Ecological Community identified as coastal sand swamp forest located adjacent to the west (north) of the railway line north of Harley Hill Road. This area of Endangered Ecological Community has been identified as having high conservation significance and supports a number of threatened fauna species. Impact may be mitigated through deploying measures such as compensatory habitat.

The Brown route would have a minimal impact on riparian vegetation at its three main creek crossings.

8.4.4.3 Aquatic ecology

The Brown route requires three main creek crossings and will have a minimal impact on aquatic ecology and riparian stability. As outlined above the Brown route traverses low lying land in the vicinity of the Crooked River wetland area located on the eastern side of the railway. This supports an area of high significance Estuarine Fringe Forest.

8.4.4.4 Heritage

Between Gerringong and Berry the Brown route largely avoids European heritage sites. As the route reaches Berry, it passes relatively close to the heritage registered David Berry Hospital. At the northern approach to Berry the Brown route has the potential for significant heritage impact at the Pullman Street and Tannery Lane heritage precinct.

The Brown route is likely to have minimal impact on Indigenous heritage.

8.4.5 Community impacts

8.4.5.1 Community issues

Between Gerringong and Berry the Brown route follows the existing railway corridor. For much of this length community and social issues are of relatively low impact as dwellings and farms are sparse. Around the communities of Toolijooa and Harley Hill however, impacts will be significant. Impacts include land acquisition, severance, expansion of a lightly used transport corridor, access into a relatively undisturbed rural community, access and significantly increased noise, vibration and visual intrusion.

The Brown route takes advantage of the North Street road reserve corridor as it passes Berry. This will minimise severance and land acquisition although visual intrusion will be significant as this option is likely to require a significant extent of noise mitigation features.

The northern approach to Berry presents the opportunity to provide an interchange at the northern extreme of the town. Potential locations for an interchange to the south of Berry would be the same as for the Blue and Orange routes.

8.4.5.2 Noise and vibration

Between Gerringong and Berry the Brown route involves construction of a new highway remote from the existing highway. The Brown route will therefore have a significant noise impact on the community as it passes through areas that currently have low road traffic noise levels. The noise reduction that may be obtained at residences on the existing road alignment does not offset the impact at other residences.

In addition, the noise reduction that may be achieved for houses on the existing highway may be limited as it is likely that the existing route will remain operational (although traffic numbers are expected to be significantly reduced following the opening of the upgrade).

At Berry the Brown route would have a similar noise impact to that associated with the Orange route as both routes follow the same alignment along the North Street corridor. The town of Berry would still be significantly affected by road traffic noise with some receivers in particular the dwellings along North Street experiencing an increase in noise levels.

Noise mitigation measures will be required to meet Department of Environment and Climate Change requirements. Notwithstanding this, the Brown route provides significant benefits to Berry as a whole as through traffic is removed from Queen Street.

8.4.5.3 Urban design, landscape and visual amenity

The visual impact of the northern part of the Brown route on nearby residents is significant because the route represents a new feature that is raised on embankment and highly visible in an otherwise established visual environment.

The straight and flat alignment along the railway line gives the motorist travelling on a two to three metre high embankment a good view of the surrounding pastures and wetlands to the east and Toolijooa ridge to the west. The southern part of the route has a moderate to low visual impact as the vertical alignment follows the rolling terrain to the south-west of Toolijooa and through Harley Hill.

As the Brown route passes Berry it would have moderate visual impact as it follows the existing highway alignment along the North Street corridor. Distant views are afforded as it descends the ridge separating Broughton Creek from Broughton Mill Creek. Subtle curves with large radii provide variety, flow and integration with the existing landscape.

8.4.6 Engineering

8.4.6.1 Structures

The Brown route requires bridge structures at Crooked River, Harley Hill Road, and Galls Lane and four bridge sites to cross the Broughton Creek floodplain. The Brown route also requires a significant bridge structure at the northern approach to Berry to cross Broughton Mill Creek and Woodhill Mountain Road. This bridge will be in the order of 300 m long and have a maximum height above the existing ground of 10 m. The bridge would span the existing highway (envisaged to be maintained to provide local access), Broughton Mill Creek and Woodhill Mountain Road. Being a significant structure relatively close to the northern entrance to Berry, considerable care will be necessary to develop a slender and unobtrusive design.

The bridge required at Kangaroo Valley Road would be relatively simple as the upgrade would be in a five metre deep cutting.

8.4.6.2 Ground conditions

The Brown route crosses the floodplain of Crooked River and low lying areas of Toolijooa, adjacent to the railway line. Estuarine soils, which are likely to be soft and may contain acid sulphate, occur along the sections of Brown route where it is adjacent to the railway line.

At Berry the ground conditions encountered by the Brown route are generally favourable. Preliminary geotechnical investigations indicate that there is a low risk of encountering acid sulphate soils and soft soils as the route traverses the Broughton Mill Creek floodplain.

8.4.6.3 Flooding and drainage

The low lying areas to the north of the Brown route are flood prone and suitable treatments are required to mitigate the effects. These include raising the finished road level above the required flood immunity level, providing adequate cross drainage measures and ensuring that cut slopes and embankment earthworks are appropriately designed, constructed and maintained.

The crossings of Crooked River, Broughton Creek and Broughton Mill Creek will require solutions meeting flooding requirements.

Careful consideration will be given during future more detailed studies into flood detention measures which may bring benefits to the town during flood events e.g. transverse drainage structures may be sized to control the flow from upstream and therefore manage the rate of flooding downstream and potentially reduce the probability of creeks overtopping. The Brown route in particular has the potential to provide this benefit in regard to Town Creek and Bundewallah Creek, however this would require close examination later in the study process.

8.4.6.4 Major public utilities

Close to Gerringong the major public utilities comprise the Eastern Gas Pipeline and the Optus fibre optic cable. Just south of Gerringong, the Brown route crosses the Eastern Gas Pipeline and then runs parallel to it for approximately three kilometres. It is envisaged that the crossing will be accommodated by using fill material and protective structures as necessary. The Optus fibre optic cable is not affected by the Brown route.

The Brown route does not encounter any major public utilities in the vicinity of Berry.

8.4.6.5 Earthworks

As the Brown route crosses floodplain for much of its route, fill embankments are required to provide appropriate flood immunity. Soft soil conditions, as with the other sections will require appropriate treatments e.g. preloading and surcharging.

Although the optimum alignment requires some cuttings, they are relatively minor. The net effect of a relatively small amount of re-usable material from cuttings plus the need for a significant amount (approximately 500,000 cubic metres) of fill material is the requirement to import fill from elsewhere. This may involve transporting material from a borrow pits or quarries located outside the study area. Opportunities for importing the material by rail would be reviewed as the impact of moving such a large volume of earth by road is significant.

8.4.7 Value for money - cost, constructability and project risk

Concept cost estimates are presented in **Chapter 9**.

A significant length of the Brown route comprises off-line construction providing reduced traffic management impacts to existing road users during construction. The whole length from Gerringong to Berry would have to be completed before any of it could be opened and therefore benefits realised. Careful traffic management measures would be required during the construction of the section from the south of Berry to Croziers Lane.

Due the presence of soft soils and acid sulphate soils, timely construction methods would have to be employed to manage short and long term settlement. As much of this route is off-line, preloading and or surcharging could proceed with limited traffic disruption, after delivery of fill material, as traffic could continue to use the existing highway.

Near Berry, the Brown route which includes the North Street corridor is significantly less costly. This is attributable in part due acquisition of some of the land along the North Street corridor following gazettal in the late 1960's.

8.5 Section D (south Berry to Bomaderry)

8.5.1 Overview

Only one route option is included in the short list to be considered further i.e. the Purple route - an upgrade of the existing alignment (refer **Figure 8.8**). The route has the potential to make use of the existing pavement where the alignment and cross sectional shape meets current standards.

The existing horizontal alignment will require little correction. Some vertical curves are substandard and will be upgraded. This will involve balancing earthworks and making the best use of existing road pavement and drainage structures. Widening on one or both sides of the existing highway will be considered to make the best use of the existing road pavement and road reserve and to minimise impacts on adjoining properties. Traffic management will require careful attention to ensure safety for motorists and construction workers and minimal disruption to traffic, as the work will be carried out under traffic.

This route will require reconstruction, augmenting or duplication of the existing structures over the main waterways of Flying Fox, Jaspers and Abernethys Creeks.

8.5.2 Alignment (road safety / efficiency)

The quality of the alignment is very good i.e. relatively straight and flat which provides very good efficiency and a high level of road safety.

8.5.3 Regional and local economic development

8.5.3.1 General

The Purple route has minimal impact on regional and local development. The route utilises existing highway and promotes the reuse of resources. Impacts of land acquisition are minimised and the route is consistent with local and state planning policies, with the route supporting tourism and trade opportunities to the north and south of Bomaderry and Berry.

8.5.3.2 Planning and legislation

The existing road would be upgraded almost entirely within land zoned 1(b) Rural (Arterial and Main Road Protection) under the Shoalhaven Local Environmental Plans. The zoning objectives of preserving views and managing road access will be adopted along this route. The road will be permissible with development consent.

8.5.3.3 Land use and property impacts

The impacts of property acquisition and severance will be minimised as some sections of the existing highway have adjacent land designated as road reserve. Access to properties and local roads will be maintained, but controlled to meet road design and road safety standards. Impact on and access to Meroo Meadow Union Church at Boxsells Lane, Meroo Meadows will need to be considered and some residential properties in close proximity to the existing highway in Section D may need to be acquired depending on the level of direct or indirect impact.

8.5.4 Environmental impacts

8.5.4.1 Water quality

Impacts on water quality are minimised by upgrading the existing highway. Some existing drainage structures may need to be widened to achieve flood immunity. This includes the reconstruction, augmentation or duplication of existing structures at Flying Fox Creek, Jaspers Creek and Abernethys Creek. Appropriate precautions and mitigation measures will be implemented during construction of this structure and for the future operation of the upgrade. These precautions and measures will ensure minimal impact on water quality. The precautions and measures will be the subject of a water quality management plan to be developed as part of this study.

8.5.4.2 Terrestrial ecology

The Purple route will have minimal impact on terrestrial ecology. Some clearing of roadside vegetation with conservation significance will be required. Little or no significant habitat occurs adjacent to the existing highway in this section, although there are some recordings of threatened fauna in the vicinity of the existing highway, at Meroo Meadow and in the vicinity of Abernethys Lane in the south. Refer to the Preliminary Biological Report - Terrestrial Flora and Fauna (**Appendix G**) for further details.

8.5.4.3 Aquatic ecology

The Purple route will have little or no impact on aquatic ecology.

Waterway crossings will be required at Flying Fox Creek, Jaspers Creek and Abernethys Creek. These will be in the form of reconstruction, augmentation or duplication of existing structures and appropriate precautions and mitigation measures will be implemented to minimise impacts on aquatic habitats.

8.5.4.4 Heritage

There may be some impact on European cultural heritage values in the vicinity of Meroo Meadow as a result of upgrading the existing highway and some high archaeological value land associated with riparian corridors, particularly in the south of Section D. Refer to the Preliminary Indigenous and non-Indigenous Heritage Assessment Report (**Appendix I**) for further details.

8.5.5 Community impacts

8.5.5.1 Community issues

Community feedback on Section D has been limited to:

- Convenient access.
- Safe access.
- An upgrade alignment which removes blind summits and local road intersections.
- Concerns relating to property acquisition and property price effects.

As discussed above, the final design of the Purple route will include combinations of different widening techniques to optimise land acquisition. This will also include minimising clearing of valuable flora and fauna habitats.

8.5.5.2 Noise and vibration

An upgrade of the existing route will have the least impact on receivers as the noise environment will not change significantly other than minor increases associated with an increase in road traffic speed and minor alignment changes.

8.5.5.3 Urban design, landscape and visual amenity

The Purple route follows the existing highway which has three lanes and wide shoulders in some locations. It is also accommodated in a relatively generous existing road reserve. As the Purple route requires relatively little change to the existing alignment it will have a low visual impact on the surroundings. Value of visual amenity to the driver will be relatively unchanged and care will be taken to limit clearance of existing mature trees, which will support the local fauna.

By upgrading the existing highway many of the urban design objectives can be satisfied as both the natural and cultural landscape context have evolved within this corridor for some time. The key urban design initiatives of this route option will:

- Protect and enhance the ecological and cultural values of this section of the corridor, by limiting the increased footprint of the highway.
- Respect and respond to Bomaderry by providing safe and improved access and minimising potential effects on the existing built environment of the town.
- Maintain the enjoyment of the existing journey for the motorist with strong visual connections to both the hinterland and the mountains beyond.

8.5.6 Engineering

8.5.6.1 Structures

The existing bridges over Flying Fox, Jaspers and Abernethys creeks will require augmentation, reconstruction or duplication.

At this stage no grade separated crossings are envisaged however further investigation of local access, traffic data and land use may require consideration of a local road under or overpass.

8.5.6.2 Ground conditions

The Purple route traverses an area between the Shoalhaven floodplain and the lower reaches of the Cambewarra Range. Preliminary geotechnical investigations indicate that there is a low risk of encountering acid sulphate soils and soft soils over the length of this route.

8.5.6.3 Flooding and drainage

As the Purple route traverses an area between the Shoalhaven floodplain and the lower reaches of the Cambewarra range, it is not subject to inundation by flood. As with other upgraded sections of the existing highway located on elevated ground, the Purple route will exceed the requirement to achieve a 1 in 20 year flood immunity without the need to raise the road on earth embankment.

8.5.6.4 Major public utilities

The major public utilities in Section D comprise the Eastern Gas Pipeline and Optus and Telstra fibre optic cables and the 132 kV electricity transmission line.

The Purple route will not experience conflict with any of the major public utilities. To the north and west of this section, the Eastern Gas Pipeline and the Optus cable meet up with and follow the 132 kV transmission line corridor. The Telstra cable is to the south and follows the line of the railway.

8.5.6.5 Earthworks

Some of the small crests on the existing highway are too “sharp” and will need to be “smoothed out”. This will result in the construction of a series of cuttings and embankments to produce an acceptable grade. Overall the earthworks will be balanced for this section.

8.5.7 Value for money - cost, constructability and project risk

Concept cost estimates are presented in **Chapter 9**.

This option is relatively straightforward in terms of upgrading a highway. Construction will be able to proceed under construction speed zone control, with one lane in each direction available for traffic. Apart from provision for traffic this route presents no major or unusual construction risks.

Assuming appropriate construction methods and plans are put in place and followed appropriately, this route attracts no particular adverse risk.

8.6 Road safety audit summary

8.6.1 Background

The preliminary concept designs for the short listed routes have been subject to a Stage 1 Road Safety Audit. The objective includes the early identification of potential road safety issues inherent in the designs and to eliminate or reduce the incidence and severity of road accidents.

This section presents a summary of the audit findings. They have been grouped into general observation types and the route(s) to which they apply have been identified. The findings in full are included in the Road Safety Audit - Stage 1, Route Options - Preliminary Concept Design (**Appendix R**).

8.6.2 Summary of findings

8.6.2.1 Horizontal and vertical alignment

- Extended lengths of straight flat alignments may contribute to (Yellow / Brown / Blue):
 - Potential for increased speeds.
 - Drivers having difficulty in maintaining concentration.
 - Drivers being less prepared for horizontal curves and in selecting the appropriate negotiation speed.
- Vertical alignment with grades exceeding six per cent are undesirable resulting in (Red / Pink / Green):
 - The speed differential for cars and trucks on uphill sections will increase the potential for land changing type crashes.
 - Merges located on steep upgrades particularly where trucks are a significant proportion of entering traffic will increase the potential for rear-end and land changing type crashes.
- Combinations of steep grades and minimum radii horizontal curves, particularly where horizontal curves commence over crests may reduce the driver's ability to read the alignment and increase the likelihood of accidents (Red / Pink / Green).

- Inappropriate coordination of horizontal and vertical design elements may lead to (all routes):
 - Sight distance issues.
 - Reduced appreciation of approaching geometry and conditions.

8.6.2.2 Cross section

- Although a relatively narrow median width would permit headlight glare from oncoming vehicles at night, it is noted that this would be a significant improvement to the existing situation (especially as the proposal includes median barrier treatment) (all routes).

8.6.2.3 Interchanges

- Some routes will include interchanges. Location and geometry must provide adequate provision for sight distance, deceleration and acceleration (Red / Blue / Orange).

8.6.2.4 Intersections

- Some routes will include intersections with local roads. A controlled access strategy will be applied including "left in" / "left out" only arrangements, protected right turns and U-turn facilities. Intersections increase the amount of potential points of conflict and hence designs must provide adequate provision for sight distance, queuing, deceleration and acceleration (all routes).

8.6.2.5 Pavement drainage

- Long flat sections of pavement may lead to aquaplaning if not drained appropriately (Red / Pink / Yellow / Brown).

8.6.2.6 Interface with existing highway

- Inappropriate approach signage and/or geometry may not alert drivers to the changing road conditions from the upgrade to lower and/or different geometric standards and potentially lead to vehicle conflicts (Red / Purple).

8.6.2.7 Roller coaster grading

- Vertical alignments with many crests and sags may lead to opposing vehicles going in and out of vision which may confuse drivers at night due to head light glare. Confusion may lead to vehicle conflict (Blue / Purple).

8.6.2.8 Sun glare

- Potential exists for drivers existing tunnels or driving on an easterly or westerly direction to be affected by sun glare (Green / Yellow).

8.6.2.9 Reduced cross section in tunnel

It is understood that the common practise of reducing the standard nearside shoulder widths may be applied in the proposed tunnels. Appropriate provision should be considered for dealing with safe vehicle breakdowns (i.e. safe refuge for drivers of broken down vehicles and appropriate indication of land closure) and safe refuge and/or routes for drivers to evacuate the tunnels by foot (Green / Yellow).

8.6.2.10 Construction staging

- Many different temporary tie-ins and sidetrack scenarios may be faced by drivers during construction. Treatments should be consistent and include appropriate speed control to ensure safe operation (all routes).

Figure 8.1 Section A - Red route



Figure 8.2 Section B - Pink route

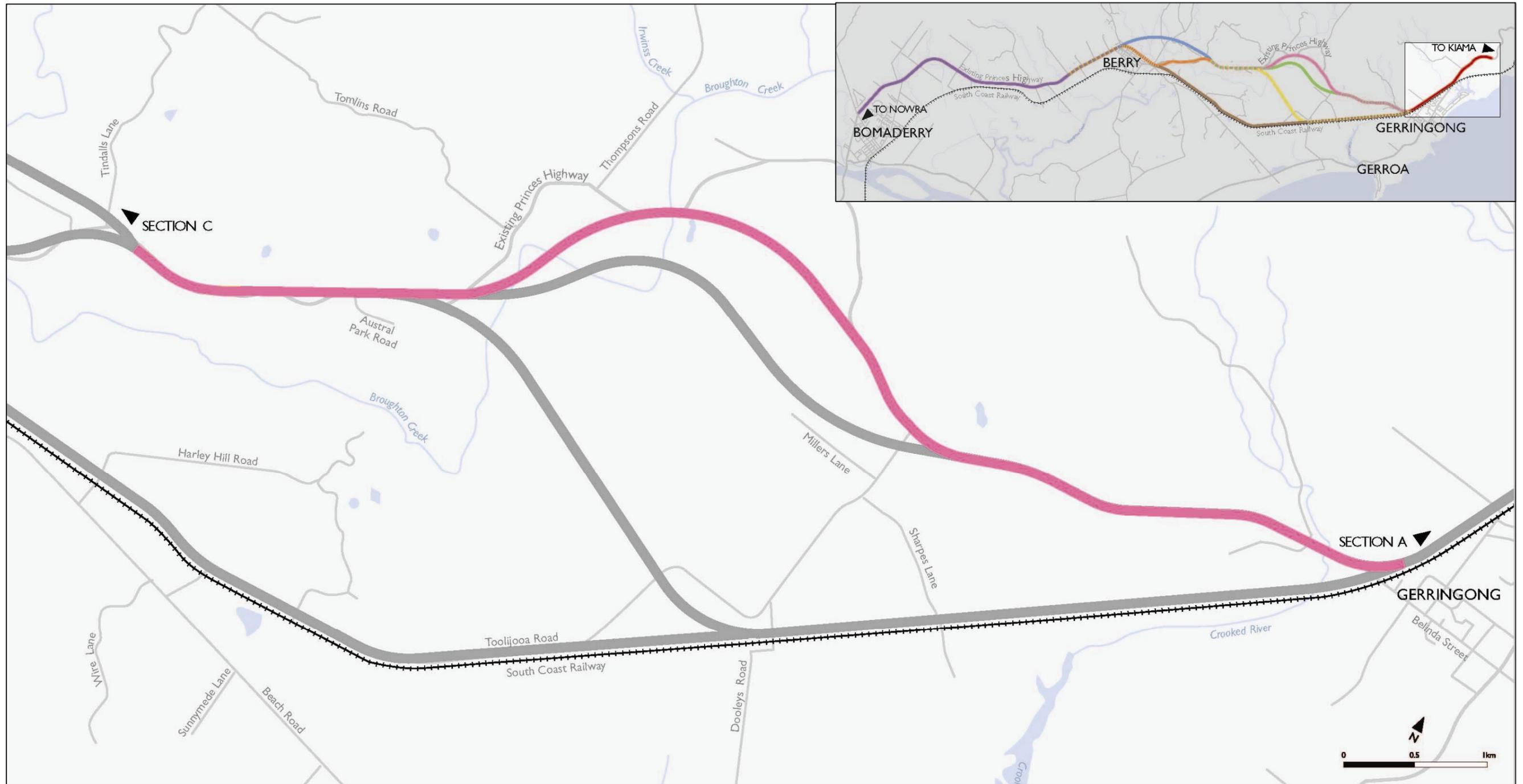


Figure 8.3 Section B - Green route

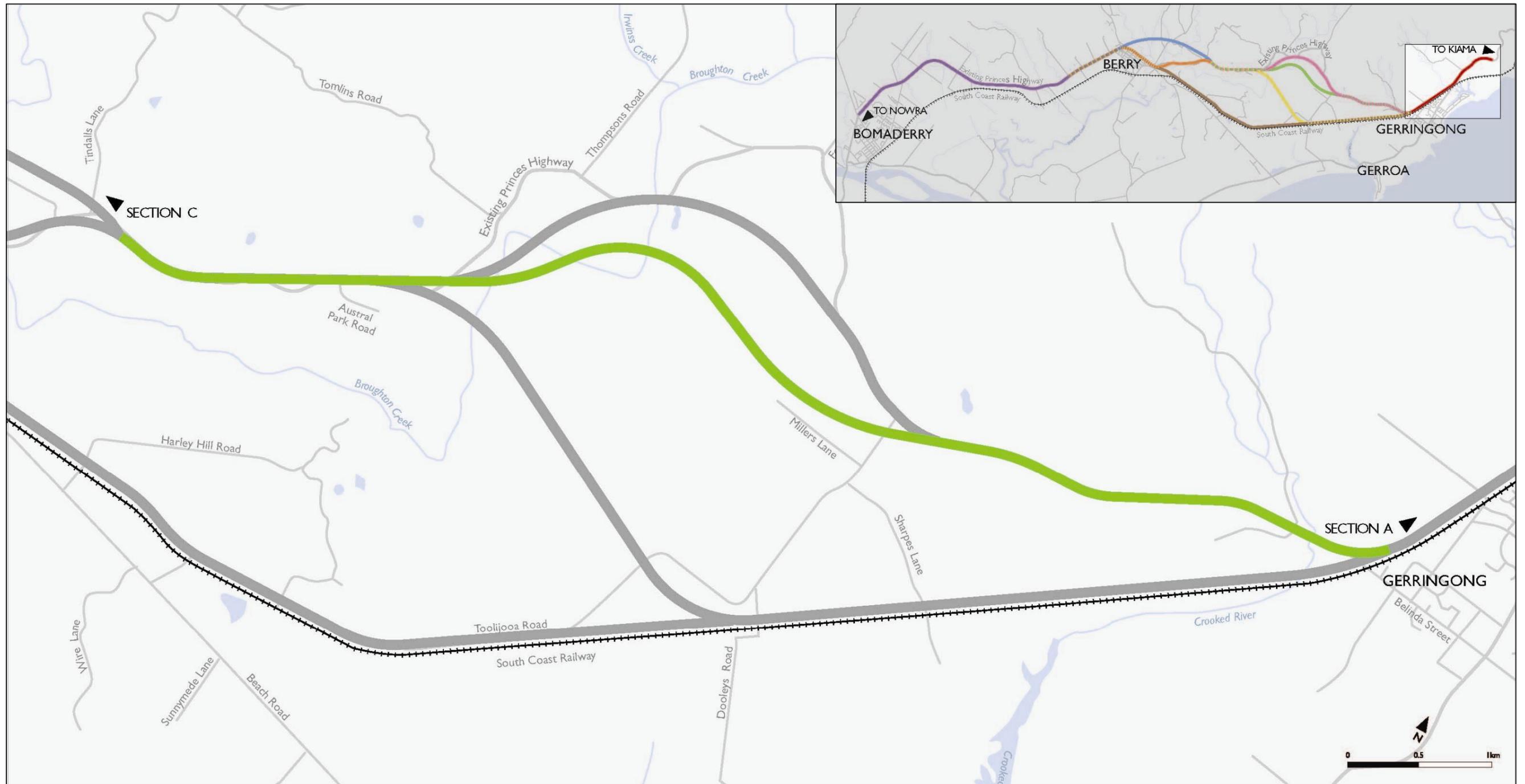


Figure 8.4 Section B - Yellow route

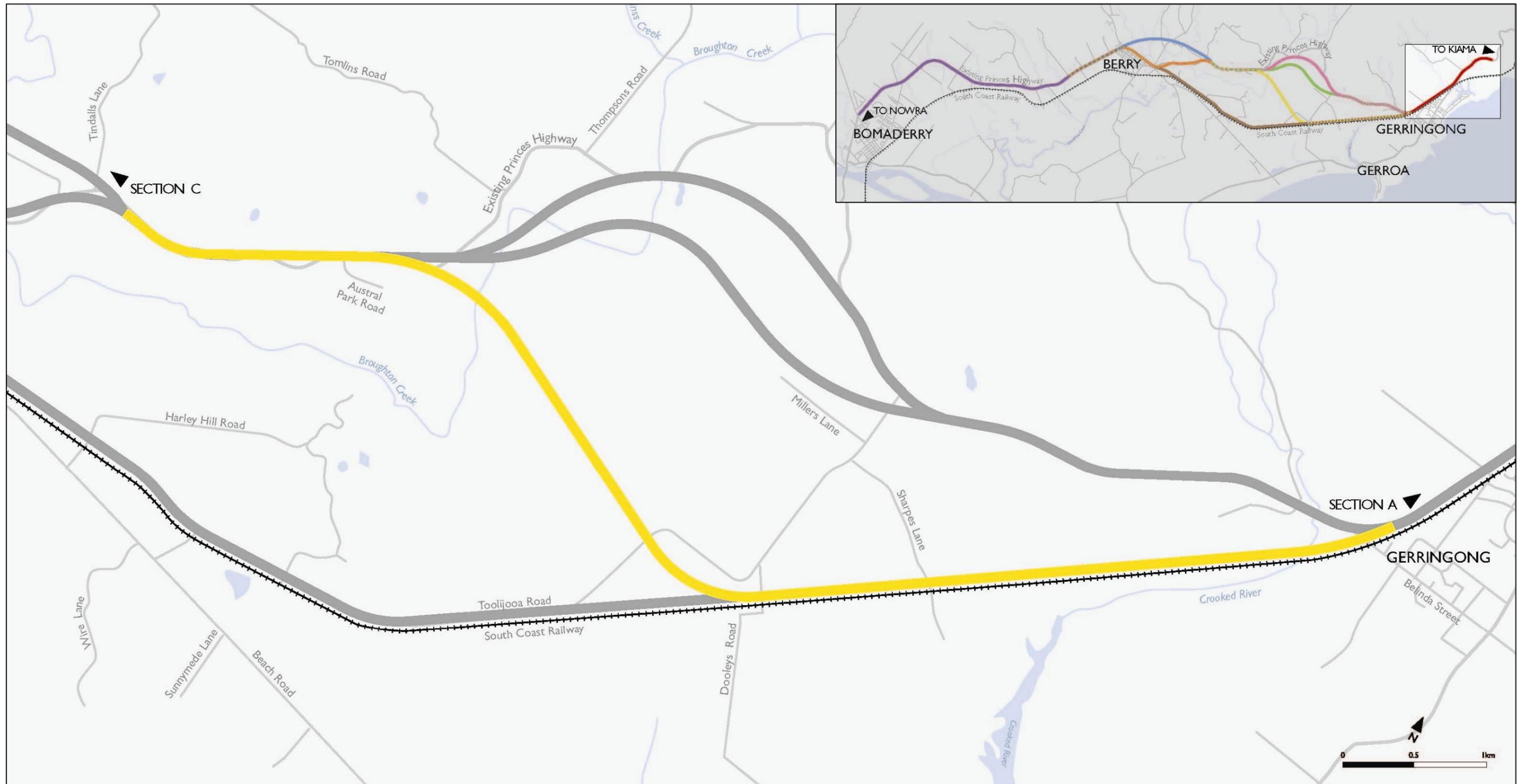


Figure 8.5 Section C - Blue route

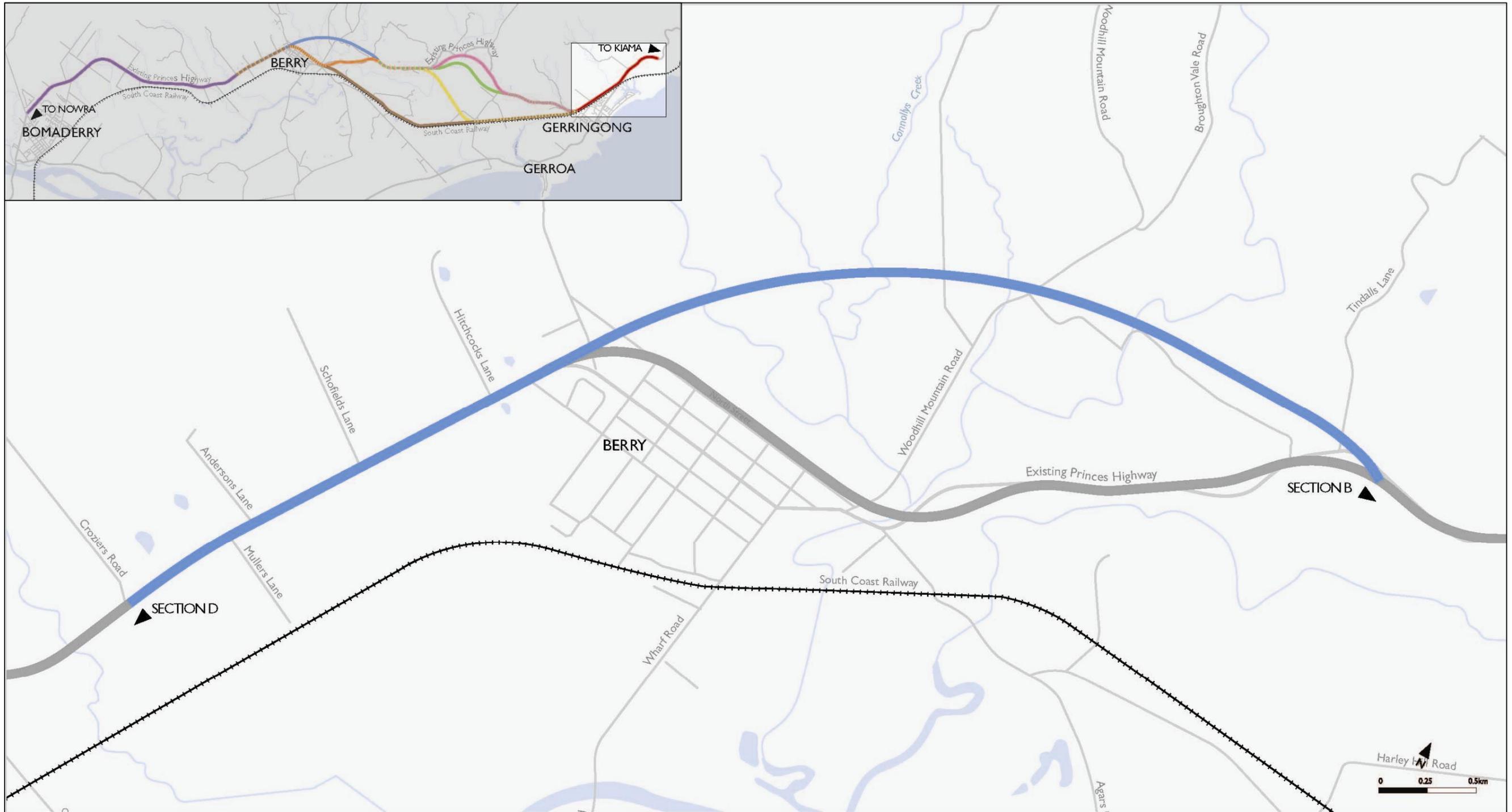


Figure 8.6 Section C - Orange route

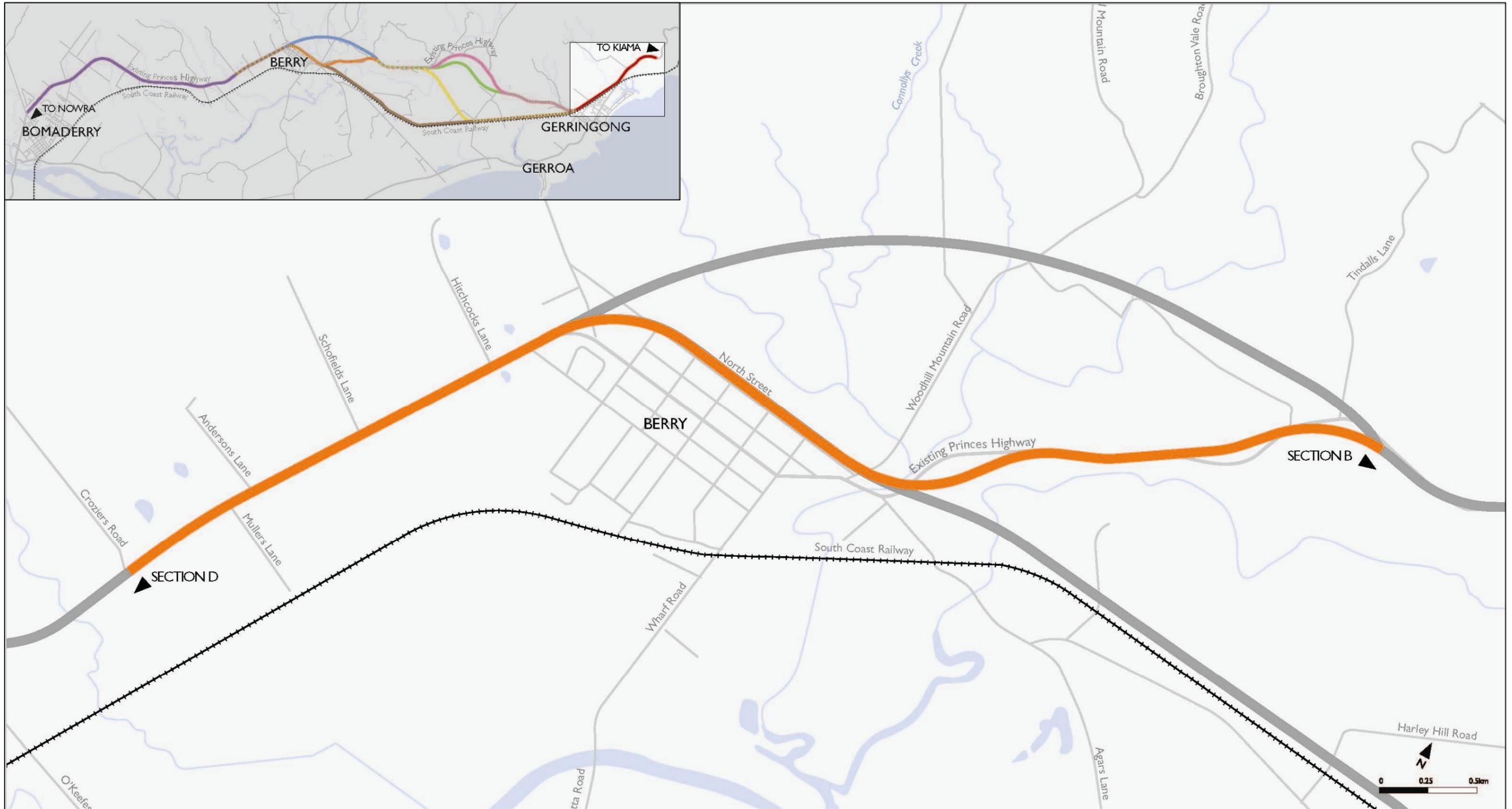


Figure 8.7 Section B/C - Brown route

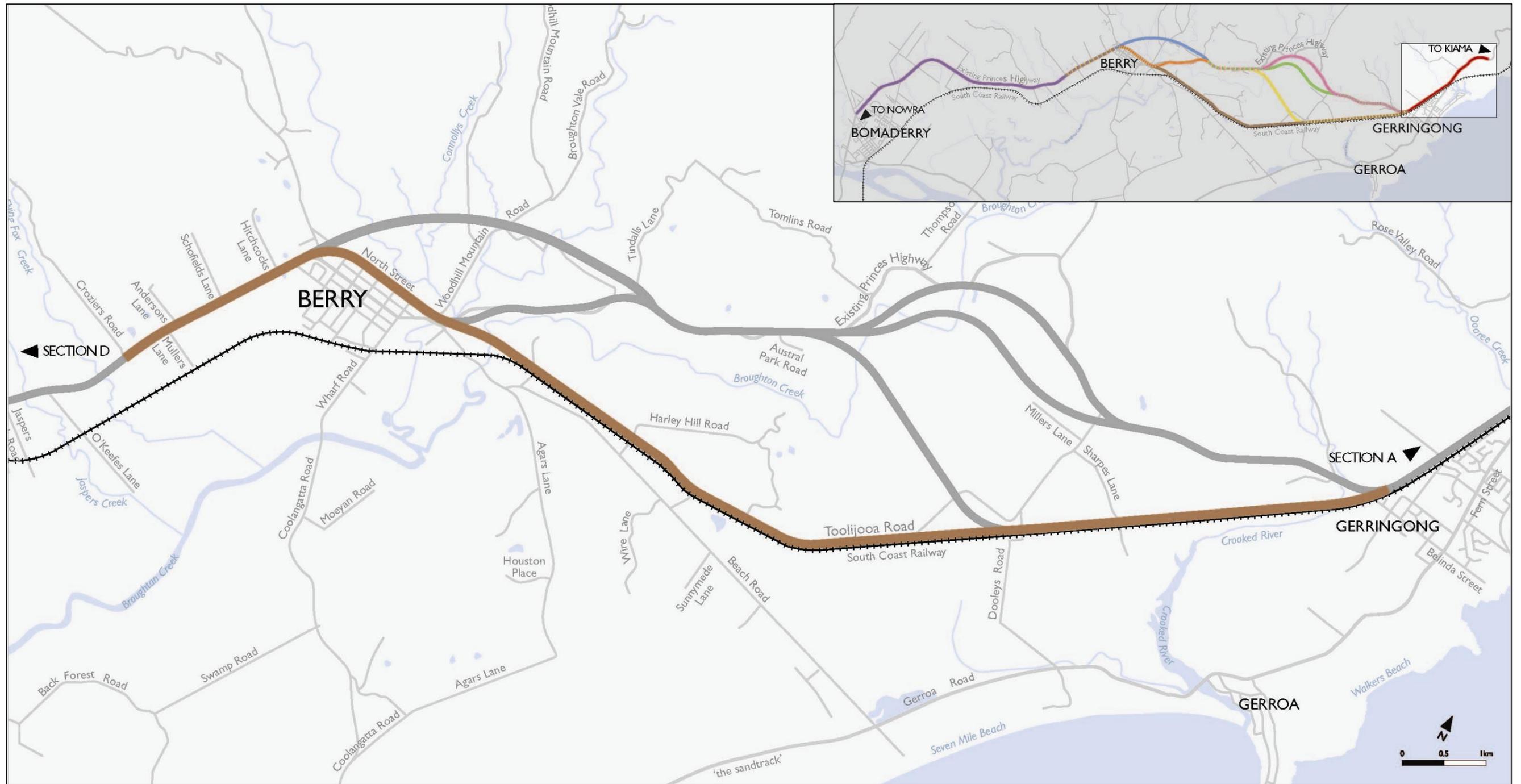
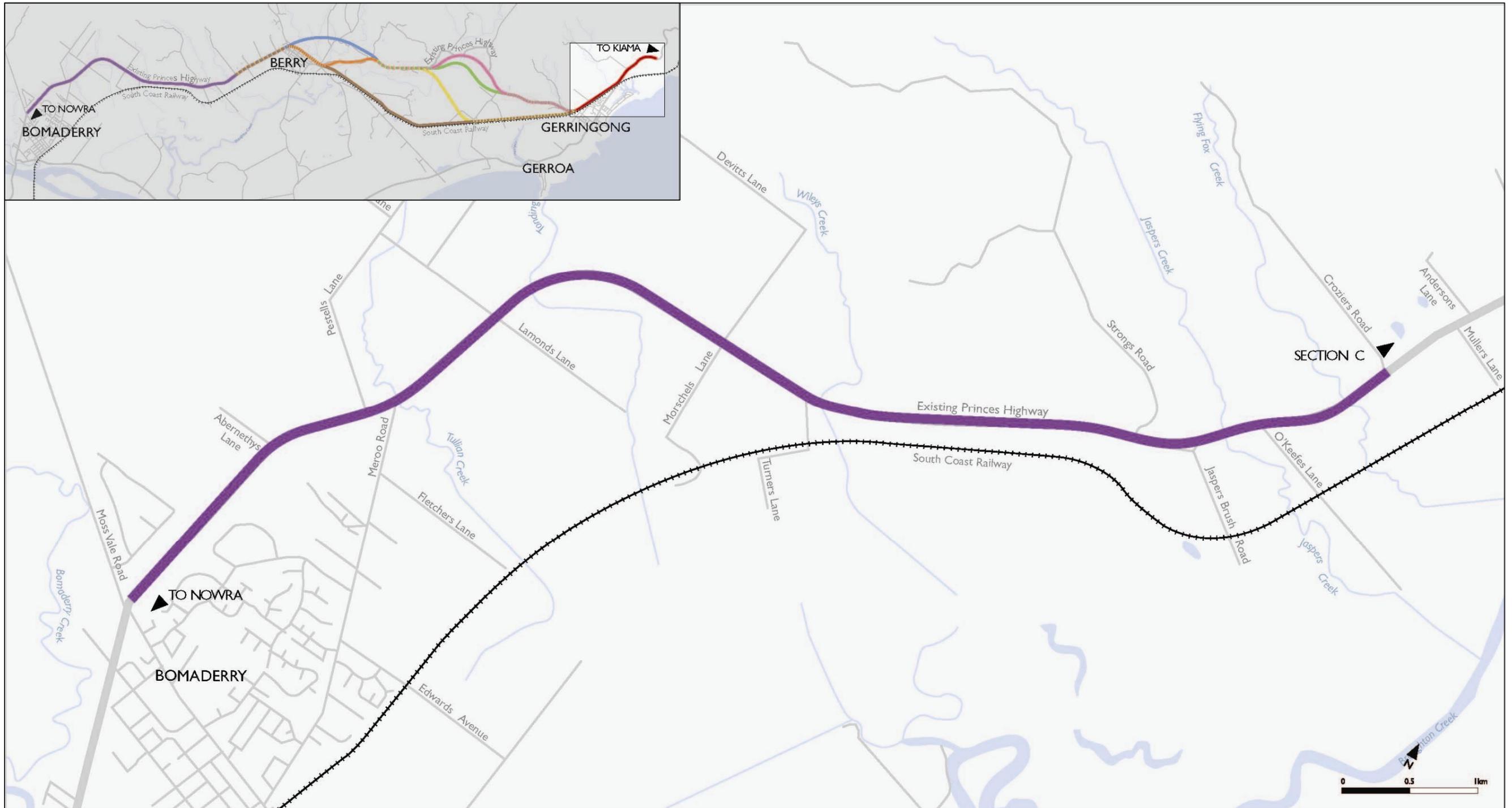


Figure 8.8 Section D - Purple route



Not used