CHAPTER 06

Alternatives and proposal options

ILLABO TO STOCKINBINGAL ENVIRONMENTAL IMPACT STATEMENT

ARTC

INLAND RAIL

An Australian Government Initiative

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6. Alternatives and proposal options

This chapter provides a summary of the alternatives that have been considered as part of the development of Inland Rail overall. These included the strategic alternatives to Inland Rail as a whole (including road upgrades, upgrading the east coast railway, and greater use of maritime and air freight), and alternative route locations. The chapter also includes a summary of the main options that were considered during the concept design process for the Inland Rail—Illabo to Stockinbingal project (the proposal). Information on how the options were developed and assessed is provided.

6.1 Alternatives to Inland Rail

6.1.1 Strategic alternatives—alternative freight transport solutions

Alternative freight transport solutions with the potential to address Australia's current and future freight challenges were considered as part of a strategic options assessment set out in the *Program Business Case* (ARTC, 2015), and examined in the *Inland Rail Implementation Group Report* (Inland Rail Implementation Group, 2015) (Inland Rail Implementation Group Report).

6.1.1.1 Strategic options assessment

Three options were assessed by the *Program Business Case* (ARTC, 2015):

- progressive road upgrades
- upgrading the existing east coast railway
- an inland railway.

These options were subjected to a rigorous assessment consistent with *Infrastructure Australia's Reform and Investment Framework Guidelines* (Infrastructure Australia, 2013). The options were assessed against seven equally weighted criteria:

- capacity to serve east coast future inter-capital regional/bulk freight market needs
- foster economic growth through improved freight productivity and service quality (including improved reliability and resilience)
- optimise environmental outcomes
- alleviate urban constraints
- enable regional development
- ease of implementation
- cost-effectiveness.

Overall, constructing an inland railway ranked highest, with an average high likelihood of improving outcomes across all criteria. Progressive road upgrades and upgrading the existing east coast railway both had an average medium overall ranking across all criteria. In relation to individual criteria, progressive road upgrades outranked an inland railway only in relation to ease of implementation and ranked equally with an inland railway in relation to enabling regional development outcomes. An inland railway was found to be the best option across all other criteria.

6.1.1.2 Review of alternatives

The following alternatives were reviewed in the Inland Rail Implementation Group Report:

- maritime freight
- air freight
- road freight
- rail solutions.

The results of the review of alternatives undertaken in the Inland Rail Implementation Group Report are summarised in the following sections.

Maritime shipping

Maritime freight was examined as a potential alternative to Inland Rail based on two types of services:

- a dedicated service between the Melbourne and Brisbane (coastal shipping)
- using spare capacity on vessels calling at Melbourne and Brisbane as part of an international voyage.

The report concluded that:

- shipping is unlikely to be a strong alternative to Inland Rail, as it does not provide the level of service (transit time and service availability) required by the majority of the Melbourne to Brisbane interstate market
- shipping still has a role to play, especially due to its strengths in transporting high-volume and long-distance cargo around the coast. Shipping must be used in conjunction with other modes, such as an inland railway, to meet Australia's future transport needs.

Air freight

Domestic air freight accounts for less than 0.01 per cent of total domestic freight movements in Australia by weight. The majority of these movements are comprised of newspapers and parcels between major cities, on either dedicated freight flights or on existing passenger flights. Air freight is highly specialised due to the inherent constraints on aircraft size and the nature of the goods that can be carried. The report concluded that:

- air freight has a limited role in the transport of bulky or heavy goods on the Melbourne to Brisbane corridor but will continue to play a crucial role for small, high-value and time-dependant goods
- air freight is not a viable alternative for addressing Australia's freight requirements on the Melbourne to Brisbane corridor into the future.

Road freight

The role of road transport was considered as a potential alternative to Inland Rail. While rail carries a larger volume of freight overall, road transport is the main mode of transport for the majority of commodities produced or consumed in Australia.

Along the north–south corridor, the main routes for road freight are on the Hume Highway (between Sydney and Melbourne), the Pacific Highway (for coastal transport between Sydney and Brisbane) and the Newell Highway (between Melbourne and Brisbane).

The identified issues and considerations relevant to road freight on these corridors include:

- the north–south road corridor will face significant local and regional capacity constraints for road freight in the medium to longer term
- the mix of local traffic, private vehicles and freight vehicles on road transport corridors reduces reliability as a result of the different average travel speeds between cars and heavy vehicles, and increases accident rates
- conflicts between local traffic, private vehicles and freight vehicles on these corridors will increase in line with significant forecast growth in population, employment and demands for freight transport
- compared with rail, road freight results in additional environmental costs, including from air pollution, greenhouse gas emissions and water pollution
- the cost to freight operators of congestion in urban areas as a result of reduced travel speeds and reliability for freight transport is estimated to be around $60 million per year for Melbourne to Brisbane inter-capital freight alone
- Australian and state governments are investing in road infrastructure along the north–south corridor; however, this investment will be insufficient to remove all the existing and predicted future issues along the full length of the corridor, leaving trucking productivity exposed to the cumulative effects of the remaining deficiencies.

The report concluded that:

- while road transport will continue to contribute to Australia's freight task, unless substantial additional investment is made, it will be unlikely to meet the longer term needs for Australia's freight task alone
- should the Australian Government decide not to proceed with a rail solution, further investigation of road transport is required to determine its capacity to manage the future north–south freight task.

Rail solutions

The two main rail solutions considered were enhancing the existing east coast railway and constructing a new inland railway.

The report noted that there are a number of capacity, reliability and performance issues associated with the existing east coast railway, mainly relating to constraints associated with moving freight trains through the Sydney metropolitan rail network.

As a sub-option of enhancing the existing east coast railway, the report noted that the proposed new Outer Sydney Orbital corridor would provide opportunities for a rail route that could ease freight congestion on Sydney freight networks; however, the main role of this corridor would be to address freight capacity constraints on other routes, such as those for intrastate and export freight. In addition, this option would not provide significant transit time savings for Melbourne to Brisbane freight, as the missing link between north-west NSW and southern Queensland would still be required, or the existing coastal line would need to be upgraded. The report concluded that use of the Outer Sydney Orbital corridor would complement, but not replace, Inland Rail.

The report concluded that:

- for Melbourne to Brisbane freight, the existing east coast railway would not be competitive with road in terms of cost or time, even with significant further investment, and it is not a viable alternative to Inland Rail
- Inland Rail would meet Australia's future freight challenge and bring significant and positive national benefits by boosting national productivity and economic growth, while promoting better safety and environmental outcomes.

Summary of findings

Overall, in relation to the various alternatives to Inland Rail, the Inland Rail Implementation Group Report concluded that:

- while shipping and air will continue to play a role in the interstate freight market, they are not viable alternatives to rail
- without Inland Rail, road is the only mode capable of addressing the majority of the future freight task, with associated direct and indirect costs.

6.1.1.3 The 'do nothing' alternative

Not developing Inland Rail would result in continued growth in the use of road for freight transport between Melbourne and Brisbane, particularly along the Newell Highway. The issues associated with using road transport alone to address Australia's freight needs into the future, are identified in section 6.1.1. In addition, road transport would be unlikely to meet the longer term needs for Australia's freight task alone, unless substantial additional investment is made (Inland Rail Implementation Group, 2015).

6.2 Alternative route options for Inland Rail

Alternative routes for Inland Rail have been considered by the following two studies:

- *North–South Rail Corridor Study* (Department of Transport and Regional Services, 2006)
- Melbourne–Brisbane Inland Rail Alignment Study (ARTC, 2010).

6.2.1 North–South Rail Corridor Study

The *North–South Rail Corridor Study* (Department of Transport and Regional Services, 2006) (North–South Rail Corridor Study) considered potential corridors for the rail line to determine which route would deliver the best economic and financial outcome.

6.2.1.1 Options identified

Potential options were identified within a 'north–south rail corridor', defined by the standard-gauge rail line along the NSW coast, and a broad arc west of Shepparton, Jerilderie, Coonamble, Burren Junction, Goondiwindi and Toowoomba. Within this corridor, four sub-corridors were identified for comparative analysis, each of which could be combined with alternative routes between Melbourne and Junee, via Shepparton or via Albury. The four sub-corridors comprised:

- far-western sub-corridor—linking Junee to Brisbane via Parkes, Dubbo and/or Narromine, Coonamble, Burren Junction, Narrabri and/or Moree, North Star, Goondiwindi, Warwick and/or Toowoomba
- central inland sub-corridor—linking Junee to Brisbane via any inland route that includes the Werris Creek to Armidale to Tenterfield rail links

- coastal sub-corridor—following the existing coastal route between Junee and Brisbane (via Goulburn), through Sydney
- hybrid sub-corridor—combining elements of an inland and coastal route, linking Junee to Brisbane via Muswellbrook and Maitland.

Within each of these sub-corridors, the feasibility of 136 possible route options was investigated. These options involved different amounts of new track and/or upgrading existing sections of track.

6.2.1.2 Analysis of options

The route options were compared using an optimisation model specifically developed for the study, based on the following criteria:

- operating efficiency
- infrastructure requirements
- market demand
- environmental constraints
- financial and economic viability.

The study identified potential demand, financial issues, environmental issues and infrastructure costs relevant to the four sub-corridors. The analysis undertaken for the study concluded that the far-western sub-corridor (as shown in Figure 6-1) was superior to the other alternatives and formed the basis for the *Melbourne–Brisbane Inland Rail Alignment Study* (ARTC, 2010) discussed below.

FIGURE 6-1: FAR WESTERN SUB-CORRIDOR

6.2.2 Melbourne–Brisbane Inland Rail Alignment Study

The purpose of the *Melbourne–Brisbane Inland Rail Alignment Study* (ARTC, 2010) (Melbourne–Brisbane Inland Rail Alignment Study) was to determine the optimum alignment as well as the economic benefits and likely commercial success of a new standard-gauge inland railway between Melbourne and Brisbane. The terms of reference for the study required it to develop a detailed route alignment, generally following the far western sub-corridor identified by the North–South Rail Corridor Study.

6.2.2.1 Options identified

The Melbourne–Brisbane Inland Rail Alignment Study short-listed and analysed a number of route options. The stages of route analysis involved:

- identification of the route—evaluation of the route options and preliminary analysis for the three main areas: Melbourne to Parkes; Parkes to Moree; and Moree to Brisbane
- analysis of the route—the route was analysed in terms of capital cost, environmental impacts and journey time, as well as its preliminary economic and financial viability
- development of the preferred alignment—the alignment was developed considering environmental and engineering factors.

The study noted that with the combination of numerous route options and sections, there were over 50,000 possible options for the route between Melbourne and Brisbane. As it was not feasible to analyse each option, two key criteria (capital cost and journey time) were used to establish a shortlist of route options in each of the three main areas.

The shortlist (see Figure 6-2) included:

- Southern section: Melbourne to Parkes—two main options:
  - via Albury, using existing track from Melbourne to Parkes (with a possible new direct line from Junee or Illabo to Stockinbingal by-passing Cootamundra)
  - via Shepparton, using the existing broad-gauge Mangalore–Tocumwal line via Shepparton, the disused standard gauge line to Narrandera, and a new direct connection through to near Caragabal, before re-joining the existing line to Parkes.
- Central section: Parkes to Moree—four main options:
  - Parkes to Moree via Werris Creek, using existing track (with a new section of track at Binnaway and Werris Creek to avoid reversals)
  - Parkes to Moree via Binnaway and Narrabri, using existing track to Binnaway, and then a new section connecting to the existing track near Emerald Hill or Baan Baa
  - Parkes to Moree via Curban, Gwabegar and Narrabri, using existing track to Narromine, predominately new track between Narromine and Narrabri, and existing track from Narrabri to Moree
  - Parkes to Moree via Burren Junction, using existing track to Narromine, and predominately new track via Coonamble and Burren Junction to Moree.
- Northern section: Moree to Brisbane—two main options:
  - the Warwick route—a new 'greenfield' route via Warwick to the existing standard-gauge Sydney–Brisbane line
  - the Toowoomba route—a new corridor direct from Inglewood to Millmerran and Oakey, near Toowoomba, and then a new alignment down the Toowoomba range, and use of the proposed Southern Freight Rail Corridor from Rosewood to Kagaru.

6.2.2.2 Analysis of options

The shortlist of route options was subjected to more detailed technical, financial and economic assessment. Selecting the proposed alignment from each of the shortlisted options involved an iterative process, with evaluation of the following:

- environmental and land issues
- railway operations considerations
- engineering assessments
- capital cost estimates.

The final preferred Inland Rail alignment, between South Dynon in Melbourne and Acacia Ridge in Brisbane, incorporated:

- Melbourne to Parkes—670 kilometres (km) of existing track and 37 km of new track on a greenfield alignment from Illabo to Stockinbingal, bypassing Cootamundra and the Bethungra spiral (further discussed in section 6.3)
- Parkes to North Star—307 km of upgraded track, and 291 km of new track on a greenfield alignment from Narromine to Narrabri
- North Star to Acacia Ridge—271 km of new track on a greenfield alignment, 119 km of existing track upgraded from narrow gauge to dual gauge, and 36 km of the existing coastal route.

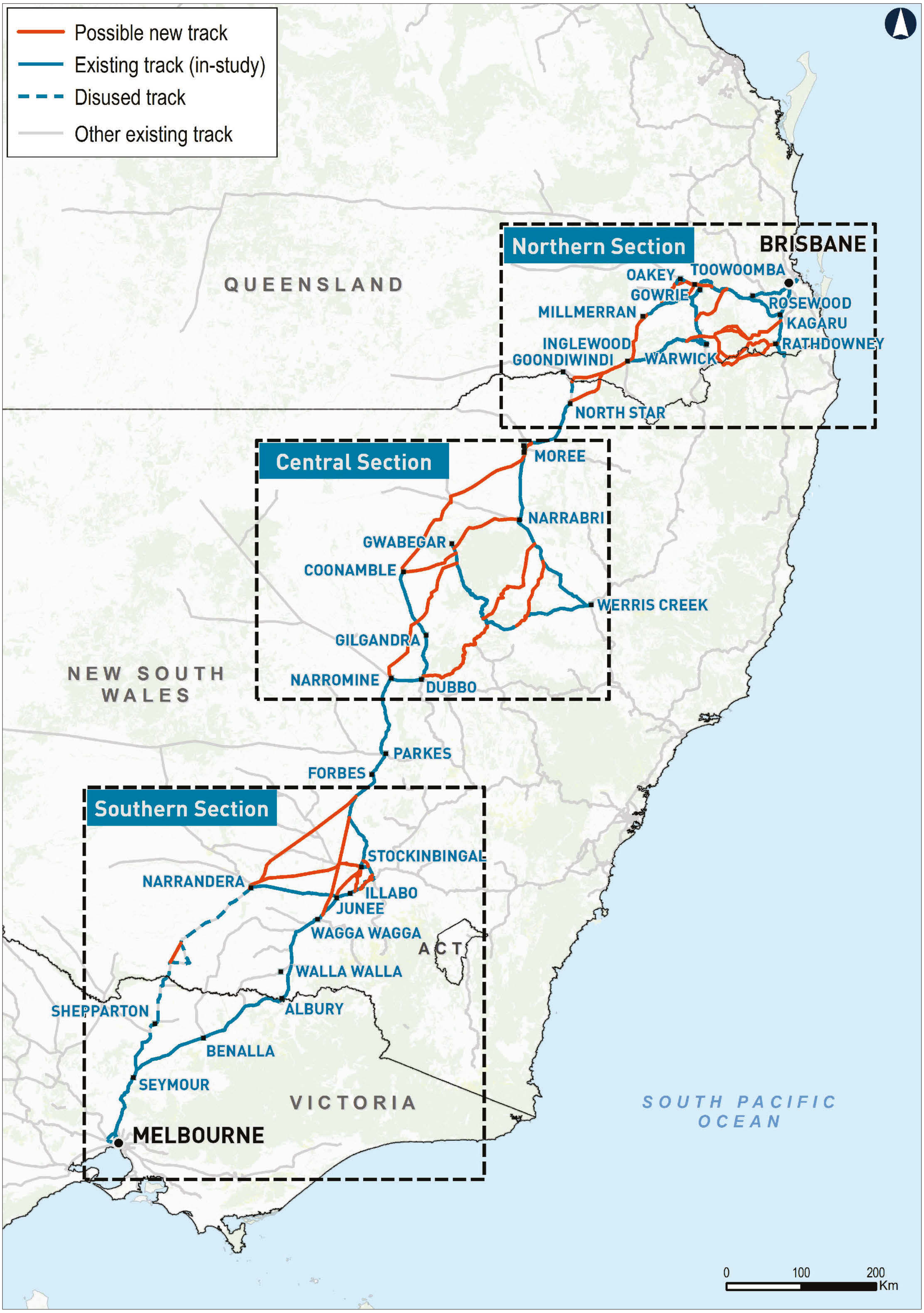


FIGURE 6-2: MELBOURNE-BRISBANE INLAND RAIL ALIGNMENT STUDY—SHORTLISTED OPTIONS

For the Melbourne to Parkes section, the route through Albury was chosen (incorporating the Illabo to Stockinbingal greenfield section, the basis of this proposal) as it offered superior outcomes for the key criteria of capital costs and transit time. Though the fastest Shepparton route offered a better transit time, this route attracted a significant extra capital cost. The Shepparton route was also limited by the potential to capture only a very small amount of regional freight.

6.3 Initial project development for Illabo to Stockinbingal 2010 to 2019

An overview of the development of the proposal is included in Figure 6-3 with further detail on the options assessment provided in the sections below.

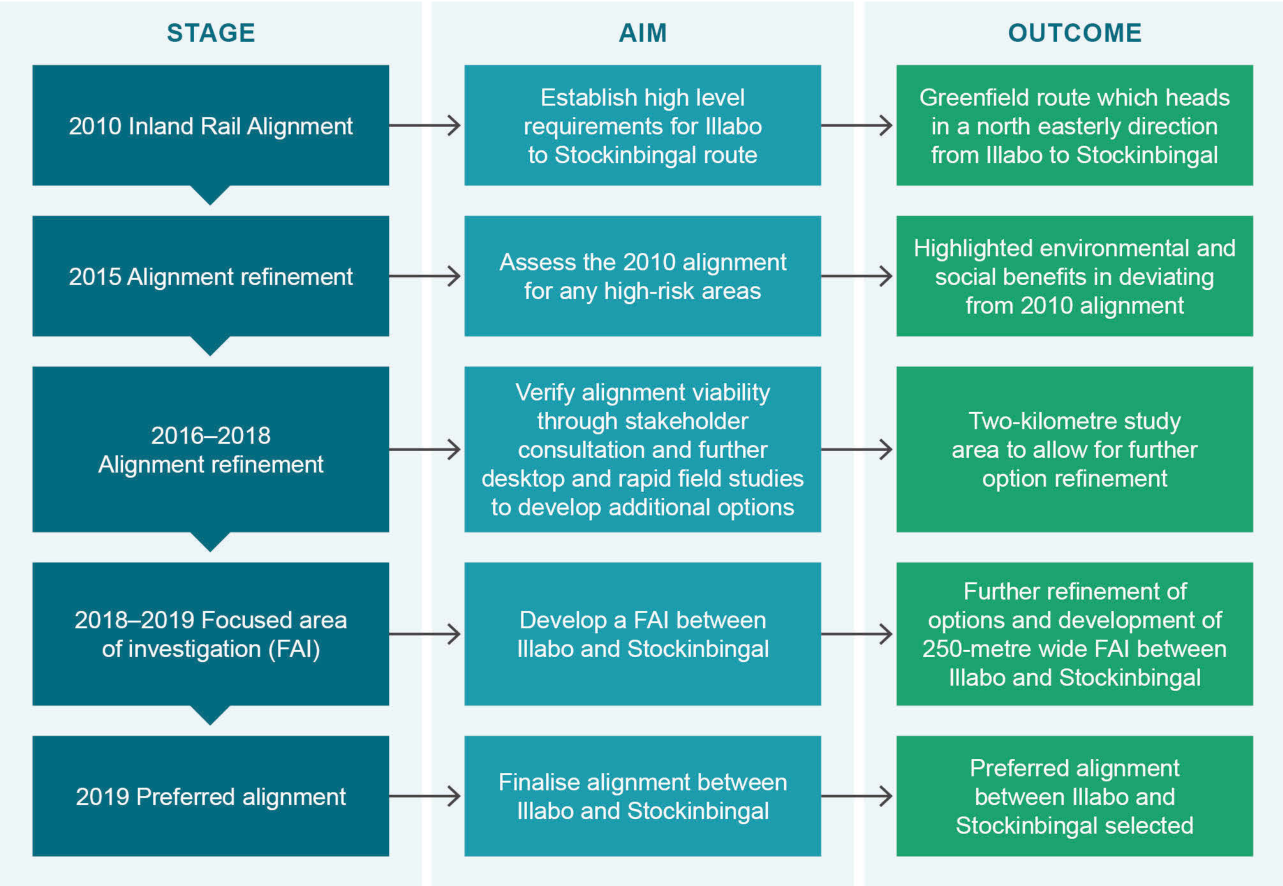


FIGURE 6-3: DEVELOPMENT OF PROPOSAL

6.3.1 Selection of Illabo to Stockinbingal option in the 2010 Inland Rail Alignment Study

As discussed in section 6.2.2, the Melbourne–Brisbane Inland Rail Alignment Study selected a route through Albury for the Melbourne to Parkes section. This included a section from Junee to Illabo.

For this section, a number of options were identified, broadly between Junee and Stockinbingal and Illabo to Stockinbingal (refer to Figure 6-4). The ‘base case’ option considered included using the existing rail corridor between Junee and Stockinbingal (via Cootamundra), with no upgrades. This option was discounted because it would not provide for double-stacked container operations, a key service objective for Inland Rail. Constraints between Illabo and Cootamundra, including the Bethungra Spiral, the rail grade and structure clearance constraints also resulted in significant impacts to travel time.

The other options considered comprised:

- a greenfield route directly from Junee to Stockinbingal (Option A)
- utilisation of existing rail from Junee to Illabo and a greenfield route from Illabo to Stockinbingal (Option B)
- utilisation of the existing rail corridor from Junee to Stockinbingal (via Cootamundra), including upgrade of the existing rail to achieve Inland Rail standards (Option C).

These three route options are shown in Figure 6-4.

FIGURE 6-4: SELECTION OF ILLABO TO STOCKINBINGAL OPTION IN THE 2010 INLAND RAIL ALIGNMENT STUDY

The options were differentiated based on capital cost and journey time. The options with the lowest capital cost per minute saved were considered the most cost-effective options. Analysis showed options to be less favourable because of:

- negative environmental impacts and land use constraints
- significant capital expenditure
- the upgrading of track did not give significant journey time improvement (due to curves and grades still constraining the speed of the train)
- options to remove speed constraints were costly for little time saving.

Option C was determined to be the poorest performing option as it shared many of the disadvantages of the base case, including a requirement to navigate constraints of the existing rail line, including the Bethungra Spiral, and an inability to provide for double stacking. Option A and B were determined to have comparable outcomes, including capital costs and similar transit times; however, given that greenfield development was considered more likely to impact on a broader range of environmental factors (e.g. biodiversity, heritage and hydrology) and to a greater degree than brownfield development, Option B (utilisation of existing rail from Junee to Illabo, and a greenfield route from Illabo to Stockinbingal) was favoured because it reduced the extent of greenfield development and associated environmental and property impacts relative to Option A (a greenfield route directly from Junee to Stockinbingal). Therefore, Option A was discounted and Option B alignment was progressed for further option assessment.

	BASE CASE Junee–Cootamundra–Stockinbingal existing corridor	**OPTION A** Junee–Stockinbingal Direct Greenfield	**OPTION B** Junee–Illabo–Stockinbingal (Brownfield and Greenfield)	**OPTION C** Junee–Cootamundra–Stockinbingal existing corridor with extensive deviations
Distance	95km	60km 35km shorter	67km 28km shorter	87km 8km shorter
Transit time	79 min	39 min 40 min saving	45 min 34 min saving	62 min 17 min saving
Double stack	No	Yes	Yes	Yes
Construction cost	$0m (for relativity)	+$150m	+$140m	+$680m
Environmental and land impact	Base Case	Major— 60km of greenfield	Moderate—39km of greenfield	Moderate— 32km of deviations
Overall				
Recommended			✓	

Favourable Neutral Unfavourable Highly unfavourable

FIGURE 6-5: JUNEE TO STOCKINBINGAL OPTIONS (INLAND RAIL ROUTE HISTORY SUMMARY 2016–2020)

6.3.2 2015 Inland Rail Report and Business Case

In 2015, the Inland Rail Implementation Group prepared the 2015 Inland Rail Report—a report on Inland Rail in response to the Australian Government's request for advice on implementing Inland Rsail to be read in conjunction with ARTC's 2015 *Inland Rail Program Business Case*. The key finding of the 2015 Inland Rail Report was to support the Inland Rail Project and agree to the Inland Rail alignment as determined in 2010 and endorsed by the 2015 business case.

6.3.3 2016–2018 option assessment and alignment refinement

In 2016, further flooding, engineering and environmental investigations (including rapid field surveys for biodiversity and heritage) and community consultation were undertaken. The information obtained during these investigations fed into further options analysis and refinement. The analysis considered environmental, engineering constraints and property impacts as well as community concerns raised during consultation. Additional options were developed based on engineering and environmental assessment and a multi-criteria analysis was applied to evaluate each alignment.

The additional options developed were designed to:

- minimise interaction with Ironbong Creek
- reduce property impacts

- improve road crossing locations by providing a straighter alignment across roads
- improve earthworks balance.

For assessment purposes, the route was divided into three sections, comprising a southern, central and northern section. To address the complexity of constraints, a number of options were investigated. To provide greater design flexibility, it was determined that a 2-km 'investigation corridor' would be defined to capture all potential options and delineate a study area for further investigations. The 2-km investigation corridor was selected to achieve optimal tie-in locations to the existing rail lines, reduce environmental and property impacts, and address community concerns raised during consultation. The investigation corridor is shown in Figure 6-6.

6.4 Studies to determine a preferred alignment (2018–2019)

6.4.1 Overview

In 2018, a multi-criteria analysis process was undertaken to identify a preferred alignment to be progressed for further design development.

The multi-criteria analysis process (see section 6.4.2), included a preliminary review of a range of potential environmental constraints in addition to technical engineering and constructability criteria. The multi-criteria analysis process did not, however, include consideration of construction cost. The application of cost considerations to the preferred alignment (as determined through the multi-criteria analysis) is discussed in section 6.6.

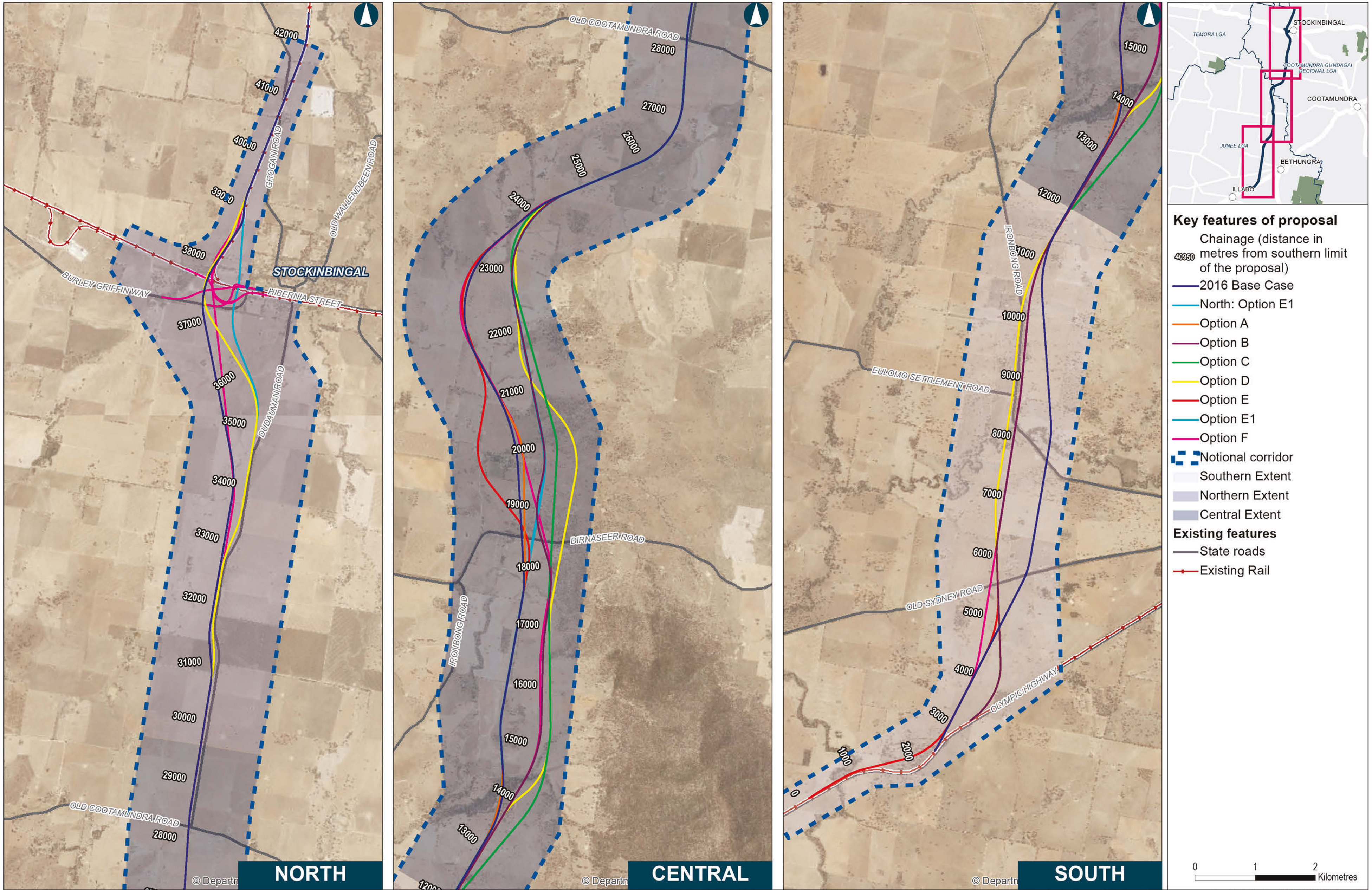
The identification of environmental constraints during this process predominantly relied on desktop information sourced through a review of the following sources of data:

- publicly accessible databases and registers
- existing mapping of topographical features, including watercourses
- aerial imagery
- the results of preliminary biodiversity and heritage surveys.

This data was used to inform a series of environmental criteria that formed part of a wider range of operational, design and constructability criteria making up the overall multi-criteria analysis framework for selection of the preferred alignment.

The options evaluation process to determine a preferred alignment was split into three areas: southern section (see section 6.4.3), central section (see section 6.4.4) and the northern section (see section 6.4.4.3) with up to seven options assessed within each area. The split in to the three areas, rather than considering the entire alignment, meant that the options could be modular and allowed for more detailed consideration of the criteria in each area.

A description of the multi-criteria analysis process and options assessment process is provided in section 6.4.2. An overview of the alignment options considered is shown in Figure 6-6.



6.6 Overview of alignment options

Data Sources: LPI, ARTC, IRDJV

6.4.2 Multi-criteria analysis

6.4.2.1 Criteria and weighting of MCA framework

A multi-criteria analysis decision framework provided the mechanism for evaluating the alignment options against the base case (in this case the 2016 alignment). The multi-criteria analysis provided a process for documenting and justifying which alignment best addressed the competing technical, social, economic and environmental project objectives. The criteria and weightings used was based on previously developed multi-criteria analysis for Inland Rail (see Table 6-1 and Figure 6-7).

TABLE 6-1: CRITERIA ASSESSED AS PART OF MULTI-CRITERIA ANALYSIS

Criterion	Sub-criteria	Criteria weighting
Technical viability	Considers the alignment, impact on public utilities, geotechnical conditions, impacts on existing road and rail networks, flood immunity and hydrology and future proofing.	17%
Environmental impacts	Considers the ecological impacts (flora, fauna and habitats), visual impacts, noise and vibration impacts, flooding and waterway impacts and the effect on air quality and greenhouse gas emissions.	12.5%
Safety assessment	Considers construction safety, operational safety, public safety, road safety interfaces and emergency response.	16.5%
Community and property impacts	Considers property impacts, Indigenous and non-Indigenous heritage, impact on community, community response and current and future land use and links to economic impacts.	12.5%
Operational approach	Considers the impact on travel time, reliability and availability, and network interoperability and connectivity including interfaces with rail terminals and network.	16.5%
Approvals and stakeholder engagement	Considers planning and approval requirements, State and Federal agency buy-in, Local government buy-in, other statutory and regulatory approvals and service authorities, such as utilities etc.	12.5%
Constructability and schedule	Considers construction duration, access, and complexity, resources, interface with operational railway and staging opportunities.	12.5%

The multi-criteria analysis provided a quantitative and qualitative basis by which each option could be assessed. The options assessed as part of the multi-criteria analysis is described further below.

6.4.2.2 How environment and community aspects were considered in the MCA process

For each option, a notional construction footprint (area of disturbance) was applied to each alignment to assess potential environmental impacts for each of the alignment options based on a preliminary design. This allowed for cuttings, embankments, bridges and culverts. The notional corridor did not take in to account any construction compounds or ancillary facilities that would be identified and located once detailed field surveys had been undertaken to further minimise any environmental impacts; however, the notional corridor was sufficient for the purposes of options analysis.

It also allowed for engagement with the community, including landowners and other stakeholders who may be directly impacted by the project. Stakeholder feedback was used to score options based on the community and property impacts weightings (in addition to other considerations).

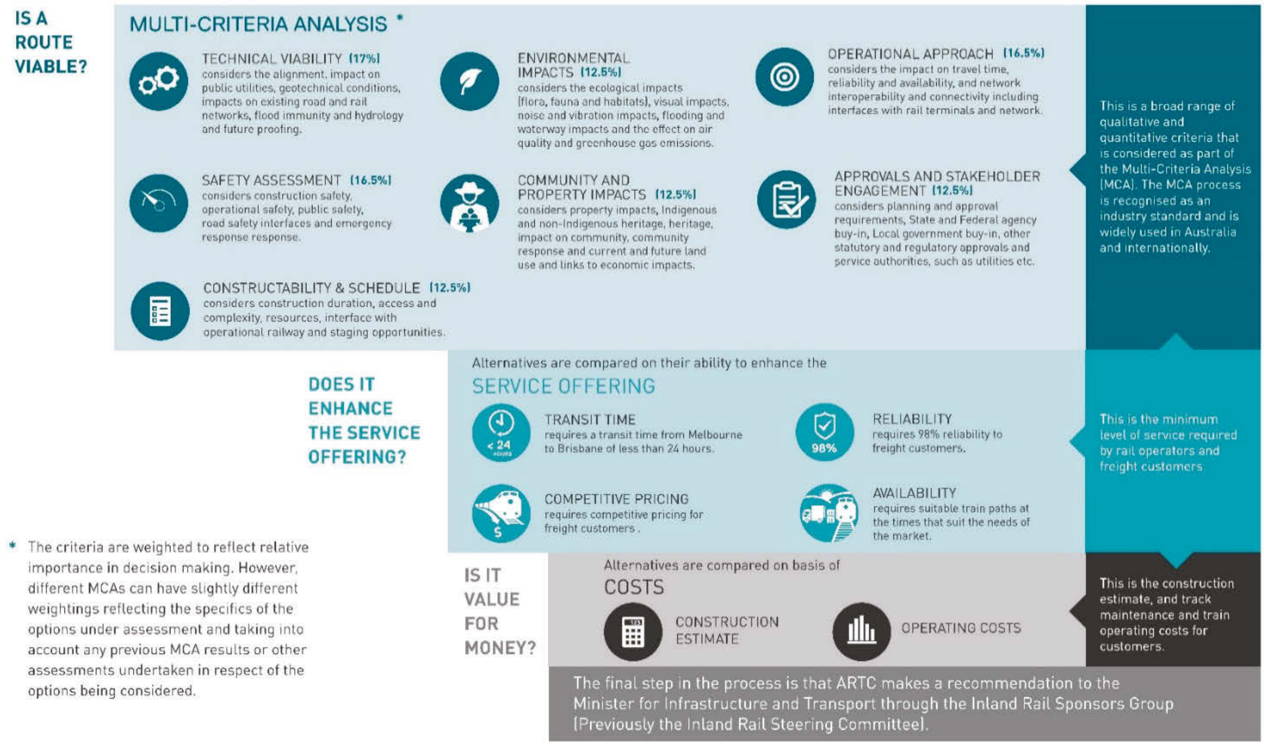


FIGURE 6-7: FACTORS AFFECTING INLAND RAIL ROUTE SELECTION SINCE 2016

6.4.3 Option development and assessment for the southern section

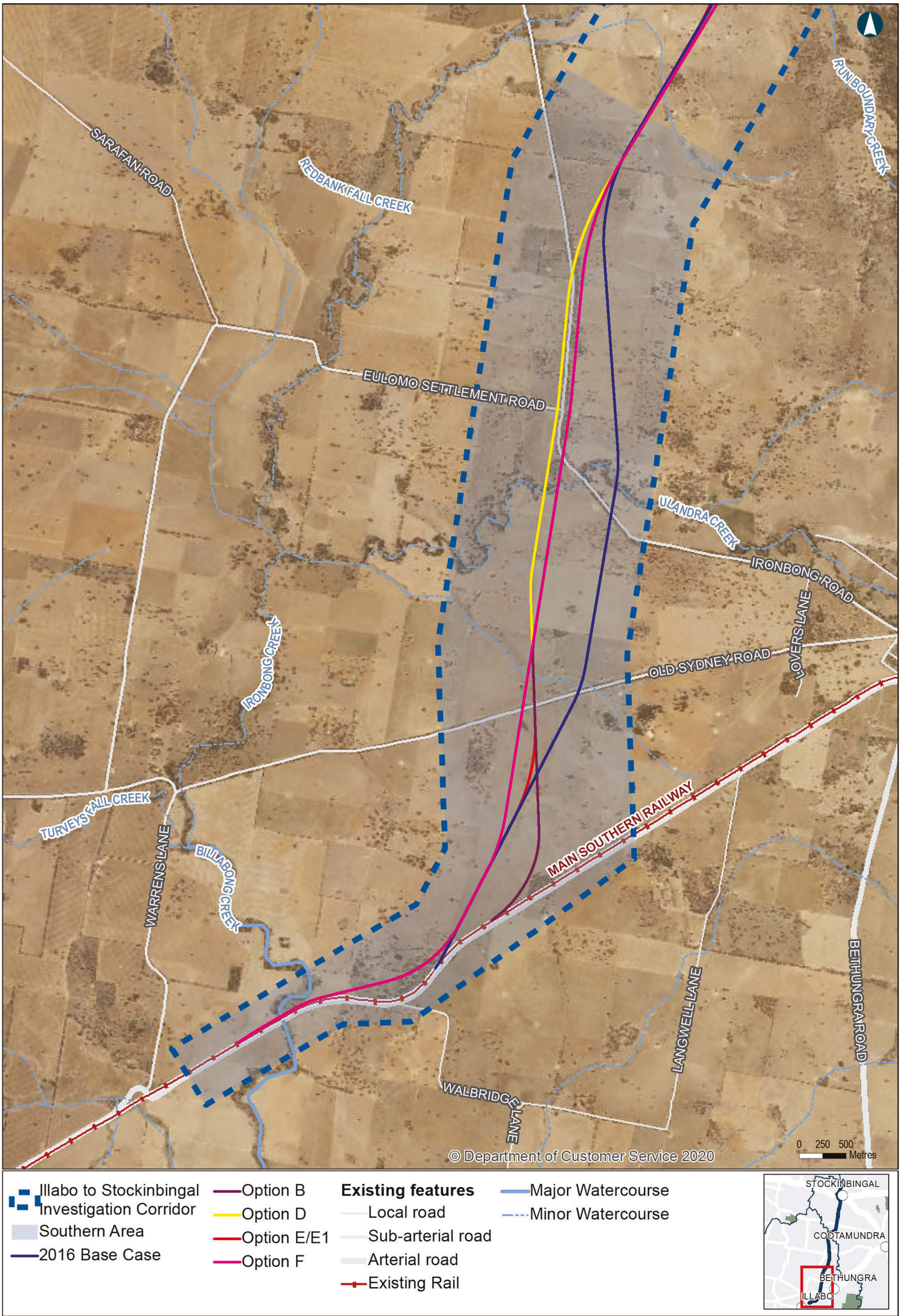
6.4.3.1 Overview of options

The southern section consists of the alignments from the existing Main South Line to the point of connection where the alignments run north, and finishes as the alignment diverges east of Ironbong Road (see Figure 6-8).

A description of the options assessed for the southern section is provided in Table 6-2. It is noted that Option A and Option C were discounted due to their similarities both in geographic location and scoring to the 2016 Base Case.

TABLE 6-2: DESCRIPTION OF SOUTHERN SECTION OPTIONS

Option	Description
2016 Base Case	The 2016 Base Case comprises track widening for 2.5 km and new track for 9.6 km. The route leaves the existing Main South Line and runs north through relatively flat topography. The alignment crosses one arterial road—Ironbong Road.
Option B	Option B comprises track widening for 3.3 km and 8.4 km of new track. The route maintains its alignment next to the Main South Line past a large hill, prior to turning north as new track. The alignment crosses one arterial road—Ironbong Road.
Option D	Option D is a minor alteration of Option B by running alongside the western side of Ironbong Road. Option D comprises track widening for 3.3 km and 8.7 km of new track. The route maintains its alignment next to the Main South Line past a large hill, prior to turning north as new track. The alignment crosses one arterial road—Ironbong Road.
Option E/Option E1	Option E and E1 comprises track widening for 0.2 km and new track for 11.3 km. Options E and E1 reduce the overall length of track widening compared to Option B due to the reduced length along the Main South Line. The routes leave the existing Main South Line and runs north initially through a large hill requiring a cutting. Option E1 follows the same alignment as Option E but has steeper gradients.
Option F	Option F utilises the same connection point as Option E/E1 and maintains this alignment until it begins to head north. As the alignment heads north, it runs adjacent to the east of Ironbong Road on the same alignment as Option B. The vertical alignment used by Option F is the same as Option E1, utilising maximum gradients to reduce earthworks impact.



6.8 Southern section options

Coordinate System: GDA 1994 MGA Zone 55
Date: 1/27/2022 Paper size: A4 Scale: 1:55,000
MAP 1 of 1

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_6_8_SouthernOptions_r1v3.mxd

6.4.3.2 Assessment of options

An assessment of the alignment options carried out against the 2016 Base Case and assessment criteria is provided in Figure 6-9.

Criterion	OPTION B	OPTION D	OPTION E	OPTION E1	OPTION F
Technical viability	🔴	🔴	🟡	🔴	🟡
Safety assessment	🔴	🔴	🔴	🔴	🟡
Operational approach	🟢	🟡	🟢	🟢	🟢
Constructability and schedule	🔴	🔴	🔴	🟡	🟡
Environmental impacts	🔴	🔴	🔴	🔴	🔴
Community and property impacts	🟢	🟢	🟢	🟢	🟢
Approvals and stakeholder engagement	🟡	🟡	🟡	🟡	🟡

🔴 Alignment option performs worse than 2016 Base Case
🟡 Alignment option performs similarly to 2016 Base Case
🟢 Alignment option performs better than 2016 Base Case

FIGURE 6-9: ASSESSMENT OF SOUTHERN SECTION OPTIONS

6.4.3.3 Selection of preferred alignment

The assessment concluded that Option F was the preferred alignment as it scored highest as an outcome of the multi-criteria analysis, with the benefits of the preferred alignment provided in Table 6-3. The preferred alignment in the south was based on its connection point to the Main South Line, reducing the works associated with track widening, interface with Ironbong Road and minimising impact on properties by running adjacent to the eastern boundary of Ironbong Road.

TABLE 6-3: BENEFITS OF THE SOUTHERN SECTION PREFERRED ALIGNMENT (OPTION F)

Criterion	Description
Technical viability	▸ Reduced overall track widening and improving the geometry profile ▸ Improved crossing of Ironbong Road.
Safety assessment	▸ Reduced structure length improving both operational and construction safety ▸ Reduced amount of material required to be handled.
Operational approach	▸ Reduced structure length improving reliability ▸ Best connection point of all options contributing to existing network connectivity.
Constructability and schedule	▸ Reduced complexity from reduced bridge lengths ▸ Shortest length of interface with operational railway.
Environmental impacts	▸ While this option doesn’t score positively in environment, the improvement in other areas outweighs the environment criteria.
Community and property impacts	▸ Reduced property impacts and severance ▸ Preferred option by the community.
Approvals and stakeholder engagement	▸ No differentiation between any options from approvals and stakeholder perspective.

6.4.4 Option development and assessment for the central section

6.4.4.1 Overview of options

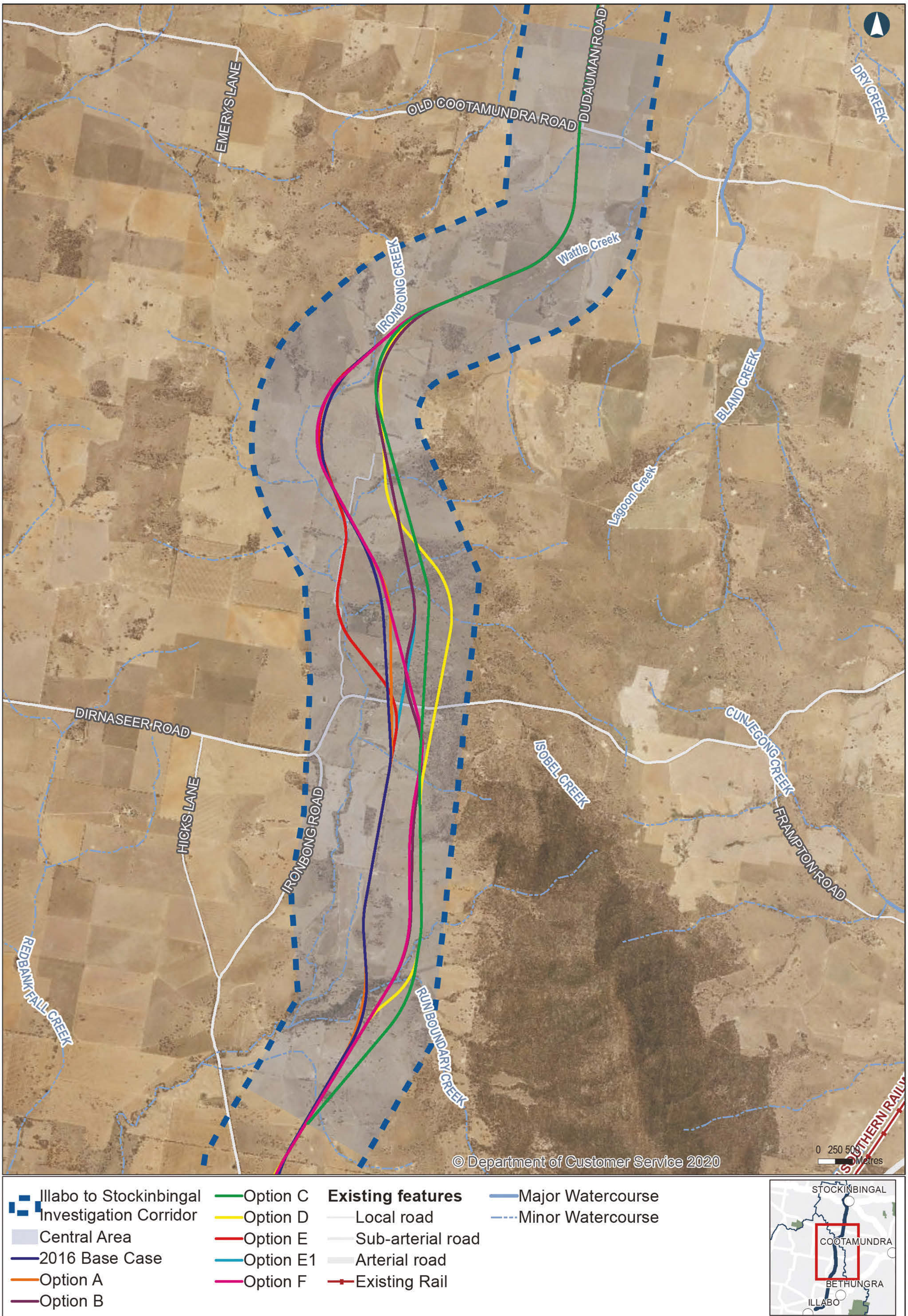
The central section of the alignment is in open land with no connections to existing railways. Topography is reasonably undulating throughout. At the interface with the northern section, there is an extended length of alignment, which is common to all options through the 'saddle'. This area is driven by the topography as the alignments use the existing topography, avoiding sharp changes in elevation.

The central section design comprises grade-separated road crossings at Dirnaseer Road and Old Cootamundra Road, a crossing loop 2,200 metres (m) in length, and a 250-m maintenance siding.

A description of the options assessed for the central section is provided in Table 6-4.

TABLE 6-4: DESCRIPTION OF THE CENTRAL SECTION OPTIONS

Option	Description
2016 Base Case	▸ The 2016 Base Case runs largely north–south, with some small curves at the southern end to follow land contours. The alignment crosses Old Cootamundra Road at the junction with Dudauman Road and then continues north paralleling Dudauman Road.
Option A	▸ Option A follows a similar path to the 2016 Base Case, with the alignment shifting slightly west when crossing Dirnaseer Road, increasing the distance between the rail line and the existing dwelling. The alignment crosses Old Cootamundra Road on an elevated structure at Dudauman Road and then continues north, paralleling Dudauman Road.
Option B	▸ Option B is approximately 500 m further east of the 2016 Base Case. The alignment is in an area of higher elevation with more natural undulation than to the east. The alignment crosses Old Cootamundra Road at the junction with Dudauman Road and then continues north, paralleling Dudauman Road.
Option C	▸ Option C is approximately 500 m further east of the 2016 Base Case. The alignment is in an area of higher elevation with more natural undulation than to the east. This is the straightest of the eastern alignments, and the alignment with the largest embankments and cuttings. The alignment converges with the 2016 Base Case before it crosses Old Cootamundra Road at the junction with Dudauman Road and then continues north, paralleling Dudauman Road.
Option D	▸ Option D is approximately 500 m further east of the 2016 Base Case. The alignment is in an area on a higher level and with more natural undulation than to the east. The alignment remains further east as the alignment continues north and is most easterly of the central area options. The alignment converges with the 2016 Base Case and crosses Old Cootamundra Road at the junction with Dudauman Road and then continues north, paralleling Dudauman Road.
Option E	▸ Option E follows the same path as the 2016 Base Case with a 500 m westerly deviation immediately after crossing Dirnaseer Road. The alignment then converges with the 2016 Base Case and crosses Old Cootamundra Road at the junction with Dudauman Road and then continues north, paralleling Dudauman Road.
Option E1	▸ Option E1 follows the Option E alignment through the south but deviates south of Dirnaseer Road, where the alignment adopts the Option B alignment.
Option F	▸ Option F deviates from the 2016 Base Case 500 m to the east, as with Options B, C and D, and after crossing Dirnaseer Road, deviates back to the west to converge with the 2016 Base Case.



6.10 Central section options

Coordinate System: GDA 1994 MGA Zone 55
Date: 8/6/2021 Paper size: A4 Scale: 1:75,000
MAP 1 of 1

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_6_10_CentralOptions_r1v1.mxd

6.4.4.2 Selection of preferred alignment

The assessment concluded that Option C was the preferred alignment as it scored highest as an outcome of the multi-criteria analysis, with the benefits of the preferred alignment provided in Table 6-5. While Option B scored well against the 2016 Base Case, Option C performed better than Option B in technical viability, and community and property impact. The main benefit of this option was the reduced impact on property, road networks and utilities, as well as offering improved flooding characteristics.

TABLE 6-5: BENEFITS OF THE CENTRAL SECTION PREFERRED ALIGNMENT (OPTION C)

Criterion	Description
Technical viability	▸ Reduced number of utility interactions ▸ Reduced number of undesirable road interactions ▸ Vastly improved flooding characteristics.
Safety assessment	▸ Improve operational safety through reduced length of bridges.
Operational approach	▸ Least number of bridges and road crossings contributing to improved reliability.
Constructability and schedule	▸ While this option doesn't score positively in constructability due to large earthwork quantities and large embankments, the improvement in other criterion outweigh the constructability criteria.
Environmental impacts	▸ Reduced visual and noise impacts due to increased distances from sensitive receivers ▸ Reduced flooding impacts.
Community and property impacts	▸ Reduced property impacts and severances ▸ Reduced impact on community due to increased distances to sensitive receivers.
Approvals and stakeholder engagement	▸ No differentiation between any options from approvals and stakeholder engagement perspective.

6.4.4.3 Assessment of options

An assessment of the alignment options carried out against the 2016 Base Case and assessment criteria is provided in Figure 6-11.

Criterion	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E	OPTION E1	OPTION F
Technical viability	🔴	🟢	🟢	🟢	🔴	🟡	🔴
Safety assessment	🔴	🟢	🔴	🔴	🔴	🟡	🟡
Operational approach	🟡	🟢	🟢	🔴	🔴	🟢	🟡
Constructability and schedule	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Environmental impacts	🟡	🟢	🟢	🟢	🔴	🟡	🟡
Community and property impacts	🟡	🟡	🟢	🟢	🔴	🟡	🟡
Approvals and stakeholder engagement	🟡	🟡	🟡	🟡	🔴	🟡	🟡

🔴 Alignment option performs worse than 2016 Base Case
🟡 Alignment option performs similarly to 2016 Base Case
🟢 Alignment option performs better than 2016 Base Case

FIGURE 6-11: ASSESSMENT OF THE CENTRAL SECTION OPTIONS

6.4.5 Option development and assessment for the northern section

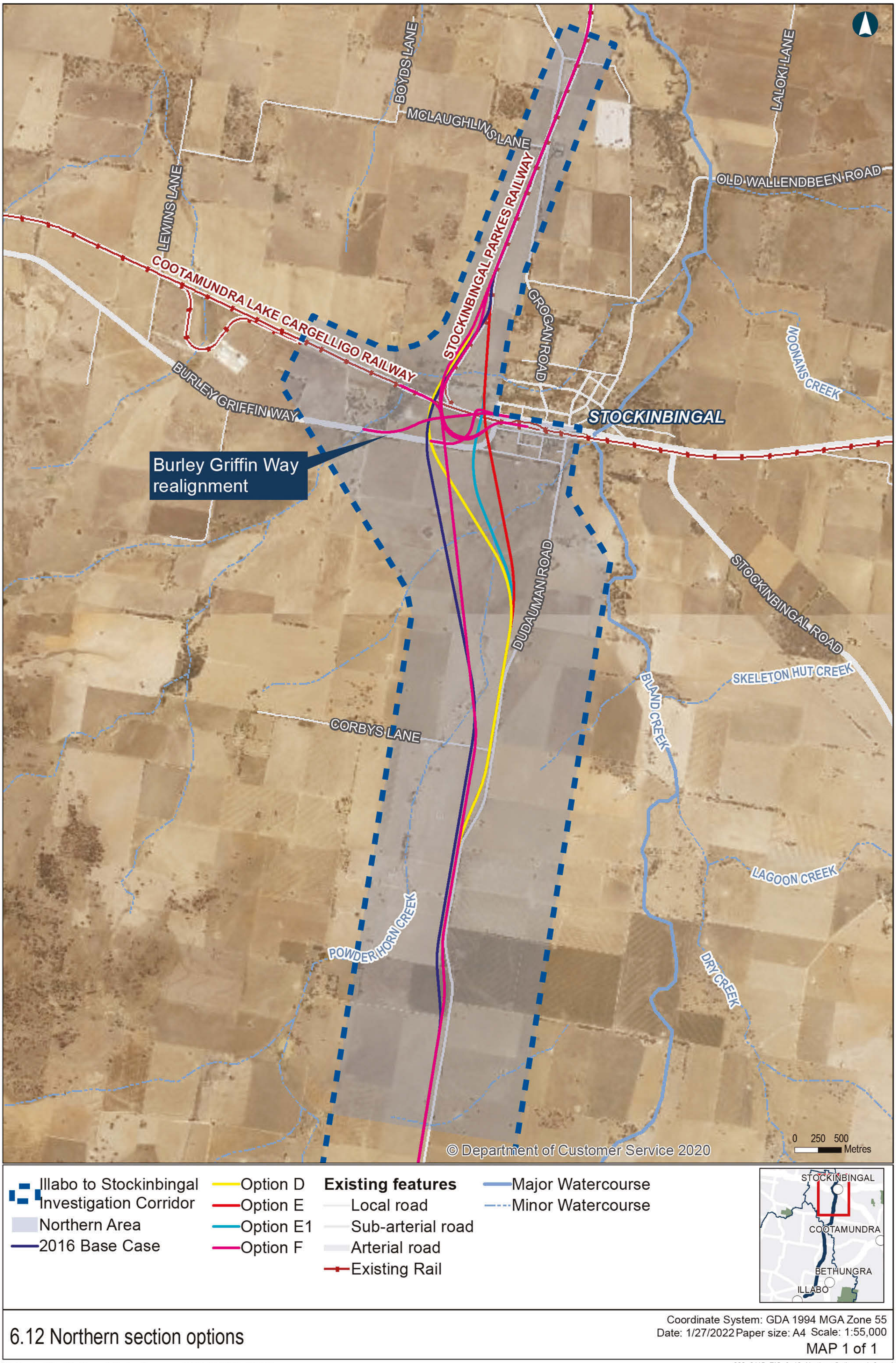
6.4.5.1 Overview of options

The options assessed comprised of approximately 10 km of new track, road–rail interface of Burley Griffin Way and the existing Lake Cargelligo line and the tie-in to the existing Stockinbingal to Parkes line. Of the options developed, all except Option F are rail-over road grade separations of Burley Griffin Way and the existing Lake Cargelligo line.

A description of the options assessed for the central section is provided in Table 6-6.

TABLE 6-6: DESCRIPTION OF NORTHERN SECTION OPTIONS

Option	Description
2016 Base Case	▸ The 2016 Base Case alignment runs along the western side of Dudauman Road and provides grade separation over both the Burley Griffin Way and existing Lake Cargelligo Line before it re-joins the Stockinbingal–Parkes Line.
Option D	▸ Option D runs along the western side of Dudauman Road and provides grade separation over both the Burley Griffin Way and existing Lake Cargelligo Line before it re-joins the Stockinbingal–Parkes Line. Option D improves on the 2016 Base Case by reducing land severances by running parallel to Dudauman Road for a longer section.
Option E	▸ Option E runs along the western side of Dudauman Road and provides grade separation over both the Burley Griffin Way and existing Lake Cargelligo Line before it re-joins the Stockinbingal–Parkes Line. Option E improves on the 2016 Base Case by further reducing land severances by running parallel to Dudauman Road for a longer section and closer to Stockinbingal.
Option E1	▸ Option E1 is similar to Option E with the difference between options being the adjustment of Burley Griffin Way to be more perpendicular in an attempt to reduce the overall span. Option E1 improves on the 2016 Base Case by further reducing land severances by running parallel to Dudauman Road for a longer section and closer to Stockinbingal.
Option F	▸ Option F runs along the western boundary of Dudauman Road and continuing north providing an at-grade crossing of the Lake Cargelligo Line combined with a road over rail diversion of Burley Griffin Way. In addition, realignment of the Lake Cargelligo Line is required. Option F has added benefits for the community by removing the level crossing located to the west of Stockinbingal.



6.12 Northern section options

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

6.4.5.2 Assessment of options

An assessment of the alignment options carried out against the 2016 Base Case and assessment criteria is provided in Figure 6-13.

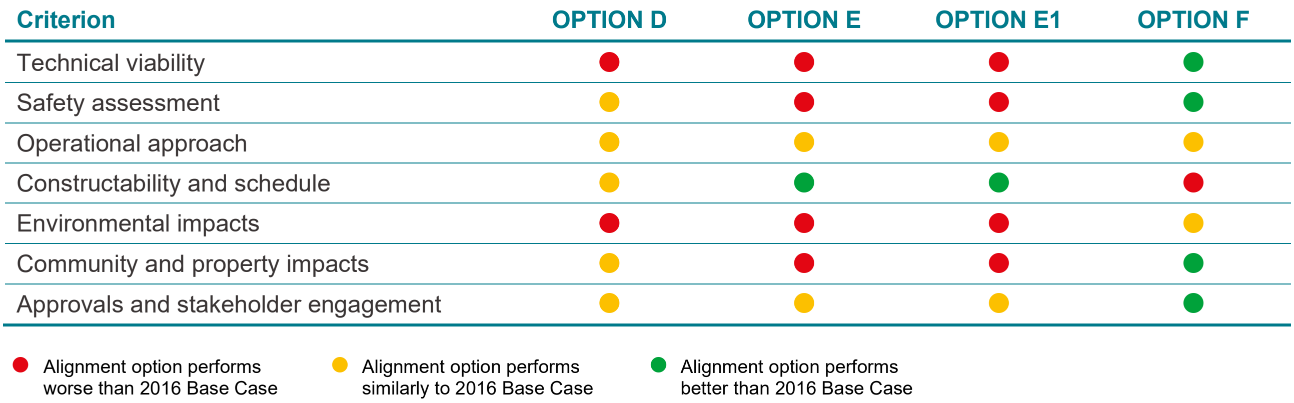


FIGURE 6-13: ASSESSMENT OF NORTHERN SECTION OPTIONS

6.4.5.3 Selection of initial preferred alignment

The assessment concluded that Option F was the preferred alignment as it scored highest as an outcome of the multi-criteria analysis, with the benefits of the preferred alignment provided in Table 6-7. The preferred alignment in the north utilised an at-grade crossing of the Lake Cargelligo Line. This option scored notably higher in the community and property impact criteria due to the removal of the Burley Griffin Way level crossing to the west of Stockinbingal and the improvement in road safety interfaces.

TABLE 6-7: BENEFITS OF THE NORTHERN SECTION PREFERRED ALIGNMENT (OPTION F)

Criterion	Description
Safety assessment	‣ Removal of existing Burley Griffin Way level crossing, thereby improving road safety interfaces.
Operational approach	‣ Improved round-trip travel time (circa one minute) compared to base case.
Constructability and schedule	‣ While this option doesn't score positively in constructability, the improvement in other areas outweigh the constructability criteria.
Environmental impacts	‣ Reduced noise impacts through realignment of the rail line further west of Stockinbingal compared to other options ‣ Improved hydrology impacts ‣ Improved greenhouse gas emissions through by-pass of speed restricted curve on mainline.
Community and property impacts	‣ Removal of Burley Griffin Way level crossing, resulting in positive response from community ‣ Installation of road bridge (rather than rail bridge) preferable from community perspective.
Approvals and stakeholder engagement	‣ Removal of Burley Griffin Way level crossing aligns with local government and council aspirations for safer roads.

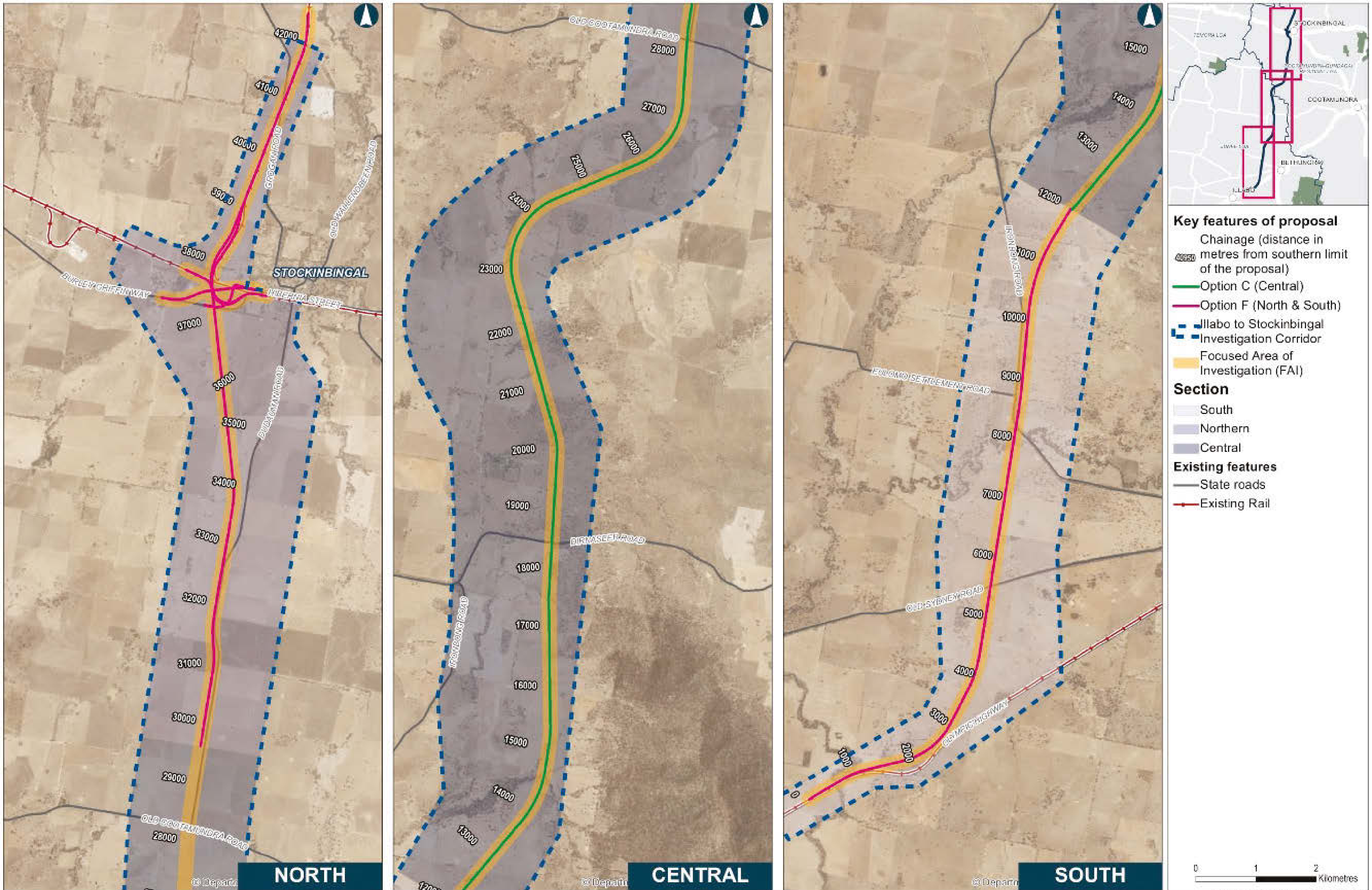
6.4.6 Confirmation of the focused area of investigation

The preferred alignment was selected based on the outcomes of the multi-criteria analysis as identified in sections 6.4.3 to 6.4.4.3. The assessment resulted in a preferred alignment of Option F in the southern section, Option C in the central section and Option F in the northern section.

Following the multi-criteria analysis process, it was determined that a 250-m wide corridor (referred to as the focused area of investigation (FAI)) would be established around the preferred alignment. The FAI would form the study area for detailed field surveys to be undertaken for the EIS. This would ensure that environmental constraints within both the immediate impact area of the preferred alignment and the adjacent areas would be fully understood. While the alignment would only use a portion of this width, consideration of the 250-m corridor allowed for flexibility to avoid environmental risks as the design progressed.

The preferred alignment and FAI are shown in Figure 6-14.

The options considered for the features of the proposal during development of the feasibility design are discussed in section 6.5.



Coordinate System: GDA 1994 MGA Zone 55
Paper size: A3
Scale: 1:60,000
Date: 8/24/2021

6.14 Preferred alignment and focused area of investigation (FAI)

Data Sources: LPI, ARTC, IRDJV

6.4.7 Refinement of preferred alignment for the northern section and modification to the focused area of investigation

As outlined above, Option F was selected as the preferred alignment. Predominantly, this was due to the option incorporating an at-grade crossing of the Lake Cargelligo railway line, and removal of the Burley Griffin Way level crossing to the west of Stockinbingal, improving the road safety interfaces.

South of Stockinbingal, however, this alignment deviated from Dudauman Road in a north–west direction. This option resulted in severance to a number of properties, which was more significant when comparing to the alignment deviating from Dudauman Road at an earlier stage. In response to this, a hybrid solution was formed, which combined the benefits of the at-grade solution (preferred option) and the preferred route option.

The hybrid option also included widening the diameter of the curve of the Lake Cargelligo connection to reduce potential wheel squeal for the nearby residents and moving the alignment further to the west of Stockinbingal.

In mid-2019, the refined Option F was taken forward as the preferred option and a modified FAI was applied. Additional environmental investigations were completed where required. The relevant modified section of the FAI is shown in Figure 6-15.

6.15 Refinement of preferred alignment for the northern section

Coordinate System: GDA 1994 MGA Zone 55
Date: 8/24/2021 Paper size: A4 Scale: 1:55,000
MAP 1 of 1

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_6_15_RefinedNorthernOptions_r1v2.mxd

6.5 Development of a feasibility design

6.5.1 Overview

Once a preferred alignment had been selected through the MCA process, design development was undertaken to develop a feasibility design (a design that provided a robust basis for determining constructability and design parameters, and defining the project for the purposes of this EIS). As part of developing the feasibility design, detailed field investigations were undertaken including environmental, geotechnical, utility investigations and survey within the focused area of investigation. In particular, ground truthing and surveying biodiversity (terrestrial and aquatic), heritage and agricultural values within the focused area of investigation were undertaken (subject to private property access limitations). In addition to providing the assessment basis for the EIS, the findings of the investigations allowed for further optimisation of the design (see section 6.5.3).

6.5.2 Detailed investigations undertaken within the focus area of investigation

Detailed field investigations within the focused area of investigation to inform the EIS were completed in late 2018 and early 2019, including biodiversity (terrestrial and aquatic), Aboriginal heritage, visual, contamination, groundwater, noise and vibration, social and agricultural values.

Targeted surveys for ecology and aquatic ecology, and further groundwater monitoring were conducted to provide information on seasonal variance and areas of high ecological importance. This included identifying areas of native vegetation and fauna connectivity.

The field surveys undertaken for Aboriginal heritage in late 2018 also identified areas of high significance within the focused area of investigation, and the need to undertake test excavations for archaeological significance of subsurface deposits. The archaeological test excavations were partially completed in April and May 2019, with additional fieldwork completed in 2021.

As part of the agronomist field surveys, farming equipment and structures required for efficient operation of agricultural activities, including stock and vehicle crossings, dams, water pipelines and property severance, were identified.

The results of field investigations for ecology, aquatic ecology, cultural heritage and agricultural impacts, were reviewed in an environmental constraints workshop to inform design development, further discussed in section 6.5.3.

6.5.3 Approach to avoiding or minimising impacts

The approach to design development has included a focus on avoiding and/or minimising the potential for impacts during all key phases of the proposal. The multi-criteria analysis undertaken during the option selection included consideration of environmental and social impacts. As part of design development, an environmental constraints workshop was held in January 2019 to identify significant constraints, risks and opportunities that the alignment should seek to avoid through design responses. The workshop provided an overview of the biodiversity (terrestrial and aquatic), heritage and agricultural constraints and suggested design responses.

6.5.4 2019 feasibility design

Following completion of the MCA process, and review of environmental constraints development, a feasibility design was confirmed within the FAI in 2019.

6.6 Design optimisation (2020–2021)

Following completion of the feasibility design in 2019, ARTC undertook further review of the estimated construction costs and program needed to deliver the proposal based on the feasibility design. It was determined that the costs and extended duration associated with construction of the proposal were not feasible and could be reduced while at the same time maintaining equivalent outcomes, or reducing impacts for other considerations including environmental, community and property impacts in some key areas.

The review confirmed that further development of the feasibility design (design optimisation) was warranted. An overview of the need, options considered, and outcomes of this design stage are outlined in the following sections.

6.6.1 Need for design optimisation

The design optimisation was primarily driven by the objective of reducing construction costs.

The main factor determining construction cost was identified as the significant quantities of earthworks required to achieve the horizontal and vertical alignment proposed by the 2019 feasibility design. The 2019 feasibility design involved substantial earthworks (i.e. the excavation, transport and placement of material to create the landform required for construction of the project) due to the inclusion of deep cuts and substantial embankments in the 2019 design (relative to natural ground levels).

To reduce capital cost, it was recognised that a reduction in earthworks volumes was required through revision of the project vertical and horizontal alignment.

Design optimisation considered changes in the vertical and horizontal alignment, including review of the most appropriate form of crossing at public roads and rail lines (including whether a level crossing or bridge was required). Further explanation of relevant design features and the need for design optimisation is outlined in Table 6-8.

TABLE 6-8: OVERVIEW OF DESIGN FEATURES AND NEED FOR DESIGN OPTIMISATION

Design feature	Need for design optimisation
Vertical alignment	The vertical alignment of the feasibility design was developed based on ARTC design criteria for maximum grades. Maintaining these grades, in combination with the horizontal alignment and topography, resulted in the requirement for significant earthworks in areas of cut and fill. Modified design limitations for maximum grades and relevant change in grades was applied to confirm options to achieve better integration between the design and surrounding topography and reduce the cut and fill requirements of the proposal.
Horizontal alignment	While the horizontal alignment was confirmed as part of development of the 2019 feasibility design, it resulted in sections of the alignment being located in areas of steeper topography. To allow for acceptable design grades (i.e. a maximum gradient generally not exceeding 1 per cent), significant earthworks would be required for areas of cut. Optimisation of the horizontal alignment, such as avoiding hills, was required in these areas to reduce the overall proportion of the proposal in areas of steep topography.
Other design features	Relocation of the crossing loop was considered due to the previous location of the crossing loop in an area of steep topography and requiring a crossing of Run Boundary Creek.

6.6.2 Design optimisation assessment process

The preferred alignment was selected through the MCA process described in section 6.4, and resulted in selection of an FAI for development of the feasibility design (see section 6.5).

The design optimisation included completion of a high-level design analysis of different optimisation opportunities. The focus of this analysis was earthworks minimisation, predominantly through refinement of the horizontal and vertical alignment design. The primary options investigated were generally confined within the FAI as described in section 6.4; however, consideration of limited options outside the FAI were also undertaken where there was considered to be a justified benefit.

The project was divided into six sections for design and construction considerations (see section 8.2).

6.6.3 Approach to consideration of environmental values

Further consideration of environmental, social, property and other issues was undertaken to ensure that site constraints were recognised and impacts of the optimised design options considered. The development of the preferred alignment and subsequent 2019 feasibility design had placed significant weight on this through:

- application of a robust MCA process that gave due weighting to environmental issues, and could be used to provide a robust justification for the preferred alignment during the EIS assessment and approval phase
- an environmental constraints workshop (in early 2019) using field-verified environmental data, and ongoing collaboration between engineering and environmental disciplines to ensure environmental constraints were considered in the development of the previous feasibility design
- consultation with landowners to understand and, where possible, mitigate severance and agricultural impacts on directly affected land holdings.

The approach to consideration of environmental values for the design optimisation included consideration of relevant change in impact compared to the previous design. In reviewing options for design optimisation, the following environmental values were considered:

- impacts on areas outside the FAI (areas where limited field survey information and less detailed understanding of environmental constraints was available)
- direct impacts to areas of threatened ecological communities and cultural heritage sensitivity
- impacts to communities (i.e. proximity of the alignment to residential receivers)
- impacts to roads and other infrastructure
- impacts to landowners associated with property acquisition.

6.6.4 Key changes as a result of the optimisation process

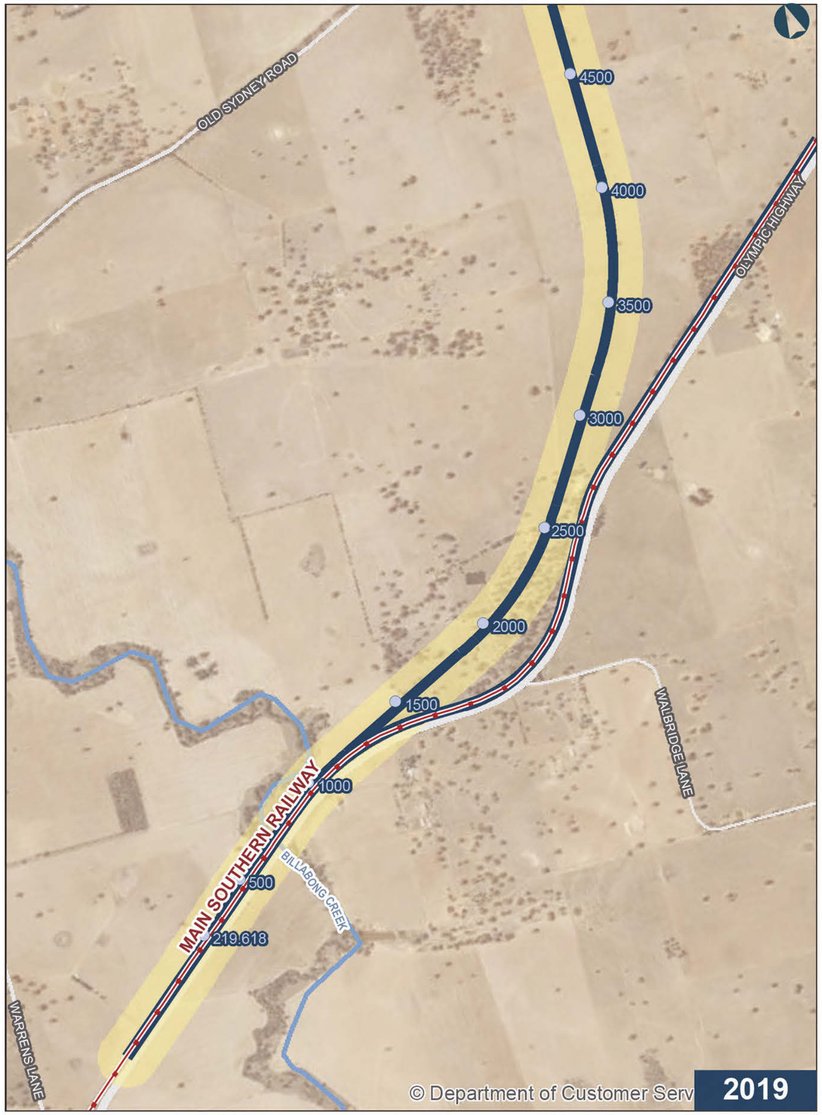
The optimisation process resulted in a number of changes. Figure 6-16 presents a comparison of the alignment and FAI, and the six sections of the proposal site (to highlight where the proposal has deviated from the FAI).

As shown on Figure 6-16, the key changes associated with the project alignment are:

1. realignment of the proposal at Illabo
2. change of the Ironbong Road crossing from a bridge to a level crossing
3. relocation of the crossing loop
4. relocation of the rail alignment eastwards at Stockinbingal.

The rationale for these four primary changes and their environmental implications are outlined in Table 6-9 below. It is also noted that due to relocation of the rail alignment eastwards at Stockinbingal, modification of the Burley Griffin Way realignment was also required.

Other environmental impacts were considered to remain broadly consistent with the feasibility design, and opportunities to reduce impact continued to be considered further through development of the design.



Key features of proposal

- Rail alignment (2021 optimised reference design)
- Rail alignment (2019)
- 40950 Chainage (distance in metres from southern limit of the proposal)
- Burley Griffin Way realignment (2021)
- Burley Griffin Way realignment (2019)
- Focused Area of Investigation (FAI)
- 1 Key changes associated with the project alignment

Existing features

- Local road
- Sub-arterial road
- Arterial road
- Existing Rail
- Major Watercourse

0 200 400 Metres

Coordinate System: GDA 1994 MGA Zone 55
Paper size: A4 Scale: 1:30,000
Date: 11/12/2021

Map 1 of 10

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

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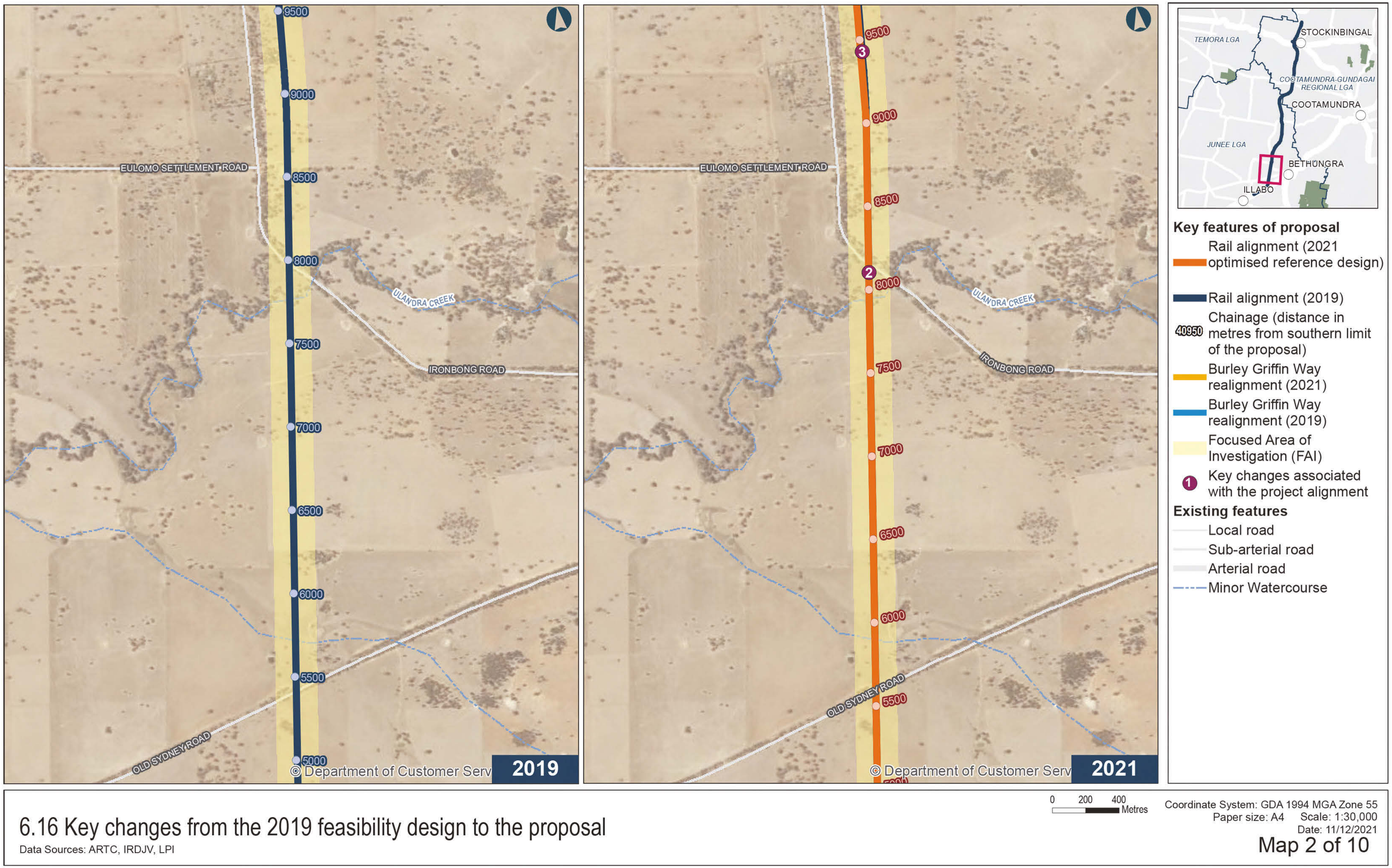

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

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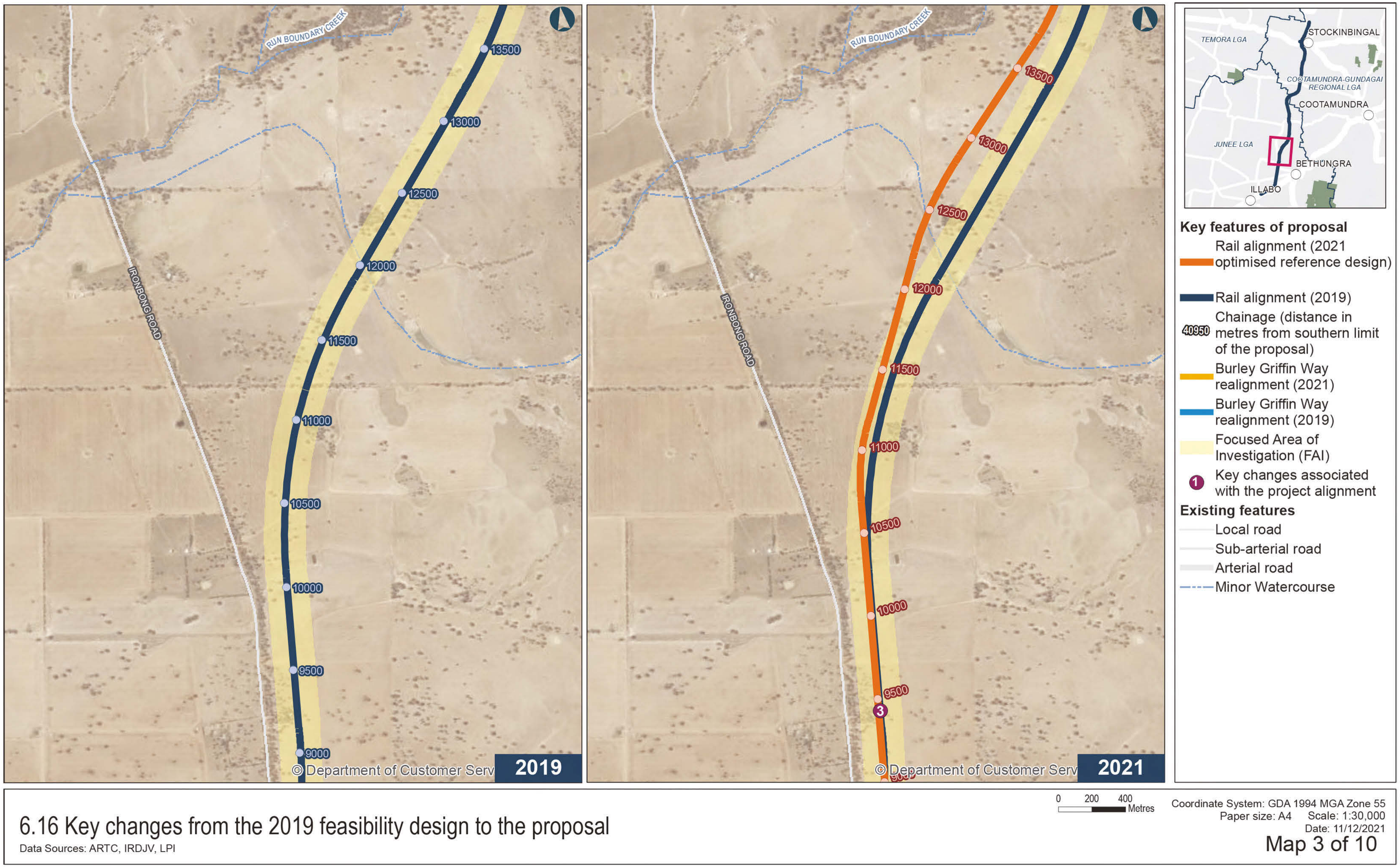

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

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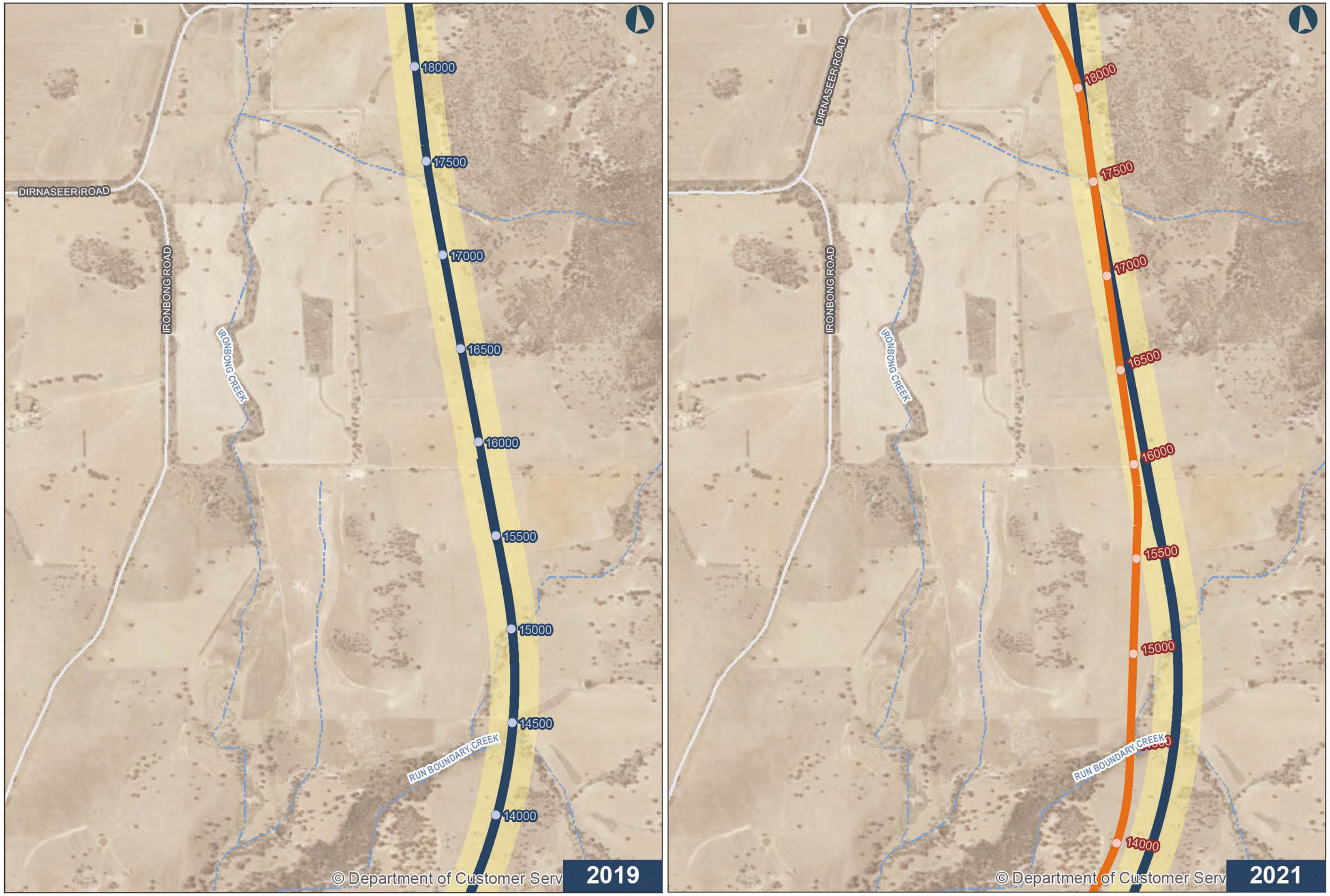


Key features of proposal

- Rail alignment (2021 optimised reference design)
- Rail alignment (2019)
- 40950 Chainage (distance in metres from southern limit of the proposal)
- Burley Griffin Way realignment (2021)
- Burley Griffin Way realignment (2019)
- Focused Area of Investigation (FAI)
- 1 Key changes associated with the project alignment

Existing features

- Local road
- Sub-arterial road
- Arterial road
- Minor Watercourse

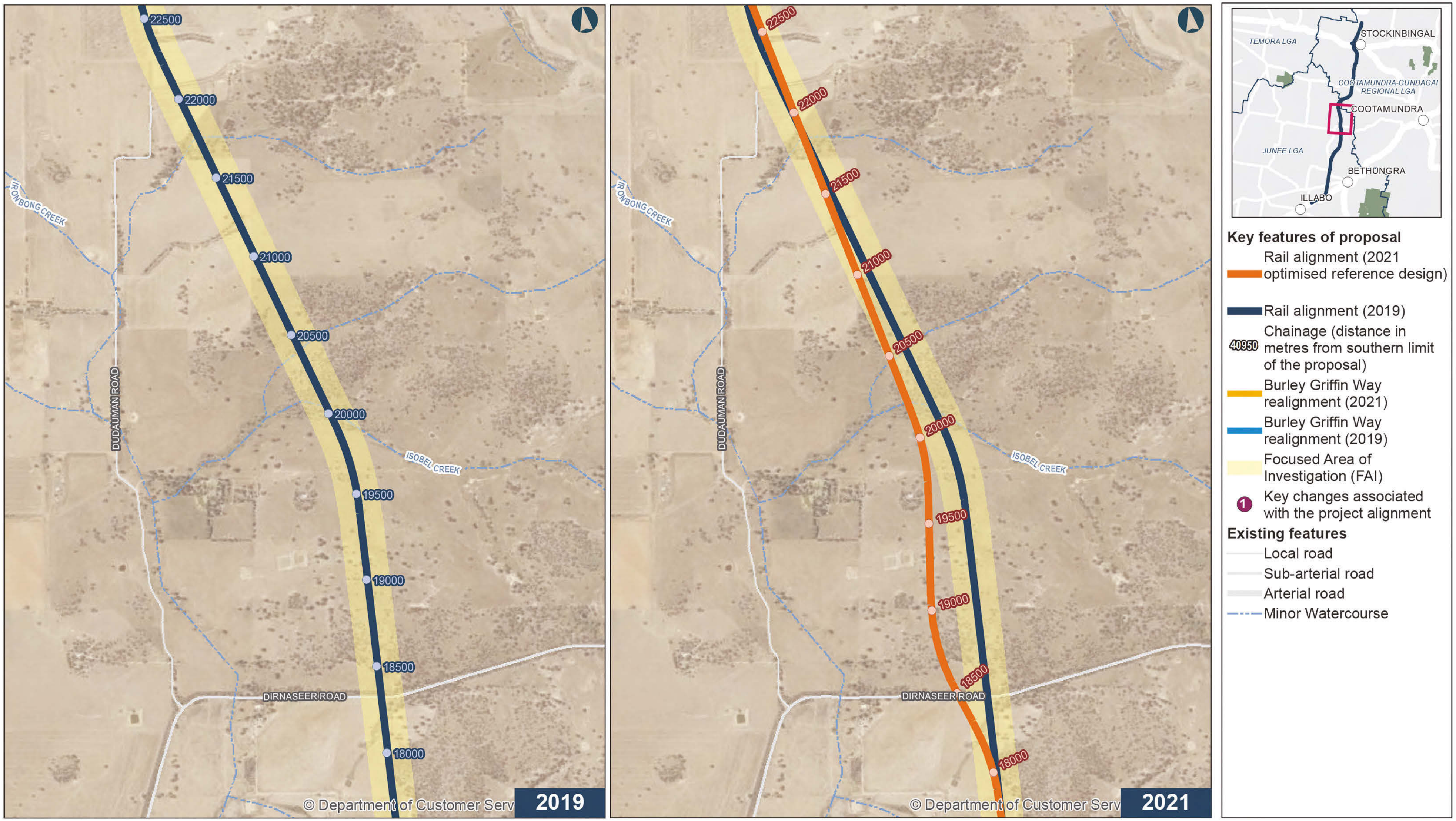
6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

0 200 400 Metres

Coordinate System: GDA 1994 MGA Zone 55
Paper size: A4 Scale: 1:30,000
Date: 11/12/2021
Map 4 of 10

220_0115_EIS_6_16_Comparison2019toOptimised_r1v7.mxd



6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Paper size: A4 Scale: 1:30,000
Date: 11/12/2021
Map 5 of 10

220_0115_EIS_6_16_Comparison2019toOptimised_r1v7.mxd

0 200 400 Metres

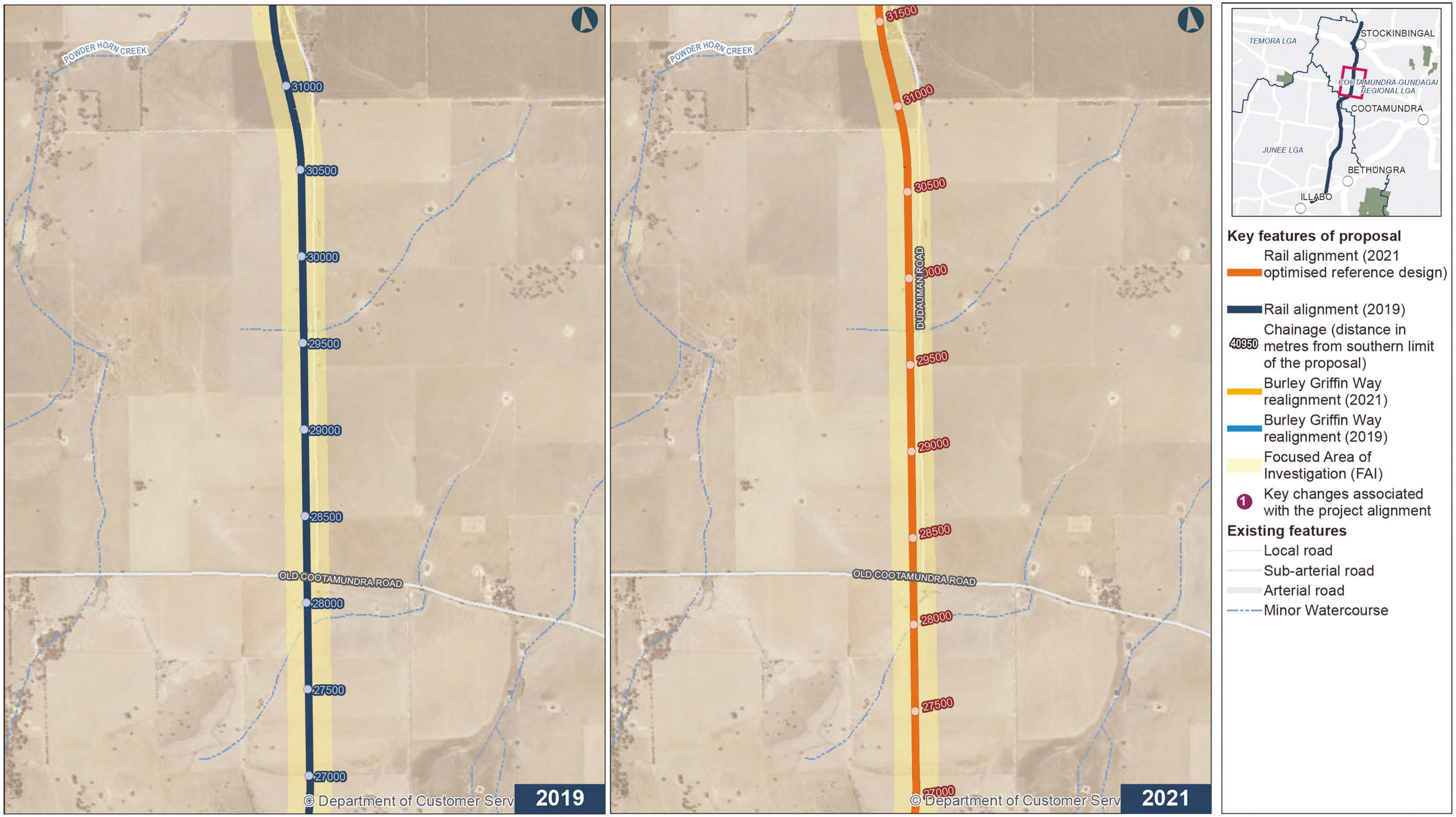
Coordinate System: GDA 1994 MGA Zone 55
Paper size: A4 Scale: 1:30,000
Date: 11/12/2021

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

Map 6 of 10

220_0115_EIS_6_16_Comparison2019toOptimised_r1v7.mxd



6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

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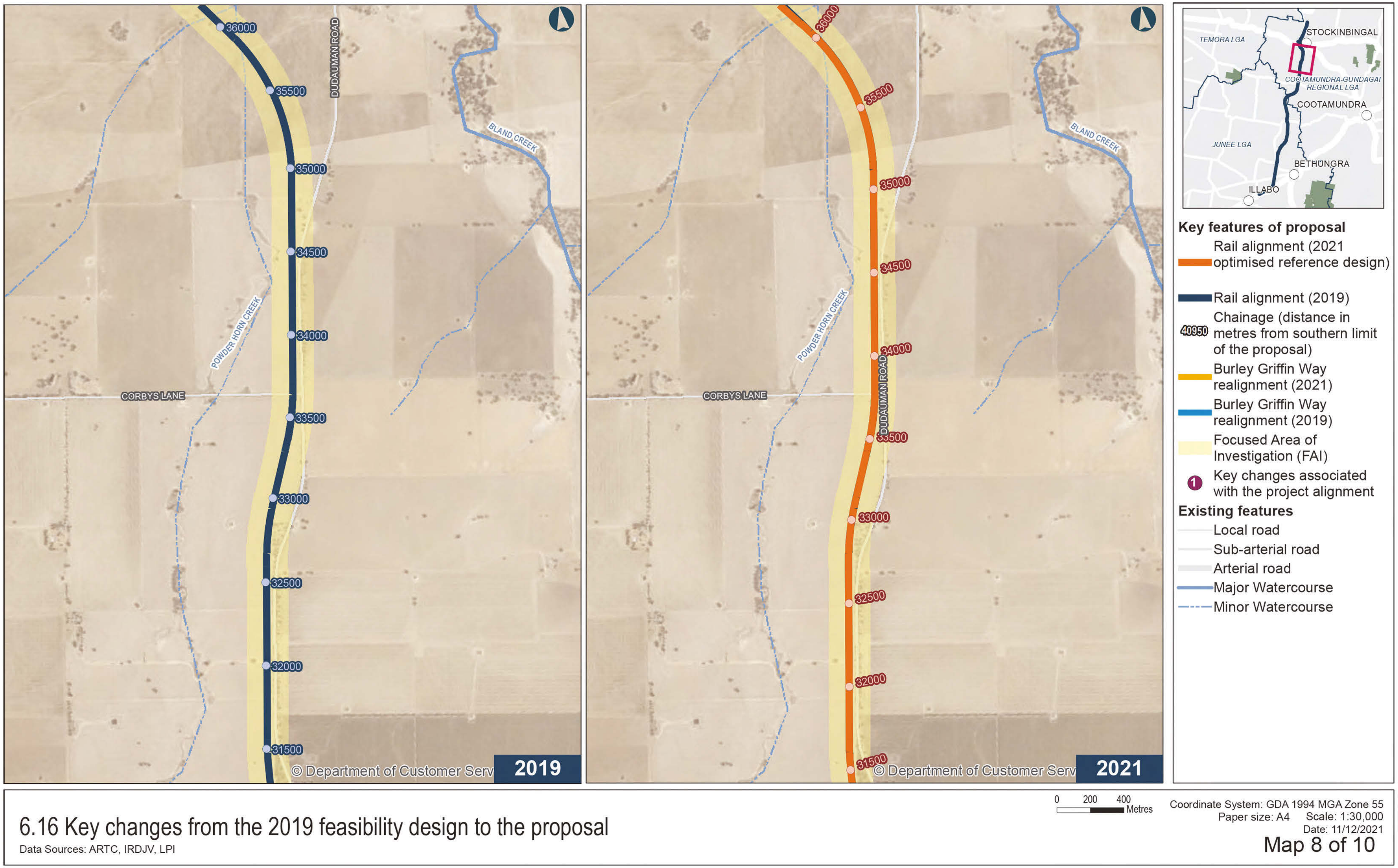

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

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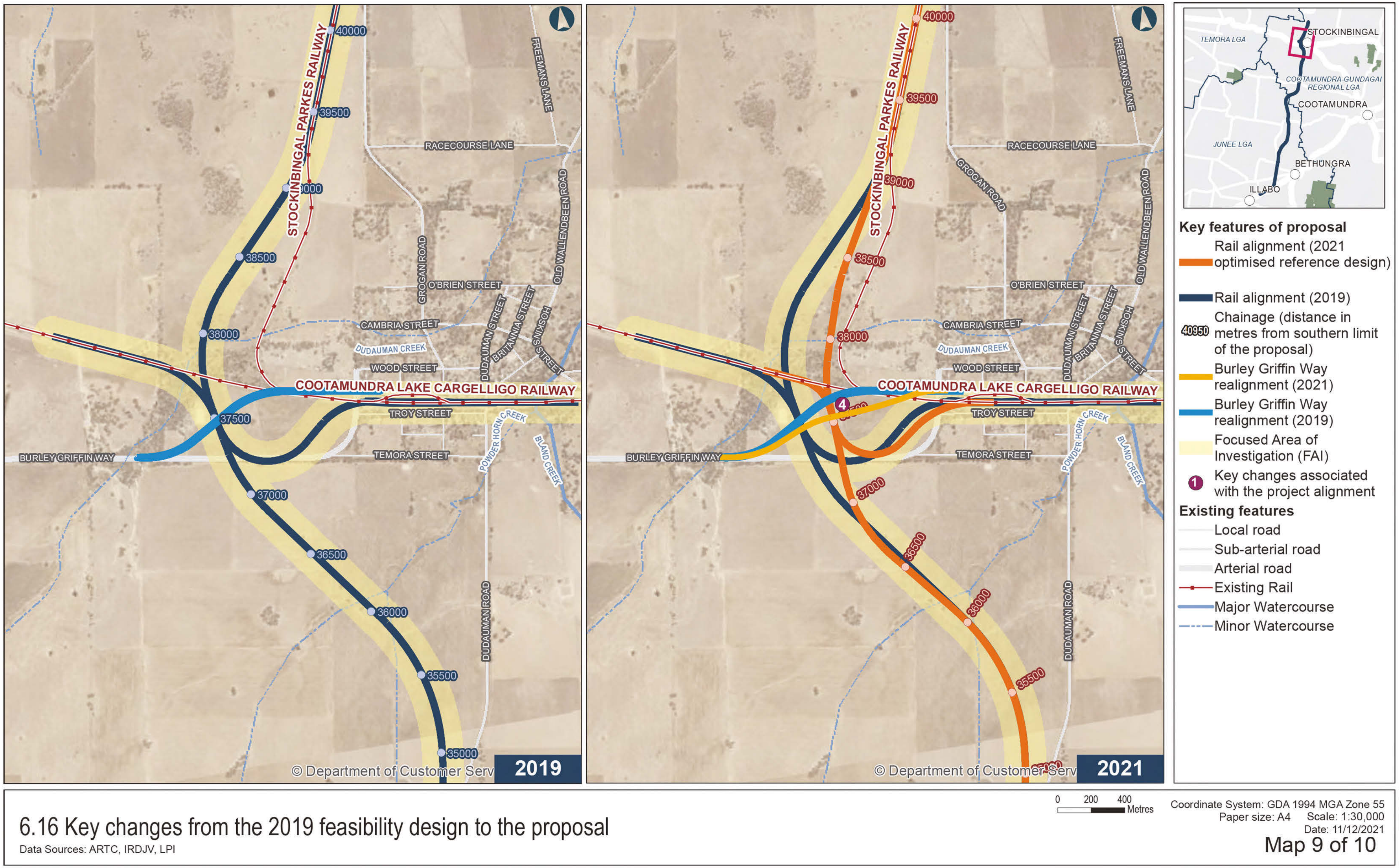

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

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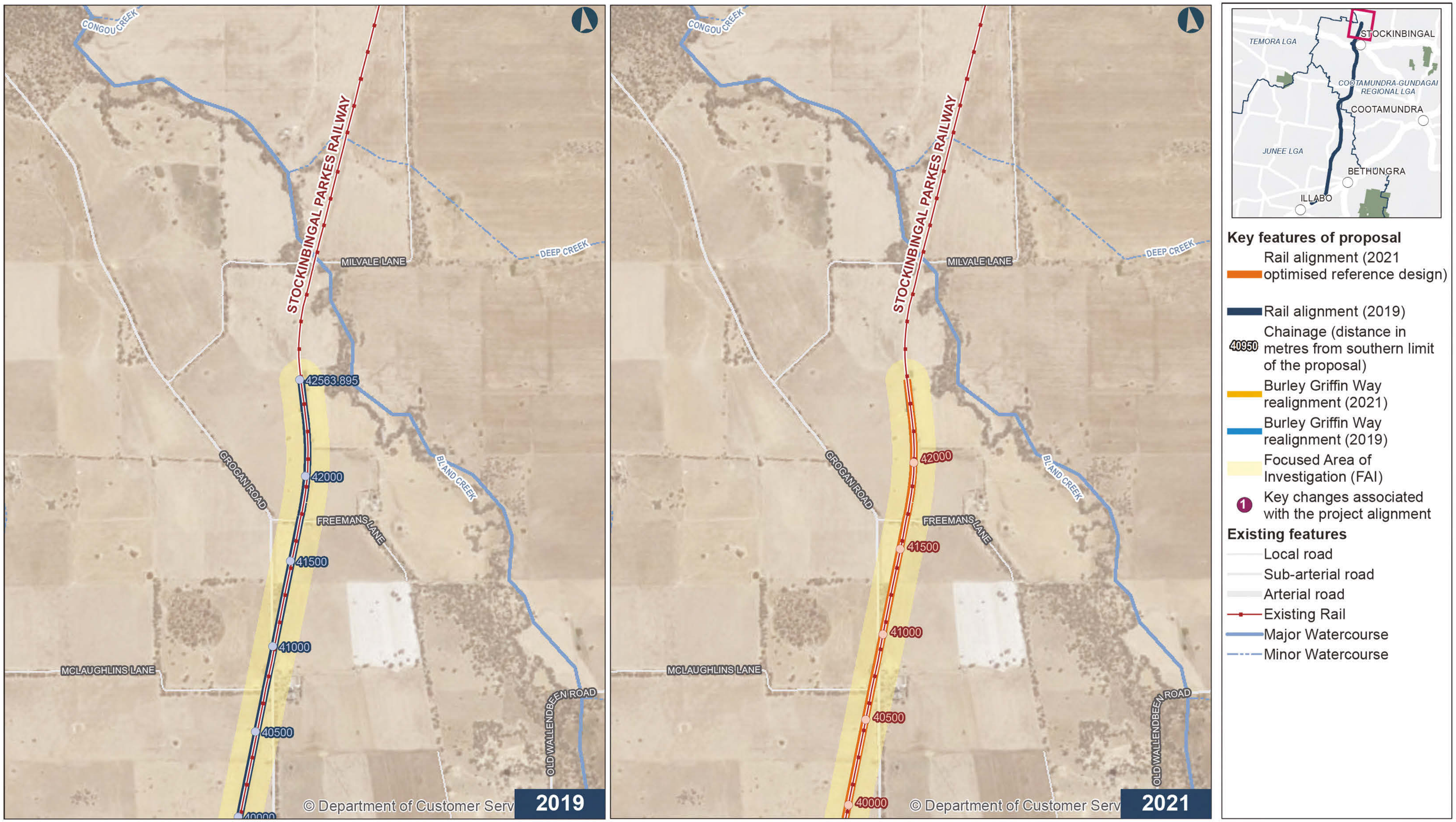

6.16 Key changes from the 2019 feasibility design to the proposal

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Paper size: A4 Scale: 1:30,000
Date: 11/12/2021

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TABLE 6-9: KEY CHANGES TO THE PROJECT AS A RESULT OF DESIGN OPTIMISATION AND ENVIRONMENTAL IMPLICATIONS

	Key design change	Rationale for change	Outside FAI	Biodiversity	Cultural heritage	Communities	Infrastructure	Landowners	Summary of implications
1	Realignment of the proposal at Illabo	Realignment avoided steep topography and associated cut in the area north of the existing railway line.	Yes	Positive change—reduction in impact	Neutral change—no impact to cultural heritage	Neutral change	Neutral change—integration with existing Main South Line.	Positive change—reduction in impact to private property	Overall, a neutral to positive change to environmental impact. Further survey was required to consider areas outside the FAI; however, the majority of this area was confined to the existing rail corridor.
2	Change of the Ironbong Road crossing from a bridge to a level crossing	Following optimisation, the rail alignment was close to the level of the road, such that grade separation would require significant earthworks. A level crossing was proposed, in conjunction with realignment and upgrade of Ironbong Road for road safety.	No	Neutral change	Neutral change—no impact to cultural heritage	Neutral change	Negative change—modification required to Ironbong road and interface with road traffic.	Neutral change	Overall a neutral change to environmental impact. The negative impact to Ironbong Road was considered minor, due to it being a local road, with relatively low volumes of traffic.
3	Relocation of the crossing loop	Relocation of the crossing loop was considered due to the previous location of the crossing loop in an area of steep topography and requiring a crossing of Run Boundary Creek.	No	Positive change—reduction in impact due to reduced footprint in an area containing threatened ecology community(s).	Neutral change—no impact to cultural heritage.	Negative change—marginal change in proximity to sensitive receivers, and visual impacts.	Neutral change	Neutral change	Overall, a neutral change to environmental impact. The negative impact to sensitive receivers was considered minor based on comparison with original location.
4	Relocation of the alignment eastwards at Stockinbingal	The 2019 optimised alignment was selected to maximise separation distances between residential sensitive receivers in Stockinbingal; however, the deep cut resulted in the need for substantial earthworks and a substantial project footprint. The optimisation process resulted in the alignment being relocated eastward to avoid this topography and reduce the quantity of earthworks required.	No	Neutral change—impact to threatened ecological communities broadly equivalent	Neutral change—impact to cultural heritage broadly equivalent. Further investigation was required to determine cultural heritage values.	Negative change—marginal change in proximity to sensitive receivers at Stockinbingal	Change in the alignment at this location, also resulted in the requirement for modification to the Burley Griffin Way realignment, which is considered a neutral change.	Neutral change	Overall a neutral change to environmental impact. The negative impact to sensitive receivers was considered minor due to the presence of existing railway infrastructure near Stockinbingal.

6.7 Development of the optimised reference design

6.7.1 Overview

Once a preferred alignment had been selected through the optimisation process, design development was undertaken to redevelop a feasibility design (a revised design that provided a robust basis for determining constructability and design parameters, and defining the project for the purposes of this EIS).

As part of developing the feasibility design, additional field investigations were undertaken including environmental, geotechnical, utility investigations and survey. Additional field investigations focused on areas where the project deviated from the FAI (and additional survey data was required), or to provide supplementary data to validate the findings of previous surveys completed in 2018/2019.

Through this process, the feasibility design was developed for which approval is now sought, as described in Chapter 7: Proposal features—operation and Chapter 8—construction of the proposal.

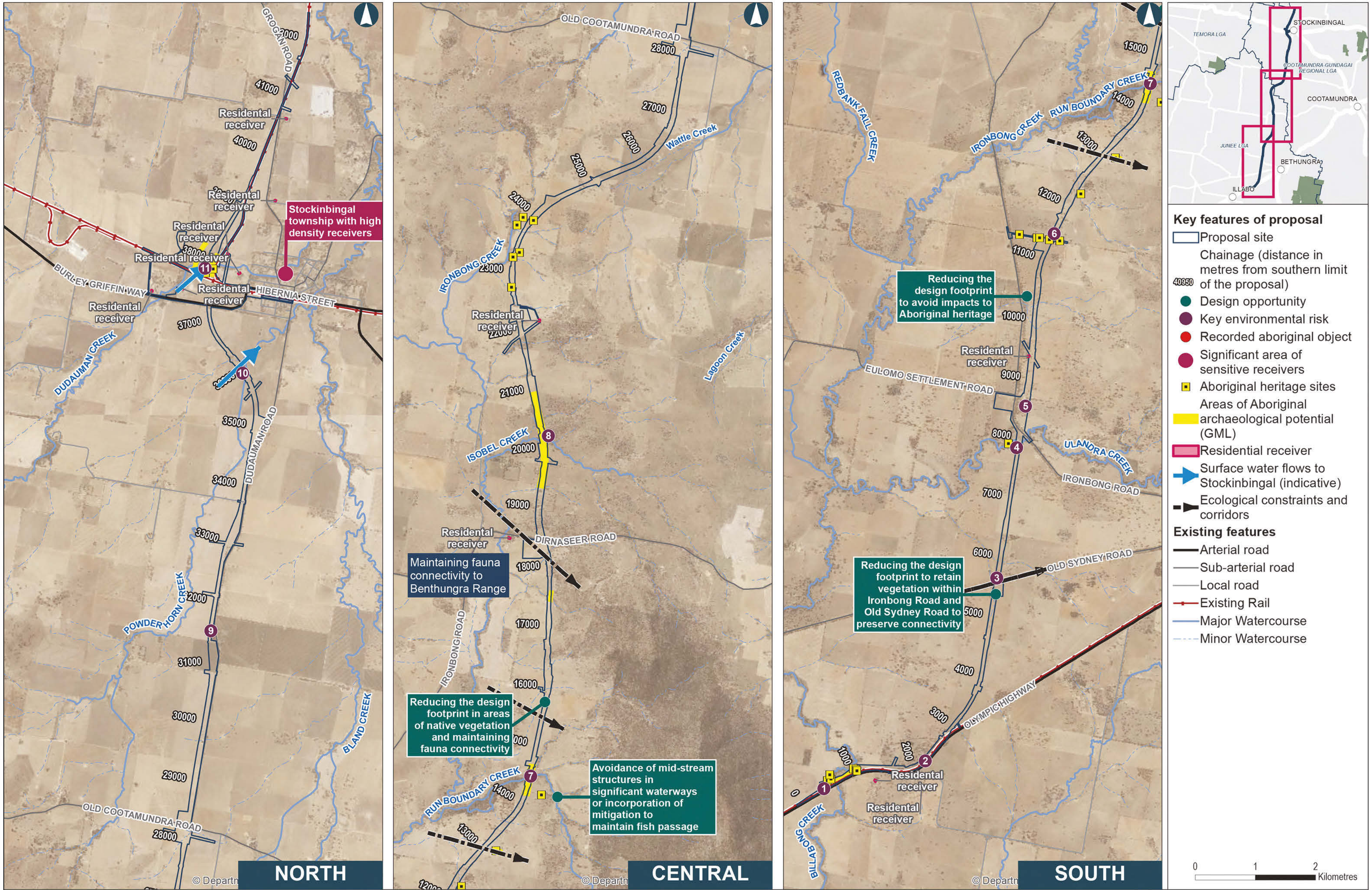
6.7.2 Summary of environmental outcomes following optimisation

During development of the 2019 feasibility design, and through the subsequent optimisation process. opportunities to minimise environmental impacts have been sought. Table 6-10 and Figure 6-17 identify key design responses to achieve environmental impact minimisation.

TABLE 6-10: SUMMARY OF ADVERSE IMPACTS AVOIDED OR MINIMISED IN FEASIBILITY DESIGN

Map ID	Environmental constraints	Design response
1	▸ Class 2 Key Fish Habitat along Billabong Creek.	▸ Optimisation of piers and interface of bridge over Billabong Creek.
2	▸ Large area of Inland Grey Box endangered ecological community (EEC), which is likely to provide habitat for threatened species; also, adjoins White Box EEC to the west. Provide potential habitat for threatened flora and fauna species.	▸ Design utilises the existing rail corridor, minimising impact to this vegetation.
3	▸ High-quality Inland Grey Box EEC, which provided habitat for threatened species. Provides connectivity east to west along Old Sydney Road and connects to Billabong Creek riparian vegetation to the west. ▸ Habitat and corridor for threatened species.	▸ Alignment shifted 120 m to the east, to avoid impact ▸ Further consideration of impact to this area is required for the construction footprint.
4	▸ Connectivity east to west associated with riparian vegetation along Ulandra Creek forms connectivity with moderate to high quality vegetation along Ironbong Road and remnants to the east ▸ Large River Red Gums occur along the creek line many of which are hollow bearing and provide habitat for threatened fauna species including Superb Parrot and Squirrel Glider ▸ Class 2 Key Fish Habitat along Ulandra Creek.	▸ Alignment shifted 120 m to the east ▸ Provision of a bridge over Ulandra Creek to maintain connectivity.
5	▸ High-quality Inland Grey Box and White Box EECs along both sides of Ironbong Road ▸ Large hollow bearing Grey Box, White Box and Yellow Box trees both along the road corridor and in adjacent paddocks provide habitat for threatened species including Squirrel Glider and Superb Parrots.	▸ Alignment shifted 120 m to the east along Ironbong Road, Bethungra.
6	▸ Inland Grey Box EEC poor condition remnants and scattered paddock trees which provide habitat for Superb Parrot ▸ Aboriginal heritage items.	▸ Alignment shifted 50 m to the east ▸ Avoidance of identified site and minimisation of disturbance footprint.
7	▸ Native grasslands derived of Inland Grey Box EEC ▸ River Red Gums occur along the creek line, many of which are hollow bearing and provide habitat for threatened fauna species including Superb Parrot and Squirrel Glider ▸ Class 2 Key Fish Habitat along Run Boundary Creek.	▸ Alignment shifted 50 m to the east ▸ Bridge over Run Boundary Creek.

Map ID	Environmental constraints	Design response
8	‣ Remnant patches of native vegetation including White Box, Yellow Box and Inland Grey Box north of Dirnaseer Road, Bethungra.	‣ Alignment shifted 100 m west.
9	‣ High-quality Inland Grey Box and White Box form linear patches along both sides of Dudauman Road ‣ Large hollow bearing Grey Box, Yellow Box and Blakely's Red Gum trees both within the road corridor and in adjacent paddocks that provide habitat for threatened species.	‣ Alignment shifted 30–65 m west of Dudauman Road at Stockinbingal.
10	‣ Class 3 Key Fish Habitat along Powder Horn Creek ‣ Hydrology and flooding issues ‣ Areas of Aboriginal heritage sensitivity.	‣ Bridge over Powder Horn Creek ‣ Minimisation of disturbance footprint.
11	‣ Class 3 Key Fish Habitat along Dudauman Creek ‣ Hydrology and flooding issues ‣ Areas of Aboriginal heritage sensitivity, including a scar tree.	‣ Bridge over Dudauman Creek ‣ Minimisation of disturbance footprint ‣ Alignment shifted to the west to avoid impact to the scar tree.



6.17 Summary of adverse impacts avoided or minimised through design

Data Sources: LPI, ARTC, IRDJV

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6.8 Other design development considerations

6.8.1 Road–rail interfaces

There are a number of locations where the proposal alignment interfaces with the public road network. This section discusses the design options for these road–rail interfaces, the policy context and approach to the determination of a proposed design solution for each of these locations.

The proposal will require the construction of both public and private crossings. Public crossings are located on state-managed or local council roads. Private crossings are created for a specific and often limited use, generally to provide access within a private property, or between a private property and a public road. The location and form of these private crossings is detailed in Chapter 7: Proposal features—operation) and would be confirmed during detailed design. The following sections describe the design development process associated with the public road–rail interfaces.

6.8.1.1 Policy framework

Central to the policy framework for determining the most suitable road–rail interface is the approach to considering level crossings. Relevant NSW and Australian level crossing policies emphasise the need to minimise the number of level crossings, as far as reasonably practicable. The Office of the National Rail Safety Regulator's (ONRSR) level crossing policy (ONRSR Policy: Level Crossings (ONRSR, 2019)) sets out the approach and broader expectations for improving the safety of railway operations, with regard to existing level crossings, and the early design of future road and rail intersections.

In terms of managing risks to safety, ONRSR's level crossing policy notes that, where a new crossing is necessary, safety risks must be eliminated or minimised by designing new infrastructure consistent with requirements of the Rail Safety National Law. The NSW Government's level crossing policy (*Construction of New Level Crossings Policy* (Transport for NSW, n.d.)) notes that building new level crossings is to be avoided wherever possible and all other options, including grade separation and use of existing level crossings, should be explored before a new crossing is proposed.

Other policies and requirements related to level crossings comprise:

- Rail Safety National Law
- National Railway Level Crossing Strategy—2017-2020
- Various state specific Rail Act and Rail Safety Act amendments/modifications
- ONRSR Policy—Railway Crossings A453375
- NSW Level Crossing Improvement Program
- Railway Crossing Safety Series 2011, Plan: Establishing a Railway Crossing Safety Management Plan (Roads and Traffic Authority of NSW (RTA), 2011)
- Rail Industry Safety and Standards Board—Consolidation of Public Level Crossings Guideline
- Australian Transport and Infrastructure Council—National Railway Level Crossing Safety Strategy 2010-2020
- ARTC level crossing strategy (fact sheet)
- Inland Rail Basis of Design
- Transport for NSW—Level Crossing Closures Policy.

ARTC's approach for the proposal is consistent with these policies and requirements.

6.8.1.2 The role of ALCAM assessment in the options evaluation process

The Australian Level Crossing Assessment Model (ALCAM) is an assessment tool used to identify key potential risks at existing and proposed level crossings and to assist in the prioritisation of crossings for upgrades. It is central to ARTC's approach to the consideration of level crossings. The risk model is used to support a decision-making process for both road and pedestrian level crossings to help determine the need for treatment or type of treatment. The ALCAM assessment model is currently applied to all crossings in Australia and in New Zealand.

The ALCAM tool can be used to:

- highlight where specific risks or design deficiencies exist

- quantify the expected consequences of an accident
- quantify the probability of an accident
- compare the relative risk between crossings within a region or jurisdiction
- model the effectiveness of treatments to address these risks.

Although it is a comprehensive tool for the assessment of level crossing hazards, The ALCAM model cannot be applied in isolation and does not preclude the need for sound engineering judgement. Any risk assessment and treatment also needs to consider other factors, including:

- collision and near-collision history
- engineering experience (both rail and road)
- local knowledge of driver or pedestrian behaviour
- social and economic assessment
- standards and international best practice.

6.8.1.3 Stakeholder and community consultation considerations

Stakeholders and the community were provided the opportunity to provide feedback through the development of the proposal. General issues related to road–rail interfaces identified during consultation are:

- the need for access points to cross the rail corridor
- adequate clearance for agricultural equipment and stock
- safety concerns from interactions of trains, vehicle and other users, including ensuring adequate sight distances
- traffic impacts to the surrounding road network
- property impacts associated with land fragmentation and access.

Relevant stakeholders, including road authorities, Transport for NSW and local landowners (where associated with a particular level crossing), would be consulted as part of further design development in the determination of the final recommended treatment.

Further details of stakeholder and community feedback are discussed in Chapter 4: Engagement and Appendix C.

6.8.1.4 Road–rail interface treatment options

A variety of treatments were considered with the objective of maintaining the connectivity of the existing road network and adequate road safety. These are described below.

6.8.1.4.1 Grade separation

Grade separation comprises the rail line crossing under or over a road such that there is no requirement for road traffic to enter the rail corridor. Grade separation frequently involves increased construction costs and material demands associated with the construction of significant crossing structures such as bridges; however, as noted in section 6.8.1.1 it is the preferred option from a road safety perspective under Australian and NSW Government policy.

Generally, road and rail interfaces would be automatically grade separated in the following instances:

- road–rail crossings with four rail tracks
- road–rail crossings of freeways and highways of four or more lanes (including both current and committed future plans)
- where grade separation is the logical option for topographical or engineering reasons, e.g when the vertical clearance between the proposed rail line and the road are sufficient to accommodate for the required legal clearance of the train or road vehicle
- where road–rail interfaces have high-risk safety issues (e.g. collision of vehicle and trains).

In addition, level crossing safety assessment using the ALCAM method (described in section 6.8.1.2) was a key input to determining whether road safety considerations necessitated grade separation. The assessment takes into consideration traffic volumes, traffic speeds, train speeds, frequency and sight distances on approach to, and at, the level crossing. A cost-benefit analysis is also undertaken to assess whether the higher levels of safety provided by grade-separation are justified.

6.8.1.4.2 Level crossings

There may be instances where level crossings are considered to be an appropriate solution. In general, the acceptability of a level crossing will be primarily determined through an ALCAM assessment and in consultation with the relevant road authority, and subject to the limitations outlined above. In addition, level crossings are not considered to be suitable in the following circumstances:

- where there are height differences between the road and rail due to topography (e.g. where the rail is in cutting or on embankment)
- where the road crosses the rail at the location of a crossing loop or siding.

Level crossings have either passive or active controls to guide road users as follows:

- passive controls—have static warning signs (e.g. stop or give way signs) that are visible on approach, which provides an unchanging warning to the road user, whether or not a train is approaching the crossing
- active controls—flashing lights and signage with boom barriers for motorists and automated gates for pedestrians. These devices are activated prior to and during the passage of a train through the level crossing.

In locations where the proposal has determined that a level crossing is the preferred solution, further assessment has been undertaken to determine the most suitable form of level crossing control (active or passive).

6.8.1.4.3 Road modifications

In addition to the establishment of grade separation or a level crossing at road–rail interfaces, road modifications were also considered. Modifications fundamentally comprise:

- road realignment in conjunction with a level crossing to improve sight lines and improve road safety
- road closure
- road diversion to an alternative crossing location (generally involving consolidation of more than one road to a single crossing point)—generally considered where road closure is required.

Road closures would generally only be considered in the following circumstances:

- where a safe crossing cannot be provided at that location
- where there are low traffic volumes (such that a grade-separated solution could not be reasonably justified)
- where alternative access (through diversion to an alternative crossing) is available or reasonably achievable
- the impact on road users (associated with increased travel time) is considered low.

Road modifications associated with new grade separations or level crossings may involve modifications to the vertical or horizontal road alignment.

6.8.1.5 Road–rail interfaces along the proposal alignment

The proposal would require the crossing of a state-controlled road (Burley Griffin Way) and a number of council and Crown roads. A summary of the number of public road crossings is presented in Table 6-11.

TABLE 6-11: SUMMARY OF PUBLIC ROAD–RAIL INTERFACES ALONG THE PROPOSAL ALIGNMENT

Road type	Number of interfaces
State-controlled	1
Local council	5
Department of Crown lands	3

6.8.1.6 Approach to determining road–rail interface solutions

As part of the initial options assessment for each road–rail interface, the proposal followed the ARTC level crossing strategy (ARTC, 2020d). The level crossing strategy involves reviewing all crossings along the proposal to determine the works required to meet relevant crossing standards and guidelines, as noted in section 6.8.1.1. The level crossing strategy consists of two stages, as summarised in Table 6-12.

TABLE 6-12: LEVEL CROSSING STRATEGY

Stage	Assessment requirements
Stage 1—identify options for level crossings and the preferred approach	▸ Identifying all existing and future level crossings across the proposal Initial field assessment of crossings ▸ Reviewing existing crossings with regard to standards and guidelines, as noted in section 6.8.1.1 ▸ Consulting with stakeholders about the use of crossings ▸ Identifying preferred treatment options ▸ Identifying potential solutions (including alternative options) for further stakeholder consultation as part of stage 2.
Stage 2—consult with relevant stakeholders (including landowners and state and council road owners) to confirm the preferred treatment and finalise the strategy	▸ Consulting with stakeholders regarding the preferred option ▸ Reviewing the preferred option for each crossing in detail, taking into account input from stakeholders ▸ Reviewing consolidation options in accordance with the requirements of the *Transport Administration Act 1998* (NSW).

6.8.1.7 Determining the preferred option

As part of developing the design of the proposal, each road–rail interface was assessed for each alignment option to determine the number of road alignments and crossing configurations.

As well as addressing new locations where the proposal alignment introduced a new road–rail interface on the road network, the assessment additionally evaluated existing level crossings and considered the local topography, existing road geometry and adjacent infrastructure, and evaluating sight lines for safe approaches and earthwork requirements. Several crossings were identified as non-compliant to these requirements and determined to require design improvement in order to comply once the proposal is operational (e.g. road modification, passive treatment, active treatment).

At both existing and proposed road–rail interface locations, the following considerations were applied in determining a preferred solution:

- existing and future traffic volumes
- potential alternative routes
- land use, property ownership and accessibility
- available sight line distances
- earthwork impacts
- community and stakeholder feedback
- cost of construction
- crossings from special user groups.

Table 6-13 summarises the key design considerations and proposed solution for all the proposed public road–rail interfaces.

TABLE 6-13: DESIGN CONSIDERATIONS AND PROPOSED SOLUTIONS

Road crossing	Road type	Chainage	Design considerations	Proposed solution
Unnamed Road	Department of Crown Lands	2,789	▸ Treatments to mitigate the short-stacking risk between the proposed level crossing treatment and the Olympic Highway, including signage and vehicle turn restrictions on Olympic Highway ▸ High-risk crossing identified by the ALCAM assessment due to the risk associated with the length of a triple track crossing and poor sight lines warranting active control level crossing treatment ▸ Grade separation considered unnecessary due to very low traffic volumes.	Level crossing (Active)

Road crossing	Road type	Chainage	Design considerations	Proposed solution
Old Sydney Road	Council (Local) road	5,588	▸ Local, relatively flat topography and low traffic volumes deemed a passive control level crossing as confirmed by an ALCAM assessment.	Level crossing (Passive)
Ironbong Road	Council (Local) road	8,152	▸ The key ALCAM criteria identifying Ironbong Road as an active crossing as the preferred treatment (in preference to a passive level crossing) are poor sighting angles and high vehicle speeds. To enhance safety further, Ironbong Road would be realigned as part of the proposal. The realignment was proposed to satisfy horizontal and vertical geometry constraints for high vehicle speeds. Further design details of the Ironbong Road realignment are provided in Chapter 7: Proposal features—operation ▸ A grade-separated design (rail-over-road bridge) was also assessed during the optioneering MCA phase. This option was not further considered due to increased requirements for rail vertical level clearance and earthworks requirements.	Level crossing (Active) and road realignment
Unnamed Road	Department of Crown Lands	11,390	▸ High safety risks due to poor sighting distances from the rail geometry, location of the crossing loop on the east and maintenance siding configuration.	Level crossing (Active)
Unnamed Road	Council (Local) road	15,934	▸ Local, relatively flat topography and low vehicle usage deemed a passive control level crossing as confirmed by an ALCAM assessment.	Level crossing (Passive)
Dirnaseer Road	Council (Local) road	18,470	▸ Local topography constraints (i.e. hill side) and associated earthwork requirements.	Grade separated (rail over road)
Old Cootamundra Road	Council (Local) road	28,263	▸ Cost effective design and location as compared to nearby intersections like at the Dudauman Road intersection.	Grade separated (rail over road)
Corbys Lane	Council (Local) road	33,769	▸ Local, relatively flat topography and low vehicle usage deemed a passive control level crossing as confirmed by an ALCAM assessment.	Level crossing (Passive)
Burley Griffin Way	State Road	37,539	▸ The grade separated design (road over rail bridge) was assessed during the optioneering and Multi Criteria Analysis (MCA) phase. The key consideration centred around road safety. The grade separation would have increased safety benefits by eliminating the existing level crossing in Stockinbingal and reducing travel times for residents and other road users as a result. This design option was also considered the most favourable option by the community and local stakeholders. ▸ Private access driveways/tracks off the proposed alignment and property implications was a key consideration to the proposed alignment. ▸ Grade separation allowed greater flexibility for design to facilitate connection between Inland Rail and the CRN line. ▸ Coordination with landowners and utility providers for access through redundant sections of Burley Griffin Way was a key consideration and subject to further consultation.	Grade separated (Road over rail)

6.8.1.8 Further consideration of road–rail interface treatment

Further consideration of the proposed road–rail interfaces, including consultation with the road asset owners and broader stakeholders, would be undertaken during design development.

6.8.2 Watercourse crossings

The proposal crosses the following watercourses classified as third-order streams and above:

- Billabong Creek
- Ulandra Creek
- Isobel Creek
- Powder Horn Creek
- Dudauman Creek.

At these locations, design development has sought to minimise impacts on aquatic habitat.

To maintain riparian and aquatic habitat and fish passage, bridges have been proposed at all of these locations (refer to section 7.2). To ensure that fish passage is maintained, watercourse crossing structures would be designed in accordance with the *Policy and Guidelines for Fish Habitat Conservation and Management Update 2013* (DPI, 2013).

6.9 Rail crossings and other infrastructure provision on private land

There are 75 private roads or access tracks that the proposal would intersect (refer to section 7.2.7.2 for further details). ARTC has consulted with landowners potentially impacted by the final rail corridor to understand their property access requirements and provide potential private access solutions. Each property solution would be negotiated on a case by case basis through ongoing consultation with landowners and further design refinement.

Where level crossings on private land are required, ARTC would work with landowners on the design that suits their requirements. For example, in areas where landowners use large farm machinery and run livestock, the design of the level crossing would include stock proof fencing, secured gates and suitable approach grades.

Both the State and National Rail Safety guidelines and policies are safety focused; ARTC would consult with each landowner to find solutions that minimise the number of level crossings across the proposal.

Consultation to identify potential private crossing solutions is further described in Chapter 4: Engagement.

The current design and layout of private crossing solutions have been developed based on the following:

- feedback from consultation with landowners on specific property requirements
- safety standards (criteria for minimum sight distances for trains and vehicles)
- alternative access arrangements
- rail design and landform
- stock movements
- vehicle access requirements (for example farm machinery, frequency of use).

The proposed level crossings are identified in section 7.2.7.

6.10 Refinement of the proposal

The proposal as described in this EIS is based on the outcomes of the current design described in Chapter 7: Proposal features—operation). Detailed design would take into account the outcomes of the current design phase; the findings of this EIS including the mitigation measures detailed in Chapters 10 to 26 (and summarised in Chapter 27: Approach to environmental management and mitigation), submissions received during exhibition of the EIS and any conditions of approval (if the proposal is approved).

The design has, and will continue to, evolve over these phases as a result of engineering, traffic, economic, social and environmental considerations. The option selection and design process has also taken into account issues raised during consultation with the community and relevant stakeholders (refer to Chapter 4: Engagement) and the findings of preliminary environmental investigations. The EIS is based on the current design for the proposal. Given the current level of design development, there remain some details which are yet to be finalised relating to technical requirements, how the proposal would be constructed, and how it would operate as part of Inland Rail overall. These details would be resolved as the design of the proposal, and Inland Rail as a whole, progresses.

A summary of the main uncertainties around the design, construction and/or operational methodologies of the proposal, and how these will be resolved, is provided in Chapter 28: Justification of the proposal.