Maroochydore Station Corridor Study

Findings and Recommendations Report

November 2009

Prepared by PB Ltd and
the Integrated Transport
Planning Division of the
Department of Transport
and Main Roads

Queensland Government

Contents

Contents (continued)

Contents (continued)

Contents (continued)

List of tables

List of figures

Contents (continued)

List of photos

Contents (continued)

List of appendices

Executive Summary

Overview

Parsons Brinckerhoff (PB) has been appointed as consultants by Department of Transport and Main Roads to investigate and identify a preferred corridor alignment for the proposed Caboolture to Maroochydore Corridor Study rail line into Maroochydore City Centre.

Considered are the alignment proposed in the 2001 Caloundra to Maroochydore Corridor Study and a second alignment identified by the Department of Transport and Main Roads in conjunction with stakeholders and incorporated in the new Sunshine Coast Regional Council's Maroochydore Centre Position Paper ("Carnaby Street"). Refer Figure ES1.

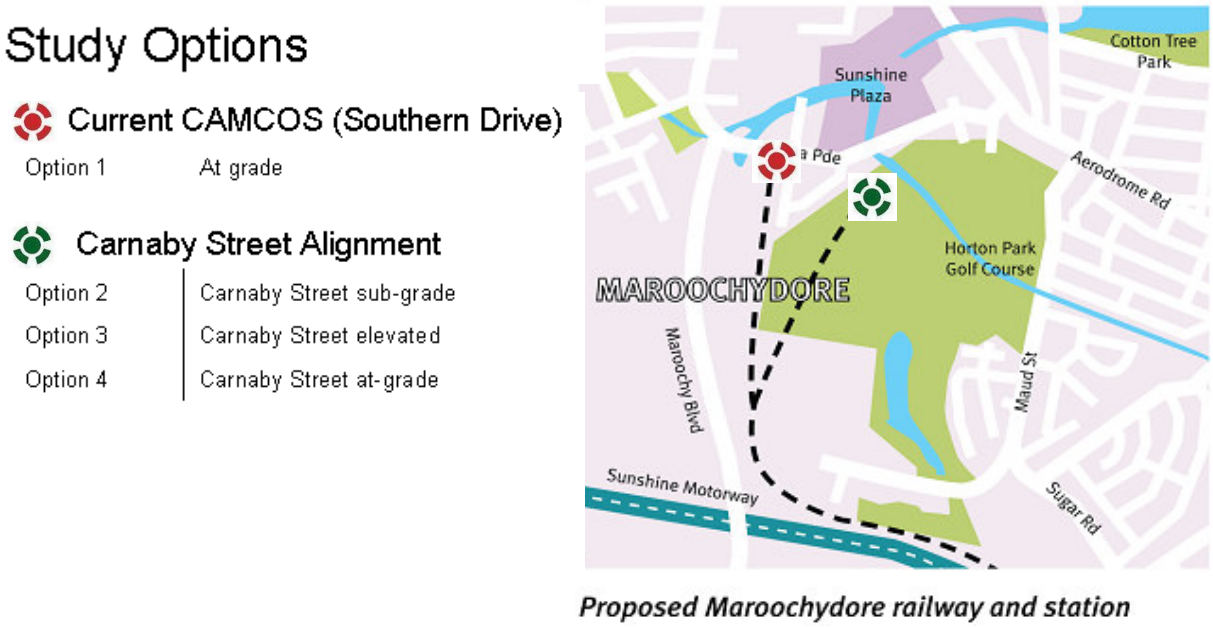


Figure ES1: Study alignment options

The primary aim of the rail realignment is to provide better transport and land use integration and delivery of a transit-oriented development for the town centre of Maroochydore.

Included in this project is assessment of social, environmental, engineering and transport integration factors related to the proposed alignment, and recommendations of a preferred alignment, transport network and urban design integration.

The analysis concludes that the preferred option is elevated rail into Maroochydore to a terminal station short of the Maud Street canal near the intersection of Plaza Parade and Carnaby Street (option 3). This is supported by the Maroochydore Centre Position Paper adopted by the Sunshine Coast Regional Council. It is estimated that the construction cost of option 3 (including north and south connections) will be $201.9 million (2007 dollars).

Arising from this study are a number of key issues that should be investigated as a matter of priority. These include the integration with the CoastConnect bus corridor and local bus services, review of the

surrounding structure plan (including road network) and opportunities for development under the rail corridor to ensure maximum benefits are achieved by the project.

Policy context

Maroochydore is the designated Principal Activity Centre for the Sunshine Coast under the South East Queensland Regional Plan 2009-2031 (Regional Plan). According to the Regional Plan:

> *"…principle activity centres serve as key focal points for regional employment and in-centre residential development. As major trip generators, these centres typically have existing or planned, dedicated public transport, including rail, bus or light rail, and comprise key nodes in the regional public transport system…"*

The South East Queensland Infrastructure Plan and Program 2009-2026 has committed to delivery of public transport corridor from Beerwah to Maroochydore in the period from 2013/14 to 2025/26.

In 2005/2006 the Maroochy Shire Council commenced master planning for a new city centre in Maroochydore. To help consolidate the new city centre as a compact walking and public transport-oriented city, the draft master plan envisaged an alternative station location to that recommended by Caboolture to Maroochydore Corridor Study. The Maroochydore Station Corridor Study was commissioned in direct response to the Maroochy Shire Council central business district master planning process and has in turn influenced the ongoing planning for Maroochydore by the Sunshine Coast Regional Council.

Following the local government amalgamation in March 2008, the newly-formed Sunshine Coast Regional Council decided to review the Maroochydore City Centre Structure Plan. Under the Premier's Housing Affordability Strategy, Maroochydore Centre has also been identified as one of the localities for which planning should be brought forward to facilitate early release of residential product. The revised Plan was adopted by Council on 26 May 2009 as the basis for amendment to the planning scheme to meet that commitment.

As part of the scheme amendment process, the Council has prepared and posted on its website a Maroochydore Centre Position Paper. The Position Paper illustrates the planning intent as the Maroochydore Centre Directions Map which shows the Carnaby Street option as Council's preferred station location and corridor. The currently-protected and Carnaby Street station location options assessed by Department of Transport and Main Roads are not inconsistent with the Plan. Figure ES2 shows the Directions Map from the Maroochydore Centre Position Paper (May 2009).

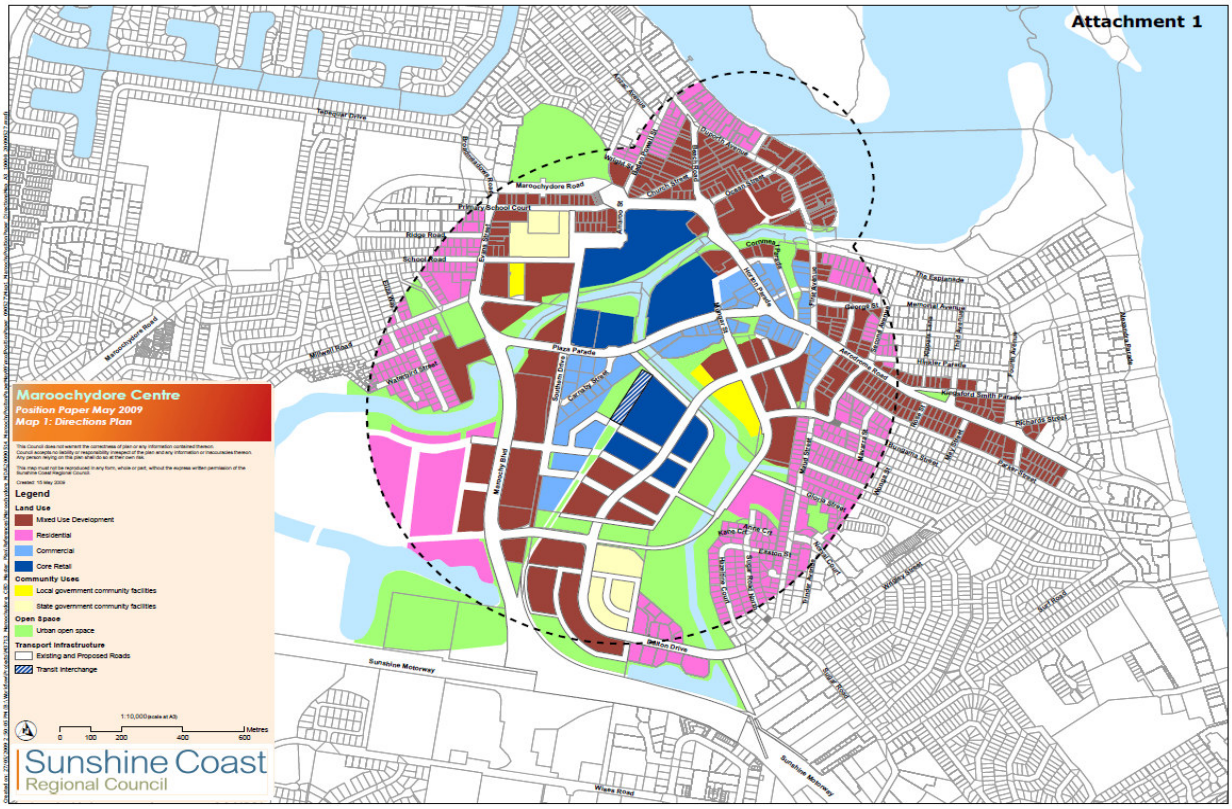


Figure ES2: Maroochydore Centre Directions Plan (Sunshine Coast Regional Council, May 2009)

Social and planning context

The alternative rail alignments into central Maroochydore proceed through and around what is currently the Horton Park Golf Course. Other key current land uses in the area include retail and low scale commercial, and some new high quality housing developments. Future land uses will include a range of retail, commercial and community facilities appropriate to a city centre, as well as low, medium and high density housing.

Sunshine Plaza shopping centre is located on the north side of Plaza Parade. It provides many of the facilities and services expected in a town centre, including shops, cafes and restaurants, banks and cinemas. Further expansions to the shopping centre are currently proposed. Sunshine Plaza is located in the potential walking catchment for the proposed Maroochydore railway station (Carnaby Street).

The land surrounding the proposed rail alignment is allocated as 'urban footprint' under the Regional Plan. 'Urban footprint' identifies land suitable to provide for the region's urban development needs until 2031, and includes existing urban areas as well as new greenfield sites. Land contained within the urban footprint is intended to be well located with regard to existing and planned urban infrastructure, including public transport. Therefore it is considered that the development of the proposed corridor supports the overall intent for SEQ's 'urban footprint'. This part of the urban footprint, including a major portion of the Horton Park Golf Course, is the focus of the Sunshine Coast Regional Council's Maroochydore City Centre planning.

A principle of the Regional Plan is to integrate development with transport infrastructure, community services and employment. This can be achieved through Transit Oriented Development (TOD):

> *"A transit orientated development precinct has a walking and cycle-friendly core with a rail or bus station and is surrounded by relatively high-density residential development, employment or mixed uses."*[1]

Under the Maroochydore Centre Position Paper,

> *"The Direction Plan reflects a strongly integrated approach to land-use and transport planning for Maroochydore. The intended land use structure is focussed on a walkable heart for the Centre, built around the transit centre, a major public plaza (interconnected with a significant open space network) and key community facilities. The economic, social and environmental success of the Centre is closely tied to its walkability and the effective provision of public transport."*[2]

> *"The structure of the Centre needs to facilitate a core of commercial (office and retail) space integrated with the proposed CCAMCOS transit station (in the vicinity of Carnaby Street), and linked to Sunshine Plaza by footpaths and cycle ways."*[3]

The Council's planning for Maroochydore centre is based on the assumption that the Horton Park Golf Course will become available for redevelopment. Indeed, it is a critical factor in delivering the Council's vision for Maroochydore centre. To the west of the golf course is the 'Sunshine Cove' development featuring significant residential and commercial development. A major regional 'health hub' has been committed for the southern end of the Maroochydore central business district by Queensland Health.

Environmental context

The land affected by this study can be divided into three areas.

The first area is highly disturbed land associated with urban subdivision currently underway. Although the Queensland Herbarium lists remnant vegetation, there was little evidence of this during field studies.

The second area is that currently occupied by the Horton Park Golf Course. From an environmental point of view, this consists of mostly degraded land featuring introduced and exotic shrubbery and grasslands (as appropriate for a functioning golf course). No remnant vegetation is mapped by the Queensland Herbarium in this area. Field studies indicate the vegetation in the golf course provides habitat for local fauna. In particular, the Maud Street canal runs through the golf course, and stands of mangroves along this creek may provide breeding ground for fish and other aquatic life.

The third area is a pocket of remnant vegetation alongside the Sunshine Motorway to the west of Maroochy Boulevard. This area was determined to be of high ecological integrity with a diversity of native species of flora and potential for a range of rare and threatened fauna.

A geotechnical review of the area shows it to be formed from ancient tidal delta and estuarine deposits of sand and clays. Existing data indicates the area is likely to contain both actual and potential acid sulfate soils. The management of these soils will be an important part of the design and construction of the rail alignment.

[1] South East Queensland Regional Plan (2009). Page 101

[2] Maroochydore Centre Position Paper, May 2009. Page 1

[3] Op.cit. Page 8

Figure ES3: Typical environment of Horton Park Golf Course

Alignment options

The following station locations and associated rail alignments into central Maroochydore were investigated:

- the currently approved Caboolture to Maroochydore Corridor Study alignment to a station on Southern Drive adjacent to Plaza Parade
- the alignment identified by the Maroochydore draft Concept Plan (2006), with a line through the centre of the Horton Park Golf Course to a station facing Horton Parade opposite First Avenue. The Council's Maroochydore Centre Position Paper no longer accommodates this option and it has not been included in this report. However, it is included in the Maroochydore Station Corridor Study report included in websites www.pb.com.au/maroochyscsc and www.transport.qld.gov.au/maroochystation.
- a third alignment identified by the Maroochy Town Centre Enquiry by Design Workshop (June 2007) which passes through a corner of the Horton Park Golf Course to a station near Carnaby Street and the Maud Street canal. This option is supported by the Council's Maroochydore Centre Position Paper.

The original Caboolture to Maroochydore Corridor Study (Southern Drive) station location is at-grade. The Carnaby Street alignment is considered under three construction options – at-grade (conventional rail on ballast), elevated on structure, or sub-grade (in a cutting suitable for future covering). Each alternative has been designed to comply with current QR Ltd standards for urban passenger rail.

The Carnaby Street alignment also features a fully integrated bus/rail interchange at the terminal station.

The currently-protected alignment and station location at Southern Drive does not comply with all QR standards, and further negotiation would be required with QR for construction. In particular, the corridor is not wide enough for standard batter, provision for maintenance access is by way of an easement rather than by a dedicated right of way within the corridor, and there is insufficient space at the station location for a third rail layover space, nor for a fully integrated bus/rail interchange.

Minor variations in alignment exist between the elevated and at-grade options for the Carnaby Street alignment. This was done originally to allow for full integration of the surrounding road network.

In order to preserve the future option of extending the rail northwards beyond Maroochy Boulevard (with the corridor currently protected as far as the Sunshine Coast Airport at Pacific Paradise), each of the at-grade options would require reconstruction of Maroochy Boulevard for a distance and to a height necessary for the north-west leg of the rail line to pass under the roadway. The elevated options would pass over the Boulevard without interference, while the sub-grade options would pass below.

Figure ES4: Overview of alignments

Social impacts

The Carnaby Street options are reliant on the acquisition of land from the Horton Park Golf Course as part of its redevelopment.

The currently-protected Southern Drive option has lower overall land take requirements as an existing transport corridor is in place. However, this corridor is very narrow and ongoing impacts on adjacent land owners can be expected. This includes use of shared easements for maintenance access, and use of local streets for bus stops and associated circulation. At such time as the line might be extended northwards beyond Maroochy Boulevard, the north-west link would also impinge onto the “Sunshine Cove” (formerly 'Wises Farm') development.

The need to maintain appropriate rail standards for curvature and transitions on a short length of track, together with a desire to provide an east-west road link between Maroochy Boulevard and Dalton Drive for local connectivity and permeability has meant there is a slight difference in alignment between the at-grade and elevated variations of the Carnaby Street option.

The elevated option remains clear of the 'Brencorp' development to the east of Maroochy Boulevard, but impinges slightly on land (designated as green space) in the ‘Sunshine Cove’ development to the west. As the rail would be on an elevated structure at this point, the interference will be minimal.

The at-grade option avoids ‘Sunshine Cove’, but in order to allow for the road connection, is located further to the east. This will require land acquisition from Brencorp as the alignment cannot be contained within the current corridor and buffer zones.

A detailed noise and vibration assessment has been carried out on each of the options. These show that each of the options complies with Department of Environment and Resource Management (DERM) standards for noise and vibration, but may not comply with Sunshine Coast Regional Council standards, particularly with regards to sleep disturbance. The Carnaby Street sub-grade option performs best, followed by at-grade options (with standard noise abatement facilities in place) with elevated solutions performing the worst (unless noise tube design is included). The Southern Drive option performs poorly as it is located much closer to existing and potential development.

The rail corridor design will have a significant influence on the quality of the urban environment. A rear laneway/’back-of-lot’ approach would have contributed towards a negative outcome. The Council’s Maroochydore Centre Position Paper incorporates active frontage facing the rail station which helps improve local amenity.

Environmental impact

A comparative analysis of the options identified for the rail and station alignment was conducted based on a set of pre-determined environmental criteria and environmental values identified by site investigations.

In terms of level of impact on the identified environmental criteria, the existing Southern Drive alignment is considered to be the most benign option, as this alignment does not traverse the Horton Park Golf Course but is located within an existing significantly and recently disturbed environment with little ecological value.

There is expected to be little difference in potential impacts between grade options (2, 3 and 4) for the ‘Carnaby Street’ alignment.

The ecological values identified within the study area as a result of this preliminary investigation reinforces the need for further targeted flora and fauna surveys in order to ascertain the presence/absence of species listed under the Nature Conservation (Wildlife) Regulation (NCWR) and the *Environment Protection and Biodiversity Conservation Act 1999* and whether the alignment options will have any implications for those species. Further targeted studies as part of the subsequent detail design phase will allow the ecological values of the area to be managed through an integrated strategic transport planning solution.

Transport integration

As a key transport node for the Sunshine Coast, integration between transport modes at Maroochydore station is essential.

The Carnaby Street options have been designed to ensure permeability for both vehicular and pedestrian movements. The at-grade option does not provide as much permeability as crossing points will be limited to formally constructed over- or under- bridges. For this reason, the elevated or sub-grade solutions are preferred.

Bus-rail integration is also critical, and Maroochydore Station will serve as a rail head for a wide area of the Sunshine Coast. Local buses will serve areas such as Buderim, Marcoola and Kuluin and distribute arrivals at Maroochydore Station to the Maroochydore foreshore and Cotton Tree precincts. The CoastConnect: Caloundra to Maroochydore project will also likely deliver express buses from other areas on the Sunshine Coast.

An elevated structure in particular provides the opportunity for an integrated bus/rail station with bus platforms located at ground level beneath overhead rail platforms. This would take the place of a separate bus station at Sunshine Plaza as the main bus terminus for Maroochydore. For the Carnaby Street options, a Sunshine Plaza east bus facility on Horton Parade would remain as a premium quality through stop.

The local road network within the Maroochydore Structure Plan has been redesigned with bus movements in mind, and the Public Transport map in the Council's Maroochydore Centre Position Paper provides for continuation of priority bus corridors interfacing with the station as well as introducing a further shuttle loop linking various parts of the City Centre. This provides an appropriate framework for a review of local bus routes to serve the station.

Construction costs

Indicative construction costs have been developed for each of the Carnaby Street options. These have been developed using standard unit rates, with no allowance for special conditions or land acquisitions, and are subject to review following detailed design. Table ES1 summarises these costs, which include a 50% contingency.

Table ES1: Construction costs

Option	Description	Construction cost (millions, 2007 dollars)*
2	Carnaby Street alignment, sub-grade	$275.8
3	Carnaby Street alignment, elevated	$201.9
4	Carnaby Street alignment, at-grade	$126.5

*Note: Excludes land acquisition costs. Includes 50% contingency allowance

Preferred option selection

A weighted multi-criteria analysis (MCA) of the options was conducted in order to determine the preferred solution. Twenty-two MCA criteria in 6 broad categories were agreed in advance with stakeholders. The categories were:

- Transport integration (including network efficiency)
- Engineering (including construction cost)
- Economics (including development yields and stageability)
- Urban placemaking (including quality of built form)
- Natural environment
- Social environment (including noise, amenity and property impact)

The weighted MCA showed that the preferred alignment overall was the Carnaby Street elevated option (option 3).

To confirm the robustness of this conclusion, a range of sensitivity tests were undertaken. These tests showed that:

- Carnaby Street elevated is the preferred option from an economic and natural environment point of view, as well as under the balanced approach
- Carnaby at-grade becomes the preferred solution if engineering costs become the main criterion, to the exclusion of nearly all other criteria
- Carnaby below-grade becomes the preferred solution if socio-economic criteria become dominant. A moderate increase in the importance of the social environment is necessary to make the change
- At no stage is the Southern Drive alignment (currently-protected Caboolture to Maroochydore Corridor Study at-grade alignment) the preferred option.

Conclusion

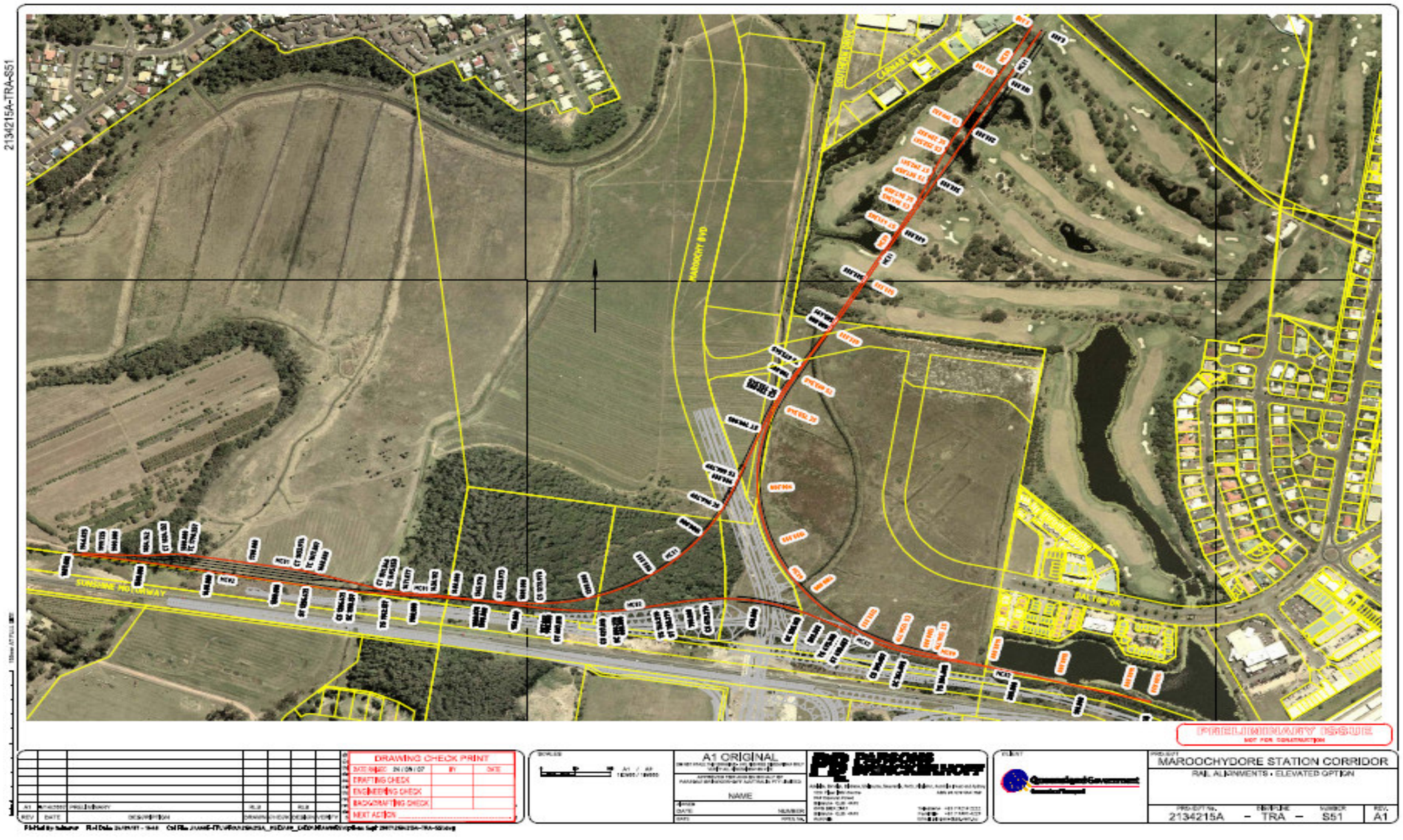
It has been established from an engineering perspective that all options are feasible. While the nature of the ground (low lying) means that sub-grade work is challenging, the sub-grade options are not physically impossible.

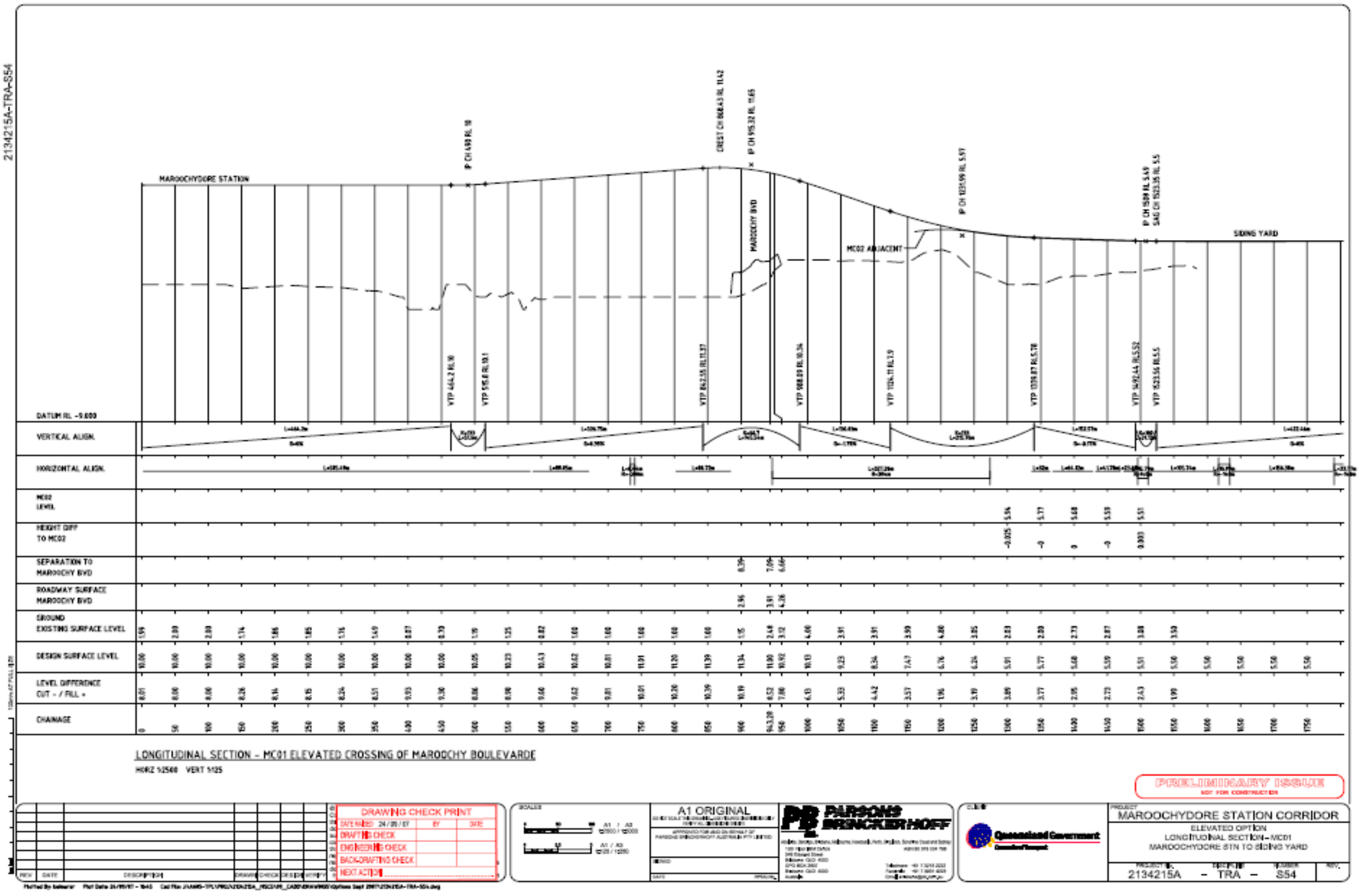
The weighted MCA indicates that option 4, the “Carnaby Street” alignment, when constructed as an elevated structure is the preferred option.

This option is consistent with the planning intent of the Council's Maroochydore Centre Position Paper in terms of best serving the land use distribution and pedestrian network of the Directions Plan and integrating with local connectivity as illustrated in the Public Transport Map of that Position Paper.

This option also provides a positive opportunity for integration with complementary public transport and supports the work undertaken in the CoastConnect: Caloundra to Maroochydore project.

Figure ES5: Preferred option – horizontal alignment





FigureES6: Preferred option – elevation

1. Scope and purpose

1.1 Brief for this study

The Department of Transport and Main Roads is undertaking a review of the location for the proposed railway station to be constructed in Maroochydore as part of the Caboolture to Maroochydore Corridor Study project (see section 2.1 below for details of this project).

The brief for the Maroochydore Station Corridor Study was to review the preferred alternative identified in the then Maroochydore CBD Master Plan. However, this report discusses the preferred option identified in the new Maroochydore Centre Position Paper. The investigation involves examination of elevated and below surface alignments,(Carnaby Street options), assessment of environmental, social and cultural heritage factors and a program of community consultation.

The Carnaby Street options (horizontal and vertical) are assessed against the currently approved alignment, to recommend:

- a final corridor alignment and station location
- a conceptual public transport interchange configuration
- any future work that is required, including any need to produce a detailed environmental impact assessment relating to the new corridor.

The study area is shown in Figure 1-1 below.

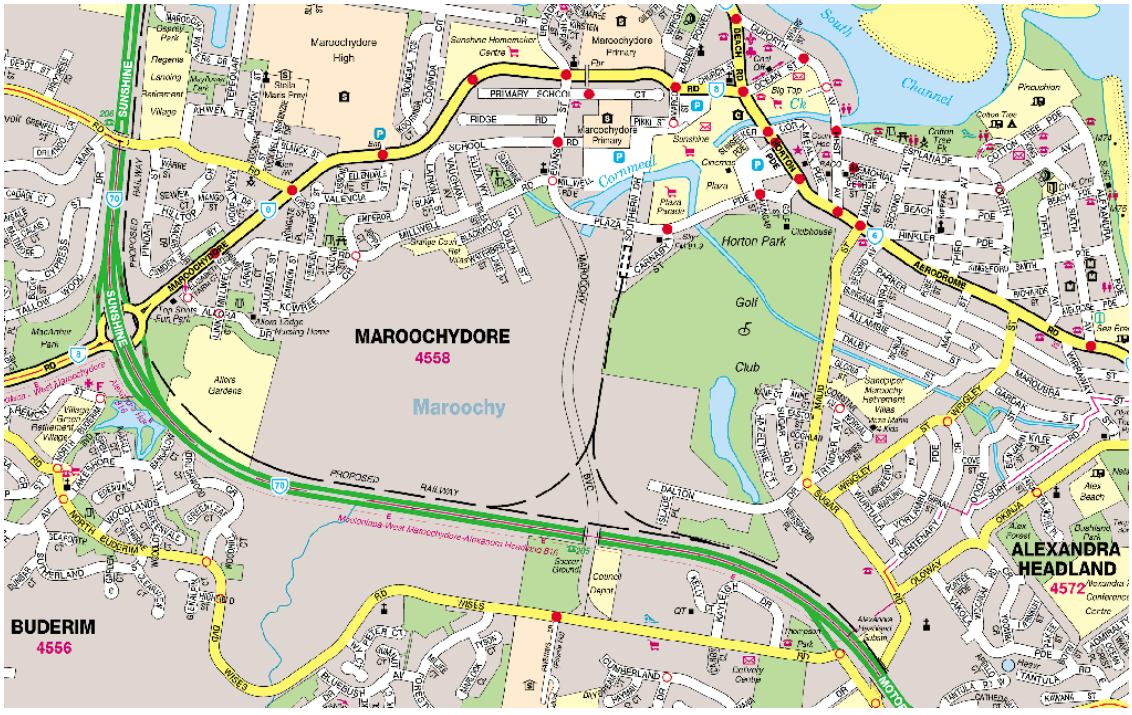


Figure 1-1: Study area

1.2 This report

This report presents the key findings to date on the current Caboolture to Maroochydore Corridor Study alignment and an alternative alignment (Carnaby Street sub-grade, elevated and at-grade) for the railway through central Maroochydore.

In particular, this report presents the social, land use and geological setting of the proposed alignments, gives details of the options from an engineering point of view and summarises the key constraints on the project presented by the geological and natural environments. It also summarises the key findings of specialist studies into the noise impacts of the project, the land use and development potential impacts of the options and the approvals processes necessary to secure the alignment.

2. The Caboolture to Maroochydore Corridor Study (2001)

2.1 Background to Caboolture to Maroochydore Corridor Study

The South East Queensland Integrated Regional Transport Plan of 1997 identified the need for protection of major transport corridors. In the Sunshine Coast region this led to the commencement of the Caboolture to Maroochydore Corridor study.

This study was conducted in the context of a high population growth on the Sunshine Coast, with an estimated 70% increase in population between 1997 and 2011 resulting in a potential 300% increase in car trips. In this environment, it was considered that an increase in the road network alone was not an option that would be viable in the long term. Rather, there should be a shift to more sustainable transport options, which would include a dedicated line-haul public transport route linking the key regional centre of Maroochydore with the main Brisbane railway system.

One of the terms of reference for the Caboolture to Maroochydore Corridor Study was that it should identify and preserve an alignment into Maroochydore that “maximises the public transport opportunities and benefits without unacceptable impact on the environment”.

2.2 The Caboolture to Maroochydore Corridor Study process

The Caboolture to Maroochydore Corridor Study project was completed in a three stage process.

The first stage consisted of the establishment of base criteria and the development of a range of working papers, covering planning and land use, transport and the environment, leading to the identification of a range of potential corridors. These included a coastal route via Caloundra, an inland route via Sippy Downs and a wide range of variations (refer Figure 2-1).

Figure 2-1: Alignments considered (Caboolture to Maroochydore Corridor Study Corridor Options Report)

The second stage evaluated the various corridor options to produce a preferred corridor for the majority of the study area. A Corridor Options Report was released in September 1998.

Finally the third stage concluded evaluation with the selection of a preferred corridor for the length of the corridor, and led to the preparation of a Final Impact Assessment and Land

Use Transport Strategy (IAS). The draft IAS was opened to public comment in 1999 and following revision, a final IAS was released in February 2001.

Some of the key issues in the Maroochydore area found as part of the consultation process included

- traffic impact concerns
  - concern was expressed that there would be an increase in traffic around the stations, particularly residential streets in both existing residential development to the north-west of the station, and in proposed new development to the south and west.
- proposed station locations
  - Sunshine Plaza
  - near the western option (Maroochydore)
  - adjacent to the motorway (for another station, Mooloolaba)
- Sunshine Coast University connections
  - the consultants determined that the university would not have a station as it would not be on the route. There would be an integrated transport system to address issues to access it.

A Community Attitude Survey was undertaken in August 1999 and found

- In each case the preferred place to begin or end a journey was a shopping centre and/or 'park and ride' facility. In each case there was a non-specific request for the locations to be 'central' without many nominating the 'CBD area' which, for the Sunshine Coast, was taken to be Maroochydore.
- The consultation report found from this attitude survey that Maroochydore was the area most reported as the destination of travel for regular work.

The extensive nature of the consultation process for the full Caboolture to Maroochydore Corridor Study (refer Figure 2-2) meant that for the Maroochydore Station Corridor Study the consultation process has been limited largely to key stakeholders and directly affected individuals.

Type of Submission	Corridor Options Assessment Report	Draft IAS
	Number of Submissions	
Written Submissions (including faxes and E-mail)	214	38
Written Shopfront Comments	250	24
Response to QT newsletter surveys	1057	N/A
Form Letters	547	N/A
TOTALS	**2068**	**62**

Figure 2-2: Caboolture to Maroochydore Corridor Study consultation (IAS)

2.3 Summary of Caboolture to Maroochydore Corridor Study findings

2.3.1 Demand, economic and overall evaluation

The three different alignments through central Maroochydore were assessed using a benefit-cost ratio and multi-criteria analysis. The results of the benefit-cost ratio indicate that an ordinary (not guided) busway should be constructed. The results of the multi-criteria analysis showed the railway to be the best mode for all alignments. The railway had the highest patronage forecast, assuming a combination of Brisbane bound and local area traffic.

A 30-minute headway on services was adopted for Brisbane and a 15-minute headway was adopted for services on the Sunshine Coast. The estimated capital expenditure was $399 million (1999 dollars).

2.3.2 Maroochydore CBD alignment and station location

Three different alignments through central Maroochydore were considered by the Caboolture to Maroochydore Corridor Study project in the Corridor Options Assessment Report (September 1998). These were a western alignment and an eastern alignment as well as an at-motorway alignment.

The location on the Sunshine Motorway was supported by a number of landowners (as their lands would not be affected directly) and, at that stage, by the Maroochy Shire Council as it would keep rail out of the central business district. However, it was rejected by the consultants as it would discourage many potential users (with up to 30-60% switching mode to car), besides being inconsistent with official Maroochy Shire planning schemes for the central business district.

The western alignment (“L2”) was planned to follow closely the route of the then proposed “Southern Access Link” (now Maroochy Boulevard) from the Sunshine Motorway to a station on Southern Drive adjacent to Plaza Parade.

The eastern alignment (“L1”) would leave the Sunshine Motorway corridor at the same location, but then curve to the northeast through the Horton Park Golf Course before terminating in central Maroochydore adjacent to Horton Parade.

The L1 alignment was considered the preferred alignment by the draft COAR Report on the grounds that it provided a railway station in the heart of the traditional town centre of Maroochydore, provided better access to current and predicted centres of employment and gave a better overall land use result. On the other hand, there was much stronger support for L2 following community consultation, particularly from directly affected landowners who rejected resumption and other property impacts that the eastern alignment would cause.

Ultimately, the Caboolture to Maroochydore Corridor Study report recommended the western (L2) alignment into Maroochydore.

2.3.3 Final Caboolture to Maroochydore Corridor Study recommendations

The final Caboolture to Maroochydore Study recommendation is for a heavy-rail alignment linking Brisbane and the Sunshine Coast Airport via Caloundra and Maroochydore (Figure 2-3, below).

The corridor leaves the North Coast Main Line at Beerwah before turning east to Pelican Waters then northwards, passing to the east of Caloundra and along the established Multi Modal Transport Corridor through Kawana Waters to southern Mooloolaba. It then runs along the west side of the Sunshine Motorway, crossing over to the east side at Sugar Road, in south Maroochydore. The line then follows the north/east side of the motorway, across Maroochy River and north to a terminal station at the Sunshine Coast Airport.

There is a branch line into central Maroochydore, leaving the main line near the intersection of Maroochy Boulevard and the Sunshine Motorway, heading due north to a station on Southern Drive, adjacent to Plaza Parade. A triangle junction is proposed, allowing trains to enter Maroochydore from the north and depart to the south (and vice-versa) as well as through trains bypassing Maroochydore altogether.

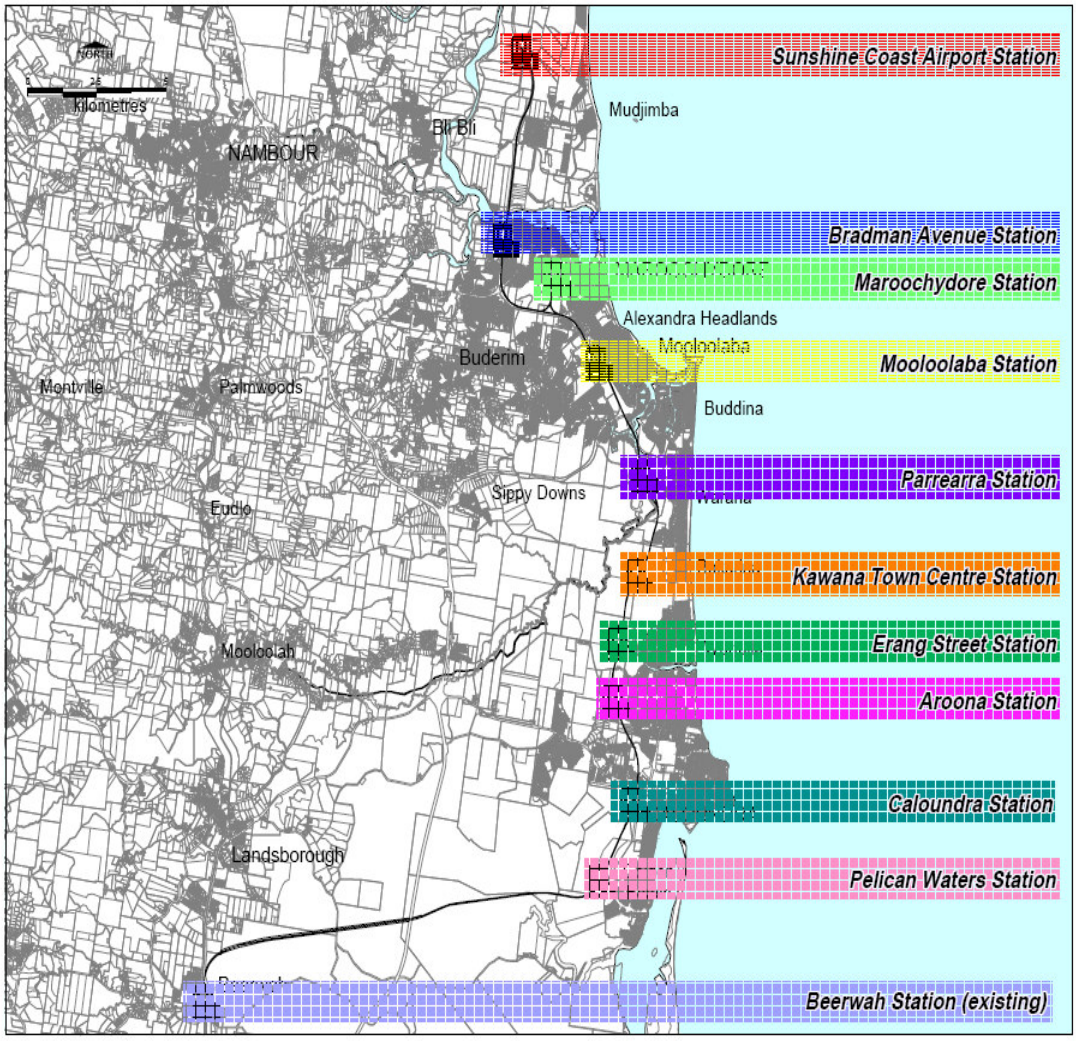


Figure 2-3: Final alignment and stations (IAS)

2.3.4 Timeframes

The original Caboolture to Maroochydore Corridor Study proposed a phased introduction of services onto the preferred corridor identified in that study with an interim busway and rail progressively constructed post 2015 (Figure 2-4). The South East Queensland Infrastructure Plan and Program 2009-2026 (SEQIPP) indicates construction commencing in the period from 2013-14 to 2018-19 and extending through the period 2019-20 to 2025/26.

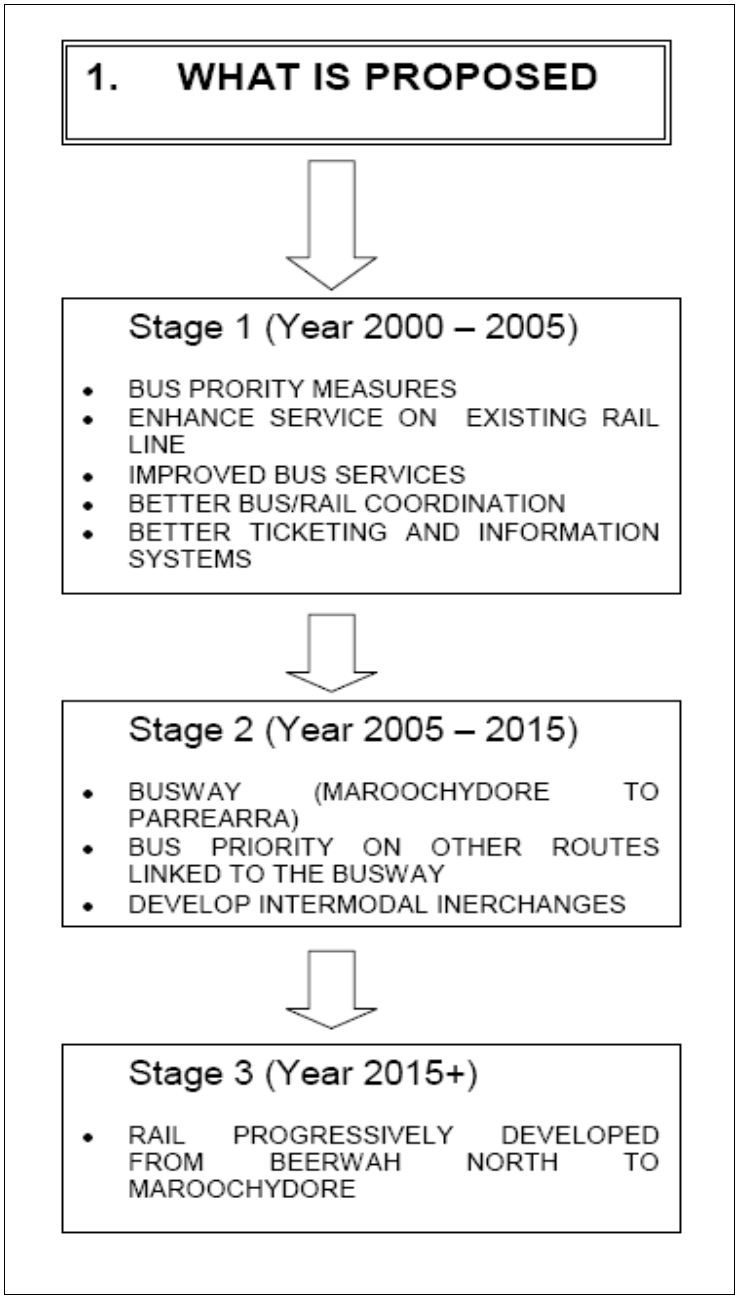


Figure 2-4: Proposed Caboolture to Maroochydore Corridor Study implementation (IAS)

3. Context for this study

3.1 Policy setting

3.1.1 South East Queensland Regional Plan 2009-2031

Context

First published June 2005, the South East Queensland (SEQ) Regional Plan was recently updated to cover the period 2009 to 2031. It sets out the future pattern of development for the south-east Queensland region. The key strategic directions in the Plan are encouraging a more compact urban form, development of the Western Corridor and sub-regional self containment. The Regional Plan, including its regulations, has statutory force and effect.

Strategic directions

The following two quotes from the Regional Plan (page 12) illustrate its strategic directions in respect of public transport:

"Prime locations for infill development are around urban activity centres that have existing facilities, services and amenities, and along public transport corridors and nodes where the public transport system can best service the additional population"

"The provision of roads and public transport to support current and future residents is a priority."

Activity centres

Maroochydore is recognised as the principle regional activity centre for the Sunshine Coast.

"Regional activity centres are accessible locations that have concentrated businesses, services and facilities for employment, research and education, as well as higher density residential development serving a regional population. The SEQ Regional Plan proposes a strong network of regional activity centres connected by quality public transport to create compact, self-contained and diverse communities. Regional activity centres are also a key land use element to create an efficient public transport system."

Integrated land use and transport planning

The SEQ Regional Plan states that "A transit oriented development precinct has a walking and cycle-friendly core with a rail or bus station, and is surrounded by relatively high-density residential development, employment or mixed uses" (p101). The Regional Plan also notes that " Transit oriented development in SEQ will be based around frequent and high-capacity public transport systems, primarily rail and busway." (p101). Figure 3-1 illustrates transit oriented development principles identified for development in SEQ.

Table 4: Transit oriented development principles for South East Queensland

Location	
Infrastructure and services levels	Locate development around nodes or corridors where infrastructure capacity exists or can be created. Prioritise locations with high levels of transit service frequency.
Development levels	Ensure transit oriented development occurs at a scale that is appropriate for the location.
New development	Apply transit oriented development principles in new communities where transit nodes exist or are proposed.
Land use	
Type	Ensure transit oriented development precincts are dominated by land uses that support transit.
Extent	Transit oriented development precincts focus on the area within 5 to 10 minutes of the transit node considering the nature of the topography.
Density	Incorporate higher density residential uses in transit oriented development precincts to increase vitality and provide more convenient access to services and transport. Use the following baseline density guidelines: ■ activity centres: 40–120 dwellings per hectare (net) or greater ■ suburban and neighbourhood locations: 30–80 dwellings per hectare (net) or greater ■ priority transit corridors: 40 dwellings per hectare (net) or greater
Intensity	Incorporate high-employment intensities and a mix of employment opportunities.
Mix	Provide and integrate a mix of uses to create a greater variety of services catering for the diverse needs of a vibrant community. Provide timely and convenient access to services and facilities required to support people's daily needs, including an appropriate mix of commercial and retail services, jobs, community infrastructure and open space relevant to the context of the surrounding area.
Continuity	Encourage continuous activity in transit oriented development precincts to provide a sense of vitality and safety.
Design	
Adaptability	Ensure development delivers a built form that is robust and flexible, allowing development to be adapted or redeveloped over time to vary uses, increase densities or increase employment intensity.
Built form	Ensure development features high-quality subtropical design that maximises amenity, street activity and pedestrian connectivity.
Public realm	Provide for a high-quality public realm to meet the needs of the surrounding community, including open space, pedestrian areas and transit access. Deliver design that promotes social interaction and inclusion, physical activity and a sense of place and identity.
Integration	Ensure design seamlessly integrates transit nodes and the community.
Safety and accessibility	Ensure development promotes a high sense of personal and community safety, and equitable access to all public areas.
Parking	Locate, design, provide and manage car parking in transit oriented development precincts to support walking, cycling and public transport accessibility.
Transport	
Mode share	Create an increased mode share for walking, cycling and public transport by providing high levels of accessibility and public amenity within precincts and to stations and surrounding areas for cyclists and pedestrians, with priority for pedestrians.
Transport efficiency	Facilitate a high level of intermodal connection.
Social	
Social diversity and inclusion	Ensure development creates an environment that supports social inclusion and diversity of different age, cultural, employment and income groups. Provide a mix of housing types, tenures and affordability to support social diversity. Promote physical and social connections between new and existing communities. Ensure community development initiatives are carried out as an integral part of community building.
Process	
Coordination	Planning for development in transit oriented development precincts requires the coordinated effort of all stakeholders, including state agencies, local government and the development industry.
Community engagement	Engage with the community likely to experience change early and throughout planning and development processes to promote a sense of ownership and involvement.
Timeframes	Transit oriented development outcomes take time to deliver, and precincts mature over time.

Figure 3-1: Transit oriented development principles for SEQ (SEQ Regional Plan)

Transport infrastructure

The Regional Plan states: "Transport infrastructure is required to facilitate the creation of a network of communities, linked through public transport with centres and enterprise areas." (p23). A key project identified in the Regional Plan is:

- "Improved public transport connections between Beerwah and coastal centres from Caloundra South to Maroochydore."

Figure 3-2: Transport Infrastructure Sunshine Coast (SEQRP, Map 24)

Conclusion

A station location which best serves quality access to the facilities and activities of the principle activity centre will be most consistent with the intent of the SEQ Regional Plan.

3.1.2 South East Queensland Infrastructure Plan and Program 2009-2026

Context

The SEQ Infrastructure Plan and Program (SEQIPP) is reviewed and updated on an annual basis. The latest version (SEQIPP 2009) was released in July 2009.

Infrastructure

SEQIPP 2009 supports "… greater self-containment of travel and economic growth within the Sunshine Coast…" SEQIPP notes that planning and land acquisition will continue for an integrated public transport corridor between Beerwah and Maroochydore on the CAMCOS alignment. It also states that refinements to the CAMCOS alignment are being investigated at Caloundra South and the Caloundra aerodrome site, at Kawana and into the Maroochydore central business district (p45).

Specific recommendations

SEQIPP 2009 outlines a transport infrastructure investment program for the Sunshine Coast. With self-containment of travel and economic growth listed as the criteria, the program focuses on:

- providing improved access between Maroochydore and Caloundra and emerging population centres, including improved public transport
- increasing the capacity of the North Coast Rail line and upgrading connections between the rail line and coastal activity centres
- enhancing the safety and efficiency of the Bruce Highway, a national transport link
- accelerating development of the Principal Cycle Network
- investigating the long-term transport requirements in the subregion and preserving transport corridors to cater for future growth.

SEQIPP 2009 lists a total of 24 significant infrastructure projects to be undertaken or commenced on the Sunshine Coast in the period 2009/10 to 2025/26. These include CAMCOS: Beerwah to Maroochydore public transport infrastructure, which is scheduled for delivery in the 2013/14 to 2025/26 timeframe, and has been costed at $3.3 billion.

Conclusion

SEQIPP 2009 specifies the construction of public transport infrastructure between Beerwah and Maroochydore with expected construction in the 2013-2026 timeframe.

3.1.3 Maroochydore Structure Plan

One of the core drivers for the review of the Caboolture to Maroochydore Corridor Study corridor has been the planning undertaken by the former Maroochy Shire Council (MSC) in 2006-07 and subsequent planning by the new Sunshine Coast Regional Council since March 2008 for the establishment of a structure plan for the Maroochydore CBD, reinforcing its role as the Principle Activity Centre for the Sunshine Coast.

An 'Enquiry-by-Design' workshop was held during May 2006 which led to the examination of a number of land use options. Each option was focussed around a railway station in Maroochydore in various locations and forms. The options were:

1. continuation of previous planning with a station at Southern Drive
2. improved Southern Drive precinct, including changing of land uses and a more permeable street network generated by an elevated rail line
3. new town centre located around a railway station on the Sunshine Motorway
4. new town centre located around a station centrally located on the Horton Park Golf Course
5. new town centre located around an elevated station located adjacent to Horton Parade opposite First Avenue with redevelopment of the Horton Park Golf Course.

An elevated rail option to Horton Parade (not discussed further in this report) was selected for further investigation through a Draft Concept Plan (October 2006). The Concept Plan outlined a number of general strategies and approaches to deal with the issues surrounding the Maroochydore City Centre in an effort to:

"…transform Maroochydore into this Country's Premier Regional City by creating a successful place for future generations to enjoy. A City that is: accessible, vibrant, distinctive, prosperous, a people place and a place of variety."

The Plan provided for capacity beyond 2026, with provision for flexible growth that would be managed in stages to respond to market conditions. The Concept Plan and Strategies were illustrated in a series of drawings representing the planning strategies and specific solutions to deliver Council's stated vision.

Land uses which support public transport, including commercial office space, entertainment/ recreation and high density residential were envisaged for the precinct surrounding the rail corridor and station.

The MSC then requested the Department of Transport and Main Roads to further investigate the feasibility and implications of changing the rail corridor to match its preferred option (then known as the First Avenue Option), resulting in the commissioning of this study.

Following an initial findings report by the study team in October 2007, the MSC undertook further discussions with key stakeholders in the area, including property owners and developers. This led the Department of Transport and Main Roads and MSC to convene a further workshop to review the option previously identified as preferred and to consider alternatives. The result of this workshop and a subsequent technical feasibility study was to recommend a (second) alternative station location and alignment for the rail line which would traverse a portion of the golf course at a more northerly alignment, terminating at a station short of the Maud Street canal near Carnaby Street (referred to in this study as the Carnaby Street Option).

MSC then utilised the workshop findings to develop a land use plan that would complement this station location and alignment (refer figure 3-3).

In the meantime, the Department of Infrastructure and Planning declared the Maroochydore City centre and environs as a "Major Development Area" for which a Structure Plan was required to be prepared. At the time, it was envisaged that the Structure Plan would be given statutory force and effect by being adopted as an amendment to the SEQ Regional Plan. The key development intent for the 'Maroochydore Major Development Area' (MDA) is specified to be achievement of quality of built form, a compact city core, and high levels of safety and amenity.

Drawing upon these and themes identified in the previous studies, a range of strategies were identified and incorporated in the Maroochydore City Centre Structure Plan. This structure plan was endorsed by the Maroochy Shire Council in November 2007 as a 'draft for first State Interest Check'.

Since this time the Maroochy Shire Council has been merged with neighbouring councils to form the Sunshine Coast Regional Council. The new Council has further reviewed the Structure Plan and revisited some of its findings.

In the meantime, the Department of Infrastructure and Planning has determined that, rather than the Structure Plan being incorporated as an amendment to the SEQ Regional Plan, it would be treated as a "local area plan" by way of amendment to the Council planning scheme.

On 26 May 2009, the Council endorsed the Maroochydore Centre Position Paper setting out the intent of the local area plan and including a "Directions Plan' (Figure 3.3). The Position

Paper can be viewed on the Sunshine Coast Regional Council's website at http://www.sunshinecoast.qld.gov.au/sitePage.cfm?code=maroochydore-position-paper.

3.1.4 Maroochy Shire Transport Strategy Report (2007)

Context

A report prepared for the then Maroochy Shire Council advised it to *"move forward with integrated transport and land use planning actions in a strategic and coordinated fashion in the best interests of the Shire"* p2. The report presents a high level strategy for the Maroochy Shire.

Specific recommendations

The report was generally supportive of expanding role for public transport, both bus and rail based.

It expressed some concern about the rail corridor, especially as wide station spacing means it may limit its suitability for local transport, and fast commuter rail services may encourage the Sunshine Coast to become a dormitory suburb for Brisbane.

Nevertheless, the Maroochy Shire Transport Strategy Report recommends the implementation of the Caboolture to Maroochydore Corridor Study corridor and the realignment of the corridor to the Maroochydore City Centre. Public transport mode share targets for the Maroochydore area are 10-15% by 2026. Bus and rail infrastructure should include:

- bus:
  - buses layover outside CBD
  - Sunshine Plaza to remain a key stop
  - street network permeability
  - build a "pre-Caboolture to Maroochydore Corridor Study" bus station at Sunshine Plaza now
  - build a bus-rail interchange at Maroochy Station by 2016.

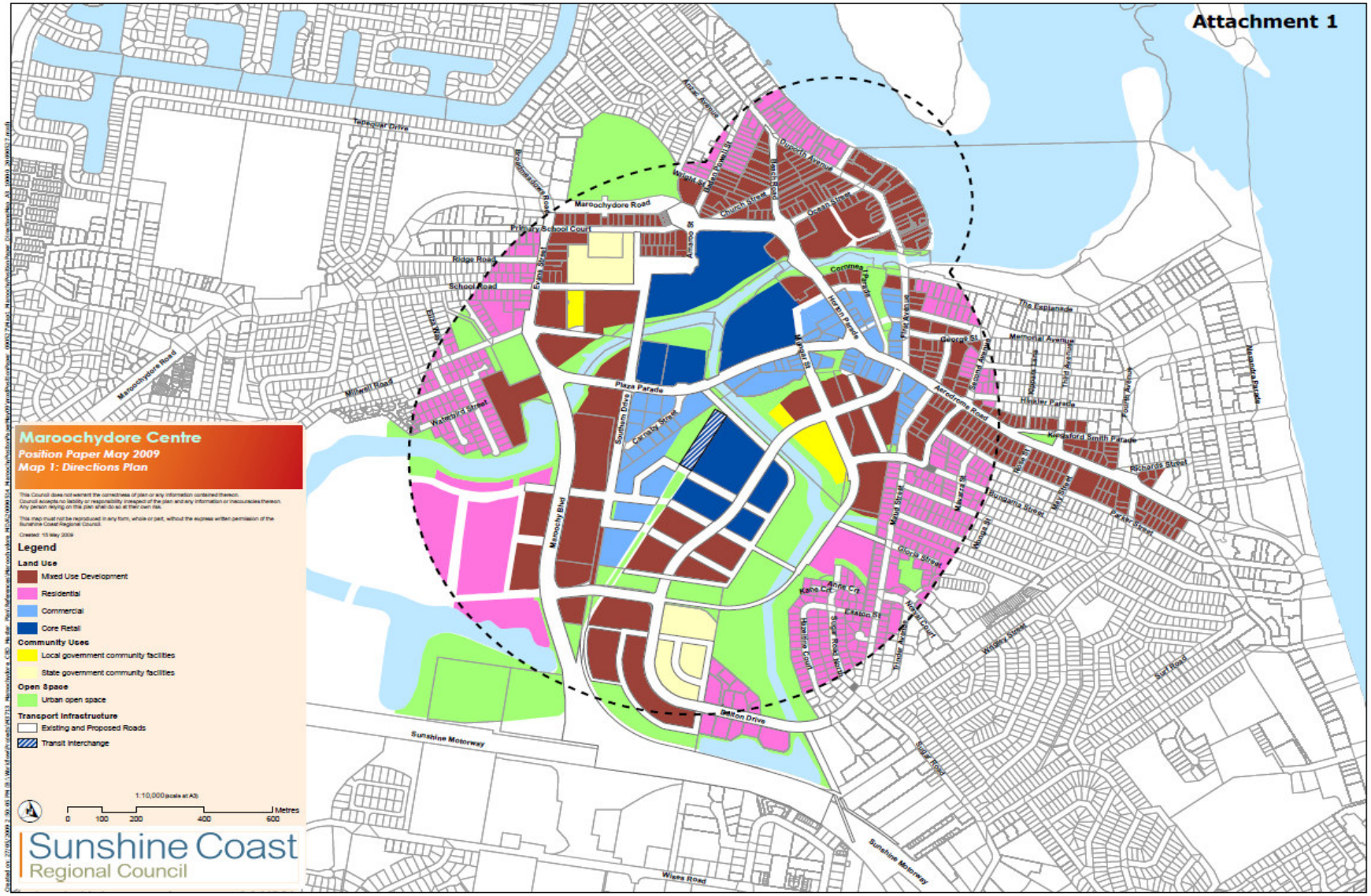


Figure 3-3:Maroochydore Centre Directions Plan (Sunshine Coast Regional Council, May 2009)

rail:

- re-align rail to CBD
- provide kiss and ride facilities at Maroochydore Station
- complete construction of Caloundra to Maroochydore by 2026.

Conclusion:

The Maroochy Shire Transport Strategy Report recommends the construction of a Caboolture to Maroochydore rail line. It specifies the need for a bus/rail interchange at Maroochydore station. However it recommends an alternative alignment and station location and requires permeable street network, which implies below or above grade vertical alignment.

3.1.5 SunTRAN

Context

The SunTRAN project, commissioned by the SunROC group of councils (then Noosa and Maroochy Shires and Caloundra City, now amalgamated as the Sunshine Coast Regional Council), and the Department of Transport and Main Roads, is designed as a cohesive transport vision for the Sunshine Coast. Stage 2 of the project culminated in a "Directions Report" which was endorsed by the Councils and the department as a reference document providing a strategic framework to guide more detailed transport planning by both State and local governments.

Specific recommendations

The SunTRAN study area covers the then local government areas of Noosa, Maroochy and Caloundra (now the Sunshine Coast Regional Council). It discusses a range of themes including

- integrated land use and transport planning
- public transport
- road network
- pedestrian and cycling movement
- travel demand management
- tourism and visitor travel
- freight movement.

The key message from SunTRAN is that the road network in the Sunshine Coast cannot be expanded forever, and a more sustainable solution is an increased investment in public transport and a cultural shift away from the private car to more sustainable modes of transport (walking, cycling and public transport).

The SunTRAN report is strongly supportive of construction of the Caboolture to Maroochydore Corridor Study corridor, and calls for construction of the full corridor to be brought forward to 2015, rather than a staged approach as well as additional trunk corridors through the region. It also stresses the importance of a transit link into Sunshine Coast Airport, but does not specify fixed rail for this link. A number of bus and bus/rail interchanges are identified under SunTRAN, including Maroochydore.

It notes that a structure plan for the development of a new Maroochydore CBD is being developed, but does not make any specific recommendations regarding routing in the CBD area.

Conclusion

The SunTRAN report is very supportive of improved public transport for the Sunshine Coast region, and this includes early construction of the Caboolture to Maroochydore Corridor Study rail corridor and additional trunk corridors through the region.

No specific recommendation is made concerning the preferred corridor through Maroochydore CBD, and thus there is no conflict between SunTRAN and this option.

3.2 Social setting

Maroochydore is a multi-functional urban centre which provides a high level of services and employment for residents in the greater Sunshine Coast region. The centre offers a range of retail, commercial, educational, government, residential, cultural, health, entertainment, tourist, and recreation and leisure facilities. The South East Queensland Regional Plan identifies the locality as the Principal Activity Centre for the Sunshine Coast.

3.2.1 Commercial and retail facilities

Sunshine Plaza, the largest retail shopping centre at the Sunshine Coast, is located off Plaza Parade to the north of the project area. This centre provides an extensive range of stores and services, including fashion, financial services, health and beauty, homewares and gifts, and entertainment.

3.2.2 Residential development

Maroochydore also supports a diverse mix of residential accommodation for both permanent residents and tourists alike.

There are a number of pockets of existing residential development surrounding the project site. These developments include:

- western side of Maud Street
- surrounding Sugar Road
- south of Millwell Road (west of the project area)
- multiple dwelling unit located immediately adjacent to the Horton Park Golf Course to the north of the Maud Street canal.

The Sunshine Cove (formerly Wises Farm) development is located to the west of the project area and construction has commenced. The Christadale land parcel owned by Brencorp, which is located to the south and east of the project area, is not currently developed. However, it is noted for future business and mixed use development.

3.2.3 Education

Maroochydore State Primary School is in situated less than 1 km from the project site. Other schools within a short distance of the study area include Maroochydore State High School, Kuluin State School, and Stella Maris School.

3.2.4 Health

Maroochydore is situated within the Sunshine Coast Health Service District, and is serviced by hospitals in Caloundra, Nambour and Maleny. A major Sunshine Coast University Hospital is committed to be constructed at the Kawana Town Centre on the Caboolture to Maroochydore Corridor Study rail line.

There are also a number of public health services and facilities in Maroochydore. The Maroochydore Community Service, located on Sixth Avenue, offers aged and disabled support, adult health, child and family health, (including school health), alcohol and drug counselling, home care, dental services and social work. There is also an indigenous health program operating in Maroochydore.

A major Health Hub to comprise clinical and day surgery services has recently been committed on part of the Brencorp land at Dalton Drive immediately south of the Horton Park Golf Course. This will consolidate many of the health services provided in the Maroochydore central area and will complement the inpatient services provided at the hospitals.

3.2.5 Community facilities and groups

There are a range of social and recreation opportunities within and surrounding the project area. Sporting facilities and clubs in the Maroochydore area include junior AFL, yoga, gymnastics, touch football, tennis, swimming, bowls, squash, soccer, rugby union, athletics, hockey, basketball, sailing and fitness.

Active community groups in the area include Toastmasters Club, Scouts, Masonic Club, Country Music Club, R.S.L Club, Landcare group, Surf Lifesaving Club.

3.2.6 Transport and road use

Maroochydore Road, Maroochy Boulevard, Aerodrome Road and Horton Parade are major four-lane roads in the area, and are an important part of the local traffic network. These roads form part of the route from David Low Way in the north, to Mooloolaba in the south and Nambour in the west.

The Sunshine Motorway is located to the south of the project area and functions as a major transport route for the entire Sunshine Coast region from Caloundra in the south to Noosa in the north. Maroochy Boulevard which links the Sunshine Motorway to Plaza Parade is in the immediate vicinity of the project area and would intersect with the rail alignment near the Sunshine Motorway if the rail is extended north beyond the Maroochydore City Centre towards the Sunshine Coast Airport at Pacific Paradise.

In addition to local, commuter and regional traffic, there are a number of bus services that operate in the area. Sunshine Plaza, located north of the project area, is a hub for public transport in the region and provides a major interchange for a large number of bus services. That interchange was designed to cater for smaller buses than are now coming into service and has limited capacity to accommodate planned service enhancements. TransLink is currently seeking to expand or replace that interchange.

3.2.7 Existing land use

The various rail alignment and station location options traverse a number of different existing and proposed land uses including the following:

- 'Christadale' (Lot 366 on SP160808) is currently a vacant broadacre property. A previous development approval to reconfigure the allotment to establish detached and multiple

dwelling purposes was issued by the then Maroochy Shire Council. However, this approval has not yet been actioned. Additionally, Queensland Health has committed to plans to establish a major 'health hub' providing clinical and day surgery services.;

- "Sunshine Cove (formerly Wises Farm)' (Lot 5 SP 149935 and Lot 39 RP 848499) is currently being developed in accordance with an approval issued by the then Maroochy Shire Council to establish a mixed use development. Generally, mixed-use commercial and high density residential development is proposed to the west of the rail alignment options and further residential development of lesser densities is proposed to the western and northern peripheries of the site. Open space and lake areas are also incorporated. It is anticipated that the ultimate residential population of the development will be in the range of 5,000 – 8,000 people.
- Horton Park Golf Course (Lot 2 RP868296) is currently operating as an 18-hole golf course. However, the Council is undertaking its planning based on the assumption that the golf club will relocate and that significant portions of the land will become available for urban purposes.
- Lot 367 SP179107 and Lot 3 RP205143 are two smaller, vacant properties immediately adjacent to the Sunshine Motorway.

3.3 Ecological setting

3.3.1 Desktop review

Flora

Flora database searches indicated the potential for 24 rare and threatened flora species to occur in the grid search area. These species are protected under state and/or Commonwealth legislation. The Department of Environment and Resource Management's (DERM) regional ecosystem (RE) mapping also identified five RE's potentially occurring in the study area. The five RE's have a 'not of concern' or 'of concern' conservation status under the Queensland *Vegetation Management Act 1999* (VM Act). A description of these five RE's and their corresponding state and Commonwealth conservation status is listed in Table 3-1. No threatened ecological communities protected under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1997 (EPBC Act) were identified in the grid search area. The Coastal Habitat Resources Information System (CHRIS) did not identify any areas of mapped coastal wetlands; seagrass watch sites, aquaculture sites or habitat protection areas in the study area.

Table 3-1: DERM regional ecosystems mapped to occur within the study area

RE Code	RE Description	VM Act	DERM Biodiversity	EPBC Act
12.3.2	*Eucalyptus grandis* tall open forest on alluvial plains.	Of concern	Of concern	Not listed
12.3.4	*Melaleuca quinquenervia, Eucalyptus robusta* open forest on or near coastal alluvial plains	Of concern	Of concern	No listed
12.3.5	*Melaleuca quinquenervia* open forest on coastal alluvium.	Not of concern	Of concern	Not listed
12.9-10.1	Shrubby open forest often with *Eucalyptus resinifera, E. grandis, Corymbia intermedia* on sedimentary rocks. Coastal	Of concern	Of concern	Not listed

12.3.13	Closed heathland on seasonally waterlogged alluvial plains usually near coast.	Of concern	Of concern	Not listed

Note: Each RE is attributed a vegetation management status under the Vegetation Management Act 1999 as well as a biodiversity status by the DERM. The vegetation management status for each RE is assigned as one of three categories: 'endangered', 'of concern' and 'not of concern' according to its current distribution relative to its pre-clearing distribution. The DERM's biodiversity status for each RE is assigned as either 'endangered', 'of concern' or 'no concern at present' and is based on the condition of the vegetation in addition to its current and pre-clearing distribution.

Fauna

Fauna database searches indicated the potential for 31 rare and threatened fauna species to occur in the grid search area. These species are protected under state and/or Commonwealth legislation. DERM essential habitat is mapped throughout the study area represented as RE's 12.3.5 and 13.3.13. Essential habitat is mapped for *Crinia tinnula* (Wallum froglet) and *Litoria freycineti* (wallum rocket frog). Both of these species are listed under the Nature Conservation (Wildlife) Regulation (NCWR). The CHRIS did not identify any areas of mapped coastal wetlands or fish habitat areas. The Protected Matters Search identified an additional 32 migratory species to potentially occur in the search area. Migratory species comprised 21 birds, 7 mammals and 4 reptiles. Thirty three species (the majority also listed as migratory) are also listed marine species comprising birds, mammals, ray finned fishes and reptiles. Twelve of the thirty three listed marine species were whales and other cetaceans. No koala habitat was mapped for the study area under the Koala Conservation Plan.

3.3.2 Field reconnaissance

The purpose of the field reconnaissance was to assess the likelihood/and or presence of remnant vegetation and threatened flora and fauna species to occur within the corridor footprint. The survey site was divided into three distinct survey areas based on present land-use and current ecological condition. These areas can be defined as follows:

Area 1 – Highly disturbed area used for construction. This area includes riparian vegetation associated with Dalton Lake adjacent the Sunshine Coast Motorway.

Area 2 – The Horton Park Golf Course and previously cleared areas to the south.

Area 3 – The block of remnant vegetation alongside the Sunshine Coast Motorway.

Flora observations

The following flora observations were noted for each of the three areas:

Area 1

The majority of vegetation observed is highly disturbed and modified and consists of planted or regrowth native species, as well as a variety of exotic weed taxa. The only significant remaining vegetation in this area consists of a thin (20 m) strip fringing Dalton Lake. This area is dominated by planted Casuarina, Callistemon and Melaleuca species that are functioning as an effective screen between the motorway and adjacent residences. The edges of the lake system have been colonised with a diverse range of aquatic sedges and reed species. Nearby construction work has impacted on a significant proportion of the vegetation in this area, leaving the majority of the site devoid of flora species.

Area 2

The vegetation in the golf course consists predominantly of exotic grasses in the fairway and green areas with a mixture of planted exotic and native species, as well as small islands of remnant vegetation scattered throughout the site. Whilst the canopy of these remnant areas still contain fair ecological integrity and are representative of extant remnant bushland in adjoining sites (predominantly *Melaleuca quinquinervia*), the understorey is highly disturbed and modified. Numerous rows of the introduced pine trees *Pinus elliottii* (Slash Pine) and *Araucaria heterophylla* (Norfolk Island pine) exist throughout the site as well as a stand of *Callitris columellaris* (Bribie Island pine). The mangrove species *Avicennia marina* (Grey mangrove) is present in the small tidal channel intersecting the site.

Area 3

Vegetation observed within the small bushland remnant was determined to be of high ecological integrity and representative of the mapped RE's 12.9-10.1/12.3.5. This area contains good diversity of native species, high native recruitment and exotic weed invasion limited to disturbed edges. The remnant canopy is dominated in drier areas by Corymbia intermedia (Pink Bloodwood) and Eucalyptus tereticornis (Forest red gum), whilst large stands of *Livistona australis* (Cabbage tree palm), *Eucalyptus robusta* (Swamp Stringy bark) and *Eucalyptus grandis* (Flooded gum) dominate the low lying wetter areas.

The field reconnaissance identified potential habitat in the study area for 11 of the 24 rare and threatened flora species identified in the desktop review.

Fauna observations

Area 1

The predominant habitat feature of this area is the Dalton Lake and associated riparian vegetation. The dense ground cover within this paperbark and Casuarina woodland and its low lying nature and close proximity to the water indicated this area could potentially provide habitat for a range of fauna species including rare and threatened waterbirds and amphibians. This area was heavily disturbed due to current roadworks; however the existing fringing vegetation was intact and appeared be the result of previous revegetation works. Species recorded in this area during the brief scoping included *Anas gracilis* (grey teal), Porphyrio porphyrio (purple swamp hen), *Manorina melanocephala* (noisy minor) and *Platalea regia* (royal spoonbill). Habitat consistent with this area is depicted in photos 3-3.

Area 2

The Horton Park Golf Course provided habitat for a variety of native fauna mainly common birds such as *Trichoglossus haematodus* (rainbow lorikeet), *Trichoglossus Chlorolepidotus* (scaly-breasted lorikeet), *Manorina melanocephala* (noisy minor), *Vanellus miles* (masked lapwing) and *Haliastur sphenurus* (whistling kite). Notable fauna observations included *Todiramphus macleayii* (forest kingfisher), *Sphecotheres viridis* (figbird) and *Varanus varius* (lace monitor) within a stand of paperbark at the southern limit of the golf course. Large flocks of *Cacatua sanguinea* (little corella) and *Chenonetta jubata* (Australian wood duck) were also observed foraging in the open paddocks immediately south of the golf course.

Stands of vegetation flanking fairways throughout the golf course were frequently utilised by birds in particular some one hundred *Threskiornis molucca* (Australian white ibis) which utilises a stand of Norfolk pines as a nocturnal roost site (Pat Frawley.,2007, pers.comm).

Tannin-stained paperbark waterholes were common throughout the golf course with some being well vegetated with sedges and reeds along with having a good fringing ground cover. Some of these water bodies were considered to potentially provide habitat for a range of state and/or Commonwealth listed amphibians. In addition, the existence of a small tidal channel flanked by mangroves and linked to Cornmeal Creek, provided breeding habitat for a range of marine species such as fish and crabs. This area also contains numerous large *Eucalyptus robusta* suitable for roosting bird species. Habitat consistent with this area is depicted in photos 3-3.

Area 3

This remnant block of vegetation was considered to be in good ecological condition and contained a range of available habitats for a diverse range of fauna species. Large hollow bearing trees, *Corymbia intermedia* and *Eucalyptus tereticornis* were observed in the area along with large dead stags potentially providing nesting and roosting resources for owls, gliders and insectivorous bats. Vegetation complexity was diverse with regular sightings of small passerine birds such as *Malurus lamberti* (variegated fairy wren) and *Colluricincla harmonica* (grey shrike thrush). The dense lower vegetation stratum and open canopy was considered to potentially favour raptors such as *Accipiter novaehollandiae* (grey goshawk).

Numerous fallen logs and undergrowth provided additional habitat for reptile and ground dwelling mammals, and flowering species such as Eucalypts and Melaleucas provide a potential food source for birds and flying foxes. The dense low lying areas in western half of the block which contained emergent *E. tereticornis* and a dense *Livistonia australis* mid stratum was considered potential habitat for state and/or Commonwealth listed amphibians.

Notable species recorded in this area included *Monarcha melanopsis* (black faced monarch), *Dicrurus bracteatus* (spangled drongo), *Psopodes olivaceus* (Eastern whipbird) and *Meliphaga lewinii* (Lewin's honeyeater). Two fresh burrow systems were also observed in this area and are considered more than likely to be fox dens. Habitat consistent with this area is depicted in photos 3-3.

The field reconnaissance identified potential habitat in the study area for 14 of the 31 rare and threatened fauna species identified in the desktop review.

3.3.3 Description of aquatic habitat

There are a number of watercourses that may potentially be affected by the proposed realignment. Of these, the Eastern arm of Cornmeal Creek (a small, urban tidal creek) is the most natural and substantial. The other watercourses include water traps and irrigation storages within the Horton Park Golf Course.

Cornmeal Creek

Cornmeal Creek is a small tidal inlet that joins the Maroochy River at the southern end of South Channel. It is a substantially modified urban system, its entire length within residential and commercial precincts and/or as well as the Horton Park Golf Course. Approximately 500 m upstream of its confluence with the Maroochy River estuary, Cornmeal Creek passes beneath a substantial shopping centre, Sunshine Plaza. The creek forks at this point. The

western arm of the creek skirts the plaza car park before terminating approximately 500 m upstream of the plaza. The remaining arm passes south easterly through the Horton Park Golf Course and suburban Maroochydore, before forking again. The longest thread terminates some 1,950 m upstream of the plaza.

Field observations

The eastern arm passes through a residential area and has been substantially modified through straightening and concrete lining for a large proportion of the upper reaches, with numerous purpose built urban stormwater discharge points. The riparian strip is comprised largely of mown lawns with no shrubs, or trees. The site inspection was performed at low tide following a period of low rainfall; hence there was the merest trickle of water present within the concreted portions of the creek. Very little flow was evident at the stormwater discharge points, though a green biofilm on all wet concrete surfaces suggested high nutrient concentrations. This is not uncommon in a setting such as this and is not necessarily indicative of a nutrient loading problem, as the flows were particularly low. As a result of the degree of modification, this reach of the creek would have little, if any, ecological value.

Between Maud St and Plaza Parade the eastern arm of the creek passes through the Horton Park Golf Club. In this reach the bed of the creek is largely unmodified, with a predominantly muddy substrate, and is typically less than 40 cm deep at low tide. The riparian zone along this reach is sparse and only a few metres wide. Some remnant mangrove and other riparian vegetation provide shading of the water, whilst the roots and pneumatophores that were visible at low tide would provide habitat and would stabilise the banks during higher flow events. A number of small bridges facilitate the movement of foot traffic and golf buggies, but do not appear to impact nor benefit the creek. Bream (*Acanthopagrus australis*), smooth toadfish (*Tetractenos glaber*) and sea mullet (*Mugil cephalus*) were observed in this reach.

The confluence of the eastern and western arms of the creek occurs immediately above Sunshine Plaza, the creek widening and deepening slightly, though the substrate is still predominantly mud. The creek is flanked by car parks and the commercial precinct. Stream banks along the western arm have clearly contributed sediment to the creek in the past and have been the focus of revegetation and sediment management (silt 5 curtain) projects. Floating booms have been deployed in this area to trap gross pollutants. The pylons of the plaza are oyster encrusted, and combined with the water shading effects of the buildings, may provide good artificial habitat for a number of estuarine fish and invertebrate species.

Below the plaza the creek deepens further. The banks have been modified, having been lined with rock for much of their length. The surrounding land use is commercial, and there are a number of road crossings. The rock lined banks are likely to provide some habitat for estuarine species.

The overall impression of the creek is of a system that is largely dominated by tidal influences during periods of relatively low rainfall. However, it is likely that significant flushes of low salinity urban stormwater occur during and immediately after heavy rainfall events. There is some potential that these flushes carry significant nutrient loads to the Maroochy Estuary.

Small tidal creeks of this nature are ecologically very important, providing habitat and spawning opportunities for a wide range of marine and estuarine species. However, in the case of Cornmeal Creek only the lower 1,600m of creek would perform these functions, the reaches above being too heavily modified to be of value. Within the lower sections of creek,

habitat values have been substantially modified from natural conditions. By comparison to Petrie and Eudlo Creeks and the Maroochy Wetlands, Cornmeal Creek would provide a very small proportion of the estuarine habitat available to biota within the Maroochy Estuary system.

Other waterways

There are a number of small water courses within the Horton Park Golf Course, including water traps and irrigation supplies. It is not known whether these are natural low lying areas, or were created during development of the course. No data are available on the water quality or biological communities within these systems, though the presence of lilies and other vegetation associated with freshwater systems infers that they are relatively low in salinity. These ponds are typically shallow, endorheic (fed by catchment run-off, without any outflow) systems, whose ecological value is unknown but likely to be limited by adjacent land use (i.e. the golf course and urban development generally).

3.3.4 Desktop review

As part of determining the environmental values of the study area, an array of state and Commonwealth database searches along with various online state government mapping resources were reviewed. These are listed below:

- Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) Protected Matters Search Tool
- Queensland Parks and Wildlife Service WildNet database
- Queensland Herbarium HERBRECS and CORVEG databases
- Queensland Museum database
- Birds Australia Atlas of Australian Birds database
- Department of Environment and Resource Management (DERM) Regional Ecosystem (RE) mapping (Version 5.2, 2006)
- DERM Essential Habitat mapping (2006)
- Department of Employment, Economic Development and Innovation Coastal Habitat Resources Information System (CHRIS)
- The Nature Conservation Koala Conservation Plan 2006 (KCP) Koala habitat mapping for the then Maroochy Shire.

All database searches and mapping were undertaken for a predetermined grid search area in order to capture relevant species information about the study area (Latitude 26.65457^{o}S to -26.671933^{o}S and Longitude 153.071524^{o}E to 153.094073^{o}E).

3.3.5 Field reconnaissance

A field reconnaissance of the study area was undertaken by two PB ecologists on Thursday, 12 April 2007 and then again by a PB environmental scientist on Thursday, 4 October 2007. The reconnaissance aimed to validate potential ecological constraints identified by the desktop review with regard to the development of the site for proposed rail alignments and station footprints. The rail alignments and station locations are shown in Figure 3-4.

Figure 3-4: Proposed rail alignments and station locations

3.3.6 Results

Desktop review

Flora

Flora database searches indicate the potential for 24 rare and threatened flora species to occur in the grid search area. These species are protected under state and/or Commonwealth legislation. DERM RE mapping also identified three RE's potentially occurring in the study area. The three RE's have a 'not of concern' or 'of concern' conservation status under the Queensland *Vegetation Management Act 1999* (VM Act). A description of these three RE's and their corresponding state and Commonwealth conservation status is listed in Table 3-2. No threatened ecological communities protected under the EPBC Act were identified in the grid search area. The CHRIS did not identify any areas of mapped coastal wetlands; seagrass watch sites, aquaculture sites or habitat protection areas in the study area.

All flora species of conservation significance identified through the desktop review along with an assessment of their likelihood in the study area is presented in Appendix B. Due to the extensive number of database records a full list has not been presented, however these records can be obtained from PB upon request.

Table 3-2: DERM regional ecosystems mapped to occur within the study area

RE Code	RE Description	VM Act	DERM Biodiversity	EPBC Act
12.3.5	*Melaleuca quinquenervia* open forest on coastal alluvium.	Not of concern	Of concern	Not listed
12.9-10.1	Shrubby open forest often with *Eucalyptus resinifera, E. grandis, Corymbia intermedia* on sedimentary rocks. Coastal	Of concern	Of concern	Not listed
12.3.13	Closed heathland on seasonally waterlogged alluvial plains usually near coast.	Of concern	Of concern	Not listed

Note: Each RE is attributed a vegetation management status under the *Vegetation Management Act* 1999 as well as a biodiversity status by the DERM. The vegetation management status for each RE is assigned as one of three categories: 'endangered', 'of concern' and 'not of concern' according to its current distribution relative to its pre-clearing distribution. The DERM's biodiversity status for each RE is assigned as either 'endangered', 'of concern' or 'no concern at present' and is based on the condition of the vegetation in addition to its current and pre-clearing distribution.

Fauna

Fauna database searches indicated the potential for 31 rare and threatened fauna species to occur in the grid search area. These species are protected under state and/or Commonwealth legislation. Essential habitat mapping prepared by the DEM is present throughout the study area represented as RE's 12.3.5 and 12.3.13. Essential habitat is mapped for *Crinia tinnula* (wallum froglet), *Litoria freycineti* (wallum rocket frog) and *Litoria olongburensis* (wallum sedge frog). These species are listed under the *Nature Conservation Regulation* 2006 and all have a conservation status of 'vulnerable'.

The CHRIS did not identify any areas of mapped coastal wetlands or fish habitat areas. The Protected Matters Search identified an additional 32 migratory species to potentially occur in the search area. Migratory species comprised 21 birds, 7 mammals and 4 reptiles. Thirty three species (the majority also listed as migratory) are also listed marine species comprising birds, mammals, ray finned fishes and reptiles. Twelve of the thirty three listed marine species were whales and other cetaceans and are not discussed further. No koala habitat was mapped for the study area under the KCP.

All fauna species of conservation significance identified through the desktop review along with an assessment of their likelihood in the study area is presented in Appendix B. Due to the extensive number of database records a full list has not presented, however these records can be obtained from PB upon request.

Field reconnaissance

The purpose of the field reconnaissance was to assess the presence of remnant vegetation and associated likelihood of threatened flora and fauna species to occur within the proposed corridor footprints. The survey site was divided into three distinct survey areas based on present land-use and current ecological condition. These areas can be defined as follows and are shown on Figure 3-5:

- **Area A** – Highly disturbed area associated with construction activities. This area includes riparian vegetation associated with Dalton Lake adjacent the Sunshine Coast Motorway
- **Area B** – Horton Park Golf Course
- **Area C**– Remnant vegetation alongside the Sunshine Motorway.

Flora observations

The following flora observations were noted for each of the three areas.

Area A

The majority of vegetation observed is highly disturbed and modified and consists of planted or regrowth native species, a variety of exotic weed taxa and a cover crop of predominantly exotic grass species seeded to aid erosion and sediment control. The only significant remaining vegetation in this area consists of a thin (20 m) strip of revegetation fringing Dalton Lake. This area is dominated by planted casuarina, callistemon and melaleuca species that are functioning as an effective screen between the motorway and adjacent residences. Nearby construction work has impacted on a significant proportion of the vegetation in this area, leaving the majority of the site devoid of vegetation. The Queensland Herbarium has mapped this area as being covered with remnant vegetation (RE's 12.9-10.1 and 12.3.5) however much of this has now been cleared and is unlikely to be considered remnant vegetation. Minimal potential habitat for rare or threatened flora species was observed.

Area B

The vegetation in the golf course consists predominantly of exotic grasses in the fairways with a mixture of planted exotic species, and small islands of preserved native regrowth vegetation scattered throughout the site. Whilst the canopy of these native areas retains fair ecological integrity and is indicative of vegetation that would have once occurred extensively in the area, the understorey is highly disturbed and modified. Numerous rows of the introduced pine trees *Pinus elliottii* (slash pine) and *Araucaria heterophylla* (Norfolk Island pine) exist throughout the site as well as a stand of *Callitris columellaris* (Bribie Island pine). *Eucalyptus robusta* (swamp mahogany), *Melaleuca quinquinervia* (paper bark tea tree) and the mangrove species *Avicennia marina* (grey mangrove), are present along the small tidal channel (Maud Street canal which connects with Cornmeal Creek) intersecting the site. No remnant vegetation is mapped by the Queensland Herbarium as being present within Horton Park Golf Course and the area provides limited habitat potential for rare and threatened flora species to occur.

Figure 3-5: Distinct survey areas

Area C

Vegetation observed within the small bushland remnant was determined to be of high ecological integrity and mapped by the Queensland Herbarium as RE's 12.9-10.1 and 12.3.5. This area contains generally high diversity of native species, native recruitment and exotic weed invasion limited to disturbed edges. The RE 12.9-10.1 canopy is dominated by *Corymbia intermedia* (pink bloodwood) and *Eucalyptus tereticornis* (forest red gum), whilst RE 12.3.5 consists of large stands of *Livistona australis* (cabbage tree palm), *Eucalyptus*

robusta (swamp stringy bark) and *Eucalyptus grandis* (flooded gum) dominate the low lying wetter areas.

Summary

With reference to known habitat preferences and observations made during the site specific studies, potential exists for 7 of the 24 rare and threatened flora species identified in the desktop review to be located within the study area, primarily within the remnant bushland located adjacent to the Sunshine Motorway. These species and likelihood of occurrence include:

▪ Acacia attenuata	no common name	Low likelihood
▪ Alyxia magnifolia	large-leaf chain fruit	Low likelihood
▪ Arthraxon hispidus	no common name	Moderate likelihood
▪ Boronia rivularis	wide bay boronia	Low likelihood
▪ Pararistolochia praevenosa	richmond birdwing vine	Moderate likelihood
▪ Phaius australis	lesser swamp-orchid	Moderate likelihood
▪ Rulingia salviifolia	sage-leaved rulingia	Moderate likelihood

Fauna observations

Area A

The predominant habitat feature of this area is the Dalton Lake and associated revegetation area. The dense ground cover within this paperbark and Casuarina woodland and its low lying nature and close proximity to the water indicate this area could potentially provide habitat for a range of fauna species including rare and threatened waterbirds and amphibians. This area was heavily disturbed due to roadworks; however the existing fringing vegetation was intact and appeared to be the result of previous revegetation works. Species recorded in this area during the brief reconnaissance included *Anas gracilis* (grey teal), *Porphyrio porphyrio* (purple swamp hen), *Manorina melanocephala* (noisy miner) and *Platalea regia* (royal spoonbill). Habitat typical of this area is depicted in Photo 3-1.

Area B

The Horton Park Golf Course provided habitat for a variety of native fauna mainly common birds such as *Trichoglossus haematodus* (rainbow lorikeet), *Trichoglossus chlorolepidotus* (scaly-breasted lorikeet), *Manorina melanocephala* (noisy miner), *Vanellus miles* (masked lapwing), *Entomyzon cyanotis* (blue-faced honeyeater), *Gymnorhina tibicen* (Australian magpie), *Corvus orru* (torresion crow), *Cacatua roseicapilla* (galah) and *Haliastur sphenurus* (whistling kite). Notable fauna observations included *Todiramphus macleayii* (forest kingfisher), *Sphecotheres viridis* (figbird) and *Varanus varius* (lace monitor) within a stand of paperbark at the southern limit of the golf course. Large flocks of *Cacatua sanguinea* (little corella) and *Chenonetta jubata* (Australian wood duck) were also observed foraging in the open paddocks immediately south of the golf course. One (deceased) specimen of *Pteropus poliocephalus* (grey headed flying fox) was noted in powerlines adjacent to vegetation along the drain to the rear of Carnaby Street.

Stands of vegetation flanking fairways throughout the golf course were frequently utilised by birds in particular dozens of *Threskiornis molucca* (Australian white ibis) which utilise a stand

of slash pines as a nocturnal roost site (Pat Frawley (Horton Park Golf Course).,2007, pers.comm).

Tannin-stained paperbark waterholes were common throughout the golf course with some being well vegetated with sedges and reeds. Some of these water bodies were considered to potentially provide habitat for a range of state and/or Commonwealth listed amphibians. Habitat typical of this area is depicted in Photo 3-2.

In addition, the existence of a small tidal channel flanked by mangroves and linked to Cornmeal Creek, provided breeding habitat for a range of marine species such as fish and crabs. This area contains numerous large *Eucalyptus robusta* (swamp mahogany) suitable for roosting bird species.

Area C

The remnant block of vegetation within the proposed corridor was considered to be in good ecological condition and contained a range of available habitats for a diverse range of fauna species. Large hollow bearing trees, pink bloodwood and Queensland blue gum were observed in the area along with large dead stags potentially providing nesting and roosting resources for owls, gliders and insectivorous bats. Vegetation complexity was diverse with regular sightings of small passerine birds such as *Malurus lamberti* (variegated fairy wren) and *Colluricincla harmonica* (grey shrike thrush). The dense lower vegetation stratum and open canopy was considered to potentially favour raptors such as *Accipiter novaehollandiae* (grey goshawk).

Numerous fallen logs and undergrowth provided additional habitat for reptile and ground dwelling mammals, and flowering species such as eucalypts and melaleucas provide a potential food source for birds and flying foxes. The dense low lying areas in the western half of the remnant area which contained emergent Queensland blue gum and a dense cabbage tree palm mid-stratum is considered potential habitat for state and/or Commonwealth listed amphibians.

Notable species recorded in this area included *Monarcha melanopsis* (black faced monarch), *Dicrurus bracteatus* (spangled drongo), *Psopodes olivaceus* (Eastern whipbird) and *Meliphaga lewinii* (Lewin's honeyeater). Two fresh burrow systems were also observed in this area and are considered more than likely to be fox dens. Habitat typical of the drier habitats within this area is depicted in Photo 3-3.

Summary

With reference to known habitat preferences and observations made during the site specific studies, potential exists for 14 of the 31 rare and threatened fauna species identified in the desktop review to be located within the study area, primarily within the remnant bushland located adjacent to the Sunshine Motorway. These species include:

- Acanthophis antarcticus — common death adder
- Accipiter novaehollandiae — grey goshawk
- Adelotus brevis — tusked frog
- Coeranoscincus reticulates — three-toed snake-toothed skink
- Eroticoscincus graciloides — elf skink

▪ Erthrotriochris radiatus	red goshawk
▪ Litoria freycineti	wallum rocket frog
▪ Litoria olongburensis	wallum sedge frog
▪ Ophioscincus truncatus	short limbed snake skink
▪ Phascolarctos cinereus	Koala
▪ Pteropus poliocephalus	grey-headed flying-fox
▪ Ramphotyphlops silvia	no common name
▪ Rostratula australis	Australian painted snipe
▪ Sterna albifrons	little tern

Photo 3-1: Habitat typical of Area A

Photo 3-2: Habitat typical of Area B

Photo 3-3: Habitat typical of Area C

3.4 Geotechnical setting

3.4.1 Geology

Geological conditions will impact on design, construction and maintenance costs of the rail line.

Reference to the Geological Survey of Queensland 1:100 000 Geological Map of Caloundra indicate that the proposed rail corridor is underlain by the following geological units:

- Qps – Pleistocene age tidal delta sediments comprising sand, minor clay and mud
- Qe – Pleistocene to Holocene age old estuarine and lagoonal deposits comprising clay, mud and minor sand.

The spatial distribution of the identified units is shown on Figure 3-6. The boundary between the tidal delta and estuarine sediments in the area of the proposed rail corridor is uncertain and is anticipated to be poorly defined with frequent interbedded sediments from both units.

3.4.2 Topography and geomorphology

Reference to various published topographic maps indicates that approximately 1km of the proposed Carnaby Street alignment traverses previously filled areas within the Horton Park Golf Course. The approximate length of filled area along the alignment is about 600 m and along the Caboolture to Maroochydore Corridor Study alignment is about 200 m near Southern Street.

A short, approximately 200 m long, south-western section of all three proposed rail alignments near Maroochy Boulevard crosses flat, low lying swampy terrain that is frequently subject to flooding and is poorly drained. This topographic low area is likely to be underlain by estuarine and lagoonal sediments with a thin, surficial alluvial layer. The area is covered by an isolated patch of trees, grass and reeds. Surface level (RL) of the swamp area is estimated to be about 1.5 m to 2.5 m above Australian Height Datum (AHD) and the RL of the HPGC is generally around 3.0 m to 3.5 m AHD.

Currently perimeter drains provide drainage for the golf course area. Original drainage pattern of the area is unknown however based on localised topographic features it is likely that former drainage lines were northward trending and the area drained into Cornmeal Creek. Surface drains in the area are possibly tidally influenced via Cornmeal Creek.

Previous studies (Caboolture to Maroochydore Corridor Study, 2001) indicated that groundwater levels in the area are generally shallow, and at times reached the surface, therefore interacted with surface water. Groundwater levels in the proposed corridor area expected to be similar, within 0.5 m to 1.5 m and seasonally at lesser depths. The shallow aquifers may be separated by, and possibly perched, where indurated sand layers (coffee rock) exist in sandy podsolic soils.

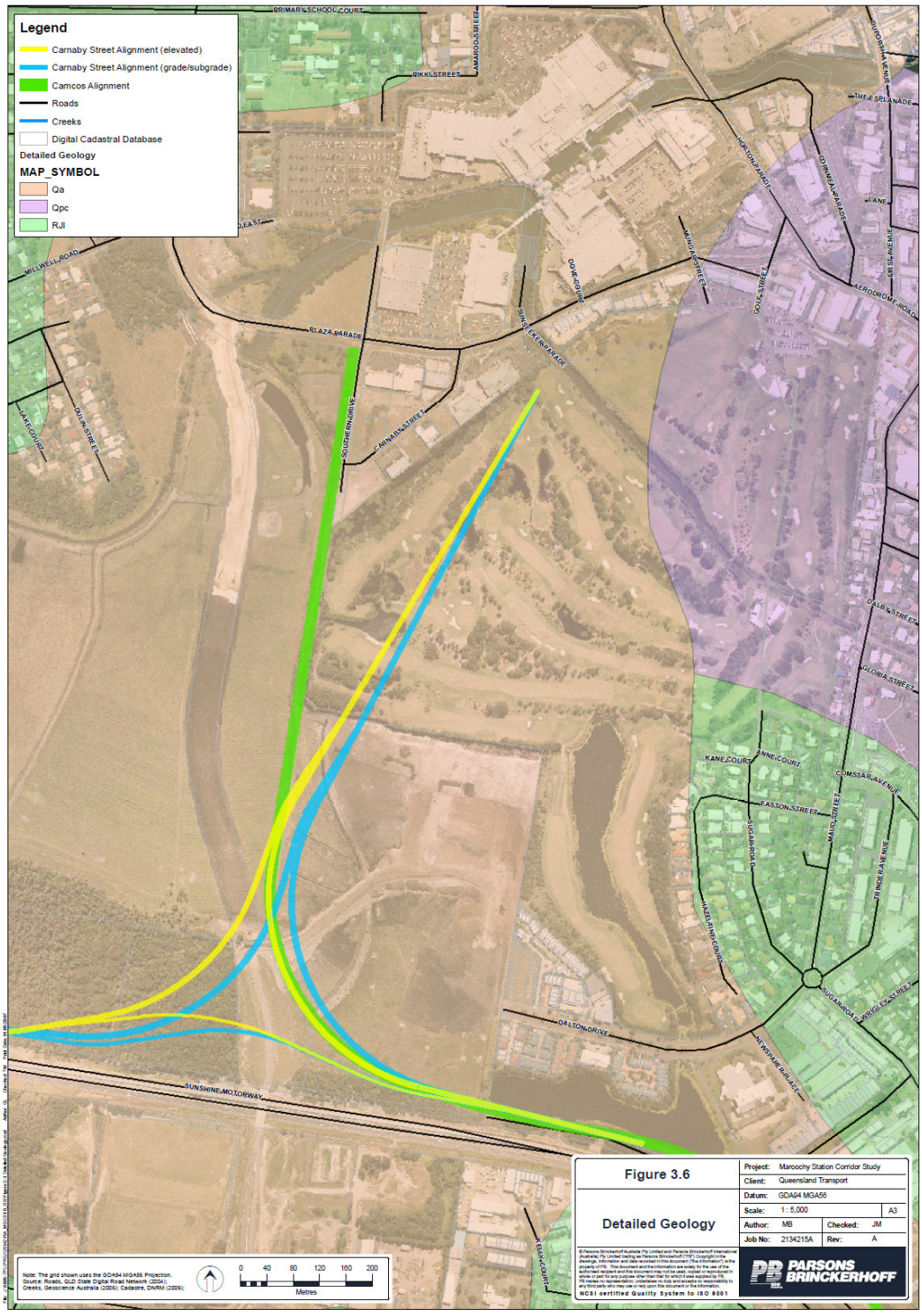


Figure 3-6: Detailed geology

3.4.3 Soils

Soils along the proposed alignments have been determined with reference to the Atlas of Soils (Qld) available as Interactive Resource and Tenure Maps located on the Department of Environment and Resource Management website link (http://www.nrw.qld.gov.au/science/slr/index.html). It is stressed that the mapped units in the Atlas are soil landscapes and that each soil landscape typically comprises a number – usually more than one – of soil types. Additional information regarding soils in the area was collected from borehole data in the QASITT report on Acid Sulfate Soil Mapping (2002).

Soil types and soil landscapes along the alignment were reviewed to assess their environmental significance, potential rates of erosion as a result of disturbance and their potential for use in rehabilitation of disturbed surfaces.

The Atlas of Soils indicates that only one soil landscape occurs along the alignment. The soil landscape and its associated geomorphologic unit are described in Table 3-3.

Table 3-3: Soil landscape description

Code	Soil landscape /geomorphology	Description
MF4	Flat to very gently undulating coastal plain less than 25 ft above sea level with a few low planated sandstone hills.	Chief soils are deep non cracking, acidic grey friable clays. Associated are pale and yellow duplex soils. Small areas of other non calcareous gradational soils occur on stream levees and terraces – some have clay D horizons below the solum; and yellow duplex soil on the sandstone areas.

The QASITT report (2002) indicated the presence of podsolic soils, Vertosol and Hydrosol in the area. This report is based on actual borehole data and therefore is considered a more reliable description of soils on, and surrounding the site.

3.4.4 Soil erosion

Soil erosion is likely to occur in any location where soils are exposed through clearance of vegetation and/or removal of hard surfaces. Erosion potential of soils during construction is generally increased due to the clearing of vegetation, unless appropriate erosion control measures are considered and implemented at the design and construction phase.

Sandy and loamy Podsol soils, Hydrosols and similar duplex sandy soils encountered in the area have the greatest erosion potential. The surface soils have low cohesion and are generally held together by the rootlets of grasses. Once vegetation is removed or disturbed, surface soils are prone to erosion by both flowing water and wind. These soils are also prone to erosion when spread on new earth structures and before re-establishment of vegetation.

Vertosols and other clayey soils are less prone to erosion when disturbed. However, they generally have low workability and trafficability when wet.

3.4.5 Acid sulfate soils

Preliminary desk-top study was undertaken to assess the potential of acid sulfate soils (ASS) occurring along the propose rail corridor.

The proportion of the alignment potentially affected by acid sulphate soils was estimated from the 1:25 000 map of Acid Sulphate Soils, Maroochy Caloundra Acid Sulphate – Sustainable Land Management Project Map 2 (QASSIT, 2002) shown on Figure 5-1.

Existing data indicates that the area is likely to contain both actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS).

Management of the ASS will need to be an important consideration in the design and construction of the proposed rail.

The ASS is expected to be associated mainly with the Pleistocene to Holocene age estuarine sediments but they may be present in the older tidal delta sediments.

Detailed ASS investigation will have to be carried out to determine the lateral extent and severity of the ASS. Preparation of an ASS Environmental Management Plan is likely to be required.

3.4.6 Hydrology

The John Wilson and Partners report (JWP 2007) on the existing catchment conditions of Maroochy CBD provides an outline of likely existing flooding results from their 2D hydraulic modelling (MIKEFLOOD software). The report looked at existing conditions, incorporating digital terrain data, roads and culverts for current and approved development.

Further hydraulic modelling is currently underway by JWP in regards to future possible development scenarios (pers. comms., Damien McGarry, 12 September 2007) and have not been provided for analysis in this report. The proposed development scenario at Horton Park is likely but has yet to be confirmed. This would impact on the current floodplain storage capacity of the Horton Golf Park, as the current model assumes existing terrain and surface roughness based on open space conditions. The future development scenario is expected to be raised above the Q100 ARI level (~3 m AHD) and fully developed (i.e. paved surface conditions).

PB is unaware of potential mitigation measures modelled to offset the development impacts, such as providing additional flood storage or stormwater run-off attenuation, but has assumed that this development will be carried out and Council's requirements will be met in terms of floodplain development. The elevation of the development will impact less on the rail alignment. Therefore, building the rail alignment within the existing conditions is considered to be worst case, based on current level of knowledge of other development scenarios. A review of the post-development model is required to confirm these assumptions.

JWP existing conditions results

The Interim Existing Conditions (JWP, 2007) report incorporates the entire Maroochy CBD, of which, Horton Park and surrounding areas are centrally located. The Cornmeal Creek catchment area incorporates a floodplain that is relatively flat and contains un-defined flowpaths. Cornmeal Creek itself flows in north-east direction into the mouth of the Maroochy River just downstream of the Maroochy Shire Council and is subject to tidal influence (JWP,

2007). Refer to Figure 1 in Appendix D for the locality map extracted from the JWP report (2007).

Existing waterways that may impact on or be impacted by the rail alignment options and were included in the model are:

- Horton Park channel
- Christadale channel
- Dalton channel
- Maud Street canal
- possibly Cornmeal Creek
- various weirs, bridges and culverts modelled by JWP exist in the area of the alignments and may also impact or be impacted by the alignments. These are depicted in Figure 4 of the JWP (2007) report (see Appendix D).

The JWP model undertook a range of design events (i.e. Q2 to Q100 and PMF), focusing mainly on duration independent storm (DIS) average return interval (ARI) events. A constant downstream water level was incorporated in the hydraulic model as the tailwater boundary condition, equivalent to the mean high water springs (MHWS) of Maroochy River at Picnic Point. This was obtained from the Semidiurnal Tidal Planes 2007 published by Maritime Safety Queensland. For the purposes of this report, only the Q100 ARI event has been discussed.

Analysis by JWP (2007) predicted that Maroochy Boulevard (see Figure 1 in Appendix D) divides the catchment into eastern and western sub-catchments. The overland flow from the western side discharges into the Wises Development Lake system, where they are attenuated by the lake. The eastern sub-catchment flood waters discharge into the lake systems at Dalton Drive and Horton Golf Park and flow into Maud Street canal. Additionally, the flood levels in these areas that are also bounded by the Sunshine Motorway are generally 3 m AHD in a Q100 ARI event due to flat terrain.

Table 3-4 presents extracts from the JWP published results (2007) and the respective reporting points are depicted in Figure 8 of Appendix D.

Table 3-4: Flood levels (m AHD) from JWP (2007) MIKEFLOOD model of existing catchment conditions of Maroochy CBD.

Reporting point	Flood level (m AHD)	Description of location
14	2.79	Near location of siding yard
19	3.02	Section of rail alignment options which adjoins rail connection to Caboolture
26	3.07	
28	3.03	Horton Park
29	2.8	Connection between Maroochy Blvd and Dalton Dr
30	2.71	Maroochy Blvd, near Carnaby St
35	2.69	Carnaby St adjacent to Horton Park
36	2.14	Maud Street canal adjacent to Horton Park
37	2.99	Horton Park

The JWP (2007) report also presented RAFTS hydrologic modelling results and indicated that a Q100 ARI event would produce a flood volume of 3,099 ML, a peak discharge of 299 m^3/s and requiring 6.5 hr to peak.

4. Corridor options

4.1 Operational assumptions

The level of service to be provided on the Caboolture to Maroochydore Corridor Study Line is yet to be determined. This decision is unlikely to be taken until the line is under construction and detailed operational planning underway.

For the purposes of the Maroochydore Station Corridor Study it is necessary to consider different levels of service that might be provided. This information is needed not only for any patronage modelling work, but also for such matters as air quality, noise impacts, and of course track requirements.

4.1.1 Service options

Based on current standards in Brisbane as well as Australian best practice, the following four service patterns are used as standards for analysis.

1. Regional Service.
2. Basic suburban service (with our without airport service).
3. Extended suburban service (with or without airport service).
4. Urban Service (with airport service).

Table 4-1: Service options for Maroochydore line

Option	Description	Route	Peak headway	Inter-peak headway	Night/Weekend headway
1	Regional	MCY-BNE	30	60	60-120
2a	Basic Suburban	MCY-BNE	15	30	30
2b	Basic Suburban	APT-MCY-BNE	15	30	30
3a	Enhanced Suburban	MCY-BNE	15	15	30
3b	Enhanced Suburban	APT-MCY-BNE	15	15	30
4	Urban	APT-MCY-CAL	10	15	15
		MCY-BNE (express)	20	30	30

These options are described in more detail below.

Regional service

This is the minimum level of service that might reasonably be applied to the Maroochydore Line. It is a level of service similar to that provided to regional commuter destinations in Victoria (e.g. Geelong, Ballarat and Latrobe Valley lines) and New South Wales (Blue Mountains/Katoomba and Southern Highlands/Moss Vale lines)

The basic service allowance is every half hour during peak hours and hourly during the off peak. This service will operate from Maroochydore to Brisbane stopping all stations between Maroochydore and Caboolture.

Basic suburban service

The basic suburban service is that provided as the standard service on the current QR CityTrain network (and is also that found in Adelaide).

The basic service allowance is every 15 minutes during peak hours and half-hourly during the off-peak.

Depending on whether or not the Maroochydore – Sunshine Coast Airport sector is constructed, services will either be Maroochydore – Brisbane or Airport – Maroochydore – Brisbane, stopping all stations between Maroochydore and Caboolture.

Enhanced suburban service

This is the level of service that is provided as the base level of service for suburban lines in Melbourne, Sydney and Perth. Generally speaking, it is also the minimum level of service necessary to attract people out of their cars in a suburban environment.

The basic service allowance is every 15 minutes throughout the day, with extra services during the peak, and dropping back to 30 minutes at night and on Sundays.

Once again, depending on whether or not the Maroochydore – Sunshine Coast Airport sector is constructed, services will either be Maroochydore – Brisbane or Airport – Maroochydore – Brisbane, stopping all stations between Maroochydore and Caboolture.

Urban service

Currently in Brisbane, a true 'urban' level of service is only found in the immediate inner city (e.g. South Bank – Eagle Junction) part of the QR network. The key feature of an urban service is a 'turn up and go' frequency, which means a maximum headway of 10 minutes (although 5 minutes is desirable and many true urban services are more frequent still).

While it is extremely unlikely the Sunshine Coast will ever need, say, 90 second headways as found on the London Underground, it is not unreasonable to consider an enhanced service level for at least the core Maroochydore – Caloundra sector.

For the purposes of this study consideration was given to the implications of overlaying a reasonably frequent stopping service on the Airport-Maroochydore-Caloundra core sector with regular Maroochydore-Brisbane express service (e.g. stopping at Mooloolaba and Caloundra only). We assume that the stopping service would be every 10 minutes during peak hours and 15 minutes in the off peak, while the express service would run every 20 minutes during the peak and 30 minutes during the off-peak. This does not consider the proposed Creekside and Caloundra South District stations, with major park and ride facilities, which were not planned in any detail at the time this work was done.

4.1.2 Technical implications

In order to evaluate train operations at a feasibility level for the varied scenarios described above, several key assumptions have been made. These are as follows:

- typical train acceleration rate of 0.3 m/s^2
- typical train deceleration rate of -0.5 m/s^2

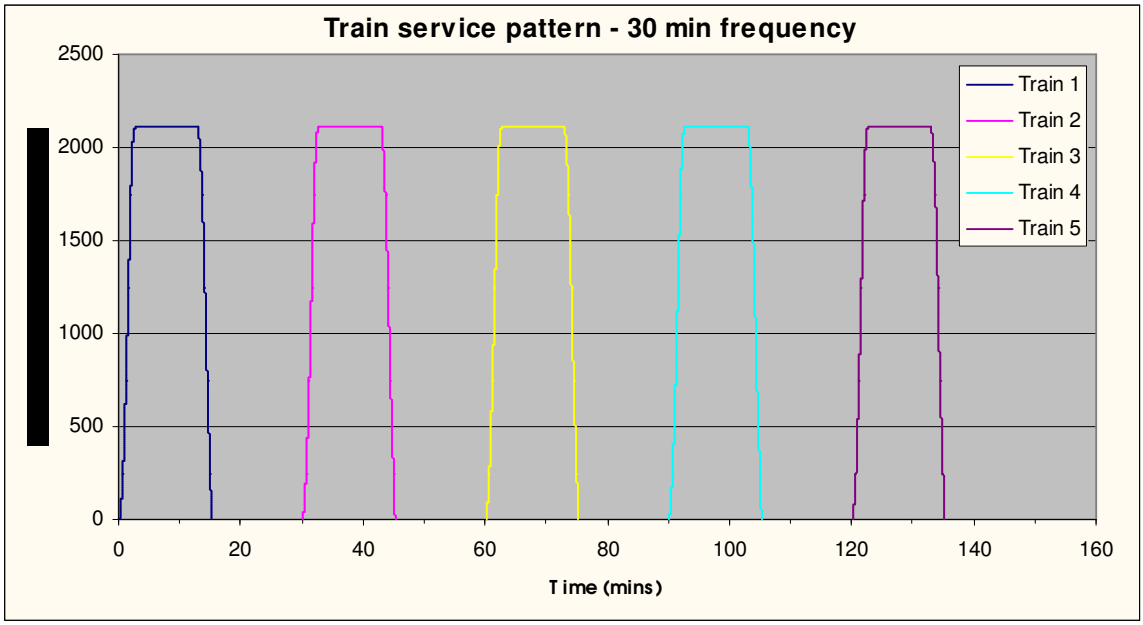
- trains enter section from a standstill (e.g. a red signal) and depart at 60 km/h
- due to its short length, the line speed for the straight section of track leading up to Maroochydore station has been assumed to be 80 km/h
- the curved section of track leading into the Maroochydore spur line has been assumed to be 60 km/h.

Regional service

Basic half hourly service patterns can be achieved on the Maroochydore spur line with a very simple single line, single platform layout, due to the brief journey times in and out of the section. However, this will leave the service vulnerable to train failure.

This option would require minimal signalling and minimal maintenance.

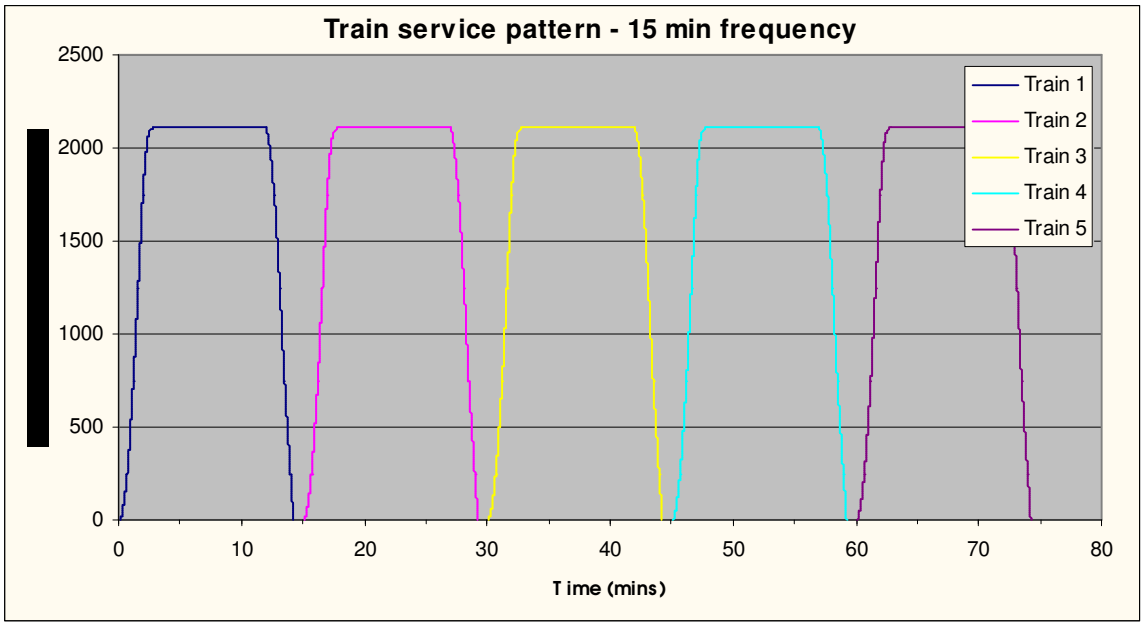
Below is a sample service pattern diagram for peak hour running, with trains stopping at Maroochy station for 10 minutes.



Basic suburban service

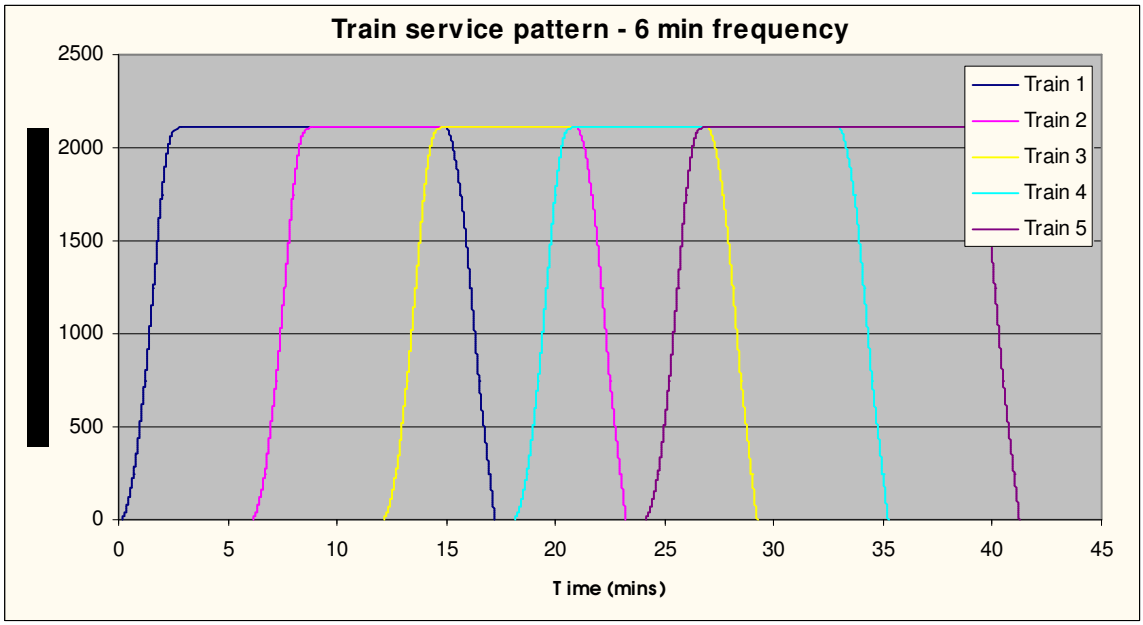
As above, it is still possible to run a basic 15 minute service during peak times with a single track, single platform arrangement. However, the time trains are held at the platform would need to be reduced to 9 minutes and the margin for delay would be substantially reduced. This means that any train delayed at Maroochydore station would be likely to have a knock on effect on the next service, which would in turn delay the next service etc. For this reason it would be preferable to have a two track, two platform arrangement and allow flexibility of service. This would also allow a greater stoppage time at the station. Two tracks would of course necessitate additional maintenance and signalling to a single track option.

The example below shows an approximate running pattern for a single track, single platform arrangement.

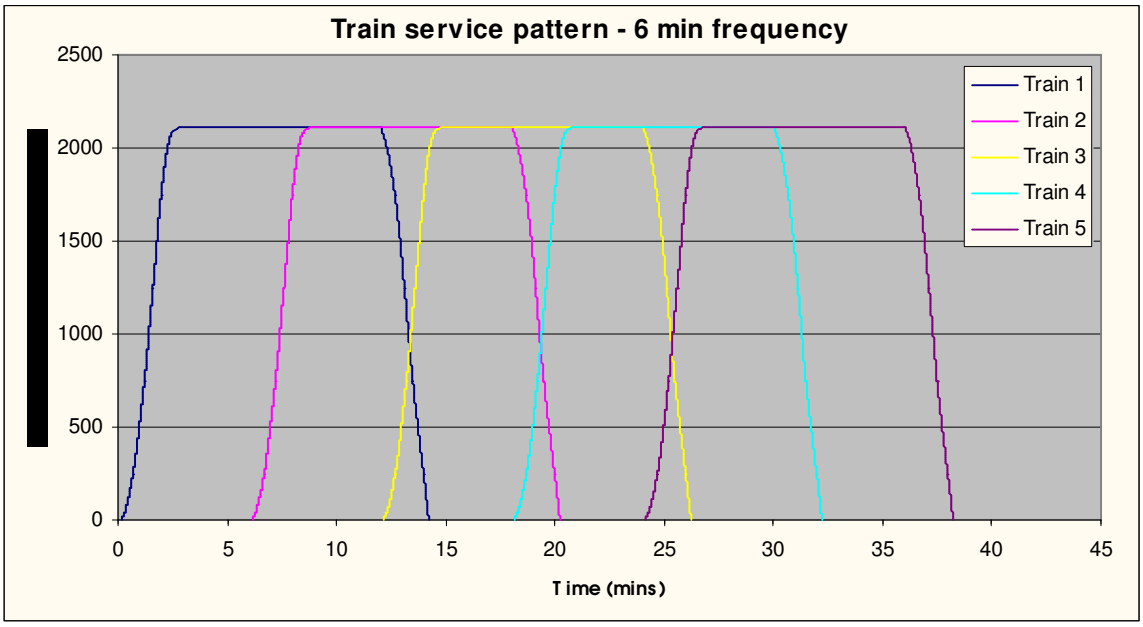


Enhanced suburban service

Running additional services during peak hours will necessitate an additional track or platform. Frequencies as low as 6 minutes can be achieved with a simple single track, triple platform arrangement although signalling would need to be more complex than the options above. The diagram below shows a typical service pattern for 6 minute departures from Maroochydore station with only a single track. Train stopping times at the station are increased to 12 minutes to allow trains to pass in the platforms and station throat area.



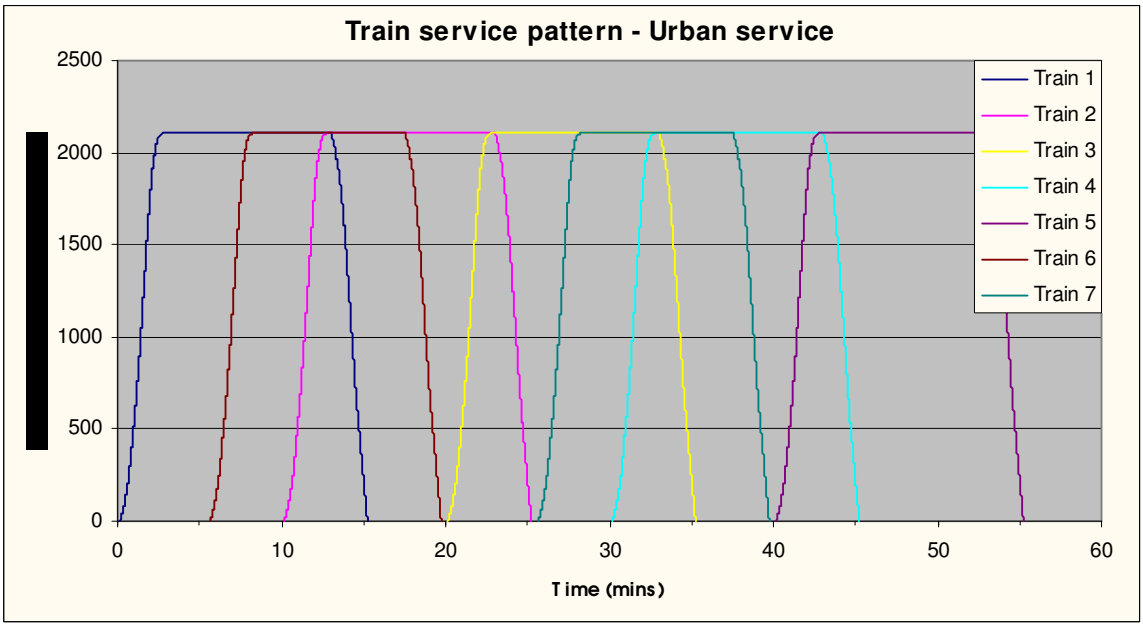
An alternative example is below, showing a running pattern utilising two tracks and two platforms.



This option would involve significantly more train movements than those above and therefore require additional track maintenance.

Urban service

The most complex of the options within this report, a 10 minute suburban/20 minute express service pattern can still be achieved with a single track, three platform option as shown below. Suburban trains would be held in the platforms for 10 minutes whilst express services would wait only 9 minutes. Again, this option carries high risk and it is recommended that a second track be provided to prevent cascading delays should there be a service failure.



Train numbers 6 and 7 represent the express services whilst the others are suburban services at 10 minute intervals.

4.1.3 Conclusion

The critical factor for train operations is the number of platforms. The number of tracks provided allows for increased reliability and flexibility.

From an operational perspective, it is recommended that the Maroochydore station be laid with two tracks and two platforms initially with scope for an extra track and platform to be constructed at a later date as train operations increase. This allows some flexibility of operations and provides some spare capacity should a train break down on the spur or in one of the platforms.

4.2 Options definition

4.2.1 Overview

Four options are considered in this report. For further information on a further 3 options, which were investigated (but which have been effectively precluded by the land use pattern endorsed by the Sunshine Coast Regional Council in their Maroochydore Centre Position Paper), see the draft Maroochydore Station Corridor Study at www.pb.com.au/maroochyscsc and www.transport.qld.gov.au/maroochystation. These vary in horizontal and vertical alignment. The options assessed in this report are summarised Table 4-2.

Table 4-2: Summary of options

Option number	Description
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')
2	Carnaby Street alignment, sub-grade
3	Carnaby Street alignment, elevated
4	Carnaby Street alignment, at-grade

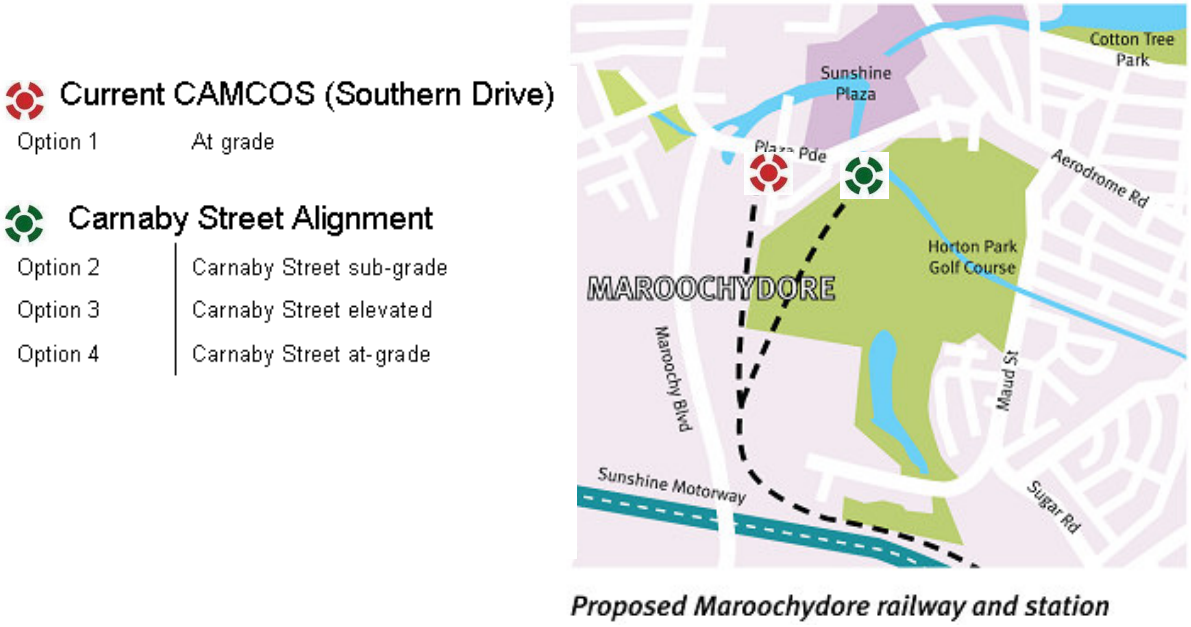


Figure 4-1: Proposed alignments

Options 2 to 4 use a new alignment through central Maroochydore to a station location near Carnaby Street immediately south of the branch of cornmeal Creek known as Maude Street

canal (Carnaby Street). By changing the alignment from the currently approved alignment, a number of changes are possible.

Maroochydore Station will be a major destination station for the Sunshine Coast and will be designed with appropriate end-of-journey facilities. These will include ticket sales/information office, public conveniences and level/lift access from platforms to street. It is also anticipated that it will be designed to integrate with the regional retail and commercial centre, incorporating direct access to shops and other commercial facilities.

Fully integrated with the railway station will be the major bus station for the region. This will incorporate loading bays for up to 8 buses, direct access to the station concourse and platforms and shared access to public facilities

Retained from the approved Caboolture to Maroochydore Corridor Study alignment are provision for tracks to the south-east (towards Brisbane) and to the north-west (towards Sunshine Coast Airport). This north-west spur has been designed to also serve potential storage sidings to be located in the area if required. It is assumed that a through-line will be retained; permitting trains to bypass Maroochydore, if this is required.

Detailed drawings of the alignments are reproduced in Appendix L.

4.2.2 Existing Caboolture to Maroochydore Corridor Study alignment

Option 1: at-grade

Option 1 is construction of a twin-track rail line along the existing approved Caboolture to Maroochydore Corridor Study alignment between the main line and a Maroochydore Station at the intersection of Southern Drive and Plaza Parade. This was the station location and configuration endorsed with the original Caboolture to Maroochydore Corridor Study investigation. It was constrained by the assumption that the Horton Park Golf Course would remain as an operating golf course.

Importantly, the current alignment is very narrow and limited space is available for a station. This has various impacts for station design and integration. These matters will be discussed further later in this report.

4.2.3 Carnaby Street

This alignment was developed based on a number of workshops with key stakeholders during July 2007, and has subsequently formed the basis of Council structure planning for the Maroochydore City Centre. It is also identified in the current Maroochydore Centre Position Paper as the Council's preferred alignment. It commences from the currently-approved alignment in the vicinity of Maroochy Boulevard and proceeds diagonally across the Horton Park site to a point adjacent to. a station on what is currently the Horton Park Golf Course near the intersection of Carnaby Street and Plaza Parade immediately to the south of the Maud Street canal.

Option 2: sub-grade option

From a Maroochydore Station with below-ground platforms (and ground-level bus station) this option continues at a depth of 9–10 m below ground level[4] in a cutting (which could be

[4] "Ground" level for the development is assumed to be 3m above AHD.

covered for building development) for approximately 650 m. At this point there is a junction, where allowance is made for two tracks turning to the north/west and proceeding under Maroochy Boulevard towards the possible sidings, while two tracks curve to the south, before rising to the surface and turning to the east, from where they then run alongside the Sunshine Motorway at an elevation of 5 m along the approved Caboolture to Maroochydore Corridor Study corridor towards Mooloolaba station and Brisbane.

Option 3: elevated option

From a Maroochydore Station with above-ground platforms (and ground-level bus station) this option continues at a height of 7 m above ground level on a monopole concrete structure for approximately 500 m. At this point there is a junction, where allowance is made for two tracks turning to the north/west and rise another 1.5 m to pass over Maroochy Boulevard towards the possible sidings, while two tracks curve to the south, descending and turning to the east, from where they then run alongside the Sunshine Motorway at an elevation of 5 m along the approved Caboolture to Maroochydore Corridor Study corridor towards Mooloolaba station and Brisbane.

Option 4: at-grade option

From a Maroochydore Station with at-grade platforms (and elevated bus station) this option continues at nominal ground level for approximately 500 m. At this point there is a junction, where allowance is made for two tracks turn to the north/west and continue under a raised Maroochy Boulevard towards the possible sidings, while two tracks curve to the south, descending and turning to the east from where they then run alongside the Sunshine Motorway at an elevation of 5 m along the approved Caboolture to Maroochydore Corridor Study corridor towards Mooloolaba station and Brisbane.

5. Impacts and analysis

5.1 Ecological impact

5.1.1 Key constraints

The following key ecological constraints were identified as a result of the desktop review and field reconnaissance.

The drainage channel that is crossed by the corridor within the Horton Park Golf Course is only a short distance (~500 m) upstream of the Maroochy River and there is potential for downstream impacts to occur as a result of the project if construction impacts are not adequately managed.

Mangroves are present along the drainage channel intersecting the northern section of the Horton Park Golf Course. Schedule 8, Table 4, item 8 of the *Integrated Planning Act* 1997 states that any disturbance to marine plants will require assessment under the *Fisheries Act* 1994.

Water bodies throughout the Horton Park Golf Course have the potential to provide habitat for state NCWR and/or EPBC Act listed amphibian species such as *Adelotus brevis* (tusked frog), *Crinia tinnula* (wallum froglet), *Litoria freycineti* (wallum rocket frog) and *Litoria olongburensis* (wallum sedge frog).

Remnant vegetation in the far south-west corner of the proposed corridor is considered to be in good condition and large enough in size to provide potential important habitat for state and/or Commonwealth listed flora and fauna species.

'Of Concern' remnant vegetation mapped within the study area must be validated through field study for the consideration of vegetation clearance approvals under the *Vegetation Management Act 1999*.

Riparian vegetation fringing Dalton Lake, alongside the Sunshine Coast Motorway, has the potential to provide important habitat for state and/or Commonwealth listed species, specifically amphibians and migratory birds.

There are likely to be locally significant habitat and feed trees for fauna species within the Horton Park Golf Course as well as a stand of pine trees which provide a nocturnal roost site for a large flock of *Threskiornis molucca* (Australian white ibis).

The ecological values identified within the study area reinforce the need for further targeted flora and fauna surveys in order to rule out the presence of species listed under the NCWR and EPBC Act at three main locations along the corridor (refer Figure 3.5):

- wetland areas in the south-east of the corridor (Area A)
- water bodies/ponded areas within the Horton Park Golf Course (Area B)
- remnant vegetation in the south-west of the corridor (Area C).

5.1.2 Option analysis

A basic comparative analysis of each of the proposed alignment (including station location) options has been conducted using certain environmental criteria which were determined through a stakeholder engagement process. These criteria consist of:

a) impact on Cornmeal Creek and other water bodies, and

b) other natural resource impact (e.g. vegetation, fauna, habitat etc).

For the purposes of comparative analysis, a basic weighting system was developed and a score assigned to each alignment option based on its expected impact on the environmental criteria outlined above and associated values which have been identified with the general study area and which have been discussed in this report. A summary table of the comparative analysis is contained below in Table 5-1. However, it should be noted that the environmental values identified in the following Table are not exhaustive and are only intended to provide an indicative analysis in this regard. As mentioned above in Chapter 4, the ecological values identified within the study area as a result of this preliminary study, reinforces the need for further targeted flora and fauna surveys in order to ascertain the presence/absence of species listed under the NCWR and EPBC Act and whether the alignment options will have any implications to same.

Table 5-1: Comparative analysis of alignment options and potential environmental impacts*

Option (from Table 3-4)	Impact Criteria				
	Impact on Cornmeal Creek and other water bodies	Impact on mapped RE's	Impact Essential Habitat values (mapped)	Impact on other identified habitat values	TOTAL
1	2	3	2	1	7
2	2	3	3	3	11
3	2	3	3	3	11
4	2	3	3	3	11

*NOTE: Score weighting: 1 = unlikely/minimal impact, 2 = moderate potential impact, 3 = high potential impact.

A number of assumptions have been made in order to conduct this options analysis including:

- due to the limited amount of detailed design information at this stage, it has been assumed that the sub-grade options will be constructed utilising the 'cut and cover' method as opposed to tunnelling due to cost associated with the latter construction method
- the elevated grade option at Carnaby Street is assumed to include both use of embankment (fill) and pylon treatments
- the width of the corridor for all alignment options is assumed to be a minimum width of 30 m.

A discussion of the results of Table 5-1 follows.

Option 1

In terms of level of impact on the identified environmental criteria, the existing Caboolture to Maroochydore Corridor Study alignment is considered to be the most benign option, as this alignment does not traverse the Horton Park Golf Course but is located within an existing significantly and recently disturbed environment with little ecological value. Further, the existing Caboolture to Maroochydore Corridor Study alignment, whilst likely to impact on Dalton Lake along the southern approach to the station, is some distance from Cornmeal Creek, thereby allowing appropriate area for implementation of appropriate erosion and sediment control through the construction period and consequently, lessening the potential direct impact to Cornmeal Creek.

However, it should be noted that the alignment of the approach to the station from the north passes through mapped regional ecosystems (conservation status 'of concern' and 'not of concern') and mapped essential habitat. Therefore, clearing of and disturbance to these areas will be required to accommodate the rail corridor. Approvals and permits pursuant to the *Vegetation Management Act 1999* may be required in this regard.

Options 2, 3 and 4

Similar to the above and given the design assumptions outlined, there is expected to be little difference in potential impacts between grade options for this particular alignment. Therefore, options 2, 3 and 4 have been considered together.

The general corridor which encompasses options 2, 3 and 4 is expected to have slightly less impact on identified environmental values and criteria than the earlier Horton Parade options no longer considered in this report. This assertion is made on the basis of the following:

- The corridor for this alignment passes through the Horton Park Golf Course terminating short of the Maud Street canal behind Carnaby Street. Therefore, this corridor will impact on habitat values identified in this area (e.g. nesting /roosting and feed trees).
- The alignment of the northern approach to the station passes through mapped remnant vegetation (conservation status 'of concern' and 'not of concern') and mapped essential habitat adjacent to the Sunshine Motorway. It should also be noted that this corridor may also impact on remnant vegetation (conservation status 'of concern') and essential habitat mapped to the south-east of the alignment (i.e. on the 'Christadale' property); however.
- The alignment is some distance from Cornmeal Creek and ceases prior to crossing the Maud Street canal which passes through the Horton Park Golf Course. Separation distances to watercourses provided by this alignment allow for an area in which to implement appropriate erosion and sediment control devices during the construction period. It should be noted however, that the southern approach to the station will impact on Dalton Lake.

Table 5-2: Option scores: impact on Cornmeal Creek

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	5
2	Carnaby Street alignment, sub-grade	5
3	Carnaby Street alignment, elevated	5
4	Carnaby Street alignment, at-grade	5

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

Table 5-3: Option scores, other natural impact

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	3
2	Carnaby Street alignment, sub-grade	3
3	Carnaby Street alignment, elevated	3
4	Carnaby Street alignment, at-grade	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.1.3 Conclusion

A desktop review and preliminary field reconnaissance of the various options proposed for the Maroochy Station Corridor was conducted in order to identify the potential for the proposed corridor options to impact on environmental values identified within and in close proximity to the study area.

A comparative analysis of seven options identified for the rail and station alignment was conducted based on a set of pre-determined environmental criteria and environmental values identified as a result site investigations. This comparative analysis indicated that the options, in order of preference are:

1. the existing Caboolture to Maroochydore Corridor Study alignment ('Southern Drive').
2. the Carnaby Street alignment (either sub-grade, at-grade or elevated grade options).

However, it should be noted that the environmental values identified as a result of site investigations and utilised in the options analysis are not exhaustive and are only intended to provide an indicative analysis in this regard. The ecological values identified within the study area as a result of this preliminary investigation, enforces the need for further targeted flora and fauna surveys in order to ascertain the presence/absence of species listed under the NCWR and EPBC Act and whether the alignment options will have any implications to same. Approval pathways such as a referral to the Commonwealth Department of Environment and Water Resources, state and local government permitting and conformance with state planning policies may also be required and further targeted studies will allow the ecological values of the area to be managed through an integrated strategic transport planning solution.

5.1.4 Impact on Cornmeal Creek

The redevelopment of Horton Park Golf Course as a major urban centre and the associated rehabilitation of the Maud Street canal will have a major impact on the aquatic environment. The railway project itself will have little additional impact, and there is only very minor difference between the options. Neither of the options directly touch the Maud Street canal feed to Cornmeal Creek.

5.1.5 Flood risk

The purpose of this assessment is to compare the rail alignments in terms of flooding, using a qualitative approach to rank the impacts on each alignment option. Due to the high level of this study, no modelling or other quantitative assessment has been carried out. The main issues and considerations when comparing the rail alignments in regards to flooding impacts are:

- location
- elevation

- flood protection
- drainage maintenance and management.

Each issue has been separately discussed below.

Location

The main factor in regards to location issues is whether the alignment falls within the floodplain. Developments are generally built with considerations of floodplain storage and subsequent mitigation measures for development infill of floodplain storage. The Sunshine Coast Regional Council's Maroochy planning scheme, based on the *Integrated Planning Act 1997*, has the purpose of regulating development by encouraging orderly and sustainable growth and provides a framework for efficient and equitable development and funding of infrastructure.

The *Strategic Plan* (Volume 2) of the *Maroochy Shire Planning Scheme* establishes the Strategic Policy to be considered in the assessment of impact assessable development. It includes Desired Environmental Outcomes, Strategic Implementation Measures and more detailed measures to address broad strategic issues across the Shire.

Section 16.4 outlines Objectives and Implementation Measures to ensure that the Stormwater Drainage and Floodprone Land Strategy provisions are undertaken, such as:

- ensuring any structure or activity is located and designed in a manner consistent with Council's Strategy on development in Floodprone Lands (section 16.4.1)
- ensuring impacts of changes in stormwater drainage characteristics does not adversely impact on State [controlled roads].

The Strategic Plan outlines the following:

> *"In addition to placing property at risk by locating within the flood plain, urban development and land filling within the flood plain can have a cumulative and adverse effect on flood levels, by obstructing flood flows and by reducing the available flood storage areas. Further, development in one part of the catchment may influence the flood regime further downstream. Such changes may include clearing of vegetation for agricultural purposes or a change in agricultural activity from grazing to cultivation. …*

Where development upstream or downstream of a State controlled road will convert land to a higher drainage impact use, a hydrology study may be required:

- to identify potential impacts of the stormwater run-off on the State controlled road; and
- to identify the measures needed to ensure the stormwater flows do not adversely affect the State controlled road by overtopping, increased afflux and stream velocities or by increased moisture penetration into the pavement or road embankments."

Mitigation measures such as creating new flood storage in close proximity to the raised land may help reduce possible inundation impacts on nearby residential development. However, a detailed hydraulic modelling study would be required to assess the mitigation measures.

Alignments outside the floodplain will have less floodplain orientated costs and issues. The larger the impact on the floodplain storage, the larger the associated mitigation costs, assuming the proposed mitigation meets Council's requirements.

Additionally, blockages of flowpaths should also be taken into account. Velocities upstream could be decreased by blockages, causing an increase in inundation time for adjacent

properties. Resizing of culverts and other cross-drainage infrastructure may be required to counter the impacts of the rail alignment. Blockages also increase flood depths and ongoing maintenance costs. Therefore, there are safety risks associated with cross-drainage on the downstream end where scour could be an issue.

Personal communications with Damien McGarry (Maroochy Shire Council, 12 September, 2007) indicated that apparent influences of a rail alignment on the hydraulics of the developed JWP model would be:

- potential loss of storage and/or conveyance through Dalton Lake and the drainage reserve leading to the Maroochy Blvd culverts
- possible extension of existing culverts that discharge from the Sunshine Motorway if a filled embankment was used for the rail line.

Analysis

The original Caboolture to Maroochydore Corridor Study alignment (option 1) is the option with the least impact to flooding. The alignment runs parallel to the floodplain, along the border of the Q100 ARI flood extent. All other alignments (options 2 to 4) pass through Horton Park, which is largely inundated by a Q100 ARI event. These will have the train station located within Horton Park, which potentially has a higher impact on flooding due to additional infill within the floodplain storage area.

In the case of future urban development at the Horton Golf Park in accordance with the Council's Maroochydore Centre Position Paper, the development will be raised above the Q100 flood extent and subsequent mitigation measures incorporated to reduce afflux to acceptable standards. Therefore, in this case, all alignments would have minimal impact on floodplain storage..

Elevation

For the Carnaby Street options passing through the floodplain and other flood storage areas, the elevation extent of the rail corridor impacts the extent of flooding. Generally, the more elevated the alignment, where it is on embankment, the larger reduction in storage and the greater the subsequent mitigation measures required. Therefore, unless constructed on structure, elevated alignments passing through flood storage areas would have a greater impact than at-grade alignments. Also, cross-drainage requirements may be larger.

Further to this, the longer the alignment that passes through the flood storage areas, the larger the impact and mitigation measures required.

Obviously, sub-grade options would not impact flood storage areas as no filling would be required. Sub-grade options, however, would not increase flood storage and require protection from inundation during a Q100 ARI event. Conversely, during construction, the sub-grade options may cause and increase in flooding, as the floodplain may be used as a temporary storage. Council will need to advise on this.

In summary, the larger the area of floodplain filled, the larger the impact.

Analysis

The original Caboolture to Maroochydore Corridor Study alignment (option 1) is not included in this analysis, as it exists outside the Q100 flood extents (as defined in the JWP (2007) report for existing conditions) and does not impact on floodplain storage.

The Carnaby Street sub-grade option is the best case scenario in terms of this issue and consideration. The elevated option (options 3) is the worst case. The at-grade option (option 4) has a lesser impact on flood storage than the elevated alignment option

As discussed in the previous section, if Horton Golf Park was completely developed for urban purposes above the Q100 ARI flood elevations with subsequent mitigation measures in place, then all alignments would have no impact on floodplain storage.

5.1.6 Flood protection

As per QR Ltd standards, rail alignments above ground must have at least 1.2 m buffer capacity from the flood level to the top of the rail (includes rail, sleepers and ballast). The rail alignments in this study will be protected against the Q100 flood event.

Submerged tunnels are particularly susceptible to flooding and require levees at tunnel portals located within the floodplain, as protection mechanisms for surface water run-off (i.e. floodwaters) entering the tunnel. The levees must be designed to protect the tunnel during the Q100 ARI event to provide sufficient protection from inundation.

Analysis

The Carnaby Street at-grade and elevated options will be designed to incorporate Q100 ARI protection (as per QR standards). These options are considered better than the sub-grade option which may require additional protection incorporated into the design (i.e. levees). This is dependant on the location of the tunnel portals, as portals outside of the flood plain do not require protection.

5.1.7 Drainage maintenance and management

Sub-grade tunnels require drainage sumps within the tunnel to collect and temporarily store any stormwater run-off and groundwater entering the tunnel and therefore also require regular pumping to remove the collected water. This will involve designing additional infrastructure as well as ongoing maintenance. Therefore, the Carnaby Street sub-grade alignment will have a higher operating cost and maintenance requirement than the elevated and at-grade.alignments.

The at-grade and elevated alignments do not require pumping water, but do require cross-drainage infrastructure such as culverts or bridges to allow flow to pass under the rail corridor during storm events. Appropriate design is required to avoid rail inundation due to insufficiently sized cross-drainage infrastructure. Longitudinal drainage is also a requirement.

Additionally, water sensitive urban design will be required to effectively manage run-off from the above-ground rail embankment in accordance with Sunshine Coast Regional Council guidelines. Elevated alignment options may require more design and consideration due to increased impervious areas and potentially higher run-off rates.

Analysis

The sub-grade alignment option is the worst case scenario in terms of drainage maintenance and management, due to the regular maintenance of pumping sump water out of the tunnel and associated risks, treatment and labour involved.

The elevated alignment would be the next worse case, dependent on the extent of construction on embankment, due to the level of costs involved with the construction of

water sensitive urban design and stormwater diversion when compared to the at-grade options.

Therefore, when comparing all alignment options from a hydrological assessment perspective, the at-grade alignment option (or elevated option to the extent that it may be constructed on structure) is the best scenario as the existing drainage paths can be utilised in the design. However, consultation with Council will be required in terms of water quality impacts and mitigation.

5.1.8 Qualitative results

Options have been ranked in terms of best (i.e. least flooding impact) to worst scenarios. Due to the high level nature of this flooding assessment, each issue and consideration has been given equal ranking for qualitative purposes only, with scoring within each issue based purely on comparison and not costs or level of impact. Indicative costs for capital and operational have not been considered.

Note that it is proposed to construct the elevated option predominantly on structure to minimise visual impact and optimise movement permeability underneath, Therefore the drainage maintenance performance is likely to be superior to even the at-grade options.

Table 5-4 presents the ranked results.

Table 5-4: Option analysis overview and project impact score rating

	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	Original Caboolture to Maroochydore Corridor Study alignment	Carnaby Street alignment	Carnaby Street alignment	Carnaby Street alignment
	at-grade	sub-grade	elevated	at-grade
Location	0	1	1	1
Elevation	0*	0	1	1
Flood protection	0	1	0	0
Drainage maintenance	1	3	2	1
TOTAL**	**1**	**5**	**4**	**3**

NB: * Option 1 has been given a 0, as the at-grade alignment will not impact on the flood levels due to the alignment being situated outside the Q100 flood extents

** The option with the lowest total will be considered the best alignment with comparatively minimised flooding impact, and vice versa for the highest total.

Therefore, the alignments have been ranked accordingly, with the ranking of 1 being the best, and the rating of 5 being the worst. In terms of flooding, option 1 – original Caboolture to Maroochydore Corridor Study alignment is option with the least impact on the project.

Table 5-5: Ranking of the 4 options in terms of flooding impact (with rating 1 as the best and 5 as the worst scenario)

Ranking	Option
1	Option 1 (Original Caboolture to Maroochydore Corridor Study alignment)
2	Option 4 (Carnaby Street alignment, sub-grade
3	Option 3 (Carnaby Street alignment, elevated
4	Option 2 (Carnaby Street alignment, at-grade

Overall ratings for the options are provided in Table 5-6, below.

Table 5-6: Option scores, flood risk

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	4
2	Carnaby Street Alignment, sub-grade	3
3	Carnaby Street Alignment, elevated	5
4	Carnaby Street Alignment, at-grade	4

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.1.9 Climate change

As part of the multi-criteria analysis to determine the preferred corridor, climate change impacts on flooding have been included, as indicated for the requirements of the detailed assessment stage of the REF.

This section of the report has been referenced from various material related to climate change, both on a general climate change basis and also pertaining directly to coastal and ocean engineering. A list of sourced reference material is outlined below:

- Climate Change: An Australian Guide to the Science and Potential Impacts (AGO, 2003)
- Climate Change Science: Frequently Asked Questions (AGO, 2007)
- The Greenhouse Effect and Climate Change (BOM, 2003)
- Climate Change in Australia (CSIRO et al, 2007)
- Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering (EA, 2004)

Climate change would potentially affect sea levels and storm intensity each of which would have a direct effect on flooding, due to the tidal and storm surge influences on Cornmeal Creek. Other phenomena impacted by climate change could potentially affect the Maroochydore Station Corridor, such as the El Niño – Southern Oscillation, hurricanes and changes to rainfall patterns and land uses.

Global mean sea-level has risen by about 10 – 20 cm over the 20th century, based on analyses of tide-gauge records. Most of the rise in sea-levels is associated to thermal expansion of the oceans in response to the rise in global temperature over the last 100 years and the retreat of glaciers (AGO, 2003; BOM, 2003).

The possibility of sea level rise alone forms a consideration of possible major impacts for the coastal zone, such as (EA, 2004):

- inundation and displacement of wetlands and lowlands
- eroded shorelines
- increased coast flooding by storms
- salinity intrusion of estuaries and aquifers
- altered tidal ranges, prisms and circulation in estuarine systems
- changed sedimentation patters
- decreased light penetration.

Impacts on Maroochydore Station Corridor

Climate change on a global scale has been a heavily researched area in recent years, However, research based on smaller regional areas such as the Sunshine Coast or South-east Queensland have been less focused.

Based on the numerical projections available from the various climate change models, predictions indicate that a global sea level rise of 18 to 59 cm is likely by 2100 (AGO, 2007), with a further 10 to 20 cm if the ice flow rates from Antarctica and Greenland continue to growth linearly (CSIRO et al, 2007).

Storm surges occurring on higher mean sea levels will result in inundation and damaging waves penetrating further inland. This would lead to subsequent flooding, erosion and damage to built infrastructure and to ecosystems. Changes to wind speed could also affect storm surge height. Storm surges in the Sunshine Coast are expected to increase the Q100 ARI tide events by ~0.45 m (CSIRO et al, 2007), with changes dominated by sea level rises. Direct flooding impacts on the Maroochydore Station rail corridor will need to be determined through modelling and adjusting the boundary conditions to simulate climate change conditions.

Changes to rainfall patterns have not been proved to be linked to climate change; however, there have been noticeable increases to the frequency of El Niño events since 1975 (AGO, 2007). This may affect the project area, through an increased severity in drought. Cyclone origins are likely to remain unchanged; however, preferred pathways and extent of poleward migration may alter. Although unable to be predicted or proven at this time, there is a possibility of cyclones migrating further south over time (AGO, 2003).

Projections for annual rainfall changes suggest that in the south-east of Australia and Queensland, range of -10% to +5% by 2030 and -35% to +10% by 2070. Rainfall changes combined with increases in potential evaporation could lead to a general projected decrease in available soil moisture across Australia, with droughts likely to become more severe. Most regions would experience an increase in the intensity of heavy rain events. Further to changes to rainfall patterns, it is predicted that where average rainfall increases, there will be more extremely wet years and where average rainfall decreases, there will be more dry spells (AGO, 2003). Sensitivity analysis on the flood modelling may be able to determine the level of impact on the rail corridor.

Additionally, increases in urban development could lead to higher overnight temperatures in the area and a greater frequency of flash flooding due to a reduction in available land infiltration (BOM, 2003). Higher run-off contaminants may also be an issue due to the land

use changes and subsequent requirements for water sensitive urban design to reduce the impact on natural waterways.

Generally, climate change could lead to an increase in flood levels, with current rail designs based largely on modelling using historical data. Constructed rail corridors may not be sufficient to protect the rail from inundation in the future if climate change impacts are severe as predicted, due to using historical data as a basis for modelling. Rail corridors located within or close to flood lines will require further modelling to observe the level of impact on the rail corridor due to climate change.

5.1.10 Soils and geology

Existing data indicates that the area is likely to contain both AASS and PASS. These pose challenges to construction, which are particularly serious for sub-grade options.

Based on the results of the desktop assessment, the elevated option and at grade options appears to have lesser number of potential geotechnical/engineering constraints than the subsurface (cut and cover) options and therefore should be considered as the preferred options.

Table 5-7: Option scores, geotechnical risk

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	5
2	Carnaby Street Alignment, sub-grade	4
3	Carnaby Street Alignment, elevated	5
4	Carnaby Street Alignment, at-grade	5

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.1.11 Biodiversity

Terrestrial ecology

This section addresses the key ecological constraints associated with the Maroochydore Station Corridor project, identified as part of a desktop review of ecological databases and online mapping systems and a one day field reconnaissance conducted by two PB ecologists on 12 April 2007.

The desktop review identified the potential for rare and threatened flora and fauna species protected under the Nature Conservation (Wildlife) Regulation 2006 (NCR) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to occur within the corridor footprint. Queensland regional ecosystem (RE) mapping also identified 'of concern' and 'not of concern' remnant vegetation within the footprint area, which is protected under the *Vegetation Management Act 1999*. The purpose of the field reconnaissance was to assess the likelihood/and or presence of remnant vegetation and threatened flora and fauna species to occur within the corridor footprint.

The following key ecological constraints were identified as a result of the field reconnaissance:

The Maud Street canal drainage channel that is traversed by the corridor within the Horton Park Golf Course is only a short distance (~500 m) upstream of the Maroochy River and

there is potential for downstream impacts to occur as a result of the project if construction impacts are not adequately managed.

Mangroves are present along the drainage channel intersecting the northern section of the Horton Park Golf Course. Schedule 8, Table 4, item 8 of the Integrated Planning Act 1997 states that and any disturbance to marine plants will require assessment under the Fisheries Act 1994.

Water bodies throughout the Horton Park Golf Course have the potential to provide habitat for state (NCWR) and/or Commonwealth EPBC Act listed amphibian species such as Adelotus brevis (tusked frog), Crinia tinnula (wallum froglet), Litoria freycineti (wallum rocket frog) and Litoria olongburensis (wallum sedge frog).

Remnant vegetation in the far south-west corner of the proposed corridor is considered to be in good remnant condition and large enough in size to provide potential important habitat for state and/or Commonwealth listed flora and fauna species.

Riparian vegetation fringing Dalton Lake, alongside the Sunshine Coast Motorway, has the potential to provide important habitat for state and/or Commonwealth listed species, specifically waterbirds and amphibians.

There are likely to be locally significant trees within the Horton Park Golf Course and a stand of pine trees within the golf course provide a nocturnal roost site for a large flock of Threskiornis molucca (Australian white ibis).

The ecological values of the Maroochydore Station Corridor listed above, enforce the need for targeted flora and fauna surveys in order to rule out the presence of species listed under the NCWR and EPBC Act at three main locations along the corridor:

- water bodies/ponded areas within the Horton Park Golf Course
- remnant vegetation in the south-west of the corridor
- wetland areas in the south-east of the corridor.

Remnant vegetation must also be validated for the consideration of clearance approvals under the *Vegetation Management Act 1999*. Once ecological values of the corridor have been assessed through targeted flora and fauna surveys of the three main areas, various approval pathways such as a referral to the Department of Environment and Water, state and local government permitting and conformance with state planning policies can be established and the ecological values of the area can be managed through an integrated strategic transport planning solution.

Aquatic Ecology

Potential Construction impacts

The most significant impacts to aquatic biota as a result of realigning the rail corridor are likely to be associated with the construction phase of the project and may vary slightly, depending on which of the options (above ground, below ground or at slope) is selected.

Water quality

The most common impact of construction projects on water quality is increased sediment loads as a result of erosion, vegetation removal, earthmoving, etc. The transport of sediment from the construction site during rainfall events can typically result in degraded water quality,

smothering of aquatic habitat, loss of aquatic flora through reduced light penetration, loss or change of fauna due to altered substrate characteristics, smothering of mangrove pneumatophores and reduced spawning/forage opportunity.

Chapter 10 of the Caboolture to Maroochydore Corridor Study Final Impact Assessment indicates that 8 structures would be required to convey flow from the Cornmeal Creek Catchment and that hydrological modelling of this system required further consideration. It is unclear at present how the proposed realignment would alter this scenario, but it must be considered that each of these structures may represent a potential source of sediment to the creek during the construction phases.

It is expected that acid sulfate soils are present within the site, although they may reasonably be expected given the low lying, coastal nature of the site. The disturbance of acid sulfate soils, if present, may result in pH shifts, altered ionic composition and the liberation of toxic elements into waterways if site run-off is not adequately managed. This can result in shifts in aquatic or riparian faunal or floral assemblages. Pollutant emissions, such as hydrocarbons, nutrients or heavy metals associated with plant, machinery or site facilities/amenities could potentially enter the creek or other waterways, although normal environmental management practices should minimise this risk.

Altered hydrology/hydrodynamics

Given the extent of modification within the upper catchment, a result of urban drainage works, the hydrological regime and the hydrodynamics of Cornmeal Creek are probably quite different than prior to urbanisation. Construction activities associated with the development of the rail corridor has potential to impose further modification to local hydrology through earthworks, diversion of stormwater from worksites, earth works and intersected groundwater aquifers (below ground option). This could result in short-term changes to water quality, altered salinity and flushing cycles and a change in the wetting/drying cycle in the intertidal zone resulting in a shift in system ecology.

Habitat destruction

Operation of heavy machinery within or immediately adjacent to waterways, such as excavating, filling, pile driving or other construction activities, could potentially result in damage to riparian or in-stream habitat. However, the corridor is essentially perpendicular to the creek and does not cross any of the other waterways identified during this survey, it is considered that the area of riparian habitat that will be affected has effectively been minimised.

Movement of aquatic fauna

Whilst it is unlikely that Cornmeal Creek is utilised by catadromous or anadromous fish species, the shallow tidal nature of the creek and the likelihood of highly variable flow and salinity levels is likely to force fish, and other higher organisms, in and out of the creek on a regular basis, depending on tidal cycles, time of day, flow regimes and water quality. At present the physical barriers of the concrete apron below the Maud St Bridge and the concrete lined channel upstream of the bridge, limit or prevent the upstream passage of any aquatic species beyond this point.

There is potential that some species may already not move up the system as a result of the need to travel through heavily shaded areas, such as bridges and the plaza, or through

areas where noise and vibration caused by heavy traffic deters them from passing through shallow water areas.

Unless the construction of a temporary coffer dam or similar structure is necessary during the construction operations it is unlikely that construction of the corridor will create additional physical barriers to the movement of aquatic biota. Notwithstanding this, construction noise, vibration or lighting may create short-term deterrents to the movement of biota.

Noise, vibration, lights

Construction noise, vibration or lighting create short-term stress factors. As water is an excellent conductor of noise and vibration, activities such as pile driving, blasting, tunnelling, or the operation of heavy machinery, may cause mobile species to avoid utilising the area during these activities, and may stress less mobile aquatic fauna. If construction is to be continued during the hours of darkness, artificial light may also cause mobile biota to avoid the area and may stress less mobile species.

Potential Operational Impacts

Construction of the railway is likely to have only a low level and short-term impact on the aquatic environment and can be expected to be further reduced during railway operations. However, ancillary infrastructure (such as an increase in car parking) may result in some impacts compared with the current scenario.

Water quality

The construction of additional car parking will increase the area of impermeable pavement, which in turn will increase surface run-off contaminant loads as well as limit recharge of aquifers. Stormwater from areas such as these may transport pollutants to nearby waterways If drainage from these areas is diverted to Cornmeal Creek unmitigated, turbidity, hydrocarbons, heavy metals and polycyclic aromatic hydrocarbon (PAH) levels in the water and/or biota can be expected to increase. This may result in a loss of biodiversity or in human health risks if contaminated fish/shellfish are consumed. Given the extent of urban development foreseen in the Maroochydore Centre Position Paper, the impacts of activities associated with the construction of the rail corridor and ancilliary facilities will be only part of the cumulative impacts of urban development.

Altered hydrology/hydrodynamics

Given the modification of the upper catchment the hydrodynamics of Cornmeal Creek is probably quite different than prior to urbanisation, operation of the Maroochydore rail corridor has the potential to further alter surface and groundwater hydrology by altering the contours and drainage lines (for the elevated and at-grade options) or altering the movement of groundwater (below ground option). This could result in changed water quality, altered salinity and flushing regimes and a change in the wetting/drying cycles in the intertidal zone. These impacts could potentially result in poorer water quality, habitat loss or in shifts in system ecology (e.g. replacement of sensitive species with those more tolerant of poor water quality/habitat).

Habitat destruction

Operation of the railway is unlikely to promote or require further habitat loss.

Movement of aquatic fauna

If sills, aprons, weirs, culverts or other structures are constructed within the creek and its tributaries, the movement of aquatic species may be restricted or prevented. Sensitive design that includes the use of mitigating structures, such as baffles under bridges, can be expected to go some way toward overcoming these issues.

Noise, vibration, lights

The impacts of noise and vibration on the aquatic environment, resulting from the operation of the railway are unlikely to be significant during the operational phase, although this may depend to some extent on the frequency of train passage.

Conclusions

The proposed realignment of the Maroochy Rail Corridor would result in the line crossing Cornmeal Creek and passing in close proximity to a number of watercourses associated with the Horton Park Golf Course, The impacts on the aquatic environment during the construction and operational phases of the project would be minimal because:

- Cornmeal Creek is a highly modified and degraded urban tidal system and represents only a very small area of low quality, disturbed habitat;
- The golf course waterways are probably constructed to improve the course and are hence of minimal ecological value. Water bodies within the golf course that were not constructed are impacted upon by the surrounding land use and represent poor quality aquatic habitat; and
- No listed aquatic species or communities are considered likely to be present within the system.

Conventional construction site environmental management protocols can be expected to mitigate potential impacts of the project.

In terms of potential impacts to the ecology of Cornmeal Creek, there would be little difference between the potential impacts of the at-grade, elevated or sub-grade options, once appropriate mitigation had been implemented.

5.2 Engineering

5.2.1 Design standards

The basic design parameters for the MSCS were agreed between PB and the Department of Transport and Main Roads at the commencement of the project. These basic standards are illustrated in Table 5-8.

Table 5-8: Agreed design standards

Design Standards
Rail level at perimeter of study area 5.0 m (as per Caboolture to Maroochydore Corridor Study study)
Development level 3.0 m, with rail level 4.2 m (when at grade)
Maximum permissible grade 2%

Target grade 1.5%
Max permissible grade on platform 0.5% (target 0%)
Combined vertical and horizontal curve acceptable if necessary
Provide for road vehicle clearance of 5.0 m on elevated options (assuming all roads to be local streets, not Main Roads)
Minimum clearance for rail lines 6.1 m (as per QR standards)
Target speed for through line 80 km/h

In addition, designs have been completed in line with QR standards as applicable.

5.2.2 Construction options

Each of the options has a different 'footprint' depending on the construction technique adopted.

The above grade solution has been designed as an elevated structure (rather than an embankment). This allows for a narrow footprint with general permeability. The sub-grade option has been designed as an open cutting with potential for capping in the future. There are different design requirements for the two. In particular an open cutting requires drainage slopes which are optional for a tunnel solution. On the other hand a tunnel requires emergency access facilities (escape stairs) at appropriate intervals.

Finally, it should be noted that the "at-grade" solution is slightly above ground level in line with QR standards.

5.2.3 Construction cost

The cost of construction is a product of the length of track to be constructed and the method chosen.

Indicative construction costs have been developed for each of the new options. These have been developed using standard unit rates, with no allowance for special conditions or land acquisitions, and are subject to review following detailed design. Table 5-9 summarises these costs. (These costs include a 50% contingency.) The original Caboolture to Maroochydore Corridor Study alignment (option 1) has not been re-costed as no detailed engineering work has been done for this option.

Table 5-9: Indicative construction costs

Option	Description	Construction cost (millions, 2007 dollars)
2	Carnaby Street alignment, sub-grade	$275.8
3	Carnaby Street alignment, elevated	$201.9
4	Carnaby Street alignment, at-grade	$126.5

Appendix I gives details of estimated construction costs for the options.

Table 5-10 shows the options scores for construction cost.

Table 5-10: Option scores, construction cost

Number	Description	Rating
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	4
2	Carnaby Street alignment, sub-grade	2
3	Carnaby Street alignment, elevated	3
4	Carnaby Street alignment at-grade	4

5.2.4 Operating and maintenance cost

While details are not yet fully known, it is expected that the Carnaby Street sub-grade option (2) will have higher operating costs, as natural drainage is likely to require supplementing with pumps.

Maintenance costs of an elevated structure may be slightly higher than an at-grade rail line (due to difficulties of access and impact of plant on local street access), but this is unlikely to be of major significance.

Table 5-11: Option scores: operating and maintenance costs

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	5
2	Carnaby Street alignment, sub-grade	4
3	Carnaby Street alignment, elevated	5
4	Carnaby Street alignment, at-grade	5

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.2.5 Engineering compliance and constructability

All options meet QR basic standards for gradient and curve radius.

Option1 at 15 metres width does not meet all QR preferences for corridor width for a double track rail line. Even with the use of an additional shared easement for service access (e.g. to the rear of the Harvey Norman store) there remains insufficient space for the necessary earthworks within the corridor..

Options 2 to 4 have been designed with a full-width 30 metre corridor. However, the elevated solution may impinge slightly on neighbouring land (depending on the extent of embankment) and may require use of shared easements for maintenance access.

Table 5-12: Option scores, engineering compliance

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	2
5	Carnaby Street alignment, sub-grade	5
6	Carnaby Street alignment, elevated	5
7	Carnaby Street alignment, at-grade	5

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.3 Land use planning and approvals

5.3.1 Maroochy Plan 2000

The current Maroochy Planning Scheme (the planning scheme) was prepared under the Integrated Planning Act, and took effect on 1 June, 2000. It is administered by the Sunshine Coast Regional Council and manages development within the previous Maroochy Shire Council area. The planning scheme also supports the SEQ Regional Plan.

Section 4.2 of the planning scheme established a retail hierarchy for the Shire and identified Maroochydore as the key regional centre for the Sunshine Coast: It states:

> *"A retail hierarchy has formed with a Key Regional Centre at Maroochydore as the predominant retail and commercial centre serving the Sunshine Coast region, so identified because of its centrality to all of the coastal centre, the existence of many regional public sector offices, the fact that it includes Sunshine Plaza, which at present houses the only large national department store on the coast, and its capability to be developed further as a multi-function centre with a distinct, attractive character and identity".*

The Council's Strategic Plan also supported Maroochydore's lead role in the retail hierarchy through the retail and commercial strategy.

The Maroochy Plan 2000 describes the vision of the Shire in the form of seven 'desired environmental outcomes' (DEO) statements. Of the DEOs included in the plan, *"DEO2 – Social Equity and Livability"* and *"DEO4 – Transport and Accessibility and Character"* are the most pertinent to the future land use implications of the Maroochydore Station Corridor.

DEO2 stated that vibrant attractive and safe local communities are provided with quality choices and amenity *"...having convenient access to a diversity of housing, shopping and other business services, community and recreational facilities and jobs – all located and designed to sustain significant ecological and scenic resources of the Shire."*

DEO4 further supported the principles of transport –oriented development (TOD) ensuring that *"Residential, visitor and business communities are serviced by an efficient, safe and convenient transport network to deliver pedestrian, cycle and vehicle integration and a viable and coordinated public transport system."*

It is clear that these DEOs demonstrate a statutory planning framework that supports the principles of TOD on the Sunshine Coast. The role of Maroochydore as a Principal Activity Centre identified in the SEQRP, combined with opportunities made available through the planned conversion of the Horton Park Golf Course to predominantly urban purposes, presents a unique opportunity to develop a world class TOD on the Sunshine Coast.

Therefore, it is considered that the development of the proposed corridor is within the overall intent of the 2000 Maroochy planning scheme.

Overlay maps

The Maroochy Plan identifies constraints in the map overlays, including

- areas below 5 m AHD (see Figure 5-1) indicating likelihood of acid sulphate soils.
- vegetation management units
- flood and drainage

Of these, the future land uses are most seriously constrained by acid sulphate soils (areas below 5 m AHD) and flood and drainage issues. Vegetation management units have previously been largely cleared from the site

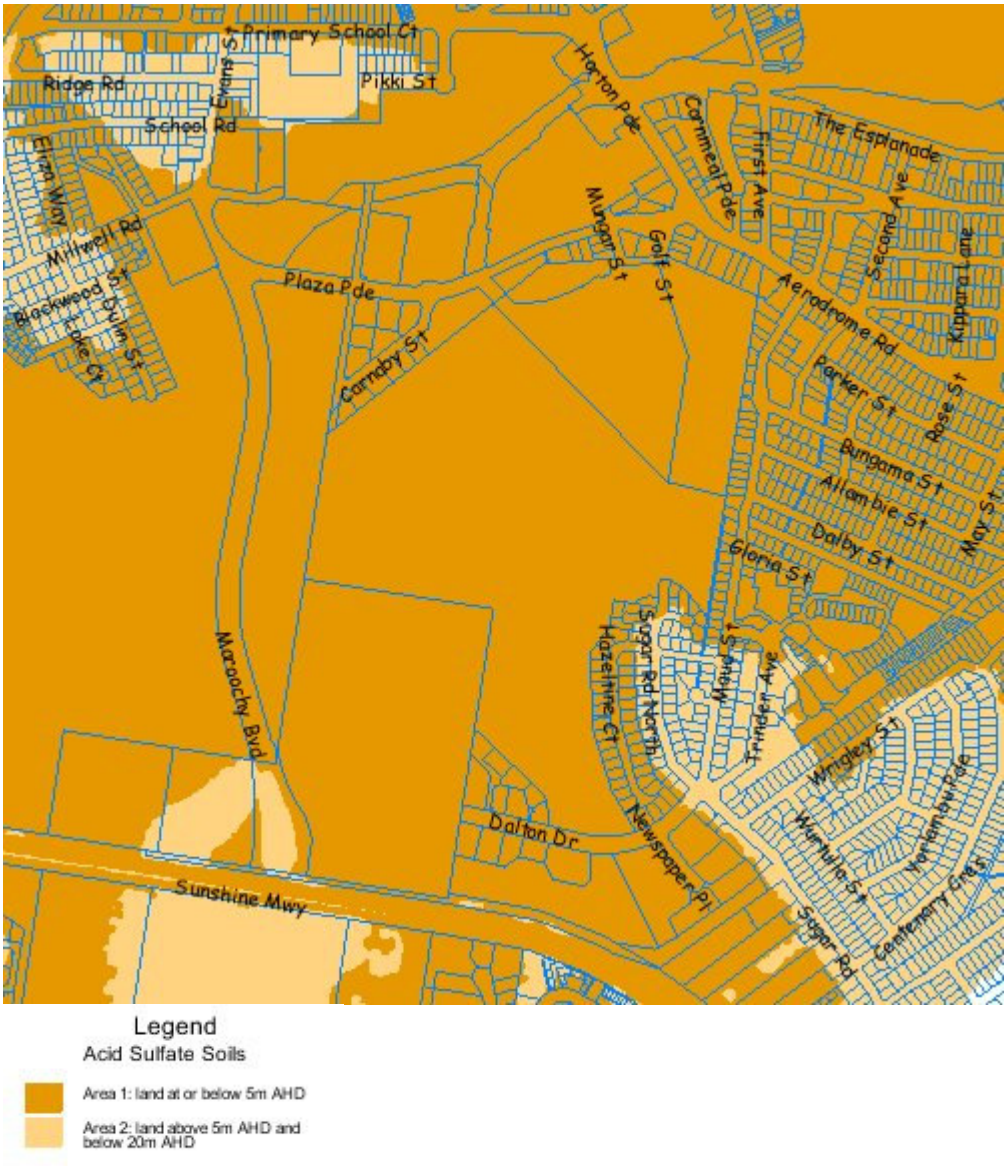


Figure 5-1: Maroochy plan acid sulfate soils overlay

Sunshine Coast Growth Management Position Paper

In July 2008, the new sunshine Coast Regional Council adopted the Sunshine Coast Growth Management Position Paper to guide future growth to 2031 and beyond, and to inform the SEQ Regional Plan review process of the Council's planning intent.

This paper again identifies Maroochydore as the Principle Activity Centre for the sunshine Coast and indicates that the area is subject to structure planning and further submission to the State government.

Maroochydore Centre Position Paper

Emerging from earlier concept plans and structure plans by the previous Maroochy Shire Council, the Maroochydore Centre Position Paper was further informed by a number of

workshops and study tours to establish its position to guide future development in Maroochydore Centre. The paper, outlining Council's vision, principles and strategies, provides holistic direction with a triple bottom line approach to guide all facets of planning in the centre.

The Position Paper was endorsed by the Sunshine Coast Regional Council on 26 May 2009 as the basis for a planning scheme amendment to be incorporated as a local area plan for the Maroochydore Centre area. Features of the Position Paper include:

- Commitment to a triple bottom line approach to sustainability, including support for employment and economic self-containment and a more transport-efficient, accessible and liveable settlement pattern.
- Assumption that the golf course lands will become available for redevelopment
- Confirmation of the function of the Principle Activity Centre as a viable centre accommodating key concentrations of employment, retailing, regional offices for government and regionally significant health, cultural and entertainment facilities, serviced by high frequency multi-modal public transport services.
- Recognition of the link between sustainability and achieving best practice in transport and acknowledging that public transport will become increasingly important.
- Providing an integrated transport system before development occurs
- Commitment to a number of priority infrastructure projects including *"the* Caboolture to Maroochydore Corridor Study *corridor, which enters Maroochydore between the golf course and Maroochy boulevard and will provide a transit centre which should form the basis of transit oriented development ion Maroochydore."*
- A transit station in the heart of the expanded town centre (the Centre) consistent with the Carnaby Street option investigated by the Maroochydore Station corridor Study.

The relevant proposed land use pattern is illustrated on the Maroochydore Centre Directions Plan and Building Heights Map, and the major public transport and active transport routes are illustrated on the Public Transport Map and the Open Space: Priority Pedestrian Streets and Walkable Waterfronts Map (see http://www.sunshinecoast.qld.gov.au/sitePage.cfm?code=maroochydore-position-paper).

5.3.2 Other relevant legislation

This section provides a brief description of the other legislation, standards and other documents/guidelines that are considered to be relevant to the design and construction of the proposed Maroochydore Station Corridor.

5.3.2.1 Commonwealth law

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) primarily provides for Commonwealth intervention on a range of actions or activities that are likely to have a significant impact on a matter of national environmental significance including, for example, World Heritage properties, nationally threatened species, Ramsar wetlands, and migratory species. Under the EPBC Act, a "controlled action" is an action that significantly impacts on matters national environmental significance.

If a proposal is considered to constitute a "controlled action" referral is required under this legislation.

Whether activities associated with the proposed corridor will trigger any EPBC Act criteria will be determined during preparation of the EIAS.

Native Title Act 1993

Broadly, the *Native Title Act 1993* (Cth) does three things:

- validates past acts of governments that affected native title
- provides statutory recognition of native title and a system for registering native title rights
- establishes a Future Acts Regime to allow native title to be incorporated into government decision making.

5.3.2.2 State Law

Aboriginal Cultural Heritage Act 2003

The *Aboriginal Cultural Heritage Act 2003* (ACH Act) is intended to provide effective recognition, protection and conservation of Aboriginal cultural heritage within the State. Under this Act it is an offence to knowingly destroy or interfere with places, artefacts and landscapes of Aboriginal heritage or spiritual culture. Individuals or corporations undertaking development in Queensland are obliged to observe the Aboriginal Cultural Heritage Duty of Care Guidelines. It may also be necessary to develop a cultural heritage management plan (CHMP) in accordance with part 7 of the ACH Act.

Further investigation as to Aboriginal cultural heritage considerations regarding the proposed corridor will be undertaken as part of the EIAS and is also discussed in more detail later in this document.

Environmental Protection (EP) Act 1994

The purpose of the EP Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The EP Act utilises a number of mechanisms to achieve its objectives, including creating a general environmental duty, licensing environmentally relevant activities (ERA's), and issuing environmental protection policies (EPP's) and regulations. Further investigation regarding ERA's and EPP's that may apply to the development of the proposed corridor will be undertaken as part of the more detailed environmental study closer to the time of implementation.

The EP Act also deals with the assessment and management of contaminated land, including administration of the Environmental Management Register (EMR) and Contaminated Land Register (CLR). If land within the proposed corridor is listed on the EMR and CLR, an application for a material change of use development permit would require referral to the Department of Environment and Resource Management (DERM) for assessment under schedule 8 of the *Integrated Planning Regulation 1998*.

Fisheries Act 1994

In general, any waterway crossings should not create a significant barrier to fish movements; however the construction of bridges and other waterway crossings may require approval

from the Department of Employment, Economic Development and Innovation under the *Fisheries Act 1994*.

Native Title Act 1993

Queensland's *Native Title Act 1993* was enacted to ensure Queensland's laws are consistent with the *Native Title Act 1993* (Cth) for dealings affecting native title. The *Native Title Act 1993* seeks to formally recognise that native title rights did, and in some cases still do, exist for the descendants of Aboriginal and Torres Strait Islander people, and that descent groups can lodge Native Title claims. Native title in land can be extinguished by valid government acts that are inconsistent with the continued existence of native title rights and interests, such as the grant of freehold or leasehold estates. Native title requirements for the proposed corridor are discussed in further chapters of this document.

Nature Conservation Act 1992

The *Nature Conservation Act 1992* seeks to achieve the conservation of nature through an integrated and comprehensive strategy for the whole of Queensland. This Act provides for the conservation of nature by the declaration and management of protected areas, and also the protection of native wildlife not found in a protected area.

As part of the EIAS for the proposed corridor, a study of flora and fauna species of noteworthy conservation significance – as detailed in the *Nature Conservation (Wildlife) Regulation 2006* (NCR (Wildlife)) – will be undertaken. If any listed species are present, approval will be required pursuant to the *Nature Conservation Act 1992*.

Furthermore, appropriate measures to limit impacts on the habitat or individuals of any endangered, vulnerable or rare species need to be implemented as per the requirements of the *Nature Conservation Act 1992* and its regulations.

Queensland Heritage Act 1992

The *Queensland Heritage Act 1992* (QH Act) aims to provide for the conservation of Queensland's cultural heritage, including for example, the regulation of the excavation of sites that contain, or may contain, objects of significance to Queensland's heritage. The Heritage Register is the principal mechanism through which the QH Act operates.

Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VM Act) seeks to regulate the clearing of native vegetation to preserve remnant endangered and of concern regional ecosystems, vegetation in areas of high nature conservation values and areas vulnerable to land degradation.

Water Act 2000

The *Water Act 2000* legislates for Queensland's non-tidal waters – i.e. waters above Mean High Water Springs (MHWS) – and promotes the sustainable and efficient use of water. Operational works approval may be required for the development of the proposed corridor should any works (e.g. placement of fill, clearing of riparian vegetation, taking of water for dust suppression during site works etc) be proposed within the bed and banks of a 'watercourse', as defined under this Act.

Land Act 1994

The *Land Act 1994* provides a framework for the allocation of State land either as leasehold, freehold or other tenure. Permits may be required if the development of the proposed

corridor will involve the temporary closure of a state controlled road, or it is necessary to occupy reserve, road or unallocated state land.

5.3.2.3 Local laws

A local law is a law adopted by a local government that reflects community needs and ensures the good rule and government of the area. Section 25 of the *Local Government Act 1993* provides that local governments may make local laws for the purpose of the good rule and government of the local government area. Through local laws, local governments can establish permit or licence regimes for activities they wish to regulate, create offences for unacceptable behaviour and provide for the issue of compliance or abatement notices. Section 31 of the *Local Government Act 1993* provides that if a State law and a local law are inconsistent the State law prevails over the local law to the extent of any inconsistency.

There are a number of Sunshine Coast Regional Council local laws that are relevant to the proposed development. Permits and approvals will need to be gained as required throughout the course of the proposed development.

5.3.3 State planning policies

This section discusses the state planning policies (SPPs) that need to be considered for the proposed Maroochydore station corridor. SPP are statutory planning instruments under the IP Act that relate to matters of Queensland state interest. These policies must be considered as part of the assessment process for development of land.

SPP 1/92: Development and conservation of agricultural land

This SPP addresses the conservation of good quality agricultural land (GQAL) and provides guidance to local authorities and state government on how GQAL needs to be considered in light of future development proposals.

SPP 1/92 also recognises that in some instances it may be necessary to build on GQAL if there is an overriding need for the development in terms of public benefit.

Due to the corridor's proximity to the Maroochydore town centre and the public benefit associated with the proposed corridor, the land is not classified as GQAL and as such the State Planning Policy is not applicable.

SPP 1/02: Development in the vicinity of certain airports and aviation facilities

This SPP sets out broad principles concerning development in the vicinity of airports and aviation facilities considered significant for the State's transport infrastructure or national defence system.

The SPP applies to development that could adversely affect the safety and efficiency of operational airspace by obstructions resulting from the erection of permanent or temporary physical structures either natural or man-made. It also applies to development that has the potential to create adverse effects on the functioning of aviation facilities caused by the penetration of the facility's sensitive area.

The nearest relevant airport under the SPP is the Sunshine Coast airport which is located approximately 5 kilometres north of the proposed corridor (at its nearest point).

Provision for SPP 1/02 is built into the Maroochy Planning Scheme. An assessment of the planning scheme overlay maps reveals that the proposed corridor will not be impacted by the requirements outlined in this State Planning Policy.

SPP 2/02: Planning and managing development involving ASS

The purpose of this SPP is to ensure that development involving ASS is planned and managed to avoid the release of potentially harmful contaminants into the environment. This SPP applies to certain areas of Queensland where the natural ground level is less than 20 m Australian Height Datum (AHD) and soil below 5 m AHD is disturbed by the proposed works.

The requirements of this SPP are translated in the Maroochy Planning Scheme and are relevant to this site as it falls below 5m AHD.

SPP 1/03: Mitigating the adverse impacts of flood, bushfire and landslide

The purpose of this SPP is to set out the State Government's interests with regard to natural hazards of flood, bushfire and landslide and ensure these matters are adequately addressed when carrying out development assessment.

Various parts of the corridor will traverse land subject to flood, bushfire and landslide, therefore this SPP is relevant to the proposed corridor. The Maroochy Planning Scheme identifies in overlay maps land with constraints relating to flood and bushfire. The bushfire and flood risk areas are shown in Figure 5-2 and Figure 5-3.

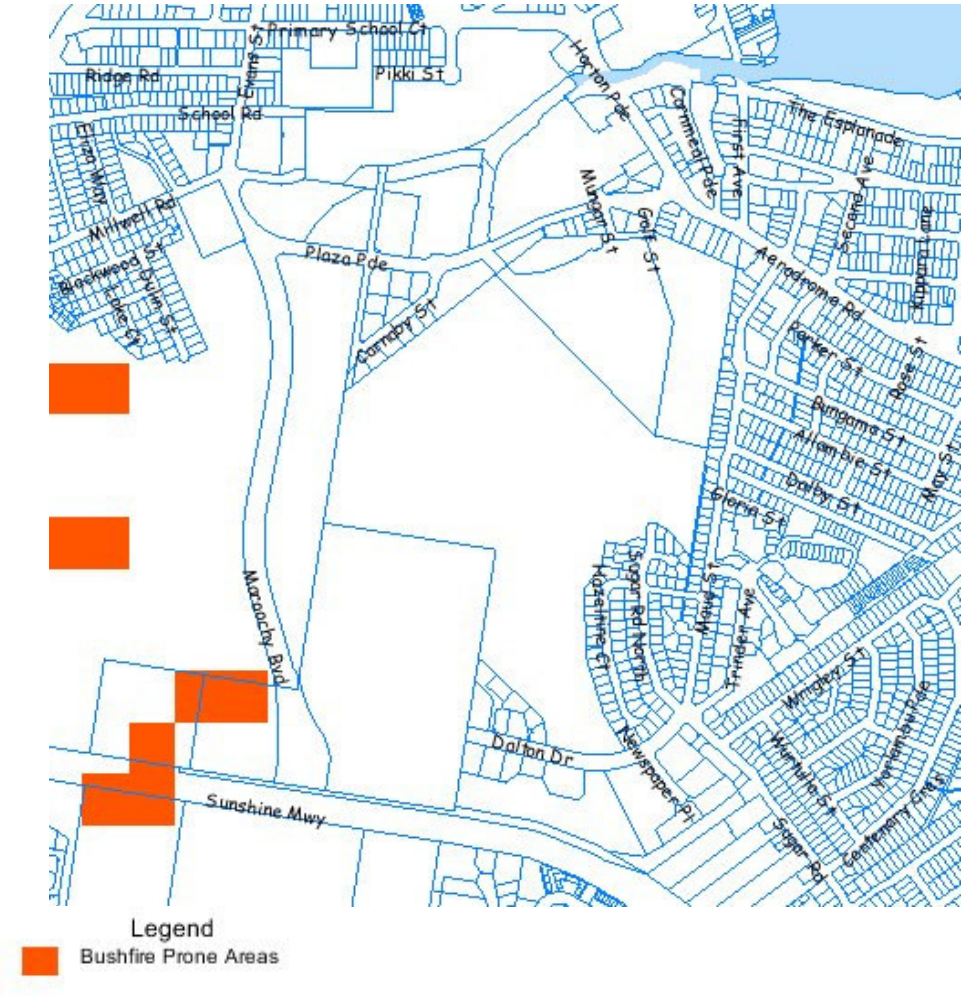


Figure 5-2: Bushfire prone areas

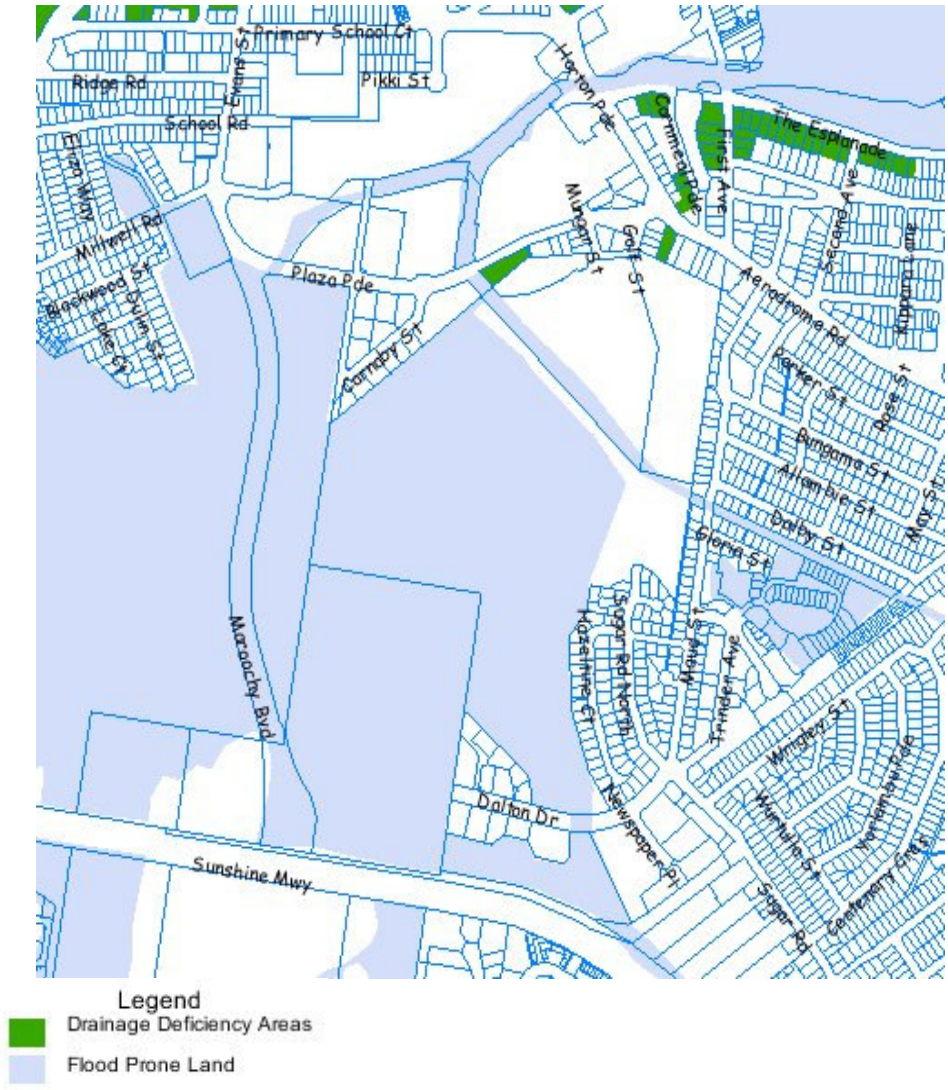


Figure 5-3: Flood prone areas

State Coastal Management Plan and SEQ Regional Coastal Management Plan

Under the *Coastal Protection and Management Act 1995*, a State Coastal Management Plan has the status of a SPP for the purposes of making and amending Planning Schemes and assessing and deciding development applications. A State Coastal Management Plan provides a framework to address and manage pressures on the coastal zone and as part of its core topics, emphasising that development should occur in an ecologically sustainable manner. The proposed corridor is within a coastal zone and as such these management plans are relevant in the assessment of the corridor and associated development.

Draft SPP for the Protection of Extractive Resources

The draft SPP for the Protection of Extractive Resources includes a list of key resource areas (KRA). The SPP aims to protect KRA from incompatible land uses.

While there are several KRA identified within the Maroochy Shire Council these are located a significant distance from the proposed corridor. Therefore, the proposed development is unlikely to impact on the key resources identified.

The Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016

At the time of writing, the Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016 (KCP) (EPA, 2006) which came into effect on 2 October 2006, were applicable. The koala plan addresses the key threats facing koalas and sets out strategies to stop the decline of koala numbers and help the species' recovery. Issues addressed in the KCP include: habitat protection and vegetation clearing; development; State Government infrastructure; vehicle mortality; dog attacks; translocation; research; zoos; public education; and, the rehabilitation of sick, injured and orphaned koalas.

Under the KCP, Maroochy Shire Council is one of 18 local government areas contained in "Koala District A". District A includes areas where koala habitat have been identified and population densities are the highest but the long term viability of some koala populations has been undermined by threats such as habitat destruction. Koalas are listed as "vulnerable" in District A areas. Koala habitat areas are statutory areas identified by the SEQRP under the IP Act, and are referred to as:

- Koala Conservation Areas
- Koala Sustainability Areas
- Urban Koala Areas.

The proposed corridor is not included in any of the koala habitat areas as mentioned above. Therefore the Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016 (KCP) will not be triggered for the future development of the public transport corridor.

5.3.4 Planning approval process

In Queensland, the *Integrated Planning Act 1997* (IP Act) is the principal legislation regulating development and the effects of development

Development of the proposed Maroochydore Station corridor is likely to involve all facets of 'development' as defined by the IP Act. Therefore, planning approval will be required.

There are four principal strategies available when seeking approval for the development of the proposed corridor. These include:

- *Integrated Planning Act 1997* - Integrated Development Assessment System
- *Integrated Planning Act 1997* - "Community infrastructure designation"
- State Development and Public Works Organisation Act 1971 - "Significant project"
- State Development and Public Works Organisation Act 1971 - "Certain works" ("Authorised works").

In addition, two other legislative processes are outlined in this document. These processes do not include a statutory framework for obtaining approval to develop the transport infrastructure (as is the case for the other five processes), but rather provide a useful mechanism for securing the transport corridor prior to seeking approval:

- Transport Infrastructure Act 1994 - "Transport Infrastructure"
- Transport Planning and Coordination Act 1994 - Part 2A "Land use and Transport Coordination".

A summary of the six strategies is provided below.

Table 5-13: Table of approvals

Strategy	Legislation	Outcome	Actions	Responsible Authority	Risks/Notes
Integrated Development Assessment System (IDAS).	*Integrated Planning Act 1997,* Chapter 3.	Approval of development.	Lodgement of development applications with Local Government. Referrals, information requests, public notification involved.	Local Government.	No land acquisition procedures. Statutory timeframes apply. Local government undertakes entire approvals process.
Designation of land for community infrastructure (CID).	*Integrated Planning Act 1997,* Chapter 2 Part 6.	Approval of development.	Adequate environmental assessment and consultation must be undertaken under section 2.6.7, which includes: The CID Guidelines, under section 5.9.9; or, An EIS under chapter 5; or, Notification and decision stages under IDAS; or, An EIS under the EP Act; or, Assessment under section 35 of SDPWO Act.	State Minister.	Development is exempt against local government planning schemes.
Declaration of a significant project.	*State Development and Public Works Organisation Act 1971,* section 26.	Provides entry point for IDAS or CID.	Preparation of EIS under SDPWO Act Development application can be submitted under IDAS, or CID can be sought.	Coordinator-General.	Is in bilateral agreement with EPBC Act. Follow up IDAS or CID process can be fast tracked.
Authorised Works.	*State Development and Public Works Organisation Act 1971,* section 108.	Approval of development and acquisition.	No EIS required, but an AEE required under SDPWO Act.	Coordinator-General.	Development is exempt against local government planning schemes. Works can be undertaken by the CG or another person on behalf of the CG.
Transport Infrastructure.	*Transport Infrastructure Act 1994* (and the *Transport Planning and Coordination Act 1994).*	Acquisition	Chief executive able to acquire land for rail corridor Acquired land becomes unallocated state land and leased back to the railway manager in perpetuity under provisions contained within section 24.	Chief Executive/Minister of relevant Department.	Land acquired for one particular transport purpose (e.g. rail) can later be declared for another stated purpose (e.g. busway). Approvals still required.

Strategy	Legislation	Outcome	Actions	Responsible Authority	Risks/Notes
Section 8E of the Transport Planning and Coordination Act 1994.	*Section 8E of the Transport Planning and Coordination Act 1994.*	Concurrence agency powers (having the effect of protecting the integrity of a future public transport corridor)	'Guideline' prepared under section 8E listing future public transport corridors. Relevant local government advised of future corridors included in Guideline. Listed future corridors become referral triggers. The Department of Transport and Main Roads becomes concurrence agency.	Chief Executive - delegates powers to the General Manager (Integrated Transport Planning) (Department of Transport and Main Roads)	A high level of certainty and planning commitment required in order to support the proposed corridor's inclusion in the 'guideline' (An EIS is ideal) Liaison with local government regarding future public transport corridors is essential. Approvals required to be sought, usually using the IDAS unless acquisition and/or designation occur.

5.4 Urban design impacts

Urban design specialists Deicke Richards have analysed the potential urban design impacts of each of the options at an 'ultimate development' scenario. This analysis was conducted in the context of the earlier concept plans and any conclusions drawn may not take into consideration changing circumstances through the evolution of planning to the current master plan (Maroochydore Centre Position Paper). Details of the current master plan were not available to conduct a full urban design assessment in that context. It is noted that many of the recommendations made by Deicke Richards in relation to the Carnaby Street options have been addressed in the subsequent planning and are now incorporated in the Directions Map of the Maroochydore Centre Position Paper.

5.4.1 Options evaluation

Option 1 - Current Caboolture to Maroochydore Corridor Study (Southern Drive)

The existing option for the Caboolture to Maroochydore Corridor Study rail line does not maximise the potential of a Maroochydore rail station. Existing outside of the city core, between neighbourhoods, it divides pedestrian movements and encourages vehicle based trips to the city centre and to the rail station itself. It does not help create or sustain the residential or commercial/retail intensity needed for a successful transit oriented development (TOD).

The proposal for a very large bulky-goods warehouse style of development immediately adjacent to the station and with its service and delivery "back door" functions oriented to the station, it presents a most inhospitable approach to the station. The environment created around the at-grade station and corridor in this location would be low amenity, reflecting a poor built form and poor connectivity for pedestrians. This would increase safety issues associated with Crime Prevention Through Environmental Design (CPTED).

Option 2 – Carnaby Street sub-grade

This option will encourage new retail and residential densities in part because it will service the full potential of the golf course development. This will require the golf course development to be substantially built out before the potential of the station is met. The station will have strong links to the existing retail and commercial centre of Sunshine Plaza and is adjacent to a future major retail centre proposed by the new Directions Plan in the Maroochydore Centre Position Paper.

This option allows for the development of the golf course to allow extension of the city core rather than to complement the existing centre. The option has potential to build a quality urban form and create a strong place for pedestrian movements and activities. The below-grade option reduces any visual impacts but increases the potential for safety concerns.

Option 3 – Carnaby Street elevated

This option reflects some of the outcomes of the original Concept Plan principles, which have now been incorporated in the new Directions Plan in the Maroochydore Centre Position Paper. It can be argued that this outcome is consistent with the principles of the plan due to its focus on walkability, its open space linkages to the civic spines and its incorporating of a new/balancing retail precinct that will provide a meaningful destination within a convenient

walk of the traditional town centre. This option promotes a more linear Town Centre along Cornmeal Creek rather than a more circular Centre. The outcome is that it will seek to balance activity though the semi-public space owned by Sunshine Plaza in addition to supporting a network of civic paths and streets around it.

This option does create a good built form, pleasing visual and urban amenity, as well as creating an attractive environment for pedestrians. Some development of residential and retail/commercial will be successful, but the station is some distance away from the historic city centre, requiring extended pedestrian connections and a proposal for a local "shuttle loop" transit service to fully exploit the potential benefits of the station and future developments.

The Maroochydore Centre Position Paper "celebrates" the option as part of a "boulevard" with active frontages along the rail line from the station to Dalton Drive.

Option 4 – Carnaby Street at-grade

Option 4 represents a significant risk in terms of the overall master plan principles. It suffers from similar draw-backs as the existing proposal at-grade, being some distance away from the historic city centre, and impinging on residential and commercial/retail developments south of the station as well as limiting permeability in that section. This creates a subdued urban environment, increasing safety risks and lessening the impact of the urban form and reducing the positive pedestrian experience ion southern extremities of the city centre.

5.4.2 Summary

The urban design analysis conducted by Deicke Richards compared each option and the likely land use outcomes against the earlier Concept Plans developed by the Maroochy Shire Council for its 2006 Draft Master plan for Maroochydore.

The scores achieved for each option are summarised in Table 5-14 below.

Table 5-14: Option scores, urban design impacts*

Option	Good Built Form	Compact Core	Safety
1	2	3	3
2	4	3	4
3	3	3	5
4	3	5	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

It is important to note that the draft structure Plan for Maroochydore endorsed by the new Sunshine Coast Regional Council in May 2009 diverges in a number of ways from the original Concept Plan, and an analysis of the options against the newer Master Plan may result in different scores. Many of the issues that affected the scores allocated to the Carnaby Street options have been addressed by subsequent master planning work since the 2007 Master Plan, and are now featured in the Directions Plan attached to the Council's Maroochydore Centre Position Paper.

5.5 Transport integration

5.5.1 Patronage potential

Overall patronage levels for the Caboolture to Maroochydore Corridor Study railway line can be derived from a multi-modal transport model that has been calibrated for the Sunshine Coast. As the VISUM model developed by the TransLink Transit Authority was not available when patronage modelling was required for this project, the Department of Transport and Main Roads made available to this study interim modelling outputs from the Inner City Rail Capacity Study (ICRCS) currently being undertaken by the department. The ICRCS used the Zenith transport model owned by Veitch Lister Pty Ltd (VLC) which covers the entire South East Queensland region. This data provides for a base case for the Maroochydore rail station (including the Maroochydore to Sunshine Coast Airport link).

The estimated 2026 boardings and alightings at Caboolture to Maroochydore Corridor Study stations for the 2 hour AM peak are reproduced in Tables 5-15 and 5-16.

Table 5-15: Caboolture to Maroochydore Corridor Study line patronage estimates (AM Peak, up) (Source Department of Transport and Main Roads/VLC model)

Station	Total Board	Total Alight
Maroochy Airport Rly Station	260	0
Pacific Paradise Rly Station	738	51
Maroochydore Rly Station	642	164
Mooloolaba Rly Station	615	307
Parrearra Rly Station	214	121
Kawana Town Centre Rly Station	94	25
Birtinya Rly Station	202	86
Aroona Rly Station	295	82
Caloundra West Rly Station	451	161

Table 5-16: Caboolture to Maroochydore Corridor Study line patronage estimates (AM Peak, down) (Source: Department of Transport and Main Roads/VLC model)

Station	Total Board	Total Alight
Caloundra West	122	549
Aroona	87	308
Birtinya	98	198
Kawana Town Centre	27	112
Parrearra	95	270
Mooloolaba	234	786
Maroochydore	130	657
Pacific Paradise	18	909
Maroochy Airport	0	212

Strategic transport models such as the VLC model are not particularly suited to small area modelling, and may not reflect small changes in station location or demographics.

To investigate whether patronage changes could be detected between the options, the PB specialised 'TOD Trips' tool was used to model the options. A 2026 'base case' was prepared using official population and employment projections (supplied by the Department of Transport and Main Roads) which was calibrated against the VLC figures. Scenarios for each of the seven options was then developed using the projected population and employment figures from the MacroPlan report (see Section 5.91).

Details of the TOD Trips modelling exercise are included in Appendix J.

The TOD Trips model reports a range of indicators, including AM peak trip numbers and mode share. It found that the very small variation in station location and population distribution between the options generated only small changes in public transport mode share. AM peak mode share was very strongly influenced by population figures and less so by employment figures. This meant that options generating high retail/commercial and lower residential land uses generate overall more trips, with a lower proportion of PT trips. The assumed availability of free parking in Maroochydore is one reason for this relationship. This results in an overall *lower* mode share for PT for these options (see Table 5-17).

It should be noted that the MacroPlan report prepared for the then Maroochy Shire Council suggests slightly higher population figures for the existing Caboolture to Maroochydore Corridor Study option than for the Carnaby Street options. If these assumptions are not met, the figures would change accordingly.

Table 5-17: Overall AM peak PT mode share (all PT, 2026)

Option	base	1	2	3	4
	Southern drive		**Carnaby Street**		
Overall mode share	6.9%	7.2%	6.5%	6.6%	6.8%

The different options did generate different numbers of passengers boarding at the rail station. Table 5-18 shows the number of rail passenger movements generated in the 2 hour AM peak for each of the options.

Table 5-18: AM Peak passenger movements (rail, 2026)

Option	base	1	2	3	4
	Southern drive		**Carnaby Street**		
Boardings	633	805	676	676	676
Alightings	172	182	327	326	196
Total movements	805	987	1,003	1,002	872

The data shows that the Carnaby Street elevated and sub-grade options perform better than the two at grade options performing somewhat worse. The Carnaby Street at-grade option was the worst performing option.

Table 5-19 lists the scores that each option receives, based on the number of rail trips generated.

Table 5-19: Option scores, patronage potential

Option	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	4
2	Carnaby Street alignment, sub-grade	5
3	Carnaby Street alignment, elevated	5
4	Carnaby Street alignment, at-grade	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.5.2 Network efficiency

Options 2 – 4 have all been designed with efficient rail operations in mind. This includes a double-track main line and a three track station for maximum flexibility and robustness. There is therefore nothing to discriminate between them.

Option 1 has a much narrower corridor and, at best, a double track line (with special engineering design dispensation from Queensland Rail) and a double platform station is constructible. This means the line will not be able to perform to its maximum potential and is less robust and more subject to delay in case of delays or breakdowns.

For bus operations, options 1 - 4 may generate greater VKT as the central bus/rail interchange is located further from the core Aerodrome Road bus route (quality bus corridor).

Table 5-20: Option scores, network efficiency

Option	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	2
2	Carnaby Street alignment, sub-grade	4
3	Carnaby Street alignment, elevated	4
4	Carnaby Street alignment, at-grade	4

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.5.3 Traffic/network permeability

Option 1 has the advantage of not directly affecting the golf course redevelopment area at all. However, it has the very strong disadvantage of forming a barrier between the golf course area and the 'Sunshine Cove' development to the west. There would be no road crossing of the railway possible between Plaza Parade and Sunshine Motorway. In particular, the desired Dalton Drive extension road would not be possible.

Option 3, being grade separated, provides excellent permeability throughout the golf course development area, including the proposed Dalton Drive extension road.

Option 4 offers reduced permeability, as any road crossings will need to be constructed as over or under bridges. The need for approach ramps means that the efficiency of the local road network is reduced.

Table 5-21: Option scores, traffic/network permeability

Option	Description	Rating
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	2
2	Carnaby Street alignment, sub-grade	5
3	Carnaby Street alignment, elevated	5
4	Carnaby Street alignment, at-grade	4

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.6 Rail and bus integration

5.6.1 Planning context

With the redevelopment of the CBD and associated works, Maroochydore is likely to entrench its position as the major retail and commercial centre for the Sunshine Coast.

The present public transport hub for Maroochydore is the bus station at the rear of the Sunshine Plaza shopping centre. This bus station is at capacity, and has been the subject of independent studies to determine its future. While the final outcome is uncertain, it seems clear that for the foreseeable future there will continue to be a major bus station facility on the Horton Parade side of Sunshine Plaza.

With the construction of a railway station in central Maroochydore, there arises the opportunity to construct an integrated bus-rail interchange. The design of this interchange, the role it may play and the efficiency of the supporting bus network will differ depending on the rail option chosen.

In addition to the rail, several other projects will have an impact into the transport infrastructure in the area. The CoastConnect Caloundra to Maroochydore quality bus corridor project is looking at bus priority along two main routes south of Maroochydore to Kawana and Caloundra. The CoastConnect Maroochydore to Noosa and CoastConnect Maroochydore to Nambour studies are investigating the need for trunk-haul public transport from Maroochydore to Noosa and Nambour.

5.6.2 Assumptions on future public transport requirements

Role of rail in the Sunshine Coast

The current very low market share for public transport on the Sunshine Coast means that it is very difficult predicting future public transport use in a scenario with two major new public transport facilities (rail and bus priority corridor) and a range of new urban developments (including the Maroochydore CBD).

Currently the main markets for the rail system are expected to be:

- rail:
  - Sunshine Coast to Brisbane trips and return (including tourist/leisure trips from Brisbane to the Sunshine Coast)
  - trips to and from Maroochydore from southern Sunshine coast, especially new developments between Kawana and Caloundra South.

- rail with bus feeders:
  - Noosa and northern coast to Brisbane (and return)
  - Maroochydore 'suburbs' to Brisbane
  - Noosa and northern coast to Kawana, Caloundra area
  - Maroochydore 'suburbs' to Kawana, Caloundra area (in part – shared with the 'Quality Bus Corridor' (QBC) being planned in the 'Coast Connect' project)

Route network assumptions

The bus network for Maroochydore and the Sunshine Coast that will be in place following the construction of the railway is not yet confirmed. The Public Transport and Parking Map in the Council's Maroochydore Centre Position Paper identifies a range of potential public transport routes and bus priority corridors which offer considerable choice of network options to be implemented to best advantage. For this analysis we have assumed the bus network to be as advised by TransLink to the CoastConnect study teams, especially with regards to origins and destinations. Within the Maroochydore CBD area we have assumed route changes to provide better coverage to important areas:

- routes have been extended to or re-routed past the proposed railway station location (with a different network for each station location)
- services entering via Maroochy Boulevard have been diverted to run to run through the town centre where appropriate
- some local services from Sippy Downs and Alexandra Headlands areas have been diverted through Horton Park/new CBD
- a route would be provided through Dalton Drive to serve new CBD and 'health hub' zone
- a route would be provided through the Sunshine Cove (formerly Wises Farm) area.

We are also assuming that fast services between Maroochydore, Kawana and Caloundra will be provided by rail. Therefore, motorway express buses between Maroochydore and Kawana could be withdrawn when the railway is in operation.

As a final assumption, for passenger convenience and quality of urban form, it has been assumed that the rail/bus interchange will, where possible, be constructed as an integrated off-road facility. This facility will provide amenities for waiting passengers as well as bus loading, unloading and turning capacity.

Operational considerations

Depending on the rail option chosen, the Sunshine Plaza bus station and the bus station located at the future Maroochydore rail station will be within 200m to 800m of each other. The Sunshine Plaza bus station has severe space constraints which limit the number of platforms available and the space for manoeuvring of larger buses. There is the opportunity at the railway interchange/bus station to make space available for both in-service and bus layover bays.

Due to future space limitations brought about by development pressures, the nature of operation of the Sunshine Plaza bus station will need to change. Currently it serves as the main terminus for services to Maroochydore with interchange between services and many services have layovers at the station. In the future there will be no space at Sunshine Plaza for layovers but space will be available at the railway station for layovers and adequate driver

facilities can be provided. It will be a matter of operational efficiency and other design factors that will determine whether such a facility also caters for bus lay-over and driver amenities on site or elsewhere.

The Sunshine Plaza bus station, or an alternative principle through-running station nearby, will still be a very important node for services and all services should route via the vicinity of Sunshine Plaza. No services should however terminate at the Sunshine Plaza and timed transfers and layovers should occur at the railway bus interchange/station. The railway station would therefore be the major interchange for Maroochydore with intermodal and inter-route interchanges occurring here.

The operation of services would be as follows:

- services terminating in Maroochydore, whether entering from the north or south would first route via the Sunshine Plaza and then terminate at the railway station
- services not terminating in Maroochydore would route via Sunshine Plaza and the railway station so as to avoid any "double back". i.e., services entering Maroochydore from the west would go first to the rail station and then Sunshine Plaza, while those from the east would go first to Sunshine Plaza and then the railway station.

The total number of services planned to terminate in Maroochydore in 2026 is 46 per hour in the peak and 40 per hour in the inter-peak period. There are only four services per direction in the peak and inter-peak periods that do not terminate at Maroochydore.

The very large number of buses terminating at Maroochydore means that not only will there be a requirement for a large number of buses to layover at the terminus, but there will also be the potential for serious bus congestion on the main street (Plaza Parade) linking the two termini.

One solution to this problem is to introduce a greater level of through routing than is currently anticipated by the TransLink Transit Authority. The normal through routing process is to have complete routes being routed from one terminus, through Maroochydore to the other outer terminus.

Through routing has the advantage of:

- reducing the need for bus layover (which takes up valuable real estate in city centre)
- reducing the number of buses circulating city streets as each pair of routes needs to serve each bus station only once (see Figure 5-4).

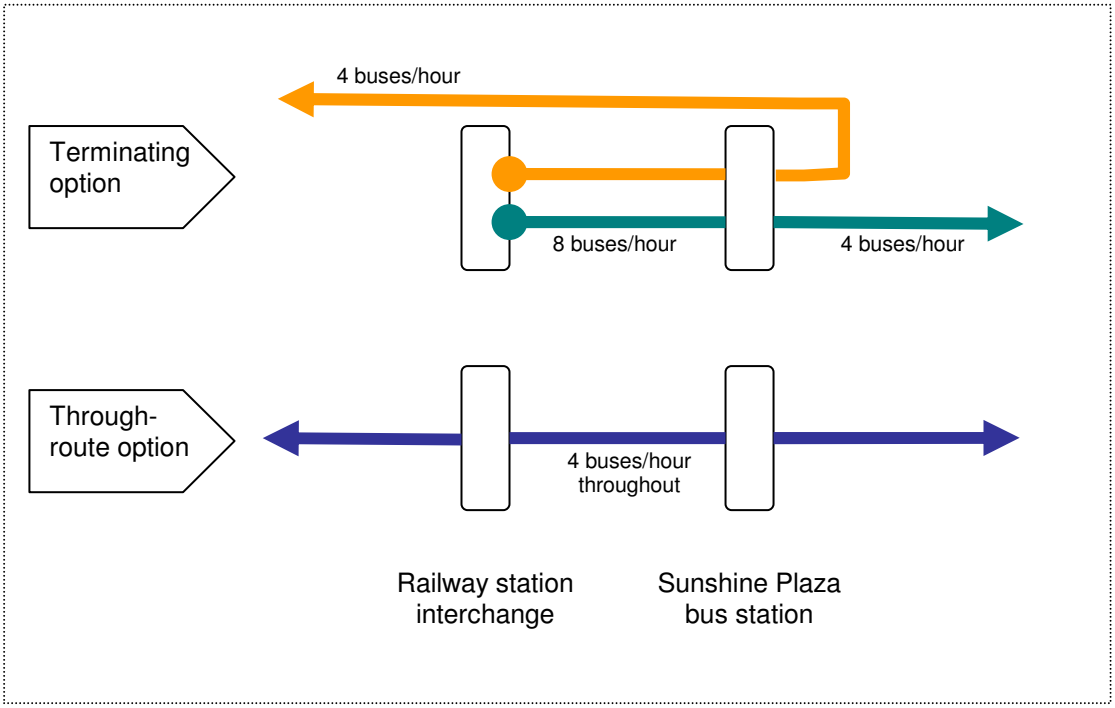


Figure 5-4; Example bus circulation impact of different route structures

There are a number of disadvantages to through routing, which need to be carefully managed:

- routes need to be designed with balanced flows in each direction
- there is no timetabled recovery period between outer termini. This can affect the reliability of services
- driver facilities still need to be provided, but can no longer be provided at one central location.

With the risk of 'knock-on' errors, effective operation of through routing requires punctual services. Ideally, bus services require on-road priority to bypass traffic congestion along the route.

For some of the study options, through-routing is essential for adequate performance of the bus network; for others it is a desirable feature.

5.6.3 Bus interchange design opportunities

Constructing a rail/bus interchange in a busy town centre creates numerous challenges. These include the need to provide an attractive facility to support passengers, a 'street face' to support quality urban development and the need to construct a facility that is operationally effective.

This section discusses some solutions that have been developed in Australia and overseas which are of specific interest to the Maroochydore bus/rail interchange.

Interchange integrated with streetscape

It is possible to integrate a railway station into the streetscape; visitors to London will be familiar with the 'shop front' entrances to many Underground stations.

Figure 5-5: Kensington High Street underground station

(source: Wikipedia)

The same approach can also be taken with bus stations. The example below is from Christchurch, New Zealand, which shows the street entrance to the city centre 'Bus Xchange'.

In Maroochydore, a street frontage could be provided as a façade to sleeve an elevated or at-grade station, or constructed over an underground station.

Figure 5-6: Christchurch Bus Xchange

(Source: PB)

Bus interchange below rail alignment

Providing a quality environment for bus/rail interchange with an elevated rail line is challenging. The examples below are proposals on how this can be achieved.

Figure 5-7 – Artist's impression of elevated rail in Maroochydore showing low visual impact rail design and use of space for bus stops and circulation. This could be either of the elevated options.

Figure 5-7: Artists impression, bus and rail, Maroochydore

(Source: Deicke Richards)

Figure 5-8 – Example from California, showing how an elevated rail line, bus circulating area and public plaza could be combined. This particular example could be applied to the Plaza Parade entrance to the Carnaby Street elevated option: the public plaza would link the station/interchange and Sunshine Plaza shopping centre

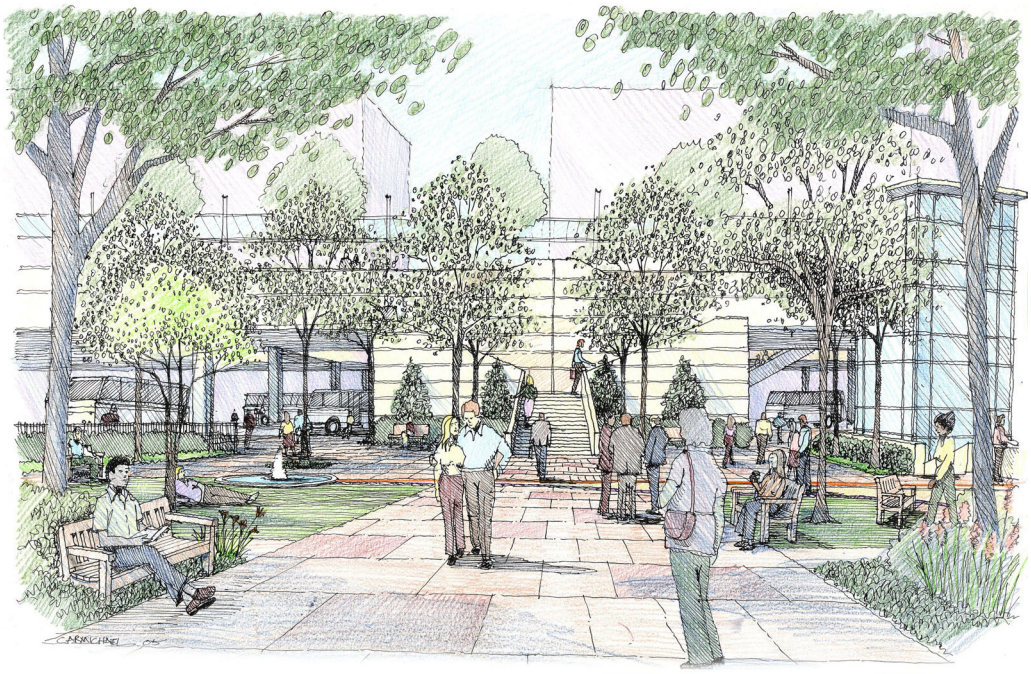


Figure 5-8: Artists' impression. Silver Spring Transit Centre

(Source: PB)

Kerbside stops

Kerbside (on street) stops are the easiest and cheapest type of bus stop to provide. TransLink has standards for kerb-side bus stops, and they range from basic stops to 'signature' stops for important destinations.

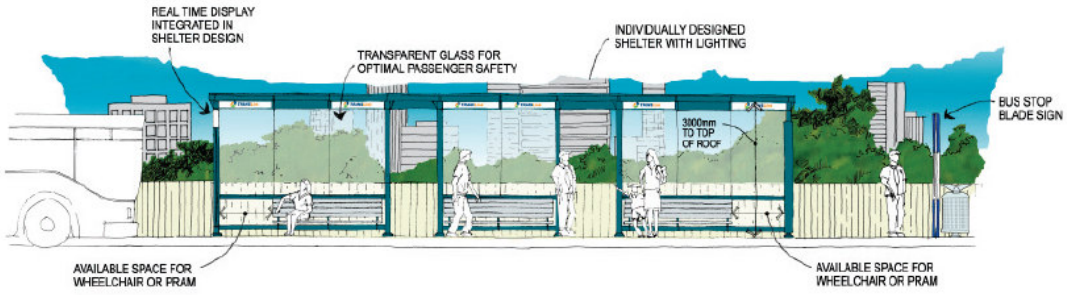


Figure 5-9: Kerbside "Signature" stop

(Source: TransLink Transit Authority)

However, if large numbers of buses are to be provided, they take up a large amount of street space, and lead to a lower quality of streetscape (see Figure 5-10). They are also less than satisfactory for transfer stations, as there is a longer distance for transferring passengers to walk, compared with a 'platform' based arrangement.

In Maroochydore, kerbside stops are acceptable for lower volume stops or routes, but are not preferred for the main interchange locations (unless there is no other choice).

Figure 5-10: Bus mall, central Townsville, showing kerbside stops

(Source: PB)

Bus interchange above rail alignment

Vertical 'stacking' of rail and bus facilities provides a good environment for passenger transfer as well as efficient use of land. The example below is Whitfords, on the Perth Northern Suburbs Railway line. Buses circulate above a rail platform, with lifts, escalators and ramps connecting the two. The entire interchange is within the 'paid' zone so passengers transferring can do so without the inconvenience of revalidating their tickets.

At Whitfords the rail runs in the median of a freeway, so visual amenity is not of major importance. For Maroochydore, if this type of design were adopted, the entire interchange would be contained within a structure with appropriate street frontage.

Figure 5-11: Bus/rail interchange at Whitfords, Perth

5.6.4 Route/station specific issues

Option 1 (Existing Caboolture to Maroochydore Corridor Study at-grade option)

The existing Caboolture to Maroochydore Corridor Study option has the railway station located well to the west of the town centre proposed in the Maroochydore Centre Position Paper, Horton Parade and the Sunshine Plaza. Hence, a large portion of the existing and proposed town centre is *outside* the walking catchment of the interchange.

The other major issue with the existing Caboolture to Maroochydore Corridor Study site is that there is insufficient space at the station for an off-road facility, as a very narrow corridor has been reserved for the railway station. This means either buses will need to use on-street (kerbside) stops and circulate using Carnaby Street, or acquisition of land will be required. This latter option will be expensive as all land in the area is developed or is currently under development. With the use of already busy streets in the Carnaby Street precinct, there is potential for serious local traffic congestion.

The number of buses likely to be using the interchange in the future will present design challenges. Careful detailed design will be required to ensure all bus movements are accommodated within the interchange so that as far as possible, seamless transfer between modes and services is achieved.

The location of the rail corridor directly adjacent to the Maroochy Boulevard also means that there is insufficient space for construction of a road overbridge to connect Dalton Drive to Maroochy Boulevard. As a result, there will be no capacity for bus services entering Maroochydore from the Boulevard to directly access the 'health hub' precinct and the new town centre. All services will need to run the length of the Boulevard and enter via Plaza Parade. This means a less direct service with some inefficient back tracking.

A through-running network design will be essential for this option, as there will be limited if any capacity of buses to terminate at the railway station. There is also the potential for bus traffic congestion on Plaza Parade if buses terminate at Sunshine Plaza and are required to serve both locations. These issues combine to reduce the attractiveness of this option.

Figure 5-12 shows the public transport map from the Maroochydore Centre Position paper.

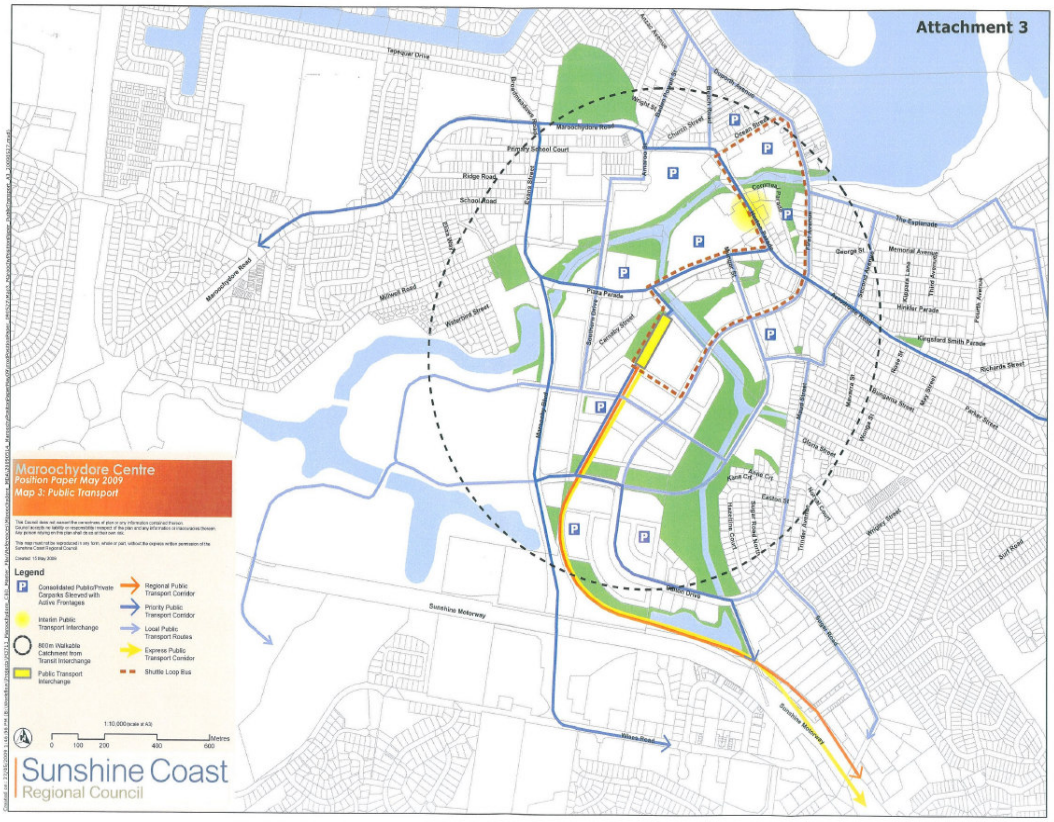


Figure 5-12: Public transport map (Sunshine Coast Regional Council, May 2009)

Carnaby Street station location – common features

A significant portion of the town centre, including Sunshine Plaza, is within 400-800m walking distance of the proposed main bus/rail interchange. However the Aerodrome Road precinct and sea-front are outside the comfortable walking catchment.

Local bus services including a "shuttle loop" are proposed in the latest Council master plan (in the Maroochydore Centre Position Paper) to provide circulation to the upper town centre (south/west of Aerodrome Road) and the Carnaby Street office and mixed use/retail precinct. The likely street network outcomes allow for through link to the health hub precinct and town centre for both local and inter-regional bus services.

An off-road bus station/interchange (e.g. under rail platforms) minimises bus traffic circulation impacts.

Through-routing allows both ends of the town centre to be served while reducing the number of buses traversing Plaza Parade. In this example, express services from the north and west have been through-routed, as have local services between the north (Buderim/Coolum) and southern inland (Sippy Downs) areas.

Option 2 (Carnaby Street, sub-grade)

The sub-grade option has the disadvantage of requiring a specific allocation of land for bus interchange (compared with an elevated option where bus platforms can be 'tucked under' the rail structure).

Land in the town centre is likely to be at a premium and extensive allocation of space for a bus facility is considered undesirable from an urban land form point of view. (The primary reason for the sub-grade option is to hide the transport infrastructure.)

While it is possible to incorporate bus facilities into a quality urban environment (see Christchurch 'Bus Xchange'), it is preferable to minimise use of land for service infrastructure to allow more productive use of the land (such as commercial or retail use). Layover bays for buses between runs takes up valuable real estate and is not desirable. For this reason, through routing becomes more attractive.

Option 3 (Carnaby Street, elevated)

The elevated option is ideal for bus/rail interchange opportunities, as the bus station can be tucked under the rail structure

The footprint of the elevated station is approximately 200 m long by 50 m wide with street frontages on at least three sides. This provides excellent opportunity for provision of both in-service and layover bays on bus platforms tucked under the elevated rail platforms.

The need to serve both bus stations means that careful design of bus routes is required to avoid congestion on Plaza Parade. This means

- through routing of local services
- routing of line haul services first to Sunshine Plaza then to the rail station interchange.

Option 4 (Carnaby Street, at-grade)

Providing a quality bus interchange for the at-grade option can be achieved through the construction of a bus/rail interchange with ground-level rail platforms and elevated bus platforms. This is effectively the inverse of option 3.

It is likely that this option will, in itself, generate a lower quality urban environment due to the degree of severance introduced by the rail line. For this reason, the impact of the bus station on the urban environment is lower than the grade separated options.

The footprint of the elevated station is approximately 100 m long by 50 m wide with street frontages on all four sides. This provides excellent opportunity for provision of both in-service and layover bays, albeit at greater cost than the elevated option.

The need to serve both bus stations means that careful design of bus routes is required to avoid congestion on Plaza Parade. This means:

- through routing of local services
- routing of line haul services first to Sunshine Plaza/Horton Parade then to the rail station interchange.

5.6.5 General recommendations

In order to optimise bus and rail operations in Maroochydore, the Council's centre planning has now addressed:

- configuration of the road network to ensure smooth connectivity (NS spine and EW link)
- provision for bus routes to new areas, especially the town centre core and Wises Farm
- maximise through running, especially for local services
- minimise terminating services (possibly CoastConnect services only)
- provide layover for terminating services at railway station, if option permits
- extend quality bus corridor treatment along Plaza Parade to Railway Station
- run all services once to both the Horton parade end of Sunshine Plaza and Railway station, assuming option permits.

Ultimately, the details of the Maroochydore bus service plan will be determined after a more detailed examination of travel patterns and a confirmation of the broader bus network. This will guide the detailed planning of this bus interchange.

5.6.6 Conclusion

From the point of view of quality urban environment and convenience for transferring passengers, an elevated rail station with integrated bus platforms below is the best option for the Maroochydore Railway Station.

The existing Caboolture to Maroochydore Corridor Study option is less satisfactory than the Carnaby Street options, as it is located beyond convenient walking distance from the main town centre locations. Additionally limited land supply means that an off-road bus interchange cannot be well integrated, and local streets will need to be used for bus movements.

To minimise the impact of buses, it is strongly recommended that a route network be developed that maximises the number of buses through-routed through Maroochydore and minimises the number of buses terminating in the centre. Where routes are required to terminate, or services need to wait for timing purposes, the railway station interchange should be used in preference to the shopping centre bus station.

5.7 Noise and vibration

A desktop noise assessment of the proposed public rail transport corridor route options has been undertaken to provide information for the selection of a preferred route.

The options were assessed quantitatively and qualitatively to enable a relative comparison of noise and vibration impacts during both the construction and operational phases of the project.

Operational noise levels are normally assessed in terms of LAeq,24hour, L_{max} and also the WHO guidelines for minimisation of sleep disturbance. This assessment was undertaken prior to the release of the Maroochydore Centre Position Paper and so no longer closely reflects the land uses. However, general statements can be made and a largely qualitative assessment of the noise impacts is reported here. For more detail of the earlier work, reference may be made to section **5.7 Noise and vibration** in the draft Maroochydore Station Corridor Study Report available at www.pb.com.au/maroochyscsc and www.transport.qld.gov.au/maroochystation

Noise impact with the potential to cause sleep disturbance proved to be a concern for all options. In addition to this it was found that due to the intermittent nature of the noise associated with the transportation corridor, criteria based on the number of residential dwelling units potentially affected by maximum noise levels was considered the most appropriate method of comparison of route alignment options.

With regard to potential noise impact, the below ground Carnaby Street option has the lowest operational impact and the elevated Carnaby Street has the highest operational impact. The at-grade option has the lowest construction noise impacts.

5.7.1 Existing environment

Description of the study area

The area surrounding the proposed station sites is mostly currently being developed. Figure 5-13 shows the allotted planned areas according to the Maroochydore Centre Position Paper.

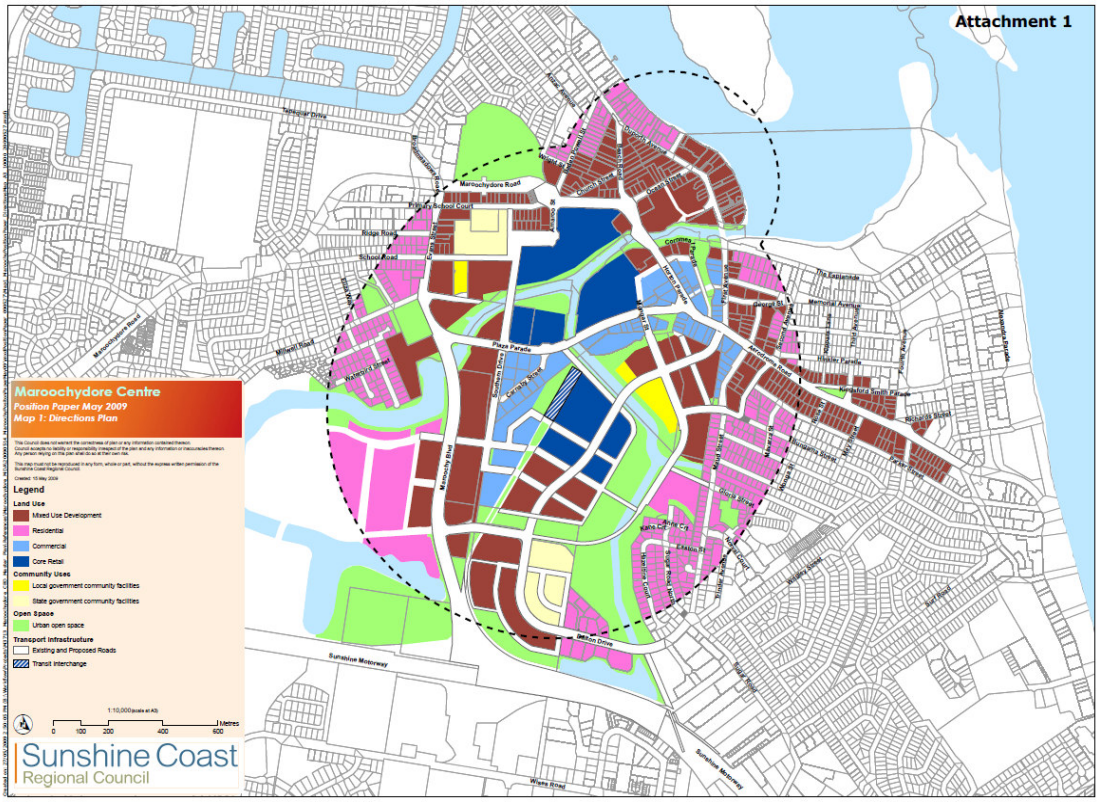


Figure 5-13: Planned area usage (Directions Plan, Sunshine Coast Regional Council may 2009)

5.7.2 Previous noise studies

Reference was made to the *Caboolture to Maroochydore Corridor study – Final Impact Assessment and Land Use Transport Strategy* – Feb 2001. However, the noise levels discussed in the report were found to be unsuitable for the current study, since the size of the study area was much greater than the area under consideration.

For the purpose of this study the area being assessed was divided into zones to allow for analysis on a 'by zone' basis. However, as these zones were based on earlier concept plans

and do not reflect the Directions Plan of the new Maroochydore Centre Position Paper, this is not discussed further here. More detailed noise impact investigations will be undertaken as part of the detailed environmental study closer to the time of construction of the project.

5.7.3 General noise and vibration assessment

Option 1 – Original Caboolture to Maroochydore Corridor Study Alignment

This option is the original approved alignment. The rail will run at grade and the roads will be elevated above the rail line. The station will be at ground level. The noise mitigation for this option is likely to be a 3 m high, non absorbing noise barrier the entire length of the track..

Option 2 –Carnaby Street sub-grade

The operational noise of this solution is reduced as compared to the at -grade or elevatednd solutions. The noise mitigation measures for this option would likely be a 3 m high, non absorbing noise barrier the length of the track that is above ground.

Option 3 –Carnaby Street elevated

This option follows the same alignment as the sub-grade solution. The operational noise of this option is comparable to the Carnaby Street at-grade solution (option 4). However, being elevated the original noise assessment applied a noise correction figure of +3dB to the bridge sections. The noise mitigation measures for this option is likely to be a 3 m high, non absorbing noise barrier the length of the track that is at grade level, connecting with a 1 metre parapet for the length of the elevated section.

Option 4 –Carnaby Street at-grade

This solution is constructed at ground level with roads being built over the rail line where required. The operation noise of this solution is similar to the elevated solution, but more than the sub-grade solution. The noise mitigation measures for this option are likely to be a 3 m high, non absorbing noise barrier the entire length of the track.

5.7.4 Construction noise

The construction noise impact is largely determined by the level of development of the surrounding area during the time of construction. If the area is undeveloped the construction noise and vibration impact will be low regardless of the alignment.

During the construction phase elevated noise levels for periods of time during the day can be expected close to the works area. The source of the major noise impacts would be associated with the following activities:

- site preparation (vegetation clearance, levelling, access track preparation etc)
- foundation excavation and installation
- erection of structures
- associated construction vehicle and equipment movement.

Table 5-22: Typical noise levels for construction equipment (Source: AS2436:1981)

Equipment type	Sound power level dB(A)
Pile driver (2 tonne drop hammer)	114 to 128
Trenching hammer (sheet piles)	114 to120
Rotary bored piles	112 to 124
Scrapers	116 to 121
Crane, truck mounted	118 to 120
Rollers	110 to 119
Dozers	115 to 118
Graders	114 to 118
Excavators	114 to 118
Dump trucks	102 to 114
Saw cutting equipment	105 to 118
Slip form paver	99 to 112
Trucks	103 to 108

Option 1 - Caboolture to Maroochydore Corridor Study

This option will have comparatively minimal construction noise and vibration due to ground level construction. Vegetation clearing, site levelling and concrete pouring and associated minor earth works are expected to be the major noise and vibration contributors.

This option will have relatively minor construction noise impacts on existing residences as the area is sparsely populated.

Option 2 – Carnaby Street sub-grade

Construction noise impacts of any of the Carnaby Street options would be minimised if construction activity is undertaken at an early staqe of town centre development as the station and corridor is relatively remote from sensitive existing intensive development other than a residential building opposite the Maude Street canal.

This sub-grade option will have comparatively major construction noise and vibration due to the heavy machinery and earth moving associated with a cut and cover tunnel system. In addition to this other noise sources expected are vegetation clearing, site levelling and concrete pouring.

The construction noise of this option will be high compared with the at grade solution due to the necessity of earth works and heavy machinery operations.

Option 3 – Carnaby Street elevated

The construction noise and vibration of this solution is higher than the at grade solution and less than the below ground solution. The nature of the noise will be determined by the elevation method chosen. It is expected that drilling, pile driving and heavy machinery will be the main noise sources.

Option 4 – Carnaby Street at-grade

The construction noise of this solution is less than both the elevated and below ground solutions. The main construction noise contributors are expected to be vegetation clearing, site levelling, concrete pouring and the relatively minor earth works required.

The noise impacts from these construction activities would be minimised through the implementation of appropriate mitigation strategies including:

- use of noise suppression measures on all construction equipment
- limiting the times of construction activity when nuisance could occur
- advising nearby affected residents of construction activities including the expected duration of construction and the nature and route of construction traffic.

The extent of noise suppression techniques required will be partly dependent on the sequencing of development and the extent of urban development that is in place by the time the station and rail line is under construction.

5.7.5 Operational noise

The Maroochy Shire Council Planning Scheme Policy No.7 – Acoustic Environment Assessment section 3.5.1 Rail Traffic Noise (Planning Level) states that new rail corridor design much achieve the limits stated within the "Railways" section of Schedule 1 of the Environmental Protection (Noise) Policy 1997. This schedule states:

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

(a) 65dB(A), assessed as the 24 hour average equivalent continuous A-weighted sound pressure level;

(b) 87dB(A), assessed as a single event maximum sound pressure level.

Noise impact investigations indicate that the MSC requirement of 65 dB(A) for L_{eq24} is not exceeded by any of the options.. In addition, none of the options will exceed the requirement of 87 dB(A).

The preliminary results from this analysis would indicate that all the alignment options will cause no disturbance to any of the residents. However, it can be expected that there will be an impact on the residents when there is a certain rise in the noise at a location

5.7.6 Sleep disturbance

Sleep disturbance is measured as the L_{max} for a noise event inside the dwelling. The facade of the building is reasonably expected to give a 5 dB reduction[5] to the L_{max} Figure measured outside the dwelling. According to *Maroochy Shire Council Planning Scheme Policy No.7 – Acoustic Environment Assessment section 3.3.2 Sleep Disturbance* the external L_{max} event for R1-3 rated areas cannot exceed 50dB(A) and R4-6 cannot exceed 55 dB(A) during the hours of 10:00 pm to 7:00 am. As there is a major health hub facility proposed in close [proximity to the options considered, additional restrictions apply to this area. The sleep disturbance external L_{max} for hospitals is 45 dB(A).

[5] Maroochy Shire Council Planning Scheme Policy No.7 Section 3.3.2

Regardless of the alignment chosen, the health hub location will require additional noise mitigation measures to ensure compliance with the Maroochydore Shire Council environmental noise specifications. The Carnaby Street sub-grade option has a clear advantage with regard to sleep disturbance criteria.

5.7.7 Results

Construction noise and vibration

As the construction sites for the options are currently sparsely populated, construction noise and vibration impacts are expected to be relatively minor. This is assuming that there will be no blasting required for construction.

Table 5-23 shows a summary of the comparative construction noise and vibration levels for the alignment options.

Table 5-23: Comparison of construction noise and vibration levels

	Option 1	Option 2	Option 3	Option 4
Construction noise and vibration impact	Low	High	Moderate/ High	Low

Rating from most preferable to least preferable:

- Option 4 - Carnaby Street alignment, at grade
- Option 1 - Original Caboolture to Maroochydore Corridor Study Alignment
- Option 3- Carnaby Street alignment, elevated
- Option 2 - Carnaby Street alignment, sub-grade

Operation noise and vibration results

Operational noise assessment is based on the area being fully developed and associated impacts on the population in the developed areas.

Table 5-24 shows a summary of the comparative operational noise and vibration impact for the alignment options.

Table 5-24: Comparison of operational noise and vibration impact

	Option 1	Option 2	Option 3	Option 4
Construction noise and vibration impact	High	Low	High	Moderate

Rating from most preferable to least preferable:

- Option 2 – Carnaby Street alignment, sub-grade
- Option 4 – Carnaby Street alignment, at grade

- Option 1 – original Caboolture to Maroochydore Corridor Study Alignment
- Option 3 – Carnaby Street alignment, elevated

Option 1 – Original Caboolture to Maroochydore Corridor Study

Of the four options, this option is the third least preferable from an operational noise analysis.

Option 2 - Carnaby Street alignment, sub-grade

This option is the most preferable option from an operation noise and vibration analysis perspective provided that suitable mitigation measures are in place to isolate the track vibration from the underground structure. This option has very little airborne noise as the tunnel effectively negates the air borne noise in the underground section. However the vibration from the track will need attention. Vibration isolation treatments will be effective in reducing the vibration transmitted to the nearby mixed use areas. In particular, if any above ground building structures form and integral part of the track slab support structure, then vibration isolation treatments would be critical and essential. However, the Directions Map of the Council's Maroochydore Centre Position Paper does not provide for buildings to be constructed over the rail corridor.

Vents from the underground station will be a cause of airborne noise and will need to be treated as well.

Option 3 - Carnaby Street alignment, elevated

This option is the second least favourable option from an operation noise and vibration analysis. The noise from the elevated structure will have a higher impact than an equivalent at grade alignment.

Option 4 - Carnaby Street alignment, at grade

This option has a lower impact than the elevated option, but a higher one than the sub-grade option.

Sleep disturbance

The alignment options are rated from most preferable to least preferable as follows:

- Option 2 –Carnaby Street alignment, sub-grade
- Option 4 – Carnaby Street alignment, at grade
- Option 3 – Carnaby Street alignment, elevated
- Option 1 – original Caboolture to Maroochydore Corridor Study Alignment.

The below ground option causes the least impact on the residential areas. The elevated option causes the greater impact on the residential areas and the original Caboolture to Maroochydore Corridor Study alignment has the greatest impact of all the options.

The differences in land use distribution associated with the Directions Plan of the Council's Maroochydore Centre Position Paper have not yet been modelled from a noise sensitivity perspective. It may mean that differences in relative locations of residential concentrations may affect the relative exposure to some extent. Further assessment would be appropriate at the design stage of the project.

5.7.8 Construction noise and vibration

All options meet DERM standards for construction noise.

As the construction sites for all options are currently sparsely populated, construction noise and vibration impacts are expected to be relatively minor. This is assuming that there will be no blasting required for construction. Table 5-25 lists the ratings achieved by each option.

Table 5-25: Option scores, construction noise and vibration

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	5
2	Carnaby Street alignment, sub-grade	1
3	Carnaby Street alignment, elevated	2
4	Carnaby Street alignment, at-grade	5

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.7.9 Operational noise and vibration

Operational noise assessment is based on the area being fully developed and associated impacts on the population in the developed areas. Table 5-26 lists the ratings achieved by each option.

Table 5-26: Operational noise and vibration

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	1
2	Carnaby Street alignment, sub-grade	5
3	Carnaby Street alignment, elevated	1
4	Carnaby Street alignment, at-grade	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.8 Geotechnical constraints

The corridor design option for each alignment is discussed in terms of local geology, geomorphology and the geotechnical constraints that may arise due to the local conditions.

5.8.1 Sub-grade (cut and cover) option

The subsurface materials along the proposed Carnaby Street alignment are expected to comprise predominantly sand with some clay and mud. The source, composition and thickness of un-engineered fill on portions of the Horton Park Golf Course are not known.

The saturated, unconsolidated estuarine and possibly tidal delta sediments are expected to be collapsible in deep excavations. All excavations are expected to require wall support and possibly dewatering.

Engineering design will have to consider:

- potential differential settlement

- potential “large” total settlement and long term creep settlement
- uplift forces due to shallow groundwater level.

Constructability of the proposed structures will require careful consideration and planning due to:

- saturated subsurface soils
- poor trafficability on the surface due to shallow groundwater and poor drainage
- potential flooding of the area during construction due to low surface RL and hydraulic connection to the Cornmeal Creek
- potential environmental risk due to prolonged dewatering
- potential presence of acid sulfate soils (ASS).

Sandy materials excavated from cuts are expected to be suitable for re-use as bulk fill, provided any present ASS is neutralised first. Clayey and muddy sediments are not expected to be suitable for re-use, but are expected to require on site or off site treatment if ASS are present.

The proposed tunnel could act as a subsurface barrier to the groundwater flow in the area. Engineering design will have to consider potential damming effect of the proposed structure. Hydrogeological assessment will be required to better understand the effect of this design option on the groundwater flow in the area.

5.8.2 At-grade option

Potential embankment heights will depend on the results of detailed flood studies. It is estimated that embankment height may be about 1.0 m to 2.0 m above existing surface level.

Foundation materials for the embankments along the alignment are expected to be mainly sand with potentially compressive clay and mud layers. Settlement of embankments on mainly sand is likely to occur relatively rapidly and will need to be considered in the design of the embankments. Embankments in areas of underlying soft clay and muddy layers could present problems of stability and may experience long-term, slow settlement. There is likely to be variations in settlement along the alignment due to the differing thicknesses of the soft soil layers. Settlement could be induced by pre-loading of the area prior to construction.

Settlement analysis, based over a 1 year time frame, for a 3.5 m high embankment in a project area similar to this project suggests that total settlement could be in the range of 25 mm to 250 mm.

Embankments over 3 m high on soft soils may be potentially unstable. Ground improvement treatment options should be considered to accelerate the rate of consolidation and reduce total and differential settlement risks. Techniques may include:

- surcharged embankments with or without wick drains, geotextiles or geogrid reinforcement
- stone columns
- embankment supported on piles (wooden piles can be considered) or control modulus columns including transition layers

- controlled modulus columns act as unreinforced displacement columns that use a special auger to displace the soil laterally. This system results in a soil/cement composite column that increases the stiffness modules of the surrounding soil. It produces a minimum of spoil and is useful in environmentally sensitive areas, where potential acid sulfate soils (PASS) may be encountered.
- dynamic replacement columns on typical 5 m grid to depth of 5 m to 6 m
- partial or full excavation and replacement of soft/firm soils (must consider PASS constraints).

Depending on the characteristics of the un-engineered fill, it may need to be removed and replaced with suitable bulk fill. Should the fill comprise material suitable for embankment then it will need to be re-compacted and possibly excavated, conditioned, placed and then re-compacted to produce suitable embankment foundations.

After removal of topsoil, surface preparation should be in accordance with the Queensland Rail Civil Engineering Standard Specification, section 6.9.2. Any unsuitable material found either in the fill, or along other sections of the alignment, will need to be removed and replaced.

The proposed embankment could potentially squeeze AASS and PASS out from the foundations. Once exposed, or elevated above the groundwater level, these soils could rapidly oxidise and have high potential to cause environmental harm.

The embankment is likely to be exposed to periodic flooding. Appropriate engineering design measures will need to be considered to reduce potential erosion of embankment toes and risk of instability due to saturation.

Embankment material will need to meet the Queensland Rail Civil Engineering Standard Specification, section 6.9.3.

Aerial photographs indicate that the Caboolture to Maroochydore Corridor Study alignment is over an area that is underlain by in situ soils. All materials for the embankments will be imported after ground improvements to the existing soils.

Un-engineered fill appears to be present throughout the HPGC and in an area just south of it. The length of alignment over this fill is approximately the same for both the HPGC and the Carnaby Street alignments. In these areas the un-engineered fill will have to be treated as described within this section above. However, it is anticipated that the existing fill materials will generally be suitable as bulk fill for the proposed rail embankments, except for outer verge and capping/Top 600 layers (as described in Queensland Rail Standard Specification: Earthworks).

5.8.3 Elevated option

The proposed railway line could be constructed as an elevated structure. This option would require deep foundations to provide sufficient vertical and lateral support for the expected loads. Bored or driven piles, founded on residual soils or weathered rock could be considered as foundation types.

Previous investigations (QASSIT, 2002) indicated that unconsolidated sediments were encountered at depths up to 8.5 m and could potentially be found up to about 15 m to 20 m depths.

Bored continuous flight augur (CFA) piles

Bored piles could be used to support the proposed elevated structure primarily in shallow alluvial soils or residual and weathered rock. The main advantage of these piles would be that they can be constructed in soils with strongly cemented B horizons of former podzolic soils (coffee rock). However, disadvantages of this method, including the disposal of the ASS and use of a sacrificial liner may be required. These piles may not be practical for use in the wet subsurface conditions expected along the proposed alignment.

Grouted piles (continuous flight auger, CFA piles), a variety of bored piles, is commonly used in unconsolidated, saturated soft soils. The advantage of these piles is that strongly cemented coffee rock can also be penetrated and foundation length can be varied depending on localised conditions.

Driven piles

Pre-cast concrete or steel driven piles could also be considered as foundation options for elevated structures. The advantage of driven piles is that there are no excavations for the installation of these piles, therefore no risk of hole collapse or oxidisation of ASS. However, driven piles should be protected against potential attack from ASS.

Penetration of areas of continuous, strongly cemented, thick layers of coffee rock may be difficult for driven piles.

5.8.4 Summary

Table 5-27 summarises the potential geotechnical constraints for the different design options.

Table 5-27: Design options and potential geotechnical constraints

Option	Potential geotechnical constraints
Subsurface (cut and cover)	▪ large volume excavations in potential ASS ▪ disposal or treatment of ASS ▪ excavation support in collapsible, saturated soils ▪ expected high total and differential settlement if soft soils are encountered ▪ shallow groundwater requiring dewatering ▪ potential interference with groundwater flow.
At grade (embankment)	▪ un-engineered fill removal/re-compaction ▪ soft foundation materials with expected high total and differential settlement ▪ embankments over 3m high on soft soils may be potentially unstable ▪ may require long-term pre-loading and consolidation monitoring ▪ potential interference with ASS ▪ embankment will need protection from flooding.
Elevated structure	▪ CFA piles appear suitable for expected conditions ▪ driven piles: ‣ may be difficult to penetrate continuous coffee rock, if encountered ‣ exact determination of foundation depth required, usually >15m

Option	Potential geotechnical constraints
	‣ protection from potential effects of ASS needed. ▪ large pile caps required for elevated bridges.

5.8.5 Conclusions and recommendations

Based on the results of the desk-top assessment, the elevated option and the at grade (embankment) options appears to have a lower number of potential geotechnical/engineering constraints than the sub-grade (cut and cover) option and therefore should be considered as the preferred options.

A summary of geotechnical constraints shown in Table 5-27 indicate that the alternative design options for each proposed alignment exhibit similar constraints, and these are not sufficiently diverse to consider geotechnical, geological, topographic, geomorphic and soil characteristics as the key component in the alignment and design selection process. The design and construction for the subsurface option appears to have the higher associated costs.

Regardless of the adopted option, detailed geotechnical investigations will be required to assess the subsurface conditions along the proposed alignment, including the geotechnical characteristics of the fill, estuarine sediments, presence of coffee rock, consolidation characteristics of the soils, ASS management and groundwater.

5.9 Economics

5.9.1 Introduction

MacroPlan was commissioned by the then Maroochy Shire Council to conduct an evaluation of the community benefits of a rail alignment and station for the Maroochydore CBD. Several alignment options and station configurations were analysed during the assessment process. The MacroPlan report represents the outcomes of the assessment of the original 7 rail options into the Maroochydore CBD. This findings report only deals with those aspects of the MacroPlan report relevant to the four options discussed herein.

The MacroPlan work was undertaken in response to earlier versions of the Maroochydore Master Plan and has not been informed by the later refinements as endorsed by the Sunshine Coast Regional Council and illustrated by the Directions Plan of Council's Maroochydore Centre Position Paper.

MacroPlan adopted an integrated project evaluation framework to identity indicative and qualitative benefits of the options. This approach considers all impacts associated with the project and where possible identifies benefits in monetary terms. The study considered three alternative rail alignments and configurations, which were tested against a base case option.

5.9.2 Promoting retail

Option 3 (Carnaby Street elevated) is likely to support a range of retail development in and around the station location and accessibility to areas leading to the station location due to its elevated nature. Options1, 2 and 4 are more likely to restrict retail opportunities to areas

more closely associated with the station area due to the disruptive nature of construction around the entrance to the station.

Table 5-28: Retail generation potential

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment	3
2	Carnaby Street alignment, sub grade	3
3	Carnaby Street alignment, elevated	5
4	Carnaby Street alignment, at grade	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.9.3 Creates residential density

Option 1 (Original Caboolture to Maroochydore Corridor Study) runs through an existing developed area at Southern Drive. It therefore has less opportunity to provide for new residential development directly adjacent to the station. Vacant land to the southwest of the station site has potential for more transit oriented development although this precinct is poorly connected to the primary pedestrian core of Maroochydore City Centre and is unlikely to achieve a development density and outcome that readily supports a railway station.

Options 2, 3 and 4 are located at the back of adjoining buildings near Carnaby Street and Plaza Parade. A range of high density mixed use (retail, office and residential uses) is planned within the 400 m walkable catchment.

Table 5-29: Density/residential generation potential

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment	2
2	Carnaby Street alignment, sub grade	4
3	Carnaby Street alignment, elevated	4
4	Carnaby Street alignment, at grade	4

*Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.9.4 Developing sequencing issues

Development of option 1 can be processed without being encumbered by the rail construction program. This provides clear signals to the market and means that investment and development is likely to be brought forward.

The Carnaby Street options provide a range of impacts of development sequencing. Options 3 and 4 are problematic due to the engineering requirements, specifically supporting bridge construction and associated land impacts. Some areas are more likely to remain underdeveloped until the rail line and supporting access bridges can be more fully appreciated.

Development of the land in the study area is likely to start before construction of the railway line. It is therefore desirable that the railway solution supports staged development with minimal disturbance.

Table 5-30: Sequencing potential

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment	4
2	Carnaby Street alignment, sub grade	4
3	Carnaby Street alignment, elevated	5
4	Carnaby Street alignment, at grade	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.10 Residential, business and community issues

5.10.1 Potential social impacts

This section of the report outlines the potential social impacts associated with the various options proposed for the Maroochydore Station and associated rail line as described previously

5.10.2 Existing social setting

Construction and operation of the rail line and Maroochydore station in the existing undeveloped environment would render fewer social impacts when compared with the future developed scenario considered below. However, as described above, existing residential uses are located within the general vicinity of the project area and impact to the existing social setting may be expected including the following:

- construction noise impacts to surrounding residential and commercial development
- disruption to traffic flow on Maroochy Boulevard associated with raising of Maroochy Boulevard required for options 1 and 4
- disruption and changes to leisure opportunities currently afforded by the Horton Park Golf Course
- acquisition of property to establish the corridor alignment for all of options 2 , 3 and 4.

During the operation phase, impacts to amenity may be expected including noise impact and a reduction in visual amenity, particularly for those residences which currently experience inland views to Buderim Mountain (predominantly in the Millwell Street area).

5.10.3 Future urban development

The Sunshine Coast Regional Council has produced a Maroochydore Centre Position Paper for the central Maroochydore area which includes the study area. The Directions Plan identifies a number of different land use types adjacent to the Carnaby Street rail alignment and station location including:

- mixed use

- mixed use high density
- new public domain
- limited access open space
- waterbody.

In attempting to indicate the potential social impacts of the various alignments and station locations, it has been assumed that at the time that the project is actually constructed, the surrounding land parcels, such as Horton Park Golf Course, Christadale, Sunshine Cove (formerly Wises Farm), will be largely developed for urban purposes. However, given that the exact nature and form of future urban development in the area is only indicative at this stage, it is difficult to assess the significance or relative consequence of any potential impacts which may occur.

It is anticipated that potential impacts associated with the project will occur both during the construction and operation phases of the project. It is likely that key impacts during the construction phase will be associated with:

- construction noise impacts to surrounding residential and commercial development
- construction vibration impacts to surrounding residential and commercial development
- disruption to traffic flow on surrounding road networks due to construction works and potential heavy vehicle movements on local streets.

Operational phase impacts are likely to include:

- ongoing noise impacts associated with operation of the rail line
- ongoing vibration impacts associated with operation of the rail line
- visual amenity impacts to surrounding residential uses associated with the at-grade and elevated options.

It should be noted that the above mentioned noise and vibration impacts may be mitigated through appropriate minimisation measures incorporated into the detailed design of the project.

Land acquisition impacts are expected to be minimal in the future developed scenario as it is assumed that any land necessary for rail alignment and station location will be acquired during the future strategic planning and development of the surrounding area.

Despite the above listed impacts, it should be noted that provision of a rail system and station into Maroochydore is expected to deliver significant social, economic and community benefits. These benefits have been well documented in previous studies. The location of the rail line and station in a largely undeveloped area of Maroochydore provides an excellent opportunity to create a master planned community which appropriately accommodates and designs for future provision of the rail line and station whilst minimising adverse impacts to surrounding land uses.

5.10.4 Horton Park Golf Course development

The Maroochydore CBD planning process has identified the use of the Horton Park Golf Course land as critical to the development of a good CBD. During the course of this project, extensive consultation took place between the then Maroochy Shire Council, the Department

of Transport and Main Roads and the golf club and their original development partners. The Maroochydore Centre Position Paper confirms the intent to redevelop the golf course land for this purpose.

During this consultation it transpired that the golf course owners and their developers were strongly opposed to an alignment through the centre of the golf course all the way to Horton Parade opposite First Avenue. Their opposition stemmed from a concern that the railway alignment could jeopardise the financial viability of the development, due to:

- a risk that a cost-conscious future government would build an at-grade railway, leading to a poor quality urban environment and severance issues
- the need for urban development to take place before the railway was built. This would mean that a wide strip of empty land would run through the centre of the development and subsequent construction would disrupt established land uses..

Table 5-31 rates the overall impact on property owners of each option.

Table 5-31: Option scores, impact on property owners

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	2
2	Carnaby Street alignment, sub-grade	3
3	Carnaby Street alignment, elevated	3
4	Carnaby Street alignment, at-grade	3

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.10.5 Visual amenity

A Visual Assessment study has been completed for the study by specialists Deicke Richards. A summary of the findings follows:

View to railway

Elevated option

The elevated railway will be visible from Maroochy Boulevard as it passes alongside and overhead. It will also be visible as it crosses road corridors between buildings. It will be highly visible from adjacent buildings and at street level. Views will generally be of the supporting structures which can be selected to have minimal visual impact

At-grade options

The rail corridor is screened from view over much of its extent by buildings and vegetation. It will be highly visible from adjacent buildings and at street level.

This option generates three bridges which will have a visual impact and limit views along the adjacent road corridors

Sub-grade option

The rail corridor is not visible over most of its extent. There will be long retaining walls where the line cuts underground that may be visible at street level. Where it runs above ground, it is likely to be screened by surrounding vegetation

View from train

Elevated option

Provides best views of Maroochydore City and the surrounding area and provides an entry experience by familiarizing the traveller with the area on arrival. Particularly beneficial for promoting Maroochydore as a tourism centre

At-grade options

Views from the train are limited to passing view corridors between buildings over much of its extent. As the train approaches the station, bridges over the line limit views out at these points.

Sub-grade option

Offers a poor visual experience for the traveller. Views are of a dark tunnel for the majority of the journey and the traveller is likely to be disoriented on leaving the station.

Conclusion on visual amenity

Due to its location, the proposed railway corridor is visible from a limited number of viewpoints, all generally in the immediate vicinity. Adjacent vegetation and buildings screen most of the corridor.

The elevated and at-grade options are screened by vegetation and buildings over much of their extent, but visible along road or park corridors. The at-grade option would require bridge structures which will impact upon view corridors running along cross roads. The below ground option is the least visible, being located underground over the majority of its extent.

The elevated option offers the best views of the city and environs by users of the facility. This is especially valuable if the area is being marketed as a tourism destination. The at-grade option provides limited view corridors between buildings and along park corridors. Adjacent to the station, bridges will limit views at the crossroads. The sub-grade option does not provide views of the surrounding area and will not provide a memorable arrival for visitors to the area.

Given the minimal visual impact of the rail corridor in the area, the elevated rail option would be recommended as it offers the best passenger experience. Table 5-32 rates the options accordingly.

Table 5-32: Option scores, visual amenity

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	2
2	Carnaby Street alignment, sub-grade	3
3	Carnaby Street alignment, elevated	4
4	Carnaby Street alignment, at-grade	4

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.10.6 Disruption to traffic during construction

The at-grade options — options 1 and 4 — will have the greatest impact on traffic during construction, as they will require the reconstruction of Maroochy Boulevard for a rail crossing. Because of the large change in height and limited corridor space, this will require complete closure of the motorway during reconstruction.

Option 1 has the additional impact of requiring resumption or realignment of Southern Drive.

Table 5-33 rates the options accordingly.

Table 5-33: Option scores, disruption to traffic during construction

Number	Description	Rating*
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	1
2	Carnaby Street alignment, sub-grade	5
3	Carnaby Street alignment, elevated	4
4	Carnaby Street alignment, at-grade	2

* Rating scale: 5= 'Excellent', 4='good', 3='fair', 2='poor', 1='very poor'

5.11 Cultural heritage

ARCHAEO Cultural Heritage Services was commissioned by PB to undertake a cultural heritage due diligence investigation as part of the study.

The cultural heritage investigation particularly noted:

- the potential for sites of Aboriginal cultural heritage to be present; and
- whether the assessment considered that further study would be required to meet the requirements of the *Aboriginal Cultural Heritage Act 2003* and the *Queensland Heritage Act 1992*.

Briefly, the results of the investigation were as follows:

- no Aboriginal cultural heritage was noted during the field assessment component of the investigation:
- the study area has undergone varying levels of ground disturbance including high levels of historic modifications such as vegetation removal, construction of a golf

course, shops and roads and subsequently falls within Categories 2 and 3 of the Cultural Heritage Duty of Care Guidelines;

- sections of the study area still retain a low to medium potential for the existence of areas of cultural heritage significance including surface and subsurface artefact deposits; and
- there is limited potential for historic heritage to be impacted on.

It was recommended that

- Diligence should be practiced during any clearing or construction phases associated with future development of the study area; and
- If at any time during the development of the study area Aboriginal cultural heritage is found, and it is necessary to excavate, relocate, remove or harm it, then construction activity should cease immediately.

These conclusions and recommendations are based primarily on the results of the visual inspection of the study area.

6. Multi-criteria assessment

6.1 Evaluation methodology and criteria

The corridor options were evaluated using a pair-wise comparison technique. The results of the evaluation, including a discussion on the results of sensitivity tests for the evaluation, are presented below.

6.1.1 Evaluation criteria

Evaluation criteria were formulated so that a balanced evaluation of the proposed corridor options could be achieved. These were developed during a stakeholder workshop and refined by the study team.

The categories that were chosen for the evaluation criteria included:

- transport integration
- cost and engineering
- economic development outcomes
- urban placemaking
- natural environment.

Owing to the nature of the cultural heritage due diligence assessment, it has been is assumed that each option would have a similar potential for impact on cultural heritage. Consequently, cultural heritage was not included as a criterion to distinguish between options in the multi-criteria assessment.

The number of criterion that have been chosen are balanced so that the number of criterion within the “harder” transport and cost and engineering criteria sets are balanced with the “softer” natural and social environment criteria sets. Table 6-1 defines the evaluation criteria.

Table 6-1: Assessment criteria

	Transport integration	
A	Patronage potential	Station location delivers patronage.
B	Network efficiency	Bus and rail network operational efficiency.
C	Modal integration/bus interchange	bus, rail and road integration and interchanging.
E	Traffic/network permeability	How well the road network functions e.g. severance, grid structure.
	Engineering costs	
F	Construction cost	Rail and road impact.
G	Operating and maintenance cost	
I	Engineering compliance, constructability	
	Economics	
K	Promotes new retail	How well can the option deliver these GFA, catalyse investment, job creation, timing.

L	Creating residential density	How well can the option deliver these GFA, catalyse investment, job creation, timing.
O	Development sequencing of rail and land uses	Timing for delivery of the various development components and the options ability to support this, e.g. pre Caboolture to Maroochydore Corridor Study.
	Urban - placemaking	
Q	Quality of built form	Measured at street level and streetscape, and investment in built form and timing.
S	Compact city core	
T	Safety	
	Natural environment	
U	Impact on Cornmeal Creek/other waterbodies	
V	Other natural impact (e.g. significant vegetation)	
X	Flood risks and climate change	
Y	Soils and geology	
	Social environment	
Z	Construction noise and vibration	
AA	Operation noise and vibration	
BB	Visual amenity	
CC	Disruption to traffic during construction	
DD	Impact on existing property owners	Area of impact and number of owners and owner type - consider acceptance by owners.

6.2 Pair-wise criteria weighting

The first stage of a Multi-criteria Assessment (MCA) is a pair-wise comparison of criteria. This generates a weighting for each criterion.

The pair-wise comparison technique compares each of the criteria against each other sequentially. For example, criterion A is compared against criterion B in terms of which criterion is “preferred” over the other one. A “value” for this level of preference is then assigned to this comparison. The range of values that have been used are 3 = major preference; 2 = medium preference; and 1 = minor preference. A value of “0” is used if the two are considered to be of equal value, or it can also be shown as, for example A/B, that is A=B.

This process then results in a pair-wise matrix, as shown in Table 6-2. The pair-wise process then generates a series of “weightings” for each criterion.

Table 6-2: Pairway evaluation of criteria

	Patronage	Network k Efficiency	Modal Integration	Permeability	CAPEX	OPEX	Engineering	Promote Retail	Create Density	Sequencing	Good Built Form	Compact Core	Safety	Cornmeal Crk	Other Nature	Flood Risk	Geology Risk	Const Noise	Op Noise	Visual amenity	Traffic Disrupt	Property Impact
		B	**C**	**E**	**F**	**G**	**I**	**K**	**L**	**O**	**Q**	**S**	**T**	**U**	**V**	**X**	**Y**	**Z**	**AA**	**BB**	**CC**	**DD**
Patronage	**A**	2a	2a	2a	2a	1a	3i	3a	2a	3a	2a	2a	2t	2u	2v	2x	2y	3a	1a	2a	3a	2dd
Network Eff		**B**	1b	2b	2f	1g	3i	1k	2b	2b	3b	1b	2t	2u	2v	2x	2y	3b	1aa	1b	3b	2dd
Modal integration			**C**	2c	2f	1g	3i	1c	1c	3o	3c	1c	2t	2u	2v	2x	2y	3c	1c	1c	3c	2dd
Permeability				**E**	2f	2g	3i	1k	1e	2e	3e	2s	2t	2u	2v	2x	2y	3e	1e	2e	3e	2dd
CAPEX					**F**	1f	3i	1f	1f	1o	2f	1f	2t	2u	2v	2x	2y	3f	1aa	3f	2f	2dd
OPEX						**G**	3i	1g	1g	1g	3g	1s	2t	2u	2v	2x	2y	2g	1aa	1g	2g	2dd
Engineering							**I**	3i	3i	3i	3i	3i	3i	1i	3i	0	0	3i	3i	3i	3i	3i
Promote Retail								**K**	2k	3o	2k	1k	2t	2u	2v	2x	2y	3k	2k	3k	3k	2dd
Create Density									**L**	3o	2l	1l	2t	2u	2v	2x	2y	3l	2k	2l	3l	2dd
Sequencing										**O**	2o	2s	2t	2u	2v	2x	2y	3o	2o	3bb	1o	1dd
Good Built Form											**Q**	1s	2t	2u	2v	2x	2y	3q	3q	3q	3q	2dd
Compact Core												**S**	2t	2u	2v	2x	2y	3s	1s	2s	3s	2dd
Safety													**T**	2u	2v	2x	2y	3t	1t	3t	3t	2dd
Cornmeal Crk														**U**	2v	2x	2y	3u	2u	2u	3u	2u
Other Nature															**V**	2x	2y	3v	2v	2v	3v	2v
Flood Risk																**X**	0	3x	2x	3x	3x	2x
Geology Risk																	**Y**	3y	3y	2y	3y	3y
Const Noise																		**Z**	3aa	3bb	3z	1dd
Op Noise																			**AA**	1aa	3aa	1aa
Visual amenity																				**BB**	2bb	2dd
Traffic Disrupt																					**CC**	2dd
Property Impact																						**DD**

6.2.1 Criterion weighting

The pair-wise matrix information is then summed to determine the total number of occurrences of "A" through to "DD". For cases where the value of each criteria comparison results in an equal comparison, for example, A=B, then in this case each criterion will receive ½ point. The resultant criterion weighting are presented in Table 6-3. The percentage weightings nominated below are the 'baseline' weightings. That is, these are the values that have been adopted for the evaluation prior to testing sensitivities for the evaluation process.

Table 6-3: Criteria weighting summary

Goals, desired criteria, functions, features		Raw score	Weight
Transport integration		17%	
A	Patronage potential	43	7%
B	Network efficiency	25	4%
C	Modal integration/bus interchange	21	3%
D	Accessibility	0	0%
E	Traffic/network permeability	17	3%
Engineering costs		20%	
F	Construction cost	28	4%
G	Operating and maintenance cost	23	4%
H	Land resumption costs	0	0%
I	Engineering compliance, constructability	75	12%
J	Benefit cost ratio	0	0%
Economics		7%	
K	Promotes new retail	26.5	4%
L	Creating residential density	16.5	3%
M	Identifiable office node	0	0%
N	benefit cost to community	0	0%
O	Development sequencing of rail and land uses	18	3%
Urban - placemaking		12%	
P	Quality open space	0	0%
Q	Quality of built form	16	2%
R	Civic space	0	0%
S	Compact city core	22	3%
T	Safety	42	7%
Natural environment		31%	
U	Impact on Cornmeal Creek/other waterbodies	46	7%
V	Other natural impact (e.g. significant vegetation)	48	7%
W	Air quality	0	0%
X	Flood risks and climate change	53.5	8%
Y	Soils and geology	54	8%

Goals, desired criteria, functions, features		Raw score	Weight
Social environment		10%	
Z	Construction noise and vibration	3	0%
AA	Operation noise and vibration	11	2%
BB	Visual amenity	8	1%
CC	Disruption to traffic during construction	0	0%
DD	Impact on existing property owners	44	7%
		641	100%

6.3 Options assessment

The ratings for each option for each criterion (as listed in Chapter 5) were entered into the MCA spreadsheet and the weightings applied.

The final step in the evaluation process is the scoring of each criterion in terms of a rating for each option. The scores that have been used in the evaluation are:

- 5 = Excellent
- 4 = Very good
- 3 = Good
- 2 = Fair
- 1 = Poor.

The resultant scores for the baseline evaluation are provided below in Table 6-4.

Table 6-4: Options ranking

Option Number	Description	Score
3	Carnaby Street alignment, elevated	**426**
4	Carnaby Street alignment, at-grade	**391**
2	Carnaby Street alignment, sub-grade	**384**
1	Existing Caboolture to Maroochydore Corridor Study alignment ("Southern Drive')	**320**

This shows that the preferred option is option 3, the "Carnaby Street" elevated option, followed by the Carnaby Street at-grade and sub-grade options. The existing Caboolture to Maroochydore Corridor Study alignment is the least preferred option by a significant margin.

6.4 Sensitivity testing

The final phase of the MCA is to perform sensitivity testing, to check the robustness of the findings.

PB uses a high level stepwise testing method. This method changes each of the weightings at a category level, keeping the individual weightings within each category at the same ratio. This weighting is increased in each category in turn, until the preferred option changes.

Table 6-5 shows the level to which each category needs to be raised until the preferred option changes.

Table 6-5: Sensitivity test trigger values

	Category under investigation					
	Transport integration	**Engineering costs**	**Economics**	**Urban - placemaking**	**Natural environment**	**Social environment**
Transport integration	38%	6%	0%	16%	0%	9%
Engineering costs	15%	70%	0%	19%	0%	11%
Economics	5%	3%	100%	6%	0%	4%
Urban - placemaking	10%	5%	0%	19%	0%	7%
Natural environment	24%	12%	0%	30%	100%	18%
Social environment	8%	4%	0%	10%	0%	51%
Total	100%	100%	100%	100%	100%	100%

These figures show that the preferred options do change depending on the emphasis given to the various disciplines.

Most particularly, the selection of preferred option is very sensitive to the weighting given to urban placemaking outcomes:

- a moderate change in emphasis (15% – 35% of total weighting) given to transport integration changes the preferred option
- a significant change in emphasis (20% – 70% of total weighting) given to engineering costs changes the preferred option
- a small change in emphasis (12% – 19% of total weighting) given to urban placemaking changes the preferred option
- a significant change (10% – 50% of total weighting) given to social environment changes the preferred option
- total exclusion of all options (increase to 100% of total weighting) given to either economics or natural environment does not change the preferred option (as the preferred option is already the preferred option for both economic and natural environment reasons).

Table 6-6 shows the option that is preferred after each change, recalling that Carnaby elevated is the preferred option under normal weighting.

Table 6-6: Sensitivity test, test results

	Transport integration	Engineering costs	Economics	Urban - placemaking	Natural environment	Social environment
Existing (Caboolture to Maroochydore Corridor Study) alignment	315.1	307.0	302.5	316.7	401.3	263.8
Carnaby sub-grade	407.5	403.6	356.6	383.9	348.9	357.3
Carnaby elevated	438.4	444.3	472.8	424.3	428.5	356.8
Carnaby at- grade	408.5	444.9	327.2	388.7	356.6	353.9

These findings show that:

- Carnaby Street elevated is the preferred option from an economic and natural environment point of view, as well as under the balanced approach
- Carnaby at-grade becomes the preferred solution if engineering costs become the main criterion, to the exclusion of nearly all other criteria
- Carnaby sub-grade becomes the preferred solution if socio-economic criteria become dominant. A moderate increase in the importance of the social environment is necessary to make the change
- at no stage is the existing Caboolture to Maroochydore Corridor Study alignment the preferred option.

7. Urban design challenges for elevated rail

7.1 Introduction

This study has determined that the preferred rail option has an elevated alignment throughout the southern part of the Maroochydore CBD. An elevated structure enhances permeability and increases flexibility for improved design around the infrastructure, over at-grade options.

The overall preferred rail alignment and station location is the Carnaby Street elevated option (option 3). Under this option, approximately 800m of elevated rail line will pass through the proposed Maroochydore CBD. This includes a 200 m long station. In this option, the station is separated from the existing core of the CBD and the existing bus station, but is relatively central to the expanded City Centre as made possible by the proposed relocation of the Horton Park Golf Course and as planned by the Sunshine Coast Regional Council and endorsed in the Maroochydore Centre Position Paper.

Of the four options considered, option 3 scored well on urban design and integration criteria. This chapter seeks to discuss some of the challenges for elevated rail in terms of detailed design and structure plan policy.

7.2 Framework and context

7.2.1 General construction details

For any elevated rail line in Maroochydore, the following construction details are assumed as standard through the Maroochydore CBD:

- 2-track suburban electrified railway on T-structure viaduct (not embankment)
- 3-platform elevated terminal station
- rail-over-road crossings, including any north-bound leg over Maroochy Boulevard near the Sunshine Motorway interchange

7.2.2 Maroochydore Centre Position Paper

The general framework for the Maroochydore CBD is set by the Directions Plan contained in the Council's Maroochydore Centre Position Paper. The key elements of this plan that apply to the Maroochydore Station Corridor Study include the intent that development of the Maroochydore CBD achieves a city that has distinctive character that:

- reflects its coastal, river and creek location; and
- is clearly defined and memorable; and
- reflects sub tropical design principles; and
- achieves design innovation and excellence; and

- is defined by high quality public spaces[6]

Furthermore, it seeks to integrate land use and transport including: city-centre transport interchanges; transit-oriented development; a high level of pedestrian amenity; and a permeable street network that promotes connectivity and accessibility.

Figures 7-1 and 7-2 below show the preferred land use pattern and public transport plans for the Maroochydore centre (from the Maroochydore Centre Position Paper).

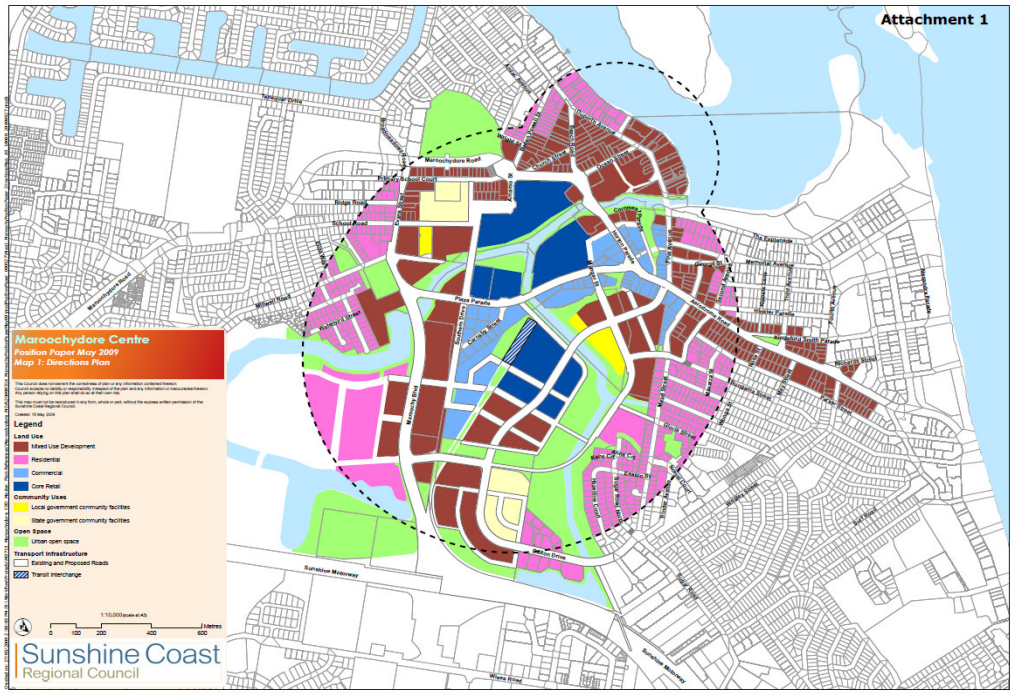


Figure 7-1: Maroochydore Centre Directions Plan

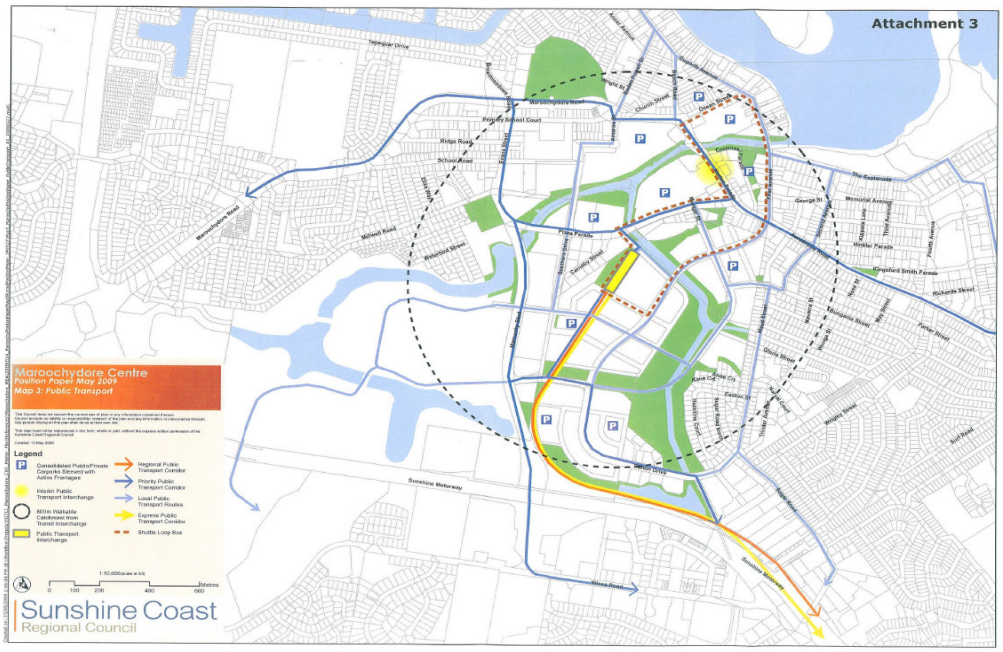


Figure 7-2: Maroochydore Public Transport Map

[6] *Maroochydore Structure Plan*, page 3

7.3 Integration and design quality

Design of any facility, public infrastructure or otherwise, must carefully consider its impacts and its influences on the function of its setting. These impacts and influences where relevant to a facility such as elevated railway and station include but are not limited to:

- security and safety (in, around, and under the facilities: addressed through Crime Prevention Through Environmental Design (CPTED) principles
- scaling: a pedestrian scale
- legibility: easy way-finding
- permeability: fine grained access for pedestrians cyclists and motorised vehicles
- accessibility and connectivity: easy access to destinations, particularly between commonly used ones
- amenity: management of noise and vibration; visual aesthetics; physical amenity (access to light and air)
- activity: density and mix of uses
- local character and identity: extending the local climatic and social characteristics to the design of public facilities.

Elevated rail, with proper design and management, can avoid resulting in depressed environments, both economically and socially. All of the above factors need to be addressed throughout the design process, for all aspects of design, and with consideration for both users and non-users of the rail service in mind. Design in this case relates to railway and station infrastructure design, design of surrounding streets and public spaces, design of adjacent buildings and development, and layout of the street network.

Figure 7-3 below is an artists impression on how a station at Maroochydore may look (note bus in background below station), taking into consideration the design influences described above.

Figure 7-3: Artists Impression: Proposed Maroochydore Station for Option 3 - Carnaby Street Elevated

At this stage in the project, the key design elements of most significance are:

- the alignment and situation of the elevated structure within the designated corridor,
- the use and form of adjoining and surrounding development, and
- the surrounding road network.

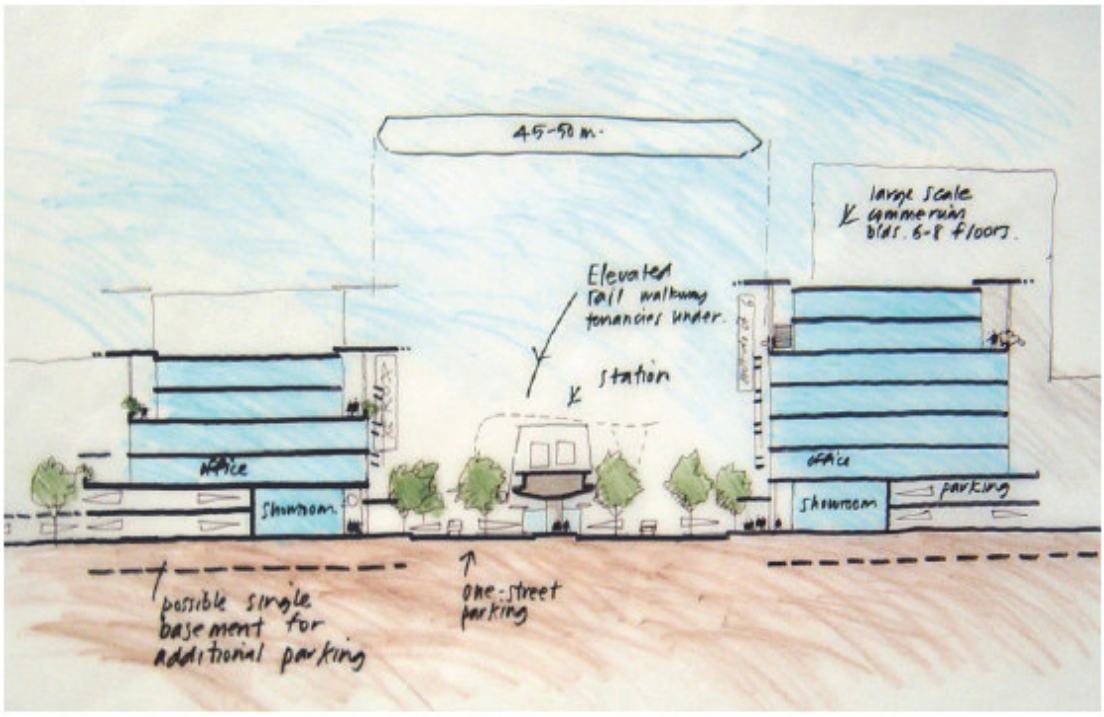
The first element is addressed further in the next section for consideration in later design phases. The surrounding road network is addressed later in this document, and has been taken into account in the latest Maroochydore Centre Position Paper.

Additionally, policy relating to detailed design of infrastructure (including use of space above, below and around the rail line), surrounding buildings and public spaces need also to be considered early.

7.4 Corridor design options

One of the key matters to be addressed early in the design of the elevated railway is its alignment and situation within its corridor and in relation to surrounding structures. This section provides examples of how this might be addressed.

7.4.1 Centred in active vehicle corridor



Business Boulevard with elevated rail

Figure 7-4: Business Boulevard. Maroochydore City Centre Structure Plan, Options Report.

This street alignment provides for a comprehensive transport function with road and rail infrastructure integrated. The space under the rail line can be used for pedestrian/cycle

facilities. Overall this approach minimises 'dead' space and provides high visibility. It does require a wide transport corridor. In the case of Maroochydore, where the length of track requiring treatment is quite short, this disadvantage might not be severe.

This is consistent with the delineation of a wide transit boulevard with activated frontages proposed in the Maroochydore Centre Position Paper. Effective implementation of such an option will require acceptance by QR of the shared use of land within the envelope of the rail structure. An example of such sharing of space is the continuity of Kalinga Park under the Airtrain structure near Toombul in Brisbane.

Figure 7-5 shows an example of a centre median rail line.

Figure 7-5: Centre median rail line, Kuala Lumpur (source: Wikimedia Commons)

7.4.2 Pedestrian corridor or open space network

Where a continuous open space network is available, an elevated railway can be threaded through this space. Provided that passage under supports is not restricted, this can be an ideal way of ensuring the rail line is under effective surveillance.

This open space can be in the form of a pedestrian plaza or mall, as in the example below of the Sydney Monorail in Darling Harbour (Figure 7-6).

Figure 7-6: Sydney monorail through public open space (source: Wikimedia Commons)

The major challenge that this approach faces is the need for appropriate size of open space. If the corridor is too narrow, then the land will be overshadowed by the rail corridor and become 'dead space'. In the case of the Maroochydore CBD, the open space corridors have been located at the opposite side of the development from the rail to match natural water features and corridors. For this reason, this is unlikely to be a complete solution for Maroochydore. However, effective use of public space such as a plaza can be an important part of the design of the terminal station.

7.4.3 Attached to adjoining development

Single-sided development offers a rail alignment with street facing one side and direct building abutting on the other. As such provides some public facing space and some private facing space. The space under the rail structure could be used for pedestrian and cycle space or possibly developed for business purposes.

Street access also allows for the innovative use of land around and under the rail alignment itself.

7.4.4 Integrated within development

Traditional construction underneath rail viaducts have suffered from noise and vibration issues, which reduces the types of potential uses. Modern engineering allows for improved noise insulation which makes many more uses possible. The example in Figure 7-7 below is

from Tokyo, where a business hotel has been constructed directly below an elevated railway station.

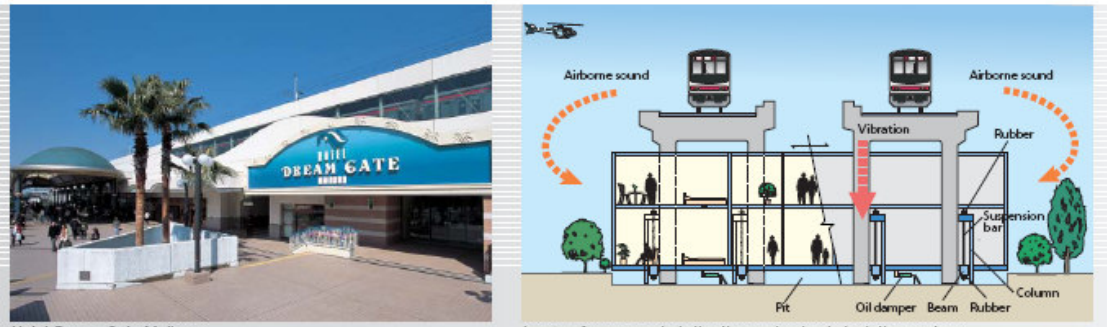


Figure 7-7: Business hotel constructed below elevated rail line (source: JR East)

Currently in SEQ, 'air rights' are seen as possible mostly above open air stations (e.g. Toowong). However, there is no technical reason why the space beneath elevated rail lines cannot be treated in the same way.

Once again, implementation of these options will require variation to current QR practice.

7.4.5 Within inactive pedestrian or vehicle corridor

An undesirable outcome would be location of rail line directly at back of lot or with adjacent service lanes only. These minimise passing traffic and passive surveillance and thus increase the potential for dead space. This reduces the general amenity of the area and increasing the likelihood of unsatisfactory outcomes. Such an arrangement is not envisaged by the councils master planning intent.

Figure 7-8: Poor amenity at a 'back lane access' station (source: Wikimedia Commons)

7.5 Transport network issues

Permeability

The elevated option was selected because it maximises permeability for both vehicles and pedestrians. In order to maintain this permeability it is important that the rail corridor remains open and not be fenced off or used as infrastructure storage space. This requires acceptance and concept 'buy in' by QR and other parties with an interest in the facility outcome.

Figure 7-9: Elevated rail in urban area showing permeable public space. This is Kottbusser Tor in Berlin (Source: Wikimedia Commons)

Transport integration

From an urban design point-of-view, one of the important issues in transport integration is to ensure good integration of bus and rail, and to ensure that bus facilities (including layover zones and bus routes) do not overwhelm the CBD streets. An elevated option provides for the ability to use space under the rail structure for a bus interchange. Again, this will need to be carefully designed.

The issue of transport integration for the various options has been considered in more detail in Section 5.6.

7.6 Achieving ideal outcomes

Providing the appropriate corridor design, street network and land uses requires a co-operative approach by government agencies such as the Department of Transport and Main

Roads, QR and TransLink, the Sunshine Coast Regional Council (SCRC) and developers of the Horton Park Golf Course.

While an elevated option can provide many benefits for the future Maroochydore CBD, it poses many design and administration challenges.

To ensure a high quality and safe urban environment, a number of issues will need to be addressed. A key issue is the orientation of the rail alignment with regards to surrounding streets.

Considerations (and the key agencies/stakeholders) include:

- Land use pattern and road, transit and pedestrian network conducive to optimum land use and transport integration – SCRC through their master planning process (as evidenced by the Maroochydore Centre Position Paper which is part of a scheme amendment process to give statutory weight to the concepts shown in the Directions Plan)
- review of policies and procedures (including titling arrangements with regards to public access under rail structures ensuring permeability) – QR
- review of policies and procedures with regards to access to rail structures, to permit development closer to or directly integrated with the station structure – QR
- review of policies and procedures with regards to development on, under and around railway land and structures ('air rights' associated with the station and its environs) – QR
- the Department of Transport and Main Roads' CoastConnect study is reviewing proposed bus infrastructure and network operations to ensure integration of bus and rail services with minimal duplication of services and suitable operating strategies (such as through-routing) – the department, TransLink, SCRC

Implementation strategies are fundamental to good outcomes. Coordination across multiple government agencies, service providers and private interests will be required to achieve the desired outcomes. Early and ongoing communications amongst these parties must address conflicting priorities to ensure delivery is not delayed or compromised.

This will require realignment of existing policies and procedures. It is recommended that an integrated approach be taken to ensure the best possible outcome.

8. Risk assessment

8.1 Introduction

This desktop risk assessment aims to identify significant hazard and risk constraints to the proposed corridor options and in particular to the preferred alignment. Having already been identified in the studies making up this report, these risk factors have already been considered by being incorporated into the multi-criteria analysis by which the preferred option was identified. This assessment does not attempt to provide an independent risk assessment based on an analysis of potential hazards from first principles, which is beyond the scope of this study.

The following section mirrors the main sections in the report, identifying the risk issues arising from each and summarising the results.

8.2 Risk categories

8.2.1 Corridor options

This is reported in detail in Chapter 4.

Operational assumptions

It was necessary for the study to make assumptions regarding the level of service that might be applied, since this has not yet been determined. There is an implied risk that an incorrect assumption at this point might result in incorrect results for the study. The conclusion regarding the track and station configuration on which the study would be based was made to provide flexibility of operation and spare capacity in the event of a train breakdown, and the risks arising from the assumptions made are therefore likely to be small.

Options definition

In addition to the original Caboolture to Maroochydore Corridor Study alignment and the early Maroochydore concept plan CBD master plan proposal, a third alignment developed as a result of a consultative process was considered in this study and now refined as part of the current master planning process. Sub-grade, elevated and at-grade options were considered for the Carnaby Street alignment. There is only a small risk that:

- a significantly better option might have been overlooked
- the options included in the study do not provide a reasonable representation of all the feasible options when assessed against the criteria used.

8.2.2 Ecological impact

This is reported in detail in Section 5.1.1.

The principal ecological risk arises from the potential impacts on remnant “of concern” vegetation, riparian vegetation, significant habitat, and state and Commonwealth listed species, and the difficulties that might be encountered in obtaining the approvals and permits needed to authorise such impacts occurring as part of the development, or the conditions they might impose. Further investigation is needed to confirm the potential impacts and the

risk that the necessary approvals might not be issued or that conditions might be unacceptably onerous. There is no clear indication based on the work done to date that the necessary approvals would not be obtained. With appropriate ecological assessment, engineering design and environmental controls it should be possible to manage this risk.

8.2.3 Hydrology and climate change

This is reported in detail in sections 5.1.5, 5.1.6 and 5.1.9.

There is an identified risk that the rail corridor has the potential to both affect flooding and be affected by it. All the corridor options cross flood prone areas. Flow paths and flood plain storage capacity may be adversely affected by any at-grade or elevated options if constructed on embankments. The risk associated with the elevated option is substantially reduced by the proposal to construct it primarily on structure (on permeability and visual impact grounds). The sub-grade option is particularly at risk from being flooded, although all options would be affected to some extent by a flood event. This poses a moderate risk to the project proceeding and to its operations, but it is most likely that all foreseeable risks could be adequately mitigated by appropriate designs.

There is a risk of increased frequency and severity of flooding as a result of climate change, and whilst this might result in the need for further studies to identify potential future issues, and additional measures to protect both the rail line and the surrounding land uses, no insurmountable issues are likely. The elevated option would be least affected by this risk.

8.2.4 Soils and geology

This is reported in detail in Section 5.1.10.

The study area is likely to contain potential and actual acid sulphate soils (PASS and ASS), which present an environmental risk when disturbed and exposed to air or dewatered. There is thus a risk in particular to the sub-grade option, but all options are likely to require some disturbance of PASS. The soils and geology of the area are also likely to pose a geotechnical risk that would require careful design, particularly for the sub-grade options. As the elevated option would have the least “footprint” of exposure to soil disturbance, it would, subject to appropriate precautions to protect the structural elements, impose the least risk in this regard.

8.2.5 Engineering and geotechnical

This is reported in detail in Sections 5.2 and 5.8.

The principal risks identified relate to the soils and groundwater in the project area, particularly for the sub-grade option which gives rise to risks from collapsible soils, saturated soils and high groundwater levels. This is likely to give rise to risks of excavations collapsing during construction, settlement problems, need for dewatering, uplift forces on tunnels, and the possible damming effect on groundwater of the sub-grade structure. These issues can be addressed by proper studies, designs and construction methods, but will add to the cost of the project. The at-grade and elevated options have lesser risks arising from the unconsolidated soils and un-engineered fill in many areas.

8.2.6 Land use planning and approvals

This is reported in detail in Section 5.3.

The Carnaby Street options are dependent on the Horton park golf course becoming available for urban purposes. The land is still being used as an operating golf course and the statutory planning scheme provisions providing for higher and better uses are not yet in place. There is a current degree of risk associated with the capacity of the Horton Park Golf Club and its financial partners to relocate the golf course activities. The amendment of the planning scheme to put in place a local area plan giving statutory force and effect to the urban utilisation of the golf course lands will substantially reduce that risk. That process is already in train with the release of the Maroochydore Centre Position Paper which is a phase of the planning scheme amendment process.

No other particular risks relating to land use planning and approvals have been identified that are not raised elsewhere. Several options for the main planning approvals process are identified, so that no significant risk is expected in relation to gaining planning approval for the project. Detailed studies for the preferred alignment might identify issues such as impacts on Commonwealth listed species, which would require referral to the Commonwealth under the EPBC Act. This may add to the approvals process or dictate a particular process be used, but is not considered likely to pose an insurmountable problem.

8.2.7 Urban design impacts

This is reported in detail in Section 5.4.

Some risks are reported for each of the options against one or more urban design objectives. These include failing to maximise the potential benefits of the rail project, dividing pedestrian movements, visual and other amenity and security matters. These competing objectives have been assessed through the multi-criteria analysis, and are not considered to represent significant risk issues. To a large extent they have been mitigated through the recent refinements reflected in the Maps attached to the Maroochydore Centre Position Paper.

8.2.8 Transport integration

This is reported in detail in Sections 5.5 and 5.6.

The main risks identified are that the project will not realise its full patronage potential, and that public transport options will compete rather than provide seamless integration and complementary support, avoiding either wasteful duplication or a less-than-optimal outcome. The integration of bus and rail services is noted as a significant opportunity. The competing objectives in this section are addressed through the multi-criteria analysis.

The network of potential public transport routes and bus priority corridors identified in the Council's Maroochydore Centre Position Paper offers considerable flexibility in the routing and flexibility of operation of public transport services. Specifically, it provides for integration between services and between modes at both the Carnaby station site and along the Horton Parade/Sunshine Plaza locality.

The planning associated with the station location includes close liaison with the complementary studies of the Maroochydore bus interchange and the CoastConnect Caloundra to Maroochydore study. These are further engaged with the TransLink Transit Authority in its operational services planning. This close level of cooperation and liaison

should result in a optimisation of coordination of public transport service outcomes at minimum risk.

8.2.9 Noise and vibration

This is reported in detail in Section 5.7.

Construction noise and vibration has generally not been identified as a significant issue. Operational noise, and particularly sleep disturbance, has been identified as a source of risk for some options. This is one aspect of the project where the sub-grade option poses a lower risk than the at-grade and elevated options. As the areas at risk are currently largely undeveloped, the full risk from operational noise would not be realised until development is much further advanced.

8.2.10 Economics

This is reported in detail in Section 5.9.

The main economic risks identified relate to potential failure of various options to integrate with the city centre, to promote development, and to provide necessary service levels. The competing objectives in this section are addressed through the multi-criteria analysis. In addition, the preferred station corridor cannot be implemented until the Horton Park Golf Course is relocated and the land made available.

8.2.11 Residential, business and community issues

This is reported in detail in Section 5.10.

The main risk issues reported in this section include the acquisition of land and consequent impacts on existing land use and proposed developments, visual amenity, noise and disruption to traffic, including pedestrian access. The competing objectives in this section are addressed through the multi-criteria analysis.

9. Conclusion

9.1 Summary of analysis

This study has analysed the different alignment options and locations for the Maroochydore Station. It has established that from an engineering perspective all options are feasible. While the nature of the ground (low lying) means that sub-grade work is challenging, the sub-grade options are not impossible.

Operationally, a two-track line with three platform station layout supports the anticipated service levels, with robustness and room for service expansion. This is supported by the Carnaby Street options, but not by the current Caboolture to Maroochydore Corridor Study alignment.

The natural environment of the golf course lands has been previously degraded and does not present a major barrier to any option, with the implementation of standard engineering and environmental management techniques to mitigate any remaining issues. An exception to this is the woodland to the west of Maroochy Boulevard adjacent to the Sunshine Motorway. This will be impacted by all options (including the current Caboolture to Maroochydore Corridor Study alignment) in the event that the rail is extended north of Maroochydore to the Sunshine coast Airport as originally planned. It is noted that this extension is not included in the current South East Queensland Infrastructure Plan and Program, so the timing of that potential extension is not known.

The Maroochydore Station project is in line with existing and proposed statutory land use provisions and opportunities exist to protect the alignment.

Based on analysis, each option has different noise outcomes, with the above-ground alignment potentially worse than the other options.

The biggest implications in this project are changes to permeability of access and likely development outcomes in the surrounding land uses. The Directions Plan attached to the Maroochydore Centre Position Paper has responded to an urban design analysis which also informed this study. That analysis concludes that the optimal urban design outcome would be one based around the principles of good built form providing a high level of convenience, amenity, legibility, and quality of public realm, together with maintenance of a compact and walkable city centre core, and crime prevention and safety through environmental design.

9.2 Preferred option selection

A weighted multi-criteria analysis (MCA) of the options was conducted in order to determine the preferred solution. Twenty-two MCA criteria in 6 broad categories were agreed in advance with stakeholders. The categories were:

- transport integration (including network efficiency)
- engineering (including construction cost)
- economics (including development yields and stageability)

- urban placemaking (including quality of build form)
- natural environment
- social environment (including noise, amenity and property impact).

The weighted MCA showed that the preferred alignment overall was the Carnaby Street elevated option (option 3).

To confirm the robustness of this conclusion, a range of sensitivity tests were undertaken. These tests showed that:

- Carnaby Street elevated is the preferred option from an economic and natural environment point of view, as well as under the balanced approach.
- Carnaby Street at-grade becomes the preferred solution if engineering costs become the main criterion, to the exclusion of nearly all other criteria.
- Carnaby Street sub-grade becomes the preferred solution if socio-economic criteria become dominant. A moderate increase in the importance of the social environment is necessary to make the change.
- At no stage is the current Caboolture to Maroochydore Corridor Study at-grade alignment the preferred option.

9.3 Recommendations

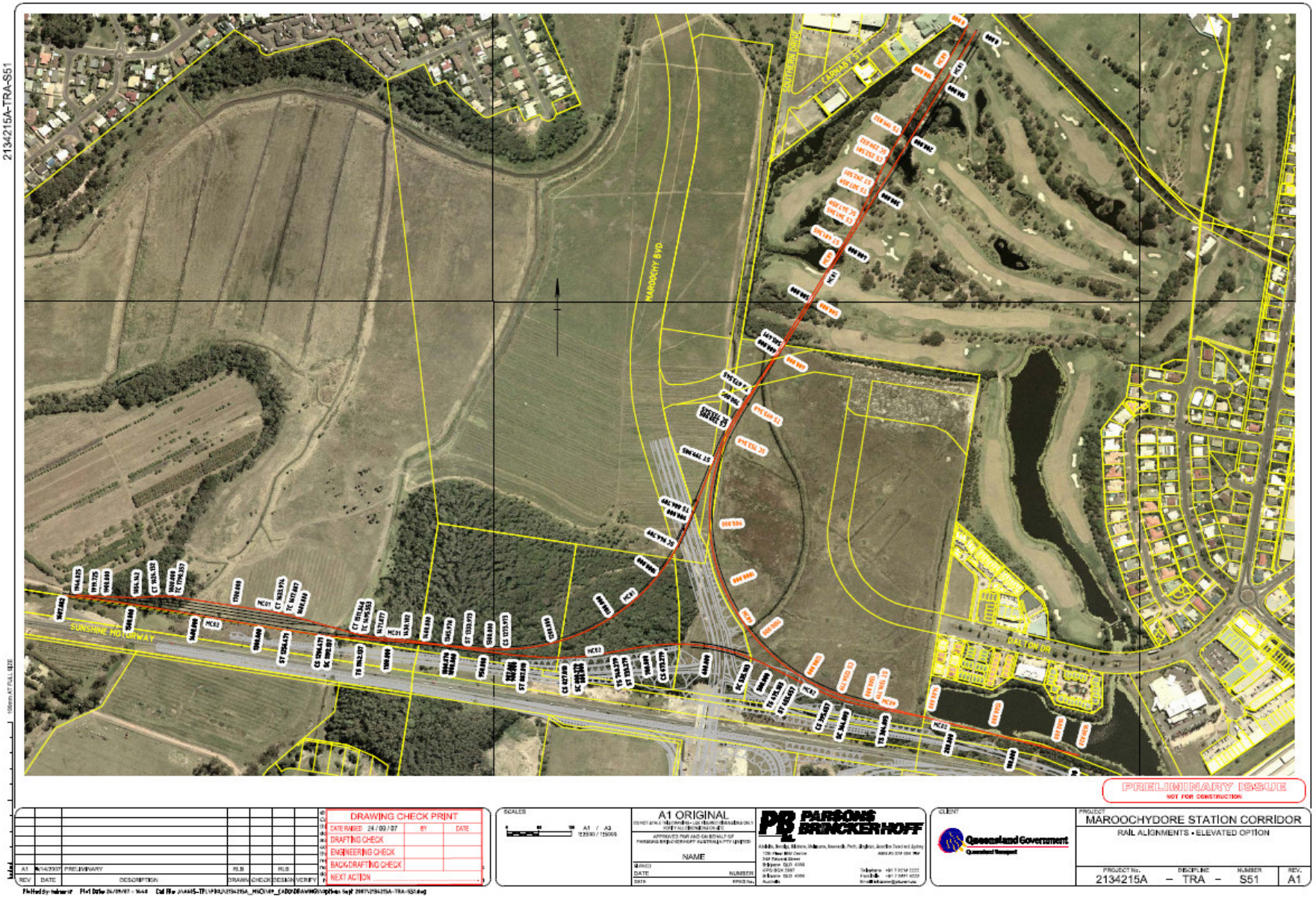
This study concludes that the Carnaby Street alignment is the overall preferred alignment for a suburban rail route into Maroochydore. It shows a range of benefits over the currently approved alignment and it is recommended that it be adopted as the preferred alignment for Caboolture to Maroochydore Corridor Study rail.

Arising from this study are a number of key issues that should be investigated as a matter of priority to ensure maximum benefits are achieved by the project. These include:

- the development of a supporting bus network, including integration of the Coast Connect bus corridor with the rail station. This is being accommodated in the coordination between the three Coast connect studies and TransLink's network planning.
- refinement of the structure plan road network to ensure maximum legibility and permeability (including suitability for bus operations). The new master plan largely achieves this..
- identifying opportunities for development under and around the rail station and opportunities for activation of the edges of the ground level of the boulevard encompassing the rail corridor to the south of the rail station..

Appendix A

Engineering drawings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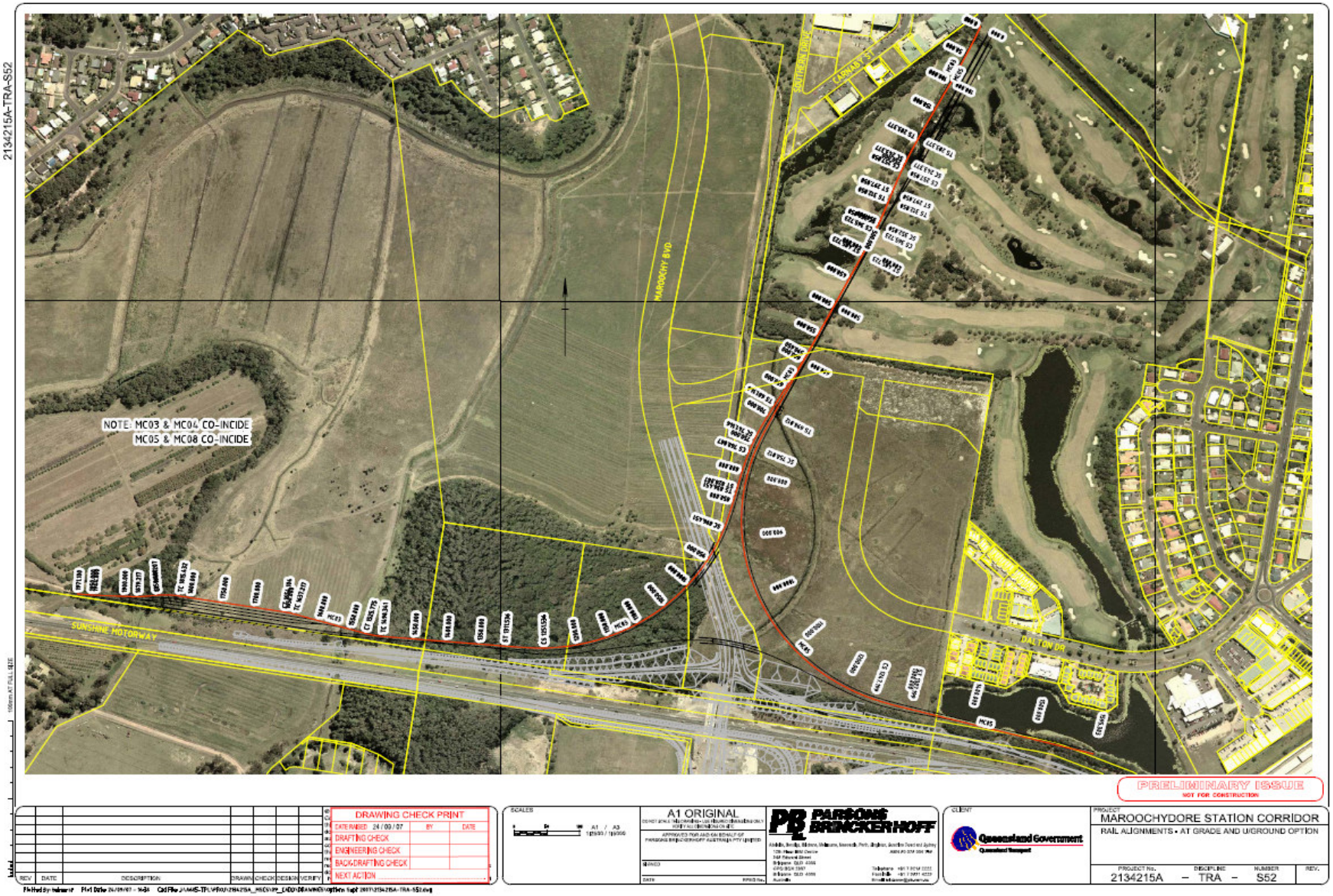
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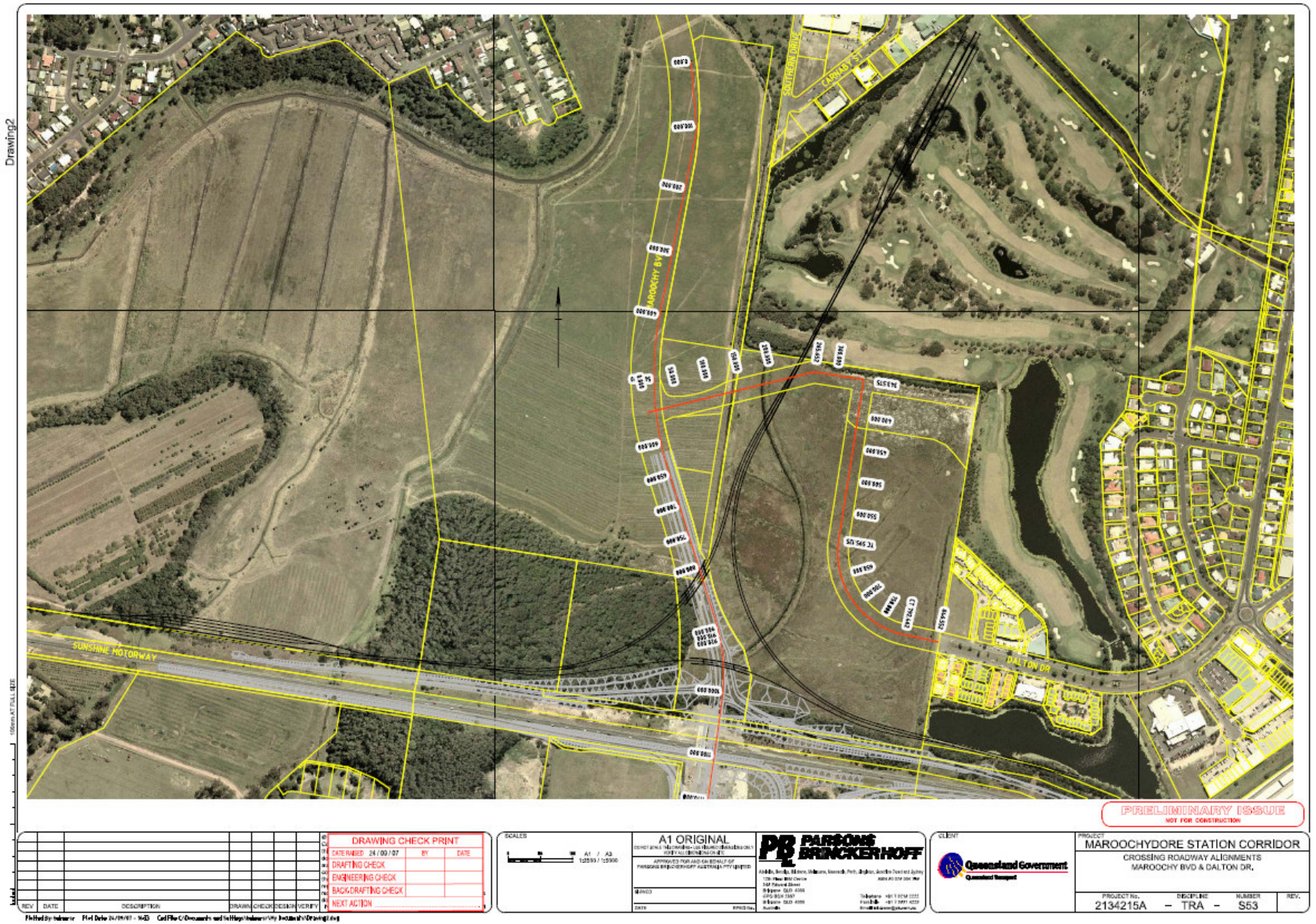
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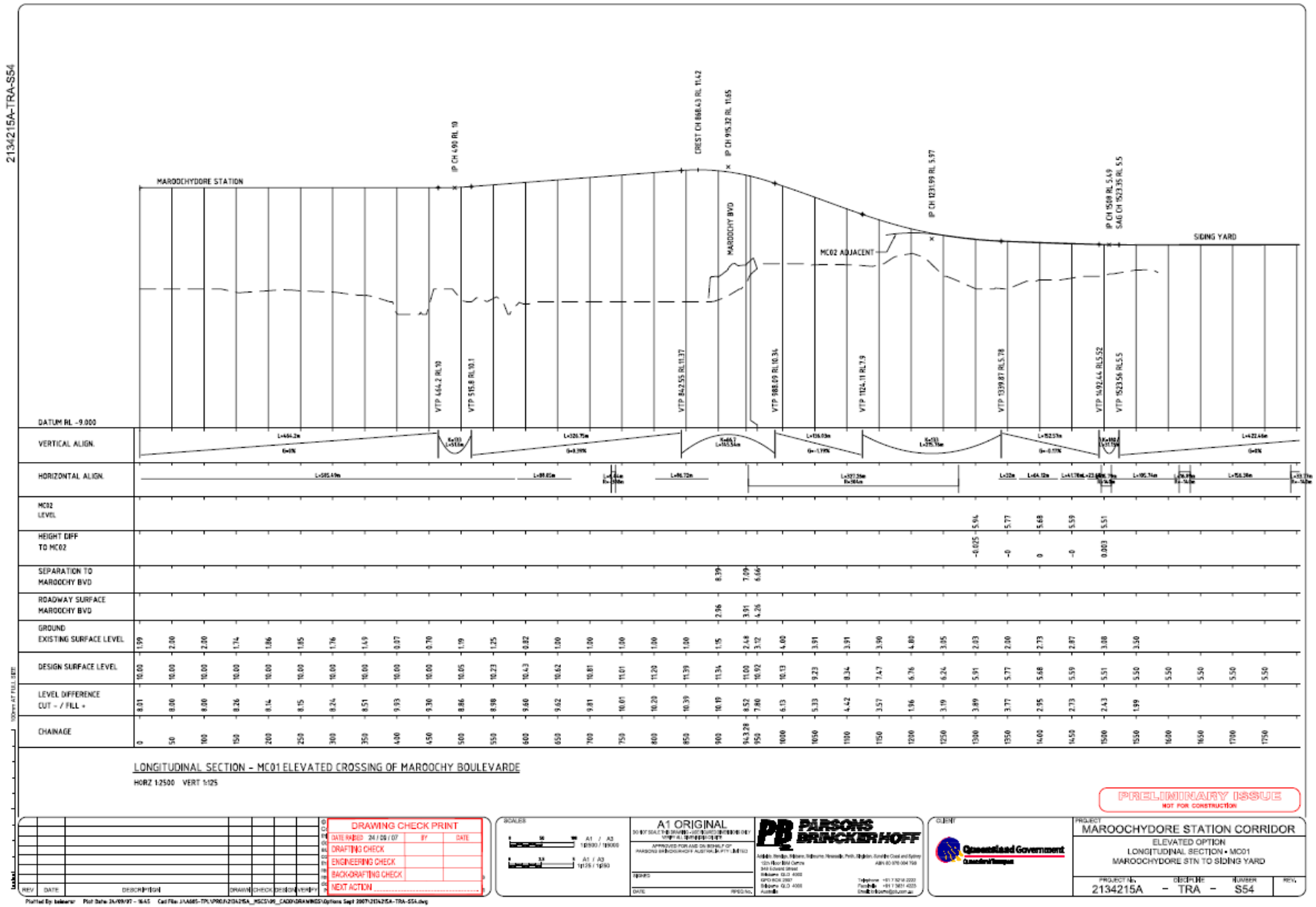
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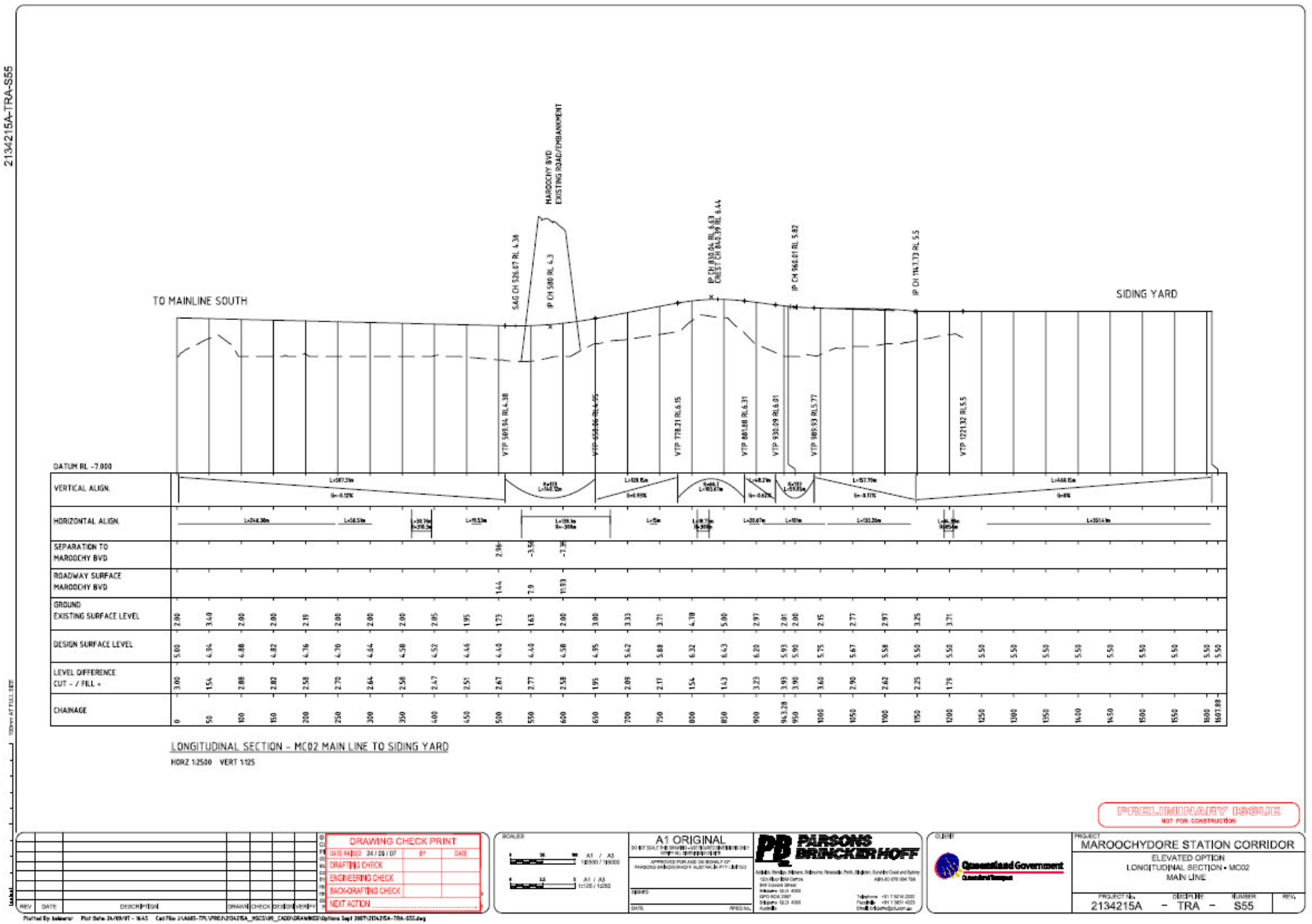
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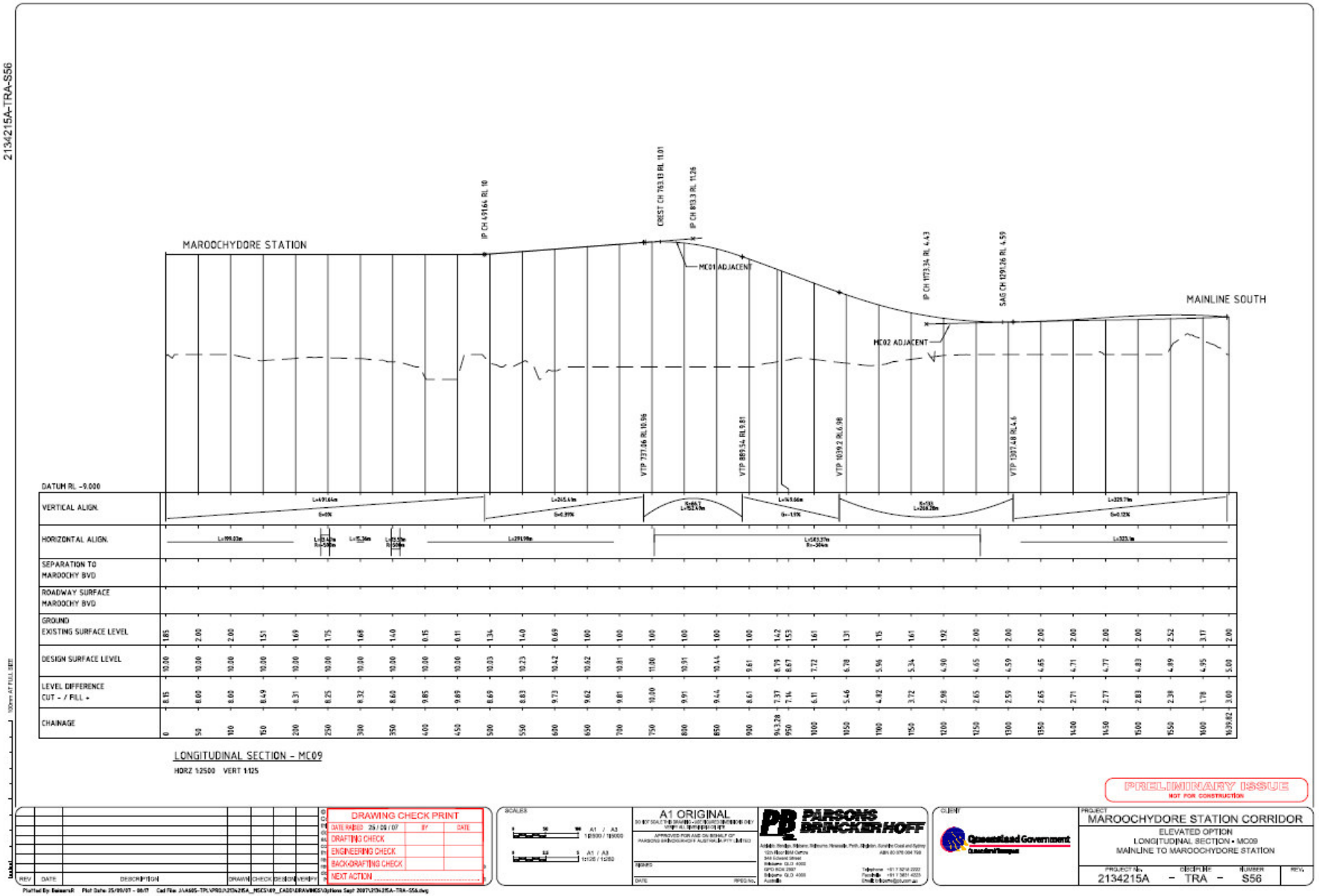
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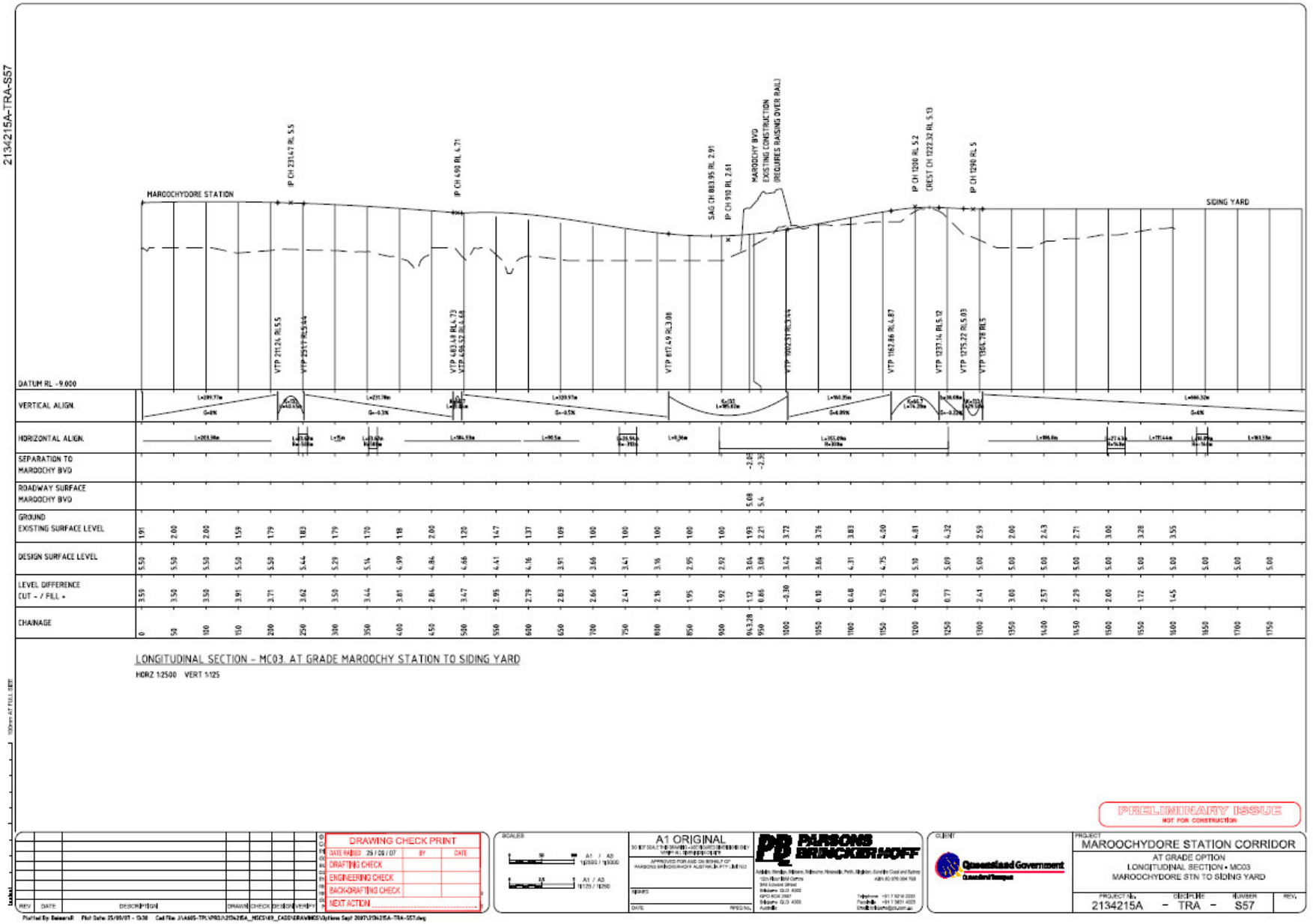
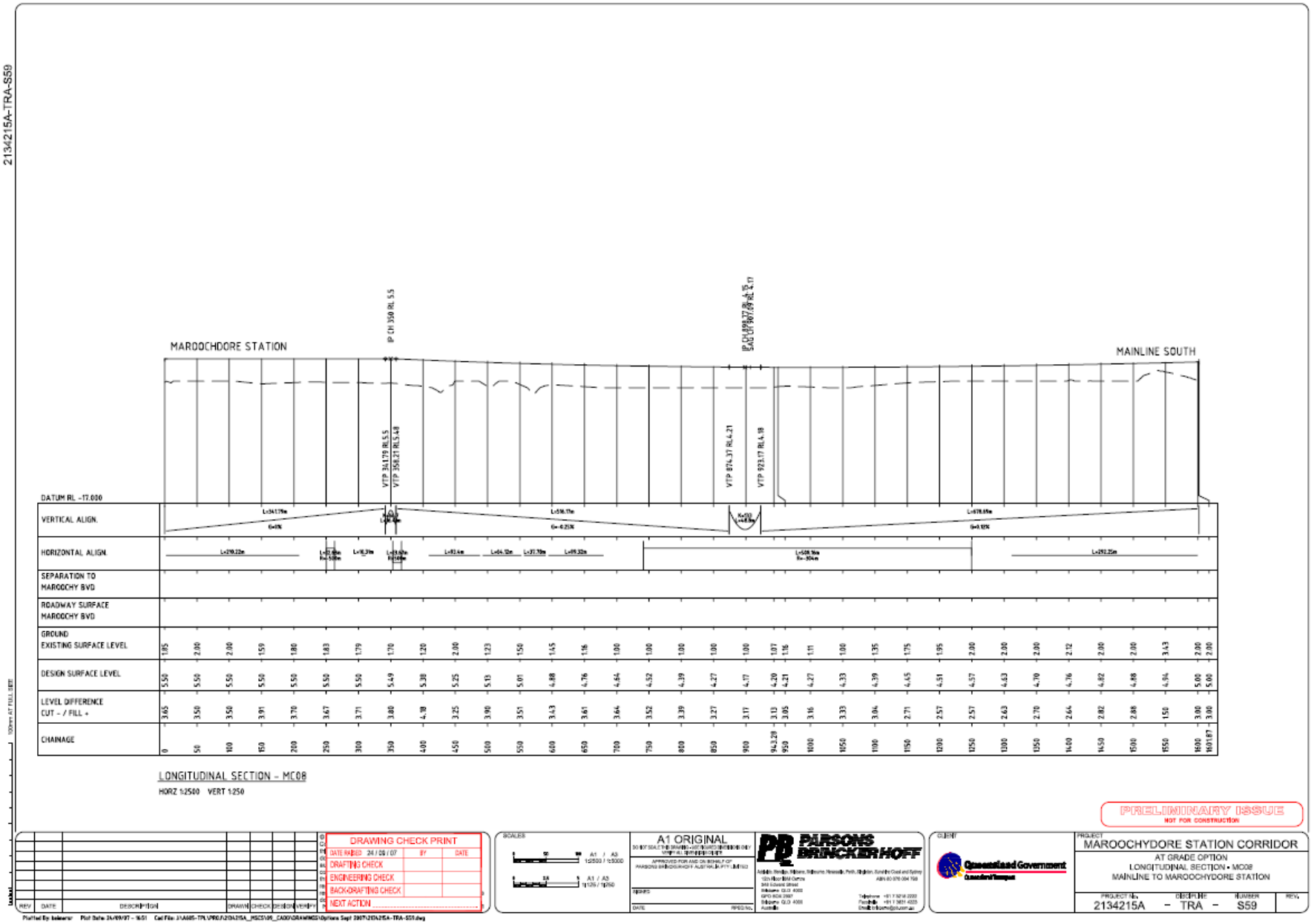
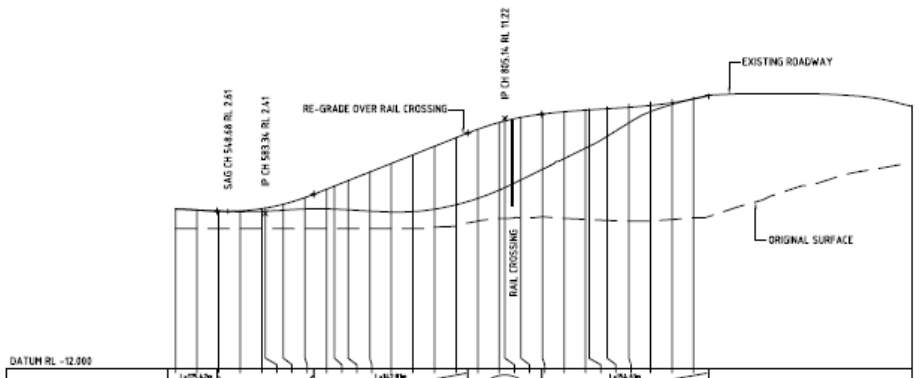
GROUND EXISTING SURFACE LEVEL
DESIGN SURFACE LEVEL
LEVEL DIFFERENCE CUT - / FILL +
CHAINAGE
LONGITUDINAL SECTION - MC09
HORZ 1:2500 VERT 1:125
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
DRAWING CHECK PRINT
DATE PLOTTED 25 / 09 / 09
DRAFTING CHECK
ENGINEERING CHECK
BACK-DRAFTING CHECK
NEXT ACTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
Queensland Government
MAROOCHYDORE STATION CORRIDOR
ELEVATED OPTION
LONGITUDINAL SECTION - MC09
MAINLINE TO MAROOCHYDORE STATION
2134215A - TRA - S56


2134215A-TRA-S57
MAROOCHYDORE STATION
IP CH 231.47 RL 5.5
IP CH 499 RL 4.71
SAG CH 883.95 RL 2.91
IP CH 910 RL 2.61
MAROOCHY BVD
EXISTING CONSTRUCTION
(REQUIRES RAISING OVER RAIL)
IP CH 1200 RL 5.2
CREST CH 1222.32 RL 5.13
IP CH 1290 RL 5
SIDING YARD
DATUM RL -9.000
VERTICAL ALIGN.
HORIZONTAL ALIGN.
SEPARATION TO MAROOCHY BVD
ROADWAY SURFACE MAROOCHY BVD
GROUND EXISTING SURFACE LEVEL
DESIGN SURFACE LEVEL
LEVEL DIFFERENCE CUT - / FILL +
CHAINAGE
LONGITUDINAL SECTION - MC03: AT GRADE MAROOCHY STATION TO SIDING YARD
HORZ 1:2500 VERT 1:125
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
DRAWING CHECK PRINT
DRAFTING CHECK
ENGINEERING CHECK
BACK-DRAFTING CHECK
NEXT ACTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
Queensland Government
PROJECT
MAROOCHYDORE STATION CORRIDOR
AT GRADE OPTION
LONGITUDINAL SECTION - MC03
MAROOCHYDORE STN TO SIDING YARD
PROJECT No. 2134215A
DISCIPLINE TRA
NUMBER S57
REV.


2134215A-TRA-S59
MAROOCHDORE STATION
MAINLINE SOUTH
IP CH 350 RL 5.5
VTP 354.179 RL 5.5
VTP 356.21 RL 5.48
VTP 874.37 RL 4.21
VTP 923.17 RL 4.18
DATUM RL -17.000
VERTICAL ALIGN.
HORIZONTAL ALIGN.
SEPARATION TO MAROOCHY BVD
ROADWAY SURFACE MAROOCHY BVD
GROUND EXISTING SURFACE LEVEL
DESIGN SURFACE LEVEL
LEVEL DIFFERENCE CUT - / FILL +
CHAINAGE
LONGITUDINAL SECTION - MC08
HORZ 1:2500 VERT 1:250
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
DRAWING CHECK PRINT
DRAFTING CHECK
ENGINEERING CHECK
BACKDRAFTING CHECK
NEXT ACTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
Queensland Government
MAROOCHYDORE STATION CORRIDOR
AT GRADE OPTION
LONGITUDINAL SECTION - MC08
MAINLINE TO MAROOCHYDORE STATION
2134215A - TRA - S59

2134215A-TRA-S60



DATUM RL -12.000

VERTICAL ALIGN.	
HORIZONTAL ALIGN.	
SEPARATION TO MAROOCHY BVD	0.02 -0.01 0.02 0.06 0.24 0.29 0.56 1.06 1.82 2.56 2.71 3.02 4.59 5.25 5.82 6.21 6.40 6.27 6.17 5.78 5.11 4.34 3.59 3.48 2.79 1.71 0.90 0.45 0.14
ROADWAY SURFACE MAROOCHY BVD	2.81 2.74 2.61 2.58 2.61 2.62 2.71 2.83 2.84 2.91 2.75 2.63 2.54 2.59 2.81 3.22 3.81 4.57 4.82 5.53 6.5 7.5 8.48 8.63 9.56 10.81 11.84 12.52 13.06 13.42 13.47 13.5 13.39 13.34 13.5 13.5 5 13.37 13.21 12.88 12.56
GROUND BEFORE MAR BVD CONST. SURFACE LEVEL	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.55 1.26 1.70 1.94 1.95 2.00 2.11 1.56 1.86 1.84 1.77 1.71 1.72 1.85 2.00 2.32 2.95 2.98 3.55 4.31 4.97 5.00 5.38 6.03 6.39 6.73 6.96
REGRADE MAROOCHY BVD. DESIGN SURFACE LEVEL	2.83 2.73 2.63 2.64 2.86 2.91 3.27 3.88 4.66 4.96 5.46 6.25 7.05 7.84 8.64 9.43 10.21 10.84 10.98 11.31 11.62 11.84 12.07 12.20 12.29 12.52 12.74 12.97 13.20
LEVEL DIFFERENCE CUT - / FILL +	1.83 1.73 1.63 1.64 1.86 1.91 2.27 2.88 3.66 3.96 4.46 5.25 6.05 6.84 7.49 8.17 8.50 8.91 9.04 9.31 9.51 9.88 10.21 10.26 10.53 10.81 11.03 11.12 11.20
CHAINAGE	500 520 540 560 580 583.34 600 620 640 647.43 660 680 700 720 740 760 780 800 805.14 820 840 860 880 883.18 900 920 940 960 980 1000 1015.17 1020 1040 1060 1080 1096.8 1100 1120 1140 1160 1173.83

LONGITUDINAL SECTION - MAROOCHY BVD REGRADE

HORZ 1:2000 VERT 1:200

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY

DRAWING CHECK PRINT

DATE RAISED 24 / 09 / 07	BY	DATE
DRAFTING CHECK		
ENGINEERING CHECK		
BACK-DRAFTING CHECK		
NEXT ACTION		

SCALES
A1 / A3 1:2000 / 1:2000
A1 / A3 1:200 / 1:400

A1 ORIGINAL
DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY
APPROVED FOR AND ON BEHALF OF PARSONS BRINCKERHOFF AUSTRALIA PTY LTD
SIGNED
DATE REGD NO.

PARSONS BRINCKERHOFF
Adelaide Brisbane Melbourne Newcastle Perth Brighton Australia Gold Coast and Sydney
ABN 80 078 004 798
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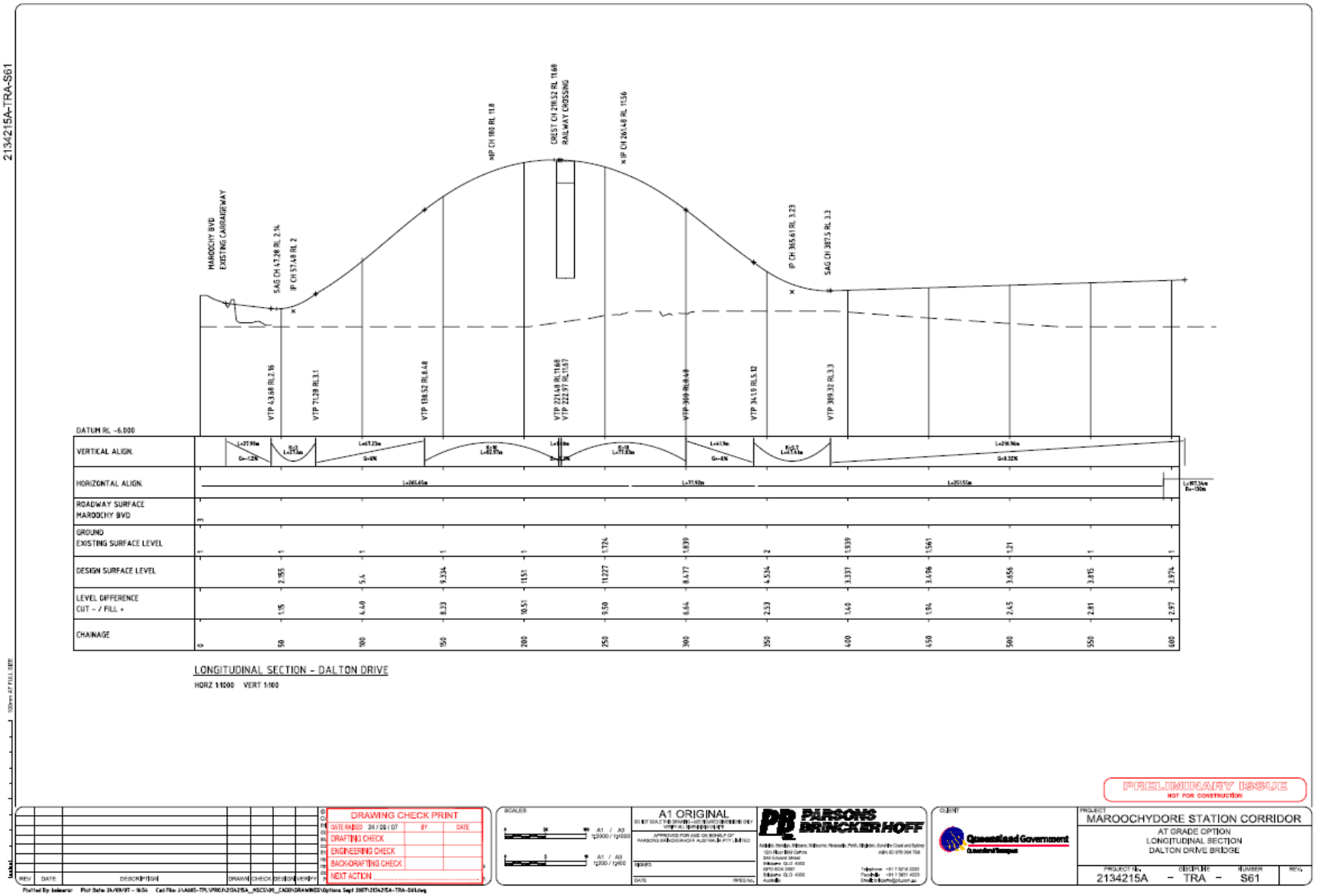
Telephone +61 7 3218 2000 Facsimile +61 7 3831 4025 Email brisbane@pbworld.com

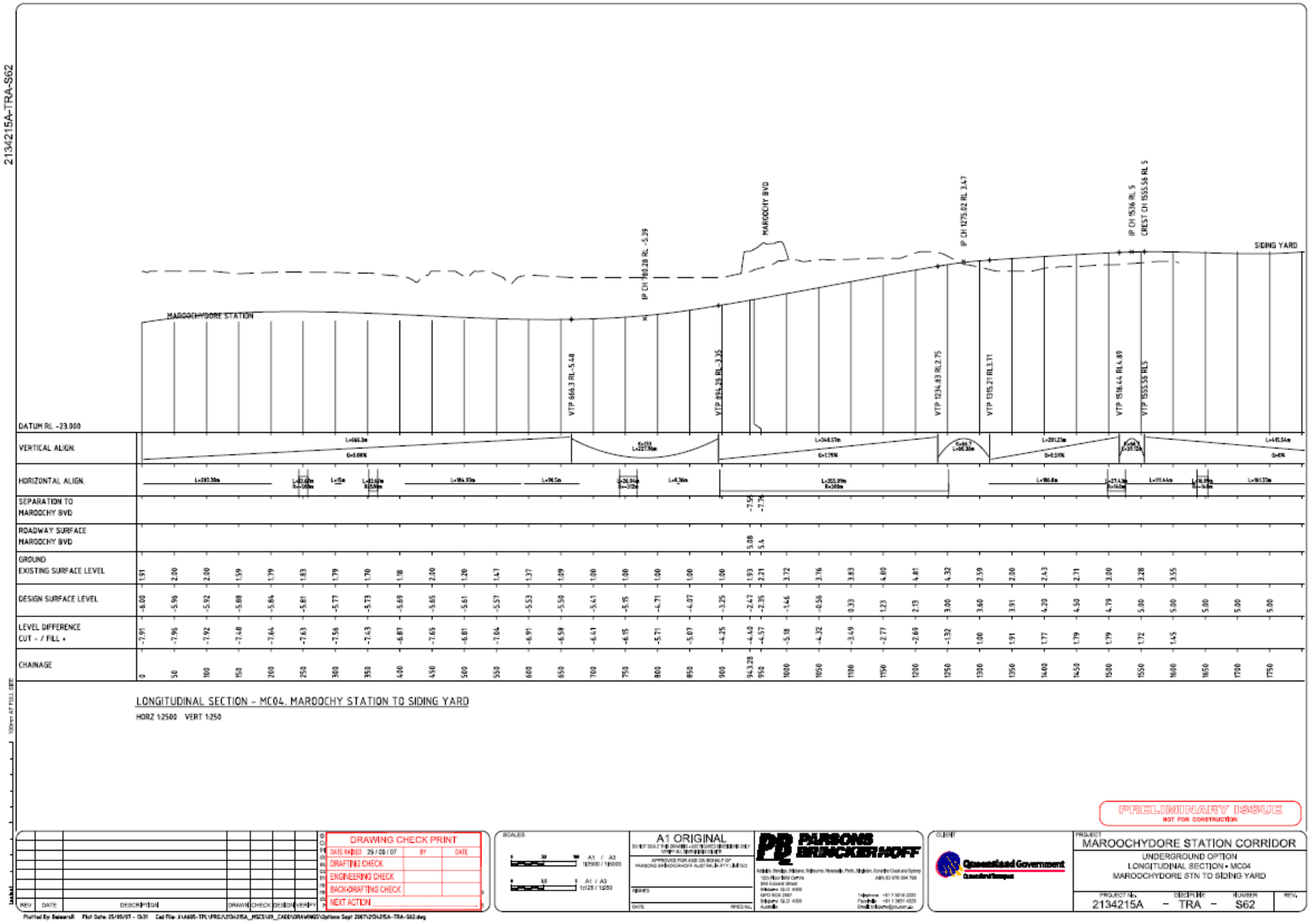
CLIENT
Queensland Government

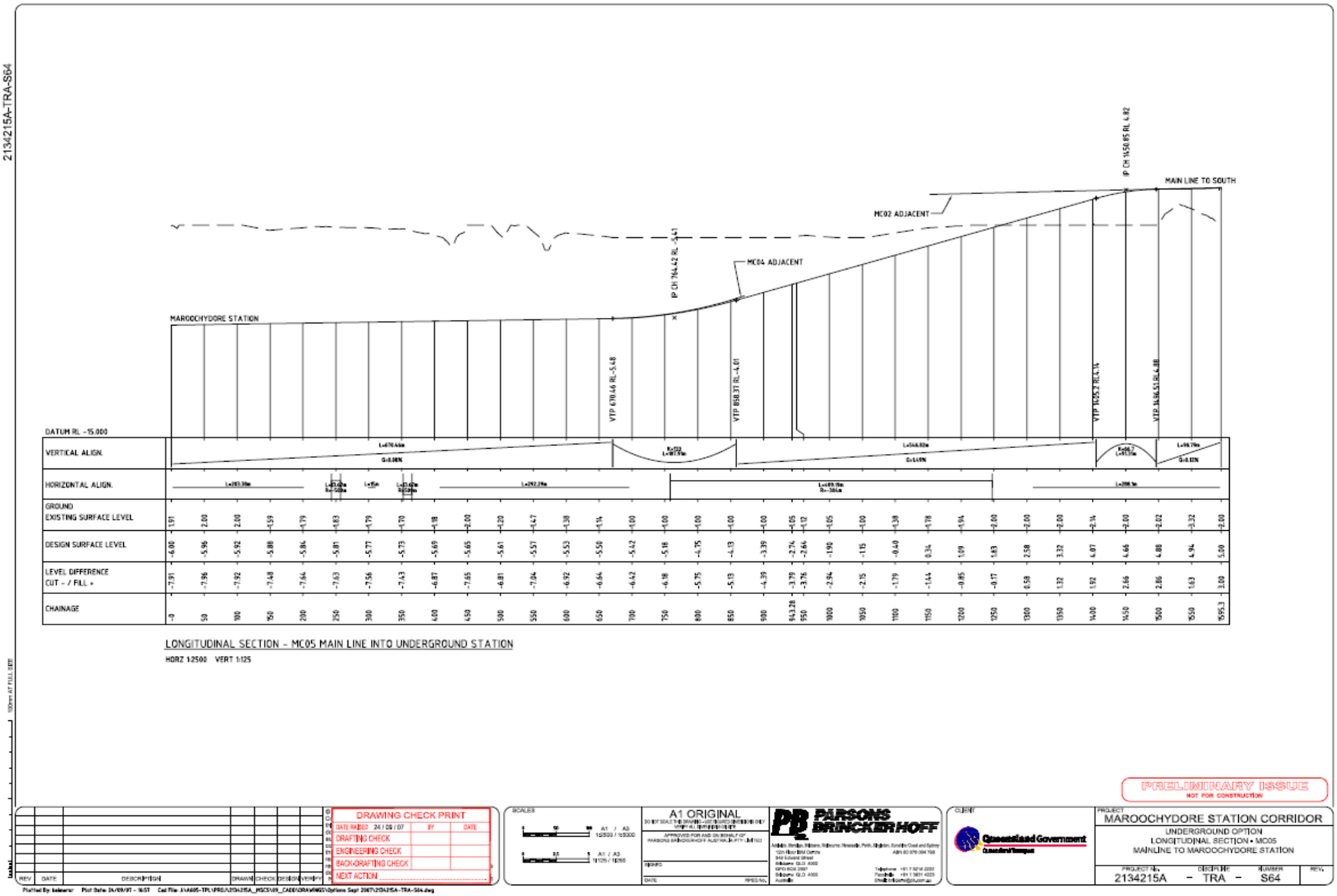
PROJECT
MAROOCHYDORE STATION CORRIDOR
AT GRADE OPTION
LONGITUDINAL SECTION
MAROOCHY BVD REGRADE OVER RAIL LINE

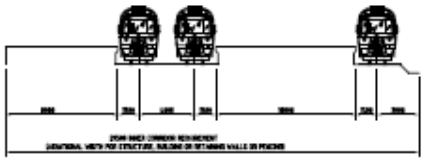
PROJECT No.	DISCIPLINE	NUMBER	REV.
2134215A	- TRA -	S60	

Plotted By: bakearor Plot Date: 24/09/07 - 16:53 Cad File: J:\AA005-TPL\PROJ\2134215A_MSCS\08_CADD\DRAWINGS\Options Sept 2007\2134215A-TRA-S60.dwg

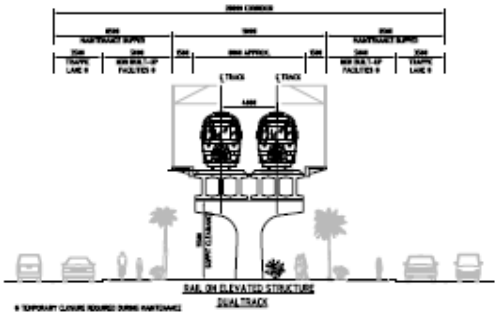

2134215A-TRA-S61
MAROOCHY BVD
EXISTING CARRIAGEWAY
SAG CH 47.28 RL 2.14
IP CH 57.48 RL 2
VIP 43.68 RL 2.16
VIP 71.28 RL 3.1
VIP 138.52 RL 8.68
VIP 221.48 RL 11.68
VIP 222.97 RL 11.67
VIP 309 RL 8.48
VIP 361.5 RL 5.12
VIP 389.32 RL 3.3
IP CH 365.61 RL 3.23
SAG CH 387.5 RL 3.3
VIP CH 189 RL 11.8
CREST CH 218.52 RL 11.68
RAILWAY CROSSING
IP CH 261.48 RL 11.56
DATUM RL -6.000
VERTICAL ALIGN.
HORIZONTAL ALIGN.
ROADWAY SURFACE
MAROOCHY BVD
GROUND
EXISTING SURFACE LEVEL
DESIGN SURFACE LEVEL
LEVEL DIFFERENCE
CUT - / FILL +
CHAINAGE
0 50 100 150 200 250 300 350 400 450 500 550 600
2.155 5.4 9.334 11.51 11.227 8.477 4.534 3.337 3.496 3.656 3.815 3.974
1.15 4.40 8.33 10.51 9.50 6.64 2.53 1.40 1.94 2.45 2.81 2.97
LONGITUDINAL SECTION - DALTON DRIVE
HORZ 1:1000 VERT 1:100
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
DRAWING CHECK PRINT
DRAFTING CHECK
ENGINEERING CHECK
BACK-DRAFTING CHECK
NEXT ACTION
SCALES
A1 ORIGINAL
PARSONS BRINCKERHOFF
Queensland Government
PROJECT
MAROOCHYDORE STATION CORRIDOR
AT GRADE OPTION
LONGITUDINAL SECTION
DALTON DRIVE BRIDGE
PROJECT No. 2134215A
DISCIPLINE TRA
NUMBER S61
REV.


2134215A-TRA-S62
MAROOCHYDORE STATION
IP CH 1160.28 RL -5.39
MAROOCHY BVD
IP CH 1275.02 RL 3.47
IP CH 1536 RL 5
CREST CH 1555.56 RL 5
SIDING YARD
VTP 666.3 RL -5.48
VTP 856.26 RL -3.25
VTP 1234.93 RL2.75
VTP 1315.21 RL3.71
VTP 1516.44 RL4.89
VTP 1555.56 RL5
DATUM RL -23.000
VERTICAL ALIGN.
HORIZONTAL ALIGN.
SEPARATION TO MAROOCHY BVD
ROADWAY SURFACE MAROOCHY BVD
GROUND EXISTING SURFACE LEVEL
DESIGN SURFACE LEVEL
LEVEL DIFFERENCE CUT - / FILL +
CHAINAGE
LONGITUDINAL SECTION - MC04, MAROOCHY STATION TO SIDING YARD
HORZ 1:2500 VERT 1:250
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
DRAWING CHECK PRINT
DRAFTING CHECK
ENGINEERING CHECK
BACK-DRAFTING CHECK
NEXT ACTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
Queensland Government
MAROOCHYDORE STATION CORRIDOR
UNDERGROUND OPTION
LONGITUDINAL SECTION • MC04
MAROOCHYDORE STN TO SIDING YARD
2134215A - TRA - S62

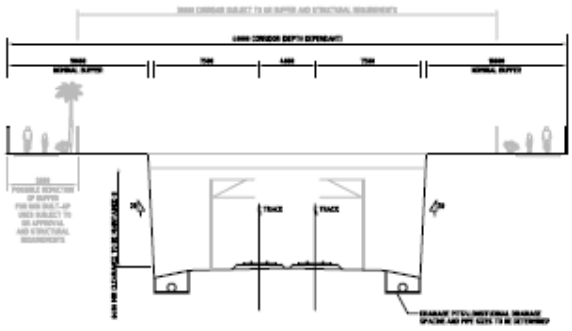

2134215A-TRA-S64
MAIN LINE TO SOUTH
IP CH 1450.85 RL 4.82
MC02 ADJACENT
MC04 ADJACENT
IP CH 764.42 RL -5.41
MAROOCHYDORE STATION
VTP 670.46 RL-5.48
VTP 858.37 RL-4.01
VTP 1025.2 RL 1.14
VTP 1156.51 RL 4.88
DATUM RL -15.000
VERTICAL ALIGN.
HORIZONTAL ALIGN.
GROUND
EXISTING SURFACE LEVEL
DESIGN SURFACE LEVEL
LEVEL DIFFERENCE
CUT - / FILL +
CHAINAGE
LONGITUDINAL SECTION - MC05 MAIN LINE INTO UNDERGROUND STATION
HORZ 1:2500 VERT 1:125
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
DRAWING CHECK PRINT
DRAFTING CHECK
ENGINEERING CHECK
BACK-DRAFTING CHECK
NEXT ACTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
Queensland Government
MAROOCHYDORE STATION CORRIDOR
UNDERGROUND OPTION
LONGITUDINAL SECTION • MC05
MAINLINE TO MAROOCHYDORE STATION
2134215A - TRA - S64



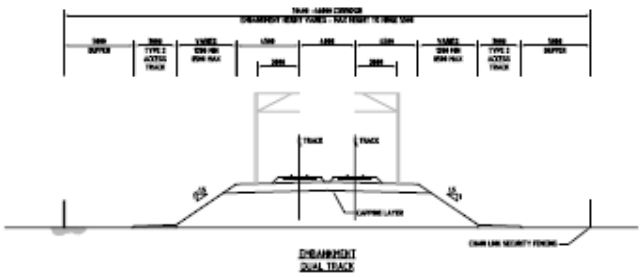
STATION REQUIREMENTS
3 TRAIN STANDING



RAIL ON ELEVATED STRUCTURE
DUAL TRACK



RAIL SUBMERGED
DUAL TRACK



EMBANKMENT
DUAL TRACK