Gold Coast
Rapid Transit

Concept Design and Impact Management Plan
Volume 7 Technical Report - Light Rail Transit Operations Assessment
Contents

1. Introduction 6
   1.1 Gold Coast Rapid Transit Project 6
   1.2 Project Stages 8
   1.3 Purpose of this Report 8
   1.4 Report Structure 8
   1.5 Reference Documents 9

2. Integration with the Public Transport Network 10
   2.1 Network Integration Strategy 10
   2.2 Heavy Rail 10
   2.3 Bus Network 10
   2.4 Future Expansion 11

3. System Operational Specifications 13
   3.1 Passenger Space Allowance 13
   3.2 Vehicle Requirements and Assumptions 13
   3.3 Spatial Requirements and Design Issues 15
   3.4 Service Frequency Requirements 16
   3.5 Predicted Demand 18
   3.6 Operational Priority 18
   3.7 Future Expansion 19
   3.8 Depot and Maintenance Facilities 19

4. System Operations 21
   4.1 Journey Times 21
   4.2 System Capacity 26
   4.3 Service Arrangements 26
   4.4 Service Frequency 26
   4.5 Service Patterns 26
   4.6 Design Periods 27
   4.7 Passenger Demand 27
   4.8 Staging Plan 27
   4.9 Reserve Capacity 29
   4.10 Off Peak Operations 29
   4.11 Vehicle Fleet 29
4.12 Staff Requirements 31
4.13 Special Events 32
4.14 Vehicle Maintenance and Refurbishment 33

5. Operational Issues to Consider for Users 34
5.1 Passenger Safety and Security 34
5.2 Stations Interchanges and End of Line Facilities 35
5.3 Fare Collection 36
5.4 Passenger Information 37

6. Intelligent Transport Systems and Security 38
6.1 Overview 38
6.2 Operations Management and Control System (OMCS) 40
6.3 Data Exchange System (DES) 46

7. Commissioning 47
7.1 Overview 47
7.2 Accreditation 47
7.3 Infrastructure 47
7.4 Systems 48
7.5 Vehicles 48
7.6 Operations 49
7.7 Commercial 50

8. Incident Management and Safety Procedures 51
8.1 Incident Management 51
8.2 Detection of Vehicle Breakdowns 51
8.3 Management of Light Rail Vehicle Breakdowns 52
8.4 General Approach to Safety in Operations 53
8.5 Risks to be Considered 53
8.6 Special Operations 56

9. Summary and Recommendations 57
9.1 Summary 57
9.2 Recommendations 57
### Table Index

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Reference Documents</td>
<td>9</td>
</tr>
<tr>
<td>Table 2</td>
<td>Recommended Design Vehicle Parameters</td>
<td>13</td>
</tr>
<tr>
<td>Table 3</td>
<td>LRT Vehicle Characteristics</td>
<td>14</td>
</tr>
<tr>
<td>Table 4</td>
<td>Design Vehicle Capacity</td>
<td>14</td>
</tr>
<tr>
<td>Table 5</td>
<td>General Corridor Design Characteristics</td>
<td>16</td>
</tr>
<tr>
<td>Table 6</td>
<td>Maximum Peak Rail Service Headway at Helensvale (mins)</td>
<td>17</td>
</tr>
<tr>
<td>Table 7</td>
<td>Average Headways of Existing Bus Services in the Core Section</td>
<td>17</td>
</tr>
<tr>
<td>Table 8</td>
<td>Predicted Peak Hour Demand</td>
<td>18</td>
</tr>
<tr>
<td>Table 9</td>
<td>Delay at Intersections</td>
<td>23</td>
</tr>
<tr>
<td>Table 10</td>
<td>Journey Time Breakdown by Gold Coast Rapid Transit Section</td>
<td>25</td>
</tr>
<tr>
<td>Table 11</td>
<td>System Capacity</td>
<td>26</td>
</tr>
<tr>
<td>Table 12</td>
<td>Design Periods</td>
<td>27</td>
</tr>
<tr>
<td>Table 13</td>
<td>Proposed LRT System Operations: 35 Metre Vehicles</td>
<td>28</td>
</tr>
<tr>
<td>Table 14</td>
<td>Fleet Requirements: 35 Metre Vehicles</td>
<td>31</td>
</tr>
<tr>
<td>Table 15</td>
<td>Fleet Purchase Plan for 35 Metre Vehicles</td>
<td>31</td>
</tr>
<tr>
<td>Table 16</td>
<td>Estimated Driver Requirements</td>
<td>32</td>
</tr>
<tr>
<td>Table 17</td>
<td>Preliminary Assessment of Fare Collection Issues</td>
<td>36</td>
</tr>
<tr>
<td>Table 18</td>
<td>Risks to be Considered</td>
<td>54</td>
</tr>
<tr>
<td>Table 19</td>
<td>Operations Staff Estimate</td>
<td>61</td>
</tr>
<tr>
<td>Table 20</td>
<td>Description of LRT Crossover Points</td>
<td>66</td>
</tr>
</tbody>
</table>

### Figure Index

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Gold Coast Rapid Transit Project Stage 1 Investigation Corridor</td>
<td>7</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Transport Network Strategy</td>
<td>12</td>
</tr>
<tr>
<td>Figure 3</td>
<td>System Hardware Architecture</td>
<td>39</td>
</tr>
<tr>
<td>Figure 4</td>
<td>OMCS System Modules</td>
<td>40</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Commissioning Strategy</td>
<td>47</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Location of Potential LRT Crossovers</td>
<td>67</td>
</tr>
</tbody>
</table>
Appendices

A  LRT Section Attributes
B  Capacity Analysis
C  Estimated Staffing Requirements
D  Indicative Cross Sections
E  Cross Over Locations
1. Introduction

1.1 Gold Coast Rapid Transit Project

The Gold Coast Rapid Transit (GCRT) project is a major Government initiative for creating a more sustainable Gold Coast City. The project will deliver a public transport system that is fast, frequent, reliable and integrated with the existing transport network.

In June 2006 State Cabinet approved the development of a Concept Design, Impact Management Plan and Business Case for two rapid transit mode options under Government’s Value for Money Framework. The GCRT project is included in the South East Queensland Regional Plan and funded in South East Queensland Infrastructure Plan and Program. The lead Government Agency, TransLink will develop the Concept Design and Impact Management Plan and Business Case in partnership with Gold Coast City Council, which has also allocated future funding for public transport improvements on the Gold Coast.

The new rapid transit system is intended to link the Gold Coast Railway at Helensvale with the Griffith University/University Hospital precinct and the busy centres of Southport, Surfers Paradise, Broadbeach, and ultimately Gold Coast Airport and Coolangatta Town Centre.

The rapid transit mode options under investigation are:

- A light rail transit (LRT) system with low floor air-conditioned vehicles on a standard gauge fixed track drawing power from overhead wires; and
- A bus rapid transit (BRT) system that offers a much higher quality service than an ordinary bus, with specially designed buses running very frequent services and higher reliability and faster travel times than buses operating in mixed traffic.

Both systems would operate within a dedicated corridor, mostly running within a central reserve on existing roads. In some areas, a corridor adjacent to the road or mixed running with traffic has been considered. Regardless of the chosen mode, the technology option will use a dedicated carriageway ‘at grade’ with an agreed level of priority provided at traffic signals to promote fast and reliable journey times.

The Concept Design and Impact Management Plan and Business Case are based on detailed studies for Stage 1 (Helensvale to Broadbeach), with initial planning investigations of Stage 2 (Broadbeach to Coolangatta). The Stage 1 corridor, as shown in Figure 1, connects to the Gold Coast Rail Line at the existing Helensvale Rail station and terminates at Broadbeach at a new bus/rapid transit interchange. Stage 1 has been evaluated and planned in the following 3 sections:

- Section 1: Helensvale to Griffith University. Two corridor options are subject to detailed planning evaluation;
- Section 2: Griffith University to Southport; and
- Section 3: Southport to Broadbeach including Surfers Paradise.
1.2 Project Stages

The project is planned in two stages:

- Stage 1: Helensvale to Broadbeach (2011 to 2016);
- Stage 2a: Broadbeach to Burleigh Heads (2016 to 2026); and
- Stage 2b: Burleigh Heads to Coolangatta (from 2026).

This report focuses on the requirements for Stage 1.

Two route options between Griffith University and Helensvale were considered:

- Option H1: University Hospital at Griffith University – Harbour Town – Helensvale; and
- Option H2: University Hospital at Griffith University – Parkwood – Helensvale.

Following a decision by TransLink, Option H2 has been used for the development of the operational strategy. If Option H1 is adopted at a later date, the operations plan would need to be revised due to the longer journey times.

1.3 Purpose of this Report

The purpose of this report is to provide a reference document for the basis and proposals for the operations of the LRT system. It sets out the requirements, assumptions and findings leading to a recommended design vehicle and proposed operations plan. As the proposed operations plan is based on a number of assumptions that are subject to change due to the ongoing refinement of both the decision making and design processes, the recommendations should be regarded as a benchmark from which further development can take place. The recommendations provide reasonable acceptable value for money and not an optimised solution.

An approach for dealing with LRT operations during special events is provided, but a detailed events management plan is not provided because it would vary depending on the scope and timing of the event.

1.4 Report Structure

The report is structured as follows:

- Section 2: Describes how the GCRT is integrated with the public transport network;
- Section 3: Sets out the operational requirements for the proposed LRT Option of the GCRT system;
- Section 4: Provides the assumptions and estimates for the various operational aspects, such as the journey times, system capacity, vehicle fleet and staffing requirements for the GCRT;
- Section 5: Describes the key operational issues to consider for users;
- Section 6: Describes the proposed ITS system and security monitoring measures;
- Section 7: Describes the commissioning of the project;
- Section 8: Describes the Incident Management Plan and emergency safety procedures; and
- Section 9: Summarises the findings and recommendations.
### 1.5 Reference Documents

The following documents, all of which have been submitted to TransLink, provide background material to the assumptions made in the preparation of this report.

<table>
<thead>
<tr>
<th>Table 1 Reference Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
</tr>
<tr>
<td>GHD Reports</td>
</tr>
<tr>
<td>LRT Reference Technology Paper</td>
</tr>
<tr>
<td>Station Access Strategy</td>
</tr>
<tr>
<td>LRT and BRT Operations Assessment</td>
</tr>
<tr>
<td>Station Validation Paper</td>
</tr>
<tr>
<td>LRT Operations Plan</td>
</tr>
<tr>
<td>Depot Locations Working Paper</td>
</tr>
<tr>
<td>Study Tour Outcomes</td>
</tr>
<tr>
<td>Assessment of BRT and LRT Vehicle Capacity and System Operations*</td>
</tr>
<tr>
<td>Overhead Traction Power Distribution Concept Design for LRT Option</td>
</tr>
<tr>
<td>Urban and Planning Working Papers</td>
</tr>
<tr>
<td>SYSTRA Reports</td>
</tr>
<tr>
<td>LRT Depot Layout Preliminary Study</td>
</tr>
</tbody>
</table>

* referred to as ‘The Capacity Report’ in future references.

Some of the items in this report supersede previous work in the above listed reports.
2. Integration with the Public Transport Network

2.1 Network Integration Strategy
The Network Integration Strategy facilitates the efficient integration of the GCRT into the broader transport network. The integration strategy criteria are:

- Bus route planning and operations support the staged implementation of the GCRT;
- Planning and location of the GCRT stations and access points facilitate convenient access and inter-modal interchange;
- Access to the GCRT stations will be achievable by all modes of transport: walking, cycling, taxi, private car and other public transport modes;
- Integration of the GCRT with the heavy rail network; and
- Integration of the GCRT with the road network.

2.2 Heavy Rail
The GCRT will have a major regional station integrated with the heavy rail system at Helensvale. Both the heavy rail and the GCRT provide a linear north-south service with the heavy rail servicing the inland areas with connections to Brisbane city and Brisbane airport with the GCRT servicing the high-density, coastal development. The heavy rail will provide a fast service with widely separated stations and the LRT a slower but more frequent service with closely spaced stations. The heavy rail and the GCRT will both provide a solid public transport base for the redevelopment of the existing bus network.

The existing Gold Coast railway operates trains to Helensvale at a frequency of 30 minutes.

2.3 Bus Network

2.3.1 Bus Network Strategy
An alternative bus network and service strategy has been proposed by TransLink to support and provide linkage to the GCRT network. The bus network and service strategy seeks to address current network and level of service deficiencies and has been structured in line with TransLink’s Network Plan for the Gold Coast. A hierarchy of services has been identified that will form the link between the heavy rail and the GCRT. The feeder bus network will be designed for convenient timed connections at Helensvale, Griffith University, Southport and Broadbeach South stations.

The bus network strategy is currently being further refined by TransLink and will form a key input to the GCRT system.

2.3.2 Bus Operations in 2011
Prior to the opening of the rapid transit operation in 2011, significant improvements in bus services are proposed to further encourage the use of public transport and to address some of the deficiencies in the existing network. Service improvements include increasing coverage, higher frequencies, longer operating hours and the introduction of weekend services. A high frequency service would be introduced...
that mirrors the route and operations of the GCRT so that bus users are accustomed to the high level of service offered by the GCRT. It is also hoped that additional patronage would be attracted during this period. This service is expected to operate at a high frequency similar to that of the 2011 BRT operations. After the opening of the BRT system, the high frequency services that mirror the GCRT will be removed/truncated and the service-kilometres reinvested in further service improvements.

The implementation of the proposed strategy will also provide:

- New services to areas of high demand and identified growing communities;
- Enhanced bus connections to heavy rail at Coomera, Helensvale, Nerang and Robina;
- High Frequency Priority (HFP) feeder services (as defined by TransLink’s Network Plan) on bus/LPV priority corridors and high demand corridors e.g.
  - Southport to Coolangatta via the Gold Coast Highway;
  - Helensvale to Southport via the Gold Coast Highway;
  - Nerang to Southport;
  - Nerang to Surfers Paradise;
  - Nerang to Broadbeach;
  - Robina to Bond University and Burleigh Heads;
  - Robina to Coolangatta; and
  - Griffith University to Australia Fair and Pacific Fair.

The bus network strategy is shown diagrammatically in Figure 2.

### 2.4 Future Expansion

Stage 2 of the project will extend the service between Broadbeach South and Burleigh Heads and Coolangatta. The proposals for Stage 1 will ensure no impediment to the subsequent development of these facilities.
3. System Operational Specifications

This section describes the operational requirements that were initially established by TransLink's Brief. In some cases these have been subsequently developed and revised. All such revisions have been agreed with TransLink and have been adopted for the development of the proposals contained in this report and Concept Design and Impact Management Plan (CDIMP) documentation and Operating Expenditure (OPEX) cost predictions.

3.1 Passenger Space Allowance

High levels of passenger comfort are required by TransLink in order to provide a service that is attractive to users and that will encourage patronage. The need for a balance between passenger comfort levels and the ability of the system to provide adequate capacity was demonstrated in *The Capacity Report*. The recommended design vehicle parameters are summarised in Table 2.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Value Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seating provision</td>
<td>35% of total capacity</td>
</tr>
<tr>
<td>Standee density</td>
<td>General design: 3 passengers per square metre</td>
</tr>
<tr>
<td></td>
<td>Peak Period: maximum 4 passengers per square metre for short duration journeys</td>
</tr>
<tr>
<td>Seat area</td>
<td>0.5 square metres per seated passenger</td>
</tr>
<tr>
<td>DDA allowance</td>
<td>Provision for two wheelchairs</td>
</tr>
</tbody>
</table>

The design standee density and seat area also provides adequate provision for normal luggage storage with additional storage areas over the wheel housings. No allowance has been made for the carriage of bicycles, surfboards or other large items. Such items are not usually provided for on rapid transit systems due to the space requirements and the impact on dwell times.

3.2 Vehicle Requirements and Assumptions

3.2.1 Vehicle Characteristics

Examples of vehicles currently in use in LRT systems around the world are discussed fully in the *LRT Reference Technology Paper*. The required length of vehicle is discussed in *The Capacity Report*, which recommends a 35 metre vehicle for Stage 1 operations to 2041. Analysis of the system has not been conducted beyond 2041, however, current patronage data and design level of intersection priority suggests a 45 metre vehicle may be required. The vehicle size required will be dependent on actual patronage and the level of intersection priority that can be provided to the LRT vehicles at that stage.

The key characteristics of the 35 metre vehicle are summarised in Table 3.
Table 3  LRT Vehicle Characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>35 m</td>
</tr>
<tr>
<td>Width</td>
<td>2.65 m (excluding mirrors)</td>
</tr>
<tr>
<td>Traction system</td>
<td>Electric 750 V DC feeding AC traction motors</td>
</tr>
<tr>
<td>Power rating</td>
<td>1050 kW</td>
</tr>
<tr>
<td>Power reticulation</td>
<td>Overhead wiring using a single pantograph</td>
</tr>
<tr>
<td>Gauge</td>
<td>1435 mm (standard)</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>80 km/h (minimum)</td>
</tr>
<tr>
<td>Maximum sustained gradient</td>
<td>7%</td>
</tr>
</tbody>
</table>

3.2.2  Design Vehicle Capacity

Design vehicle capacity is discussed extensively in *The Capacity Report*. Under normal conditions a standee density of 3 passengers per sq metre should not be exceeded. In order to optimise capacity, for short sections during short periods of time a maximum standee density of 4 passengers per sq metre has been agreed as acceptable and has been used in this assessment.

The design criteria adopted are summarised in Table 2 and the resulting vehicle capacity ratings for 35 metre and 45 metre vehicles are summarised in Table 4.

Table 4  Design Vehicle Capacity

<table>
<thead>
<tr>
<th>Standee Density</th>
<th>Normal Conditions</th>
<th>Peak Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 metre Vehicle</td>
<td>3 passengers per square metre</td>
<td>4 passengers per square metre</td>
</tr>
<tr>
<td>No. seats</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>No. standees</td>
<td>129</td>
<td>180</td>
</tr>
<tr>
<td>Total passengers</td>
<td>198</td>
<td>249</td>
</tr>
<tr>
<td>45 metre Vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. seats</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>No. standees</td>
<td>169</td>
<td>233</td>
</tr>
<tr>
<td>Total passengers</td>
<td>260</td>
<td>324</td>
</tr>
</tbody>
</table>

3.2.3  Vehicle Economic Life

The usual design economic life of an LRT vehicle is 25-30 years although 50 years has also been achieved. An economic life of 30 years has been adopted for the GCRT project.
3.2.4 Floor Level
Vehicles should ideally be 100% low floor, for the following reasons:

- Passenger comfort and ease of access;
- Passenger safety (no steps at stations and no internal steps); and
- Maximum accessibility for wheelchair and strollers.

100% low floor vehicles are recommended but if part low floor vehicles are to be used for cost reasons, the design should provide large portions of low floor around doorways to accommodate and enable ease of access/egress by wheelchairs. The low floor area should be not less than 70% of total floor area. In such instances the use of folding seats in this area may be an advantage.

3.2.5 Doors
The vehicle should have multiple doors in order to facilitate speedy boarding and alighting to minimise station dwell times. Boarding and alighting rates through doorways needs to be tested against the assumptions used in the model.

3.2.6 Power Supply and Reticulation
Full details of the power supply and reticulation are provided in Overhead Traction Power Distribution Concept Design for LRT Option.

3.3 Spatial Requirements and Design Issues

3.3.1 Alignment Characteristics
The geometric characteristics that have been incorporated into this stage of the study are:

- Location of the stations;
- Gradients;
- Radii of curvature; and
- Location and operation of the intersections with and without signals.

The issues are discussed fully in the LRT Operations Plan and the key points are summarised below.

3.3.2 Design Speed
Limits have been placed on the design speeds in defined zones for geometric design or safety reasons, particularly in high volume pedestrian areas and narrow streets. The design speeds are shown in Appendix A. It should be noted that the proposed speed restrictions have a significant impact on journey times.

3.3.3 Stations
Station categories are discussed in the Station Validation paper. Three categories that reflect the role of each in the transport network and the patronage levels they will serve are defined as follows:

- Regional: A major attractor such as a regional shopping centre;
District: A significant attractor with a good standard of passenger facilities primarily serviced by line haul services but some feeder services may also operate; and

Local: Caters primarily for the transport needs of the immediate community and is primarily accessed by walking via local paths and roadways.

Platforms will be side platforms and will be located parallel and adjacent to each other.

Stations should be designed to accommodate one LRT vehicles at any one time. As 45 metre vehicles may be required after 2041, the platform should be able to accommodate one 45 metre vehicle.

3.3.4 Summary of General Design Characteristics

The general design characteristics used for the concept design phase are summarised in Table 5.

<table>
<thead>
<tr>
<th>Table 5 General Corridor Design Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station</td>
</tr>
<tr>
<td>Platform width – at stations classified as local and district</td>
</tr>
<tr>
<td>Platform width – at stations classified as regional</td>
</tr>
<tr>
<td>Platform length</td>
</tr>
<tr>
<td>Alignment</td>
</tr>
<tr>
<td>Gauge</td>
</tr>
<tr>
<td>Minimum horizontal curve radius</td>
</tr>
<tr>
<td>Maximum gradient</td>
</tr>
<tr>
<td>Width of Rail Corridor</td>
</tr>
<tr>
<td>Rail corridor width</td>
</tr>
<tr>
<td>Rail corridor width in stations</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Relevant cross sections for different configurations are presented graphically in Appendix D.

3.4 Service Frequency Requirements

3.4.1 Minimum Headway

As discussed in The Capacity Report the minimum headway has been set at 3 minutes to potentially match the RT operations with existing intersection signal phasing thus trying to reduce the impact on existing traffic operations. The traffic signals currently operate at fixed cycle times of between 140 and 180 seconds and can be adapted to accommodate the additional phasing and frequency requirements of the RT system.
3.4.2 Maximum Headway

Maximum headway has been set based on three criteria required by TransLink as follows.

Integration with Queensland Rail

In order to integrate with the future Queensland Rail services at Helensvale, TransLink has specified the maximum headway as shown in Table 6.

Table 6 Maximum Peak Rail Service Headway at Helensvale (mins)

<table>
<thead>
<tr>
<th>Period</th>
<th>2011</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM and PM peak</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Off peak</td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

Consistency of Service Frequency with Existing Bus Services

The LRT should provide at least a similar service frequency to that provided by existing bus routes serving the core section. The average headway of existing bus routes between Southport and Broadbeach is as shown in Table 7.

Table 7 Average Headways of Existing Bus Services in the Core Section

<table>
<thead>
<tr>
<th></th>
<th>Southbound</th>
<th>Northbound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Headways (mins)</td>
<td>No. of Services</td>
</tr>
<tr>
<td>AM (07:00 – 09:00)</td>
<td>7.4</td>
<td>17</td>
</tr>
<tr>
<td>PM (16:00 – 18:00)</td>
<td>6.0</td>
<td>20</td>
</tr>
</tbody>
</table>

The average timetabled headway ranges between 5.6 to 7.4 minutes.

The intent of the operational requirements was to provide sufficient capacity to meet the expected demand without significant loss in current level of service. A maximum of 7.5 minutes was considered to provide a reasonable balance between the required headway to satisfy capacity requirements (over 15 minutes) and the minimum existing bus headway and was thus adopted.

Continuity of Service

As patronage on the system increases the passenger demand will be met through the reduction of vehicle headway and/or the introduction of larger vehicles. TransLink has advised that when larger vehicles are used vehicle headway is not to be increased, even though increased headways may meet capacity requirements due to the creation of additional reserve capacity, so that the level of service provided to patrons remains unaltered.
3.5 Predicted Demand

- TransLink has provided predicted patronage data for years 2016, 2026 and 2041 based on the VISUM model produced by Bitzios Consulting. Full details of the assumptions made in establishing the model were not available during the preparation of this report. TransLink has advised that the forecasts are 50 percentile values, i.e. the predictions are an average value.

- Two sets of data have been provided:
  - Stage 1 Patronage Data: Helensvale to Broadbeach South; and
  - Stage 2 Patronage Data: Helensvale to Coolongatta.

- From the data, peak hour flows were predicted based on the daily flow variation of buses currently serving the GCRT corridor. Stage 1 patronage values for 2011, 2021, 2031 and 2036 have been extrapolated/interpolated from the predicted data. Patronage for these design years is therefore approximate only. Further details of this calculation are presented in The Capacity Report.

Predicted station to station flows based on Stage 1 patronage data are presented in Appendix B. Predicted peak hour demand for for 2016, 2026 and 2041 based on both Stage 1 and Stage 2 patronage data are summarised in Table 8 rounded to the nearest 10.

### Table 8 Predicted Peak Hour Demand

<table>
<thead>
<tr>
<th>Design Year</th>
<th>Peak Hour One-way Passenger Demand for Stage 1</th>
<th>Peak Hour One-way Passenger Demand for Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>1,500</td>
<td>2,080</td>
</tr>
<tr>
<td>2026</td>
<td>3,250</td>
<td>3,670</td>
</tr>
<tr>
<td>2041</td>
<td>5,480</td>
<td>6,365</td>
</tr>
</tbody>
</table>

The peak hour referred to in Table 8 is the daily peak hour, which generally occurs during the PM peak.

3.6 Operational Priority

Operational priority is a key factor to the success of the GCRT and will be achieved by:

- Physical priority, which is physical segregation from potential conflict with other traffic; and
- Signal priority, which is priority at locations (generally intersections) where physical segregation is not provided.

These are outlined below.

3.6.1 Physical Priority

The LRT will operate on a dedicated, segregated or mixed corridor as follows:

**Dedicated**

Where the operation of the RT system is completely within its own corridor, fenced and grade separated from pedestrians and general traffic. For the GCRT system this only occurs at the depot and Loders Creek Bridge. In such sections speeds may be up to 80 km/h.
**Segregated**

Where the operation of the RT system will utilise an existing road corridor at grade with some form of separation from general traffic. Pedestrians and general traffic may not be excluded from crossing the operation at grade in some locations. The majority of the GCRT system operates on a segregated corridor with physical separation being generally achieved by means of a median typically raised by a 150 mm kerb.

**Mixed**

Where the operation of the RT system will be at grade on an existing road corridor and will mix with traffic and pedestrians. In areas of mixed running, traffic management, including signal priority and specifically designed lane configuration at the entry points to mixed running sections will aim to:

- ‘Meter’ the flow of general traffic such that free-flow traffic conditions are maintained within the mixed running section - even if that means creating congestion conditions for general traffic outside the mixed running section; and
- Ensure that when the LRT vehicle runs through the mixed running section, it will stay ahead of the general traffic – i.e. the general traffic will need to stop behind an LRT vehicle that is stopped at a station.

For the GCRT the only section in which mixed operation occurs is Cypress Avenue.

**3.6.2 Signal Priority**

Three scenarios for different levels of system-wide priority at intersections were developed:

- **Full:** Full, pre-emptive signal priority provided at all intersections, so the RT will experience no delays;
- **High:** Signal priority provided at most intersections, unless particularly complex or congested. Priority could be full, pre-emptive or partial; and
- **Moderate:** Signal priority provided at locations and at a level that will not unduly affect existing traffic operations.

Adoption of the appropriate priority scenario is dependent on the outcome of detailed traffic modelling, which is currently being carried out by TransLink. Signal priority is further discussed in relation to journey time in 4.1.

**3.7 Future Expansion**

Stage 2 of the project will extend the service between Broadbeach South and Burleigh Heads and Coolangatta. The proposals for Stage 1 will ensure no impediment to the subsequent development of these facilities.

**3.8 Depot and Maintenance Facilities**

Key considerations for the maintenance and stabling of LRT vehicles are outlined below:

- Proximity to the GCRT route and location in relation to start and finish of revenue services to minimise ‘dead running’;
- Availability and cost of land for the facility; and
Environmental and planning considerations associated with the site of the facility.

All the above aspects are fully discussed in *Depot Locations Working Paper* that found the preferred site to be that within the existing Council Depot off Baratta Street adjacent to Loders Creek. Details of the depot layout are provided in *LRT Depot Layout Preliminary Study*. The location is shown on the Section 2 drawing in Appendix A.
4. System Operations

4.1 Journey Times

GHD has developed a journey time model that estimates the total time for the LRT services operating along the alignment with the proposed design speeds. The travel time model considers individual segments to estimate the travel time. For each segment, local speed restrictions and vehicle performance are taken into account. Allowances are also made for delays at traffic signals and dwell times for passenger boarding and alighting activity at the proposed stations. The overall journey time is the cumulative time for the following sections of the corridor:

- Section 1 (H1) Helensvale to Griffith University via Gaven;
- Section 1 (H2) Helensvale to Griffith University via Biggera Waters;
- Section 2 Griffith University to Southport; and
- Section 3 Southport to Broadbeach.

The journey time model considers three different priority scenarios as described in 3.6.2 as well as different classes of junctions and stations. The different priority scenarios will determine the delay to be experienced on the different junction classes. The model is based on the sum of the in-vehicle running time, junction delay time and station dwell time. This is summarised in Table 10.

System journey times have been developed based on the assumption of high signal priority, which provides a relatively conservative estimate. Fleet and driver requirements are dependent on journey times and have been estimated based on this assumption and this will need to be confirmed once the detailed traffic modelling results are available.

4.1.1 In-Vehicle Running Time

The assumptions applied to the travel time model include:

- LRT acceleration and deceleration of 1.3 m/s\(^2\) (typical value for LRT vehicles); and
- Proposed design speeds provided by the design team as shown on the drawings in Appendix A.

4.1.2 Intersection Delay Time

Intersections were classified into three classes as shown in Appendix A. The intersections have been classified as follows:

**Class A**

A major signalised intersection, generally with four legs and multiple lanes of traffic, where significant delays for LRT vehicles would be expected. The Class A intersections used in the model are:

- Gold Coast Highway and Hooker Boulevard/Margaret Avenue;
- Gold Coast Highway and Monaco Street;
- Surfers Paradise Boulevard and Clifford Street;
- Surfers Paradise Boulevard and Elkhorn Avenue;
- Cypress Avenue and Ferny Avenue;
- Ferny Avenue and Surfers Paradise Boulevard;
- Queen Street and Ada Bell Way;
- Nerang Street and High Street;
- Nerang Street and Queen Street;
- Queen Street and Wardoo Street;
- Parklands Drive and Olsen Avenue; and
- Brisbane Road and Olsen Road.

**Class B**
A signalised intersection, in most instances, where some delays for LRT vehicles would be expected. The class B intersections used in the model are:
- Gold Coast Highway and Elizabeth Avenue;
- Gold Coast Highway and Victoria Avenue and T.E Peters Drive;
- Gold Coast Highway and Australia Avenue;
- Gold Coast Highway and St Kilda Avenue;
- Gold Coast Highway and Admiral Drive;
- Queen Street and Scarborough Street;
- Scarborough Street and Lawson Street and Short Street;
- Scarborough Street and Nerang Street;
- Olsen Avenue and Musgrave Avenue;
- Labrador North Station;
- Brisbane Road and Harbour Town Entrance;
- Brisbane Road and Captain Cook Drive; and
- Brisbane Road and Arundel Drive.

**Class C**
A minor intersection not always signalised, where minimum delays for LRT vehicles would be expected. The Class C intersections used in the model are:
- Gold Coast Highway and Convention Centre entrance;
- Gold Coast Highway and Wharf Road;
- Gold Coast Highway and Fern Street;
- Surfers Paradise Boulevard and Vista Street;
- Surfers Paradise Boulevard and Enderley Avenue;
- Surfers Paradise Boulevard and Markwell Avenue;
- Surfers Paradise Boulevard and Hamilton Avenue;
Surfers Paradise Boulevard and Beach Road and Hanlan Street;
Nerang Street and Davenport Street;
Queen Street and Beale Street;
Parklands Drive and Alumni Place;
Parklands Drive and University Drive; and
Brisbane Road and Marble Arch Place.

Estimated delay at each intersection classification has been assessed for each of the three priority scenarios described in 3.6.2. The findings are shown in Table 9.

Table 9  Delay at Intersections

<table>
<thead>
<tr>
<th>Intersection Class</th>
<th>Estimated Intersection Delay (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Priority</td>
</tr>
<tr>
<td>A</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>-</td>
</tr>
</tbody>
</table>

4.1.3  Station Dwell Time

Station dwell times depend on patronage, fare collection method and width and number of doors.
Patronage data is based on the predictions of the Bitzios model as described in 3.5.
The choice of fare collection/ticket validation method will impact on the station dwell times. The proposed method as described in 5.3.2 has been assumed in estimating station dwell time.
Sizing and number of doors is also not yet confirmed and the actual boarding and alighting rates at the doors will need to be tested against predictions when these details are known.

Three station classes, as described in 3.3.3, have been included in the model. The station classification and estimated dwell times are as follows:

Class A Stations (Regional)
- Broadbeach South;
- Southport;
- Helensvale; and
- Biggera Waters.
The expected dwell time is 30 seconds.

Class B Stations (District)
- Broadbeach North;
- Cavill Avenue;
- Cypress Avenue;
Gold Coast Hospital;
Griffith University; and
University Hospital.
The expected dwell time is 20 seconds.

**Class C Stations (Local)**
These stations are expected to have low levels of passenger activity (i.e. boarding and alighting). The delay assumed for this station class is 15 seconds. The class C stations included in the travel time model are:
- Florida Gardens;
- Northcliffe;
- Surfers Paradise;
- Paradise Waters;
- Main Beach;
- Broadwater;
- Southport South;
- Southport Primary;
- Parkwood;
- Parkwood West;
- Gaven;
- Labrador South;
- Labrador North;
- Arundel; and
- Marble Arch Place.
The expected dwell time is 15 seconds.

**4.1.4 Journey Time Summary**
The journey time summary including intersection delays and station dwell times for each section and for the alternative route options for Section 1 is provided in Table 10.
Table 10  Journey Time Breakdown by Gold Coast Rapid Transit Section

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Section 1- Helensvale to University Hospital</th>
<th>Section 2 Uni/Hosp to Main Beach</th>
<th>Section 3 Main Beach to Broadbch South</th>
<th>Total Route</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Station delay (min)</td>
<td>2.3</td>
<td>1.6</td>
<td>2.2</td>
<td>2.5</td>
<td>7.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Total Intersection delay (min)</td>
<td>2.3</td>
<td>0.5</td>
<td>2.8</td>
<td>4.3</td>
<td>9.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Total Running Time (min)</td>
<td>10.1</td>
<td>8.4</td>
<td>10.5</td>
<td>12.9</td>
<td>33.5</td>
<td>31.8</td>
</tr>
<tr>
<td>Total Journey Time (min)</td>
<td>14.7</td>
<td>10.5</td>
<td>15.4</td>
<td>19.7</td>
<td>49.6</td>
<td>46.3</td>
</tr>
<tr>
<td>Type of Priority</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Number of Stations</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Average Dwell Time (s)</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>56</td>
<td>55</td>
</tr>
<tr>
<td>Number of Intersections</td>
<td>9</td>
<td>2</td>
<td>10</td>
<td>19</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>Average Intersection Delay (s)</td>
<td>15</td>
<td>15</td>
<td>17</td>
<td>13</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Distance (km)</td>
<td>9.2</td>
<td>8.9</td>
<td>5.9</td>
<td>5.7</td>
<td>20.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Average Speed: Running Time only (km/h)</td>
<td>54.6</td>
<td>63.4</td>
<td>33.6</td>
<td>26.4</td>
<td>37.2</td>
<td>38.5</td>
</tr>
<tr>
<td>Average Speed: Total time (km/h)</td>
<td>37.6</td>
<td>50.8</td>
<td>22.1</td>
<td>17.3</td>
<td>25.0</td>
<td>26.9</td>
</tr>
</tbody>
</table>

Table 10 indicates a total journey time for Sections 2 to 3 of approximately 35 minutes.

The journey time for Option 2, via Gaven, is approximately 3 minutes less than that for Option 1, via Biggera Waters. This is due to the higher overall station dwell time for Option 1 and the lower speed limit of the Option 2 route.

The journey times predicted in the model are considerably longer than the predictions made by TransLink’s other advisers. The patronage predictions used in this assessment are based on the shorter journey times of the Bitzios model, which predicted 25 minutes between Griffith University and
Broadbeach South. It should be noted that patronage is sensitive to journey time, thus it must be
recognised that revised patronage figures based on the journey times in Table 10 will be considerably
lower. Lower patronage would impact on the required system capacity, in turn suggesting longer
headways might be possible with the overall effect of reducing the numbers of vehicles and operating
staff.

4.2 System Capacity
System capacity is a factor of the vehicle capacity and required minimum headway. The resultant
capacities for both 35 and 45 metre vehicles operating at 3 minutes headway are shown in Table 11,
rounded to the nearest 10.

Table 11 System Capacity

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Standee Density</th>
<th>3 pax/sq m</th>
<th>4 pax/sq m</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 metre</td>
<td></td>
<td>3,970</td>
<td>4,990</td>
</tr>
<tr>
<td>45 metre</td>
<td></td>
<td>5,200</td>
<td>6,480</td>
</tr>
</tbody>
</table>

4.3 Service Arrangements
The Stage 1 operating plan involves the following service arrangements:
- Service 1: Broadbeach to Helensvale and return; and
- Service 2: Broadbeach to Griffith University and return (generally required for periods where demand
  between Griffith University and Helensvale is low).

4.4 Service Frequency
Adopted headways comply with the requirements set out in 3.4;
- The headway units adopted in the assessment are: 3, 3.75, 5, 7.5, 10, 15, 20 and 30 minutes as used
  in the preliminary SYSTRA study;
- Headways for the southern section, Griffith University to Broadbeach South, are whole multiples of
  headways for the northern section, Helensvale to Griffith University;
- Maximum headway requirements to allow integration with rail services;
- Headways in the core section are set at a maximum of 7.5 minutes during the day and have been
  assumed to be 15 minutes during the night time period; and
- Headways for any time period are not increased on changing to a larger vehicle.

4.5 Service Patterns
The operating plan involves the following service patterns:
- Service 1: Broadbeach South to Helensvale and return; and
4.6 Design Periods
System operations have been assessed for four peak periods as defined in Table 12.

Table 12 Design Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>Abbreviation</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning Peak</td>
<td>AM</td>
<td>07:00 – 09:00</td>
</tr>
<tr>
<td>Day Time</td>
<td>DT</td>
<td>09:00 – 16:00</td>
</tr>
<tr>
<td>Evening Peak</td>
<td>PM</td>
<td>16:00 – 18:00</td>
</tr>
<tr>
<td>Night Time</td>
<td>NT</td>
<td>18:00 – 00:00 and 06:00 – 07:00</td>
</tr>
<tr>
<td>Owl Time</td>
<td>OT</td>
<td>00:00 – 06:00</td>
</tr>
</tbody>
</table>

4.7 Passenger Demand
Passenger demand is discussed in 3.5.

It is to be noted that the high predicted rates of growth impact on the planning of operations. Together with the requirement to maintain a service frequency of not more than 7.5 minutes headway, a system designed to meet the capacity requirements at the end of the vehicle design lifespan will inevitably result in over provision of capacity in the early years.

4.8 Staging Plan
Required Stage 1 system capacity can be delivered by a 35 metre vehicle to 2041. In between 2011 and 2041, it will be necessary to supplement the fleet as demand grows and service frequency correspondingly increases. Prior to purchase of new vehicles, the system operations should be reviewed in terms of:

- Actual patronage levels compared with predictions and how this will impact on future patronage predictions; and
- Possible transport policy changes that may enable increased service frequency.

A decision can then be taken as to whether to continue with 35 metre vehicles or to introduce longer vehicles. At this stage only 35 m vehicles are proposed.

The proposed LRT system headways is shown in Table 13.
<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period</td>
<td>AM</td>
<td>PM</td>
<td>DT</td>
<td>NT</td>
</tr>
<tr>
<td>Sections:</td>
<td>Headways (mins)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helensvale – University Hospital</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>University Hospital - Broadbeach South</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Year</td>
<td>2031</td>
<td>2036</td>
<td>2041</td>
<td></td>
</tr>
<tr>
<td>Time period</td>
<td>AM</td>
<td>PM</td>
<td>DT</td>
<td>NT</td>
</tr>
<tr>
<td>Sections:</td>
<td>Headways (mins)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helensvale – University Hospital</td>
<td>5</td>
<td>3</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>University Hospital - Broadbeach South</td>
<td>5</td>
<td>3</td>
<td>3.75</td>
<td>7.5</td>
</tr>
</tbody>
</table>
4.9 Reserve Capacity

Reserve capacity is the measure of available vehicle capacity over that being used by passengers. This is presented in Appendix B as follows:

- Diagrams showing the variation of reserve capacity over the route for all design periods for every five years between 2011 and 2041;
- Histograms showing a comparison of peak capacity with both standee density 4 passengers per square metre and 3 passengers per square metre and Stage 1 patronage for every five years between 2011 and 2041; and
- Graphs showing a detailed comparison of Stage 1 and Stage 2 patronage with capacity with standee densities of both 4 passengers per square metre and three passengers per square metre.

The results show:

- That with Stage 1 patronage standee densities over 3 passengers per square metre should only occur for very short time periods over short travel sections in periods of peak demand; and
- That Stage 2 patronage demand can be met by the 35 m vehicle, although there will be longer periods where standee densities will exceed 3 passengers per square metre. However, with the exception of the 2041 PM peak southbound, standee densities of 4 passengers per square metre would not be exceeded. In this one case, the excess is only marginal.

4.10 Off Peak Operations

As patronage data is only available for Monday to Friday, 07:00 – 00:00, assumptions have been made for operations on Saturdays, Sundays and Public Holidays and during ‘Owl Time’ as follows:

- Saturdays, Sundays and Public Holidays is assumed to be equal to the combined service frequency of the existing bus routes; and
- Owl Time with an hourly frequency.

It is to be noted that consideration needs to be given to maintenance which may affect Owl Time operations. Due to the limited service provided during this period it may be possible to operate the service on one line only enabling maintenance to be carried out on the other line.

4.11 Vehicle Fleet

4.11.1 Assumptions

The following assumptions have been made in assessing fleet requirements:

Journey Times

The journey times predicted by the model have been adopted in calculating fleet, driver and security guard requirements. Journey times are discussed in Section 4.1.

Recovery Percentage

This is a contingency for loss of time over the route that may arise due to:

- Delays at signalised intersections;
- Dwell times at stations that are higher than those assumed in the calculation of journey time;
- Vehicle breakdown;
- Ticket machine/reader malfunction; and
- Passenger or driver issues/incidents.

The recognised practice in most LRT systems is between 7% and 12%. Since the number of signalised intersections through which the LRT passes is high, a higher level has been adopted for peak periods. Values adopted for each peak period are:
- AM and PM: 12%;
- DT and NT: 10%; and
- OT: 7%.

**Minimum Turnaround Time**

The minimum turnaround time is the time allocated for the driver to turn the vehicle around at the terminus, to inspect the vehicle for any damage and to prepare the vehicle for the return trip by adjusting the signage and ticketing equipment. It does not include the recovery time for late running. The minimum value of 2 minutes has been adopted.

**Vehicle Spare Ratio**

This is the number of additional vehicles required in order to maintain the operating fleet at the required number when vehicles are taken out of service due to:
- Routine maintenance;
- Breakdown; and
- Accident/incident.

The generally adopted level is 20%. This is in accordance with US FTA recommended targets, an average of the level adopted by a number of LRT systems and the level recommended in the preliminary work by SYSTRA.

### 4.11.2 Fleet Requirements

Based on the assumptions above, fleet requirements to supply the proposed operating plan as described in Table 13 have been determined and are summarised in Table 14. From the capacity analysis, it is concluded that 35 m LRT vehicles will be able to handle the demand up to 2041 with only some occasions in the peak demand period with the capacity for standees with 4 passengers per m² exceeded. This is shown in the histograms in Appendix B. For operational reasons, a consistent vehicle size of 35 m is recommended because a mixture of 35 m and 45 m LRT vehicles in the timetable will lead to inefficient use of the capacity.
Table 14  Fleet Requirements: 35 Metre Vehicles

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. vehicles</td>
<td>15</td>
<td>15</td>
<td>22</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

4.11.3 Purchase Plan

A theoretical purchasing plan to provide the fleet requirements between 2011 to 2041 is given in Table 15. This is based on a vehicle design life of 30 years.

Table 15  Fleet Purchase Plan for 35 Metre Vehicles

<table>
<thead>
<tr>
<th>Year</th>
<th>No. to Purchase</th>
<th>No. retired</th>
<th>Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>15</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>2016</td>
<td>15</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>2021</td>
<td>7</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>2026</td>
<td>13</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>2031</td>
<td></td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>2036</td>
<td></td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>2041</td>
<td>15</td>
<td>15</td>
<td>35</td>
</tr>
</tbody>
</table>

4.12 Staff Requirements

4.12.1 Driver Requirements

The fleet requirements shown in Table 16 have been used to assess the required driver numbers. It is not possible to determine exact driver numbers as these will depend on the policies of the GCRT operator as to the mix of full time, part time and casual driving staff. Costs related to drivers will vary according to the mix as the effect of using part time and casual staff will increase costs as there will be a one off training/induction period. For this estimate, it is assumed that all drivers will be full time and work a 40 hour week or 8 hours a day. On an average weekday, the effective number of hours per day per driver will be less than 8 hours a day as additional drivers will be needed in order to maintain schedules to compensate for those who:
- Have a scheduled day off;
- Are off sick;
- Fail to turn up on time;
- Fail to turn up at all; and
- Are away on training courses etc.

Based on data from other Australian public transport operators, the effective working hours per day is 5.5 is assumed to be for full time drivers. The estimated number of drivers is calculated by dividing the revenue hours by 5.5 and is shown for each design year in Table 16.
Table 16  Estimated Driver Requirements

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Numbers (full time)</td>
<td>37</td>
<td>37</td>
<td>51</td>
<td>73</td>
<td>81</td>
<td>83</td>
<td>83</td>
</tr>
</tbody>
</table>

4.12.2 Operations Staff

An estimate of all staff associated with the operations of the LRT system is provided in Appendix C.

4.13 Special Events

The LRT corridor operates through Surfers Paradise where major special events, such as the Gold Coast Indy and Schoolies week, would have a major effect on the operation of the LRT services. A separate special events management plan would need to be developed to cater for these special events so that the disruption to the regular LRT services and the need for additional LRT services to cater for the demand. A detailed special events management plan has not been developed as part of this operations assessment because it would need to be customised to the specific event times and level of activity. In developing a special events management plan, the following stakeholders would be consulted:

- Gold Coast City Council;
- TransLink;
- Department of Main Roads;
- The event sponsors and organisers; and
- Business associations that represent businesses that would be affected by the change of BRT services and the special event.

The special events management plan should address the following issues:

- Plans to handle a disruption to regular LRT services;
- Coordination with other public transport services;
- Need for buses to supplement the LRT services to cater to the anticipated demand at the event;
- Space for buses to be stored close to the venue during the event;
- Pedestrian movement plans in the vicinity of the busiest LRT stations;
- Traffic management plans along the LRT corridor to divert traffic away from the busy pedestrian areas and to provide priority access for LRT and other public transport services;
- Additional staff requirements to operate the service;
- Special fare and ticketing arrangements to include the public transport fare in the ticket price for the event to reduce the ticket sales during the event;
- Communications plan to inform the public about the changes to services including brochures with timetables for the revised services; and
- Scheduling of special LRT and other public transport services to coincide with the start and end of the event when patrons are arriving or departing the event.
For special events, it has been assumed that all available LRT vehicles will be used and additional drivers and staff would be rostered to cater for the additional patronage demand. Additional buses from other bus operators would be used to supplement the LRT fleet and they would be given permission to use the LRT corridor and stations.

4.14 Vehicle Maintenance and Refurbishment

A vehicle maintenance plan will be required from the system operator to ensure a continuous standard of safety throughout the life of the vehicle.

Refurbishment or refitting will be required for mid life-span of the vehicle, after between twelve to fifteen years of service. The condition of the vehicle should be monitored to determine when refurbishment is required as this can vary significantly with usage type.
5. Operational Issues to Consider for Users

5.1 Passenger Safety and Security

5.1.1 Safety
Safety is an integral element of the GCRT planning and design and the following additional considerations should be made in the overall system design and operation:

- The design of the system should be based on a sophisticated understanding of the behaviour of all user groups, passengers, pedestrians, cyclists, motorists and staff in order to reach an appropriate balance between the risks involved; and
- As on-street rapid transit is relatively new to Queensland, safety should be considered in terms of recognised good practice from successful systems in other locations rather than simply a modification of current approaches to safety for bus or rail systems.

5.1.2 Rail Safety Accreditation

Relevant Legislation
The LRT project will be progressed within the requirements of the relevant rail safety legislation in Queensland. New rail safety legislation was introduced to the Queensland Parliament in February 2008. The Transport (Rail Safety) Bill 2008 is expected to be enacted later in 2008 and will be the Act that will apply to the GCRT.

The new Act will bring Queensland in line with national standards being jointly developed by all States and Territories as agreed by a forum of Australian Transport Ministers in 2006. As with current legislation, the new Act will require that Constructors and Operators must apply for accreditation under the Act. Separate accreditation will be required for the construction phase and the later operational phase of the project.

A key change in the legislation will introduce a high level of cross border cooperation between rail regulators in different States when making decisions about accrediting operators. For instance, this means that if an existing rail operator has conditions attached to accreditation held in another state, the Queensland Regulator will have access to the details, so they can be considered for inclusion in any new accreditation sought in Queensland.

Construction Phase
Construction contractors are obliged to gain accreditation under the proposed Transport (Rail Safety) Act. This does not supplant requirements under other Occupational Health and Safety Legislation. However, accreditation is not required until such time in the project programme that rail vehicles (of whatever type) are used on the track. This means that until such time as sufficient track has been constructed and a vehicle runs on it (whether this is a trolley for construction, a high rail vehicle or tram for test purposes) accreditation is not required.

Construction phase accreditation requires a different form of application and requires the submission of a different range of plans than for the operator’s accreditation.
Operational Phase

The Operator will be required to gain accreditation before the Regulator will sanction the commencement of operations, noting that this includes all stages of operation from testing and commissioning, through driver training and into normal passenger operations. The application for accreditation will provide details of the operation and how that operation will be managed. This requires the operator to develop and submit a suite of management plans, including:

- Operations Plan – covering normal operations and operational procedures (i.e. a ‘rule book’);
- Security Management plan;
- Emergency Management Plan;
- Employee Health and Fitness Management Plan, including sub-plans for Alcohol and Drugs Management and Fatigue Management; and
- Staff Skills, Competencies and Training Management Plan – all rail safety workers are have to have relevant skills and knowledge.

It is planned that regulations providing detailed requirements for the nominated plans will be developed in 2008. A mandatory requirement of the new legislation will be the need for consultation. Operators must now consult with those people likely to be affected management plans, including employees and contractors, when they develop or update their safety management systems.

5.1.3 Disabled Access Compliance

All aspects of the system design including vehicles, stations and access to stations have been based on compliance with DDA and DSAPT requirements. Low floor entry and close docking will enable direct access without need for ramps.

5.1.4 Security

Security for all LRT users, patrons, drivers and ticket inspectors is of paramount importance to the success of the system. Security provision by electronic means is addressed in section 6. In addition to these provisions, six security guards will patrol the RT system between 20:00 and 06:00 on Thursdays, Fridays and Saturdays. TransLink’s standard incident response policies, encompassing issue of warnings, interaction and monitoring will be adopted.

5.2 Stations Interchanges and End of Line Facilities

The station and interchange locations and their classifications are fully described in Station Access Strategy and are shown graphically in Appendix A.

Provision should be made for routine maintenance and cleaning of the stations. Electronic surveillance and monitoring of the stations is discussed in Chapter 6.

Consideration will need to be given to the possible need for end of line facilities for drivers’ personal needs.
5.3 Fare Collection

5.3.1 Methods of Fare Collection

Although detailed guidance on fare collection policy is beyond the scope of this assessment, the choice of fare collection method will impact on the system specification and user interface. The main issues to consider are discussed in Table 17.

Table 17 Preliminary Assessment of Fare Collection Issues

<table>
<thead>
<tr>
<th>Feature</th>
<th>Interface with LRT System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver fare collection</td>
<td>Inappropriate for LRT operations as the driver is usually located in an enclosed compartment.</td>
</tr>
<tr>
<td>Open or closed fare collection system</td>
<td>A closed fare collection system uses barriers to cordon stations into paid and unpaid areas. This system can reduce fare evasion but it leads to complications in stop design and impacts on the integration with urban form. It can also impact on the quality of user experience and is generally not suitable for LRT systems. An open fare collection system is one in which stations function more like conventional bus stops. The paid area is the inside of the vehicle.</td>
</tr>
</tbody>
</table>
| Safety, security and maximisation of revenue collection | There is a range of approaches to ensure the safety and security of passengers and to maximise revenue collection and safety with both open and closed systems, including:  
  * **Ticket inspectors** – who issue fines to fare evaders and can also issue tickets to passengers genuinely without tickets, for example due to faulty ticketing machines. The presence of inspectors provides a degree of safety and security monitoring.  
  * **Security guards** – who provide a higher level of safety and security monitoring, but whose presence tends to imply that travel on the system is unsafe.  
  * **On-board Customer Service Officers** – who check tickets, sell tickets to those without (with a small premium if desired) and maintain a vigilant eye on passenger safety and comfort. Many transit operators are moving towards this practice to ensure high levels of safety, security and maximisation of revenue collection. |
| On-board fare collection using ticket vending machines | On board fare collection using ticketing machines can impact on the quality of user experience, especially at crowded peak periods, due to the need to move to and use the ticketing machine. This could be improved by providing ticket machines at each doorway but this would have significant cost implications. There is usually a negative impact on revenue collection with such systems.  
  A sub-category of on-board fare collection is on-board ticket validation, which generally uses less space, is less expensive and is less time consuming for passengers, although this will depend on the ticket technology used. |
| Off-board fare collection using ticket vending machines | Off-board fare collection requires ticket vending machines that are easy to use and reliable. Experience shows that passengers expect machines that accept notes and credit cards and provide change. This system been found elsewhere to be the most cost-effective. For the GCRT, the machines would need the capability of adding additional stops as the system expands. |

It is anticipated that many passengers will use the prepaid smartcards known as ‘go cards’ by TransLink.
5.3.2 Recommended Ticketing and Fare Collection Method

- An open fare collection system without barriers at stations;
- Ticketing for the GCRT should be part of the TransLink integrated ticketing system;
- Pre-paid fare cards such as the ‘go card’ should be encouraged to minimise station dwell times and to make the system easier to use;
- Prepaid fare card validation devices should be installed near each door on each BRT vehicle;
- Automated ticket vending machines should be installed on each platform at each station to allow patrons to add value to their ‘go cards’ and to issue paper tickets; and
- Customer service officers or ticket inspectors should be employed to patrol the system and check tickets using portable devices.

5.4 Passenger Information

Good levels of passenger information are a crucial element of the GCRT. Details of the ITS system are provided in Chapter 6. The key requirements are:

- Clear route and system maps;
- Details of connecting bus and rail services;
- Real time information on vehicle arrival times;
- Timetable (or service headway) information;
- Customer service officers either at key stations or onboard vehicles; and
- Information on fares and ticketing requirements.
6. Intelligent Transport Systems and Security

6.1 Overview

Full details of the required passenger information and ITS system is provided in the ITS User Specification. This chapter presents a brief outline.

Intelligent Transport Systems (ITS) will be a critical component of the LRT system providing many of the key operational and customer-focussed elements of the LRT System. Security, surveillance, rapid transit signal priority, real time passenger information, integrated ticketing systems and communication systems will be installed at stations, along the alignment and on the vehicles to ensure safe, efficient and reliable operation of the LRT.

The ITS for the LRT will comprise the following key systems and sub-systems:

- Operations Management and Control System (OMCS);
- Rapid Transit Vehicle Systems (RTVS);
- Station Systems (SS);
- Integrated Ticketing System (ITICKS); and
- Data Exchange System (DES).

The outline system hardware architecture comprising the above listed systems for the GCRT System is presented in Figure 3 and the systems are described below.
Figure 3  System Hardware Architecture

The diagram illustrates the system hardware architecture for the Gold Coast Rapid Transit Project, focusing on the technical report on Light Rail Transit Operations Assessment Stage 1: Helensvale to Broadbeach. The architecture includes various components such as the GCRTR Control Centre, Operator Workstation, Operator Workstation 6, and Maintenance System Terminal. The data exchange system and communications network are also depicted. Additional elements include elements like Data Systems, Control / Access, and other technical details related to the system's hardware architecture.
6.2 Operations Management and Control System (OMCS)

The OMCS will comprise the central computer server equipment, operating systems and software applications required to safely and efficiently monitor and control the LRT System. The OMCS will incorporate the following three principal systems, including:

- Rapid Transit Management and Control System (RTMCS);
- Communications System (CS); and
- Plant Management and Control System (PMCS).

These modules are described in detail below. A notational block diagram of the system and sub-system modules of the OMCS is shown in Figure 4.

Figure 4 OMCS System Modules

6.2.1 Rapid Transit Management and Control System (RTMCS)

The RTMCS will monitor and control LRT vehicle movements along the alignment and at stations, as well as facilitate effective passenger movements and safety through the implementation of the following sub-systems (and discussed in detail below):

- Real Time Passenger Information System (RTPIS);
- Integrated Ticketing System (ITICKS);
- Closed Circuit Television System (CCTVS);
- Automatic Vehicle Location System (AVLS);
Transit Signal Priority System (TSPS);
Transit Vehicle Management System (TVMS);
Incident Management System (IMS); and
On-board Security System (OSS).

**Real Time Passenger Information System**

The Real Time Passenger Information System (RTPIS) will operate by collating and processing the necessary information to manage the display of all messages (text and audio) for the Real Time Passenger Information Displays (RTPID).

The RTPID will provide passengers with Real Time information regarding vehicle arrivals, destinations, stations and incidents at the following locations:

- Station platforms;
- Locations external to the GCRT System, e.g. at the Australia Fair shopping precinct, Gold Coast Convention Centre; and
- On-board LRT vehicles.

The RTPIS will predict LRT vehicle arrival and departure times based on their Real Time location determined by the AVLS, transit signal priority requests determined by the TSPS and historical performance data for each trip/day combination.

**Integrated Ticketing System**

The Integrated Ticketing System (ITICKS) will operate by processing fares in Real Time using both smartcard technology and paper based Ad Value Vending Machines (AVVM).

The ITICKS for the GCRT will operate in accordance with TransLink’s new Integrated Ticketing System to permit an integrated ticketing approach with other modes of public transport (including, bus, rail and ferry) within the South East Queensland area.

Tickets / smartcards (such as the ‘Go card’) will be purchased prior to boarding the RT vehicle. AVVM will be located on all RT station platforms (local, district and regional) to recharge and top up smartcards and issue paper based tickets.

ITICKS will be an automated system, whereby the smartcard ticket will automatically calculate passenger fares on the ticket itself employing Customer Interface Devices (CIDs) (that is, smartcard tag readers). CIDs will be located on-board all RT vehicles adjacent to the entrance and exit doors to allow passengers travelling with a smart card to validate it either on the station platform or on boarding and alighting the vehicle. Each passenger will be required to tag their smartcard at both the start and completion of their journey; the location details at each point will be used to calculate the fare.

The initial transaction will deduct a nominal fare, close to the equivalent of the maximum fare, from the smart card travel purse stored on the card. When the card is tagged off the system, the smartcard will calculate how many zones were travelled and refund the difference to the card. In order not to incur the maximum fare two transactions will need to be completed during the journey.

Roving ticket inspectors will use Portable Inspection Devices (PIDs) to verify the last transaction on passenger smartcards / tickets for enforcement purposes.
**Closed Circuit Television System**

The Closed Circuit Television System (CCTVS) will provide Transit Control Centre (TCC) operators with Real-Time visual information to enable surveillance, passenger safety and incident management of the GCRT System. CCTV cameras will be located on all station platforms and on-board LRT vehicles.

The CCTVS will be managed and operated remotely from the TCC and will incorporate facilities for pan/tilt/zoom (PTZ) functions, video wall monitor allocations and configuration of preset camera views.

**Automatic Vehicle Location System**

The Automatic Vehicle Location System (AVLS) will be based on Global Positioning System (GPS) technology and will operate by continuously tracking the location of all LRT vehicles in real time along the entire length of the alignment, including station platform and depot locations.

The LRT vehicle location information will be employed as the base input data for the following integrated sub-systems:

- Real Time Passenger Information System (RTPIS);
- Transit Signal Priority System (TSPS);
- Fleet Management System (FMS);
- Incident Management System (IMS);
- On-board Security Systems (OSS); and
- Integrated Ticketing System (ITICKS).

Details of the operation of the AVLS during incident management are provided in 8.

**Transit Signal Priority System**

The Transit Signal Priority System (TSPS) will generate priority requests from the LRT vehicle. The outcome will be based on the vehicle location and speed, the road network and intersection performance, signal timing and signal sequence. This will be assessed by means of an integrated interface with the AVLS, RTPIS and STREAMS server located locally at the GCRTCC.

The STREAMS server will assess each priority request generated by the TSPS and will accept or reject each request based on a set of predefined parameters and conditions.

Operation of the TSPS will be based on the following LRT oriented objectives:

- Improved headway adherence to reduce waiting time and reliability;
- Reduced delay to enhance LRT efficiency and travel times;
- Enhanced transit information to enable improved Real Time travel times to be processed; and
- Improved service reliability and quality: through improved headway adherence, reduced delays and enhanced transit information.

An interface will be provided between the OMCS and QDMR / GCC STREAMS Traffic Management Systems, located at QDMR Nerang Traffic Management Centre (TMC), to provide road network operators with access to graphical displays of traffic signal operations, reports and fault status information.
Transit Vehicle Management System
The Transit Vehicle Management System (TVMS) will provide functions for TCC operators to monitor and control the efficiency, reliability and quality of service of the GCRT System from a user, maintenance and operator perspective.

The TVMS will incorporate the following functional modules:

- Planning to facilitate the planning of GCRT operations to improve LRT services;
- Timetable Management to facilitate the scheduling of GCRT operations and manage the delivery of services during an operating day;
- Personnel Management to facilitate the management of maintenance and operations personnel;
- Fleet Management to manage vehicle information relating to all operating LRT vehicles;
- Driver Management to manage data relating to all drivers operating LRT vehicles;
- Vehicle Management to enable operators to monitor and manage the maintenance and availability of LRT vehicles; and
- Alert Management to enable Operators to respond to and resolve operational issues and resolve schedule conflicts identified by the OMCS.

Incident Management System
The Incident Management System (IMS) will provide functions to assist operators in managing any planned or unplanned incidents and events that will impact on the operation of the GCRT system through the integrated control of all GCRT control, monitoring and communication systems.

The key operational features of the IMS will include:

- Detection of the presence of an incident along the alignment, including station platforms and intersecting roads;
- Supply of a recommended pre-planned Incident response for the detected incident;
- Provision of the services to manage the impact of the Incident; and
- Event logs showing the progress and process in clearing the Incident.

Incidents will be detected by the IMS through both manual sources (including CCTVS, HTS, emergency service etc) and automatic sources (including Automatic Incident Detection System employing AVLS, fire detection inputs via the PMCS Supervisory Control and Data Acquisition (SCADA) system etc).

On-board Security Systems
On-board Security Systems (OSS) will be installed within each LRT vehicle to improve the quality of service and facilitate the safety and security of passengers, drivers and other staff.

The OSS will comprise the following integrated principal components:

- On-board Video Surveillance System (OVSS): this will provide full video surveillance of the passenger and driver areas of all LRT vehicles by use of high-resolution dome CCTV colour cameras.
- On-board Audio Surveillance System (OASS): this will provide audio surveillance on-board all RT vehicles, in correlation with the OVSS, to monitor and record passenger, driver and/or conductor interactions, threats and abuse.
**Emergency ‘Panic’ Button (Silent Alarm):** this will provide drivers and passengers a quick and easy means of alerting TCC operators of problems.

**Remote Vehicle Disable System (RVDS):** this will provide TCC operators a means of remotely disabling and enabling a LRT vehicle based on commands from the OMCS (for example, notification from the RTVS of an unauthorised vehicle operator).

The OSS will monitor potential incidents and/or threats locally on board each LRT vehicle employing both an autonomous and manual system. The autonomous system, based on received processing parameters, will be capable of identifying abnormal behaviour or conditions from the video and audio surveillance data collected from the OVSS and OASS. The manual system, based on emergency ‘panic’ buttons, will allow both drivers and passengers to manually notify TCC operators of an emergency situation.

On identification or notification of any potential incidents or threats the following will occur:

- The processed video and audio information will automatically be recorded in Real Time to an on-board Digital Recorder for review and processing at a later date; and
- The LRT vehicle’s identification number, driver name and current location (via the AVLS) will be output to the OMCS to assist TCC operators with further assessment of the situation.

The RTVS communications system between the vehicle and the OMCS will be able to accommodate remote downloading of both video and audio data from the digital recorder to the OMCS. The provision for Real-Time video and audio surveillance will be available, however, due to the high bandwidth and operational costs associated with real time streaming of video and audio data over a wireless link, this will only be utilised in the event of an emergency situation.

### 6.2.2 Communication System

The operational Communication System (CS) will allow communication between TCC operators and LRT vehicle drivers and on-board inspection staff, station personnel, and passengers. The following will be included:

- **Station System**
  - Help Telephone System (HTS); and
  - Public Address System (PAS).

- **On-board Vehicle System**
  - Digital two-way radio (driver to control);
  - Mobile Data Terminal (MDT);
  - Emergency ‘panic’ button; and
  - Public Address System (PAS) (both local and remote operation).

These modules are discussed further below.

### Station Systems (SS)

The SS will comprise surveillance, public address, help telephones and real time Passenger Information Display (RTIPD) equipment to provide ‘off-board’ accurate and reliable Real-Time information to passengers. This will also create a secure environment where passengers feel safe throughout the day and night.
Help Telephone System

Help telephones will be installed at each station platform to enable patrons to contact TCC operators to report or request assistance in the event of an incident and/or emergency.

The help telephones will be ‘hands free’ in operation and based on VoIP technology. The help telephones will incorporate facilities to originate the call, and enable communication with the TCC by a single push button. The call will automatically disconnect after the TCC operator disconnects.

The Help Telephone System (HTS) will manage the help telephones remotely from the TCC and will provide facilities for call control, call recording, phone diagnostics, event logging and configuration changes from the OMCS.

Public Address System

The Public Address System (PAS) will deliver operational messages from the TCC operators and from auto-announcements to passengers waiting at station platforms and travelling on-board the RT vehicles. The message types will include:

- Next station information to travelling passengers;
- Information on connecting bus and train services at station interchanges; and
- Driver information and emergency announcements.

The PAS will comprise a Public Address (PA) master station incorporating a PA microphone at each operator workstation and speakers distributed at each station and on-board the LRT vehicles. The system will allow the operator to make announcements to stations and to on-vehicle passengers with zone control provided via the PA Master Station control within the OMCS.

The PAS will be based on VoIP technology for the communications link to the stations and radio/wireless technology for the communications link to the LRT vehicles.

On-board Operations Communication Systems

The On-board Operations Communications System (OOCS) will permit communication between drivers and on-board inspection staff, TCC operators and station personnel at all times during operation. The OOCS will comprise Ex-vehicle Communications System and In-Vehicle Communications System.

The Ex-vehicle Communications System will enable communication between the driver, TCC operators and station personnel via radio (voice) and Mobile Data Terminals (MDT)(text) communications.

The In-vehicle Communication System will enable communication between the driver and roving inspectors via radio (voice) communications.

6.2.3 Rapid Transit Vehicle Systems (RTVS)

The RTVS will comprise LRT vehicle mounted control, surveillance and display equipment, position-fixing equipment and communications equipment. This will enable effective operations and management of the LRT vehicle fleet, provide ‘on-board’ accurate and reliable real time information to passengers. It will also create a secure environment where passengers feel safe throughout the day and night.
6.2.4  The Plant Monitoring and Control System (PMCS)

The Plant Monitoring and Control System (PMCS) will form part of the OMCS to monitor and control the mechanical and electrical plant associated with the safe and efficient operation and maintenance of the GCRT System and associated field equipment.

The PMCS will monitor and control the following sub-systems:

- Traction power supply and distribution systems.
- Station infrastructure including:
  - Lighting; and
  - Fire detection and protection.

The PMCS will be supported by secondary or manual systems to allow major stations and interchange locations to be safely operated in a mode involving a higher level of operator control in the event of system failure. It will utilise current digital technology consisting of modern industrial computer equipment with flexible and industry standard software interfaces. All functions will be capable of manual override and whilst the system will automatically monitor and control the mechanical and electrical plant under normal operating conditions, any response to abnormal conditions shall require operator interaction.

6.3  Data Exchange System (DES)

The DES will form part of the LRT communications network and will comprise communications and firewall security equipment to support interfaces (fixed and wireless) between the LRT vehicle, stations, OMCS and external interfaces including (but not limited to):

- TransLink’s ITICKS and Real Time Passenger Information System (RTPIS);
- Queensland Department of Main Roads (QDMR) and GCCC STREAMS Traffic Management System (TMS);
- Queensland Rail RTPIS;
- Maintenance contractor; and
- Users (SMS, web browsers etc).
7. Commissioning

7.1 Overview

Following completion of construction and prior to opening to the public, a commissioning period will be required to ensure that the LRT system will operate smoothly and according to the planned schedule from opening day.

A comprehensive suite of Testing and Commissioning Plans will be required for all of the key components, or elements, of the system, including, infrastructure, systems, vehicles, operations and commercial. An overarching Commissioning Strategy and Plan will guide the specific plans in each area as shown in Figure 5.

Figure 5 Commissioning Strategy

Each level in the plan ‘hierarchy’ must also be consistent with a Systems Integration Plan.

The following paragraphs detail the items that would be carried out in the lead up to and during the commissioning period.

7.2 Accreditation

The completion and issue of accreditation under the relevant rail safety legislation (both as a constructor and an operator), is an essential precursor to any on-track testing of vehicles and commencement of public services. This issue should be addressed in all commissioning plans.

7.3 Infrastructure

7.3.1 General

All infrastructure elements, including the LRT corridor, bridges, stations and depot facilities would be thoroughly inspected and signed-off for meeting specification requirements. This would be required
under the construction contracts. This process must be complete (at least in specific areas) before any on-track testing of vehicles is commenced.

7.3.2 Track
In addition to inspection, compliance with the set out survey and track geometry within required installation tolerances will be assured. In this respect an as-installed survey will be mandatory. As a final sign off, there should be an independent review of installation QA records, including rail adjustment (stress free temperature) records.

7.4 Systems

7.4.1 General
A specific Inspection and Test Plan (ITP) will be developed for each of the key systems. The ITP will cover factory acceptance tests (at both component and major assembly levels), installation tests and set to work tests. All ITPs will cover any specific requirements for systems integration.

7.4.2 Vehicles
A plan may be needed to carry out additional specific testing of on-board systems and interfaces once vehicles are available for on-track trials.

7.4.3 Electrical Safety
Prior to energising the OHW system, a plan needs to be in place for ensuring the safety of staff, public and most importantly, the emergency services (police, and fire). The plan should include:

- Notices and publicity (considering police, schools and the general public); and
- The briefing of Emergency Services on safety procedures when attending any incident close to live equipment and to promulgate correct communication procedures to obtain an emergency isolation of the system.

7.5 Vehicles

7.5.1 General
The vehicles will require a specific series of ITPs that will cover factory acceptance tests (at both component and major assembly levels), testing of assembled units, initial on-track trials and on-site track trials. Application of the livery etc may be carried out locally.

7.5.2 Network Equipment
Vehicles would be modified before delivery to include the any specific networks systems equipment, such as SmartCard ticket readers, ITS system and special livery for the LRT system.
7.5.3 Pre and Post Delivery Testing

Vehicles would be tested at the manufacturer’s plant before delivery. Post delivery testing is also required and will include site specific on-track trials and any testing to interface with network systems (in accordance with the System Integration Plan). These latter tests are required before the vehicles are handed over to the operator to commence driver training and operational readiness testing.

7.6 Operations

7.6.1 Accreditation

Prior to any commissioning, the operator must have safety accreditation. This requirement is discussed in 5.1.2.

7.6.2 Operations Supervisors

Controllers, supervisors and driver managers will need to be recruited and trained. They will be the key personnel in providing the operator’s input into the commissioning of infrastructure, systems and vehicles. They will need to be in place before the final phase of commissioning commences (on site trials). They will also oversee the training of drivers and other staff. Training will include familiarisation with the ‘Rule Book’, Operating Plan and the use of control equipment (SCADA, signalling and communications).

7.6.3 Drivers

Drivers (and conductors if required) would be recruited by the selected LRT operator. If the operator is selected through a competitive tendering process, the LRT company would only hire staff if it is awarded the LRT contract and a lead time for the recruitment period would be allowed for.

Driver training would be needed. Procedures would need to be established for general driving requirements, stopping at LRT stations and travelling through the prioritised signal controlled intersections along the corridor. Safety training would need particular attention especially during passenger boarding and alighting due to the multiple doors. All staff will need to be trained in emergency procedures (i.e. in the event of an accident) and particular emphasis will be placed on electrical safety (such the taking of an emergency isolation of the overhead electrification system), the use of emergency equipment and the involvement of the emergency services.

7.6.4 Timetable Specification

The LRT operator and TransLink staff would jointly develop timetables. The broad timetable would be presented for comment to the public and stakeholders by information sessions, the TransLink website and at display venues. The comments would be incorporated into the finalised timetable specification.

When the timetable specifications are signed off for implementation, the LRT operator would use them to generate a working timetable and from this develop rostering for all staff (supervisors, drivers, conductors, inspectors and support staff).
7.6.5 Emergency Services Liaison Plan

An Emergency Services Liaison Plan should be developed to cover the briefing of police, fire and ambulance, SES etc on relevant operational procedures, especially safety and ‘what to do’ in an emergency. A key section of the plan will deal with communications. In addition to the issues of the plan, it may be prudent to arrange a series of familiarisation visits by representatives of the Emergency Services to key installations, such as substations, maintenance facility, control room as well as general familiarisation with the vehicle and any specific emergency equipment. This activity should be conducted well before public services commence.

7.7 Commercial

7.7.1 Marketing Plan

A detailed marketing and promotion programme would be developed to inform the general public, media, politicians and operating staff about the type of operations, vehicles, system branding, integration with bus routes and the rail network (at Helensvale).

7.7.2 Publications

The marketing division of TransLink would prepare the published public timetables and information brochures about the LRT service and the connecting routes and services. The LRT would not be marketed as a stand-alone service, but as part of an integrated public transport system for the Gold Coast. The brochures would include maps with stop and station locations, interchange locations with the connecting bus routes, a service frequency table and fare information.

7.7.3 Information Programme

Two weeks before the start of the new LRT services, TransLink would conduct a "Helping Hands" information programme to the general public. Information brochures would be distributed to all existing bus and train passengers, all local residents and businesses in the suburbs that the LRT serves, and to public libraries, government offices and community venues.
8. Incident Management and Safety Procedures

8.1 Incident Management

A management plan for any incident or event that has an impact on the operation of the system, whether planned or unplanned, will be put in place in order to minimise the impact on the level of the service and/or to assist in restoring the normal service as soon as possible. The types of incidents to be managed include:

- Vehicle breakdown – both light rail and road;
- ITS breakdown;
- Planned events, e.g. Indy; and
- Catastrophic failure, e.g., derailment.

An Incident Management System (IMS) will be put in place as part of the Operations Management and Control System (OMCS) before system opening. Details of the OMCS and IMS are provided in 6.2. The OMCS will be developed to:

- Control the tracking of LRT vehicles via the Automatic Vehicle Location System (AVLS);
- Detect LRT incidents automatically via the Incident Detection System (IDS) and manage them effectively through a comprehensive Incident Management System (IMS); and
- Respond effectively to emergency situations along the LRT alignment in the shortest possible timeframe.

AVLS will be installed on-board the LRT vehicle to provide accurate operational and location data to allow the network controllers to track the movement of the LRT vehicle and to determine its adherence to assigned schedules. In the event of an incident e.g. a stalled LRT vehicle, the vehicle’s AVLS will interface with the IDS to alert the OMCS that an event has occurred. Lineside CCTV surveillance will be triggered to display the nearest and adjacent preset images on the monitors in the Control Centre for visual confirmation. The OMCS will interface with the IDS and IMS to identify the cause of failure and to assist in responding with the appropriate protocols for the removal of the stalled LRT vehicle and evacuation of the passengers.

8.2 Detection of Vehicle Breakdowns

The prime means for the detection and assessment of breakdowns will be through the Light Rail Vehicle (LRV) driver and the use of on board radio to contact the control centre. This will be supplemented by, or in the event of radio failure, replaced by several onboard diagnostic systems. The LRV will also be fitted with a Rapid Transit Vehicle System (RTVS) as described in 6.2.3. This will collect, process and monitor the condition of the vehicle to analyse: brake sensors, fuel, steering, processor, communications equipment, transit vehicle mileage (to facilitate mileage based maintenance), out of specification and imminent failure conditions. In the event of a vehicle failure, the RTVS will display alerts as to potential causes. The OMCS will interface with the RTVS and through the Alert Management System (AMS) enable the operator to respond and resolve the operational issues. The range of events leading to the initiation of the alert and the subsequent alert indication and default action will require approval by the Project Authority prior to implementation.
8.3 Management of Light Rail Vehicle Breakdowns

The first response to any incident involving an LRV breakdown will always be an attempt to rectify the identified fault. In some cases the LRV driver might be able to address the failure. In more serious incidents, a ‘rapid response crew’ might be despatched by road to clear the fault. Only when this approach cannot rectify the problem should the recovery or ‘parking’ of the failed vehicle be considered. When such an approach is not possible, it will become necessary to remove the vehicle from the running lines. Breakdown manoeuvres can be handled with refuges or crossovers as discussed below.

8.3.1 Refuges

The whole LRT route is approximately 23 km in length. There is therefore significant distance between its extremities and the proposed maintenance / stabling facilities (located at the mid point of the route). Depending on the operating philosophy adopted and the agreed procedures for dealing with a failed LRV, there is likely to be a need for alternative temporary storage facilities (‘parking’) for vehicles, which have to be taken out of service. This may also assist with the storage of vehicles not required during off-peak services. The preferred manner for dealing with this requirement is through the provision of ‘refuge’ sidings at both termini and at strategic locations between each terminus and the maintenance centre. Refuge sidings will need to satisfy horizontal and vertical geometric requirements that can allow the failed LRV to be shunted into the siding by a recovery vehicle (either another LRV or a suitably adapted road / rail vehicle). The area for the siding needs to be on a continuous plane (preferably as close to level as possible), as straight as possible and long enough for the vehicle plus a margin for error – for 35 m vehicles say 45 m past the clearance point of the points connecting the siding to the running line. Approach and departure lengths will need to be at 53 m long (minimum) to accommodate a 45 m LRV. The siding ‘corridor’ would need to be minimally 4m wide to accommodate the LRT line and located at least 4m centre to centre from the running line, if laid out in a parallel arrangement. Proposed stabling facilities at both the depot and terminus have sufficient space to allow for storage of a failed vehicle. However, space constraints along the LRT alignment do not allow for a refuge siding that could satisfy these geometric requirements.

8.3.2 Crossovers

As an alternative to refuges, a strategy involving ‘scissor-type crossovers’ may be implemented whereby short sections of the track containing the failed LRV would be temporarily closed, with the remaining line operating two-way (bi-directional operation) to allow a subsequent LRV to bypass the closed section.

![Diagram showing crossovers](image)

The example above shows how this arrangement would work – LRV 1 would bypass the failed vehicle by travelling in the ‘wrong direction’ on the adjacent track, whilst LRV 2 waits for LRV 1 to clear track section A-B. It should be noted that whilst such operation is in force, normal systems operation will be degraded and a normal timetable will not be possible.
Bi-directional operation will allow repairs to be made to the failed vehicle (if necessary) or for the vehicle to be towed. A special recovery vehicle is sent out to tow the failed LRV to the nearest station for passengers to alight and subsequently to the depot for repair. A specialised vehicle will be required similar to the ‘Unimog’ used on the Sydney’s Light Rail System and has been included in the operational estimate for this project.

Crossovers for LRVs need to satisfy horizontal and vertical geometric requirements. Geometrically, the position of the LRT crossover requires a minimum 44m of horizontally straight track, which also has a constant vertical grade. It would also need to be located between stations so that the distance to the nearest station is minimised (should towing be required). Given the high frequency service planned for the GCRT, the location of the crossover will need to be sited and spaced accordingly so that it does not significantly impact on the level of service.

Potential locations for crossovers are located approximately 3 minutes travel time apart with the exception of Crossover 3C. The reason for including this crossover was to maintain the potential for Cavill Ave Station to act as a temporary northern terminus during the Indy 300 races. The crossover at the southern end of Ferny Ave would allow the Cypress Ave Station to act as a temporary southern terminus, with vehicles not operating between Cypress Ave Station and Cavill Ave Station. Details of the potential crossover locations are provided in Appendix E.

8.4 General Approach to Safety in Operations

In gaining rail safety accreditation (see Section 5.1.2), the Operator will have to demonstrate that the key accreditation issues (as indicated by the Regulator) have been addressed and where the management of these issues is covered in the various management plans that will have to be produced. The overarching guide and management principles must flow from a formal policy and project strategy for safety. Such Policy and Strategy needs to be developed by Translink in conjunction with the Rail Regulator and be set in place before tenders are issued for either construction or operation.

The Operator will be expected to produce two key management documents:

- Operations Plan: covers normal operations, degraded operation (due to external issues, breakdowns and failures) or special operations (such as major events); and
- Emergency Plan: deals with accidents and other emergencies.

8.5 Risks to be Considered

In developing the Operations and Emergency Plans, consideration will be given to the main safety risks. An initial review for LRT operations suggest that there are several risk areas that must be addressed. Table 18 lists these and gives examples of specific issues that may need to be addressed in developing management plans. It must be stressed that the examples are not exhaustive, but are intended to illustrate the range of typical issues that may need to be addressed.
Table 18  Risks to be Considered

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Examples of Issues to be Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction with the Highway and other road users, including cyclists and pedestrians.</td>
<td>Road traffic accidents blocking an intersection or section of LRT route – how do the driver and controllers respond to this and how are operations managed? When is it safe to resume normal operations? Who advises this? Who initiates alternative working? What procedures are put in place? Prosedures and actions to be initiated in the event of an accident involving an LRV at an intersection? Failure of road traffic signals – do LRVs proceed under caution, or is there a need for intervention by the Police or Operations Controller (due to the length of LRVs)? How is the problem reported and action initiated? What procedures are set in place? Cyclists – potential problems of wheels in rail flangeways – particularly at oblique road crossings. How is this avoided and how are incidents managed? Pedestrians crossing at intersections – signage and audible warnings – what procedures are to be used to warn pedestrians, and what action is to be take if these are ignored?</td>
</tr>
<tr>
<td>Access to LRT stops</td>
<td>How is safety maintained for pedestrians accessing stops? This needs to consider both rail and road safety. For example the design of stops and management systems should: Prevent pedestrians crossing the track behind trams; Constrain pedestrians to crossing road at safely / controlled crossing points; Consider future extensions of the stop; Consider weather and lighting conditions; Consider tripping hazards accessed by rail flangeways and how these can be mitigated (i.e. flange fillers); and Consider the need for audible / visual warning systems and control of rail crossing points.</td>
</tr>
<tr>
<td>Pedestrians crossing the track (non passengers)</td>
<td>What measures need to be put in place to prevent or protect pedestrians crossing or walking along the track? Consideration to be given to signage and audible warnings. What procedures are to be used to warn pedestrians, and what action is to be take if these are ignored? Procedures and actions to be initiated in the event of an accidents – i.e. calls for assistance and to emergency services, use of radio etc. Need for ‘education’ programmes.</td>
</tr>
<tr>
<td>Slips trips and falls</td>
<td>How are accidents relating to trips slips and falls mitigated for both for staff and passengers at stops and onboard vehicles? Do designs for stops, workshops, offices and vehicles minimise the risk in this area? What actions procedures are to be put in place in the event of incidents related to this risk area?</td>
</tr>
<tr>
<td>Mobility impaired (MI) users (both at stops and</td>
<td>What operating procedures will be needed to accommodate MI customers? How will incidents involving MI customers be handled?</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Examples of Issues to be Considered</th>
</tr>
</thead>
</table>
| onboard vehicles | What are the responsibilities of LRV drivers and other staff in regard to assistance for MI users?  
Have all reasonable steps been taken in the design to accommodate barrier free access for MI customers? |
| Antisocial behaviour (both at stops and onboard vehicles) and Vandalism | What procedures will be needed in the event of assault on LRV drivers, other staff or customers?  
How is rowdy behaviour on vehicles and stops to be handled? Who is responsible? When is intervention required? Who initiates intervention?  
What is policy regarding the consumption of alcohol and food etc (on stops and vehicles)?  
Policy on smoking?  
Policy on vandalism? Avoiding vandalism through design – what needs to be considered?  
Security of cash and cash collection staff and for cash handing machines and stops (ticket machines). |
| Electrical Safety | What will be the procedures for normal and emergency isolation of the traction system?  
What responsibilities will staff have (drivers, maintenance staff, depot staff and other staff? What staff training and records will be needed?  
Procedures for the use of equipment and PPE?  
How will the emergency services (ES) arrange for isolation? Communication procedures? Will ES be trained and hold safety equipment and PPE?  
When is isolation required (what type of incidents require an isolation of the OHW system)?  
Public awareness and safety – what protection is considered in the design at both stops and along the running line. |
| External Issues | What external emergencies have been considered and what contingency has been put in place for:  
- Fires adjacent to the line and stops?  
- Flooding?  
- Extreme weather events (i.e. storms)?  
- Falling trees? |
| Internal Emergencies | Infrastructure Failures – what procedures are to be followed in the event of track failures (i.e. a broken rail), OHW fault etc?  
Driver incapacitation – what procedures are to be followed in the event of driver incapacitation (i.e. as a result of assault or illness? How will communication be maintained with passengers (i.e. remote announcements over LRV PA)? What fail-to-safety onboard systems are needed and how are staff to be trained in their use? What are the responsibilities of drivers of other LRVs and other staff in such circumstances?  
Reporting procedures – what communication protocols and hierarchy of responses are required? What is the responsibility of drivers and controllers etc? |
8.6 Special Operations

A noted in 8.4, the Operation and Emergency Plans will have to consider both normal and special operations. Detour plans would need to be prepared and implemented under the supervision of the operations staff.

Special operations covers two areas:

**Degraded Operations**

These may occur as a result of an accident, breakdown or other failure. In such cases, subsidiary operation plans and timetables may be needed to operate revised or reduced services over specific sections of infrastructure. The plans will need to cover strategies and procedures to be used to minimise the impacts on customers and to promote the restoration of full services as soon as possible. A critical issue will be communication procedures and protocols.

**Events**

These may be treated as ‘planned’ degraded operations and might typically include how operations are conducted during the ‘Indy Car’ races. Like other degraded operations, operations during events should be managed by the application of specific subsidiary operation plans and timetables. In addition to sound communications, procedures and protocols, procedures will be needed for ensuring adequate staffing levels (such as additional drivers for peak periods), for the marshalling of crowds at stops, and managing temporary barriers, notices etc.
9. Summary and Recommendations

9.1 Summary

This report summarises the Operations Assessment for Stage 1 (Helensvale to Broadbeach South) of the Light Rail Transit (LRT) option of the GCRT project. It summarises and updates the key findings of a body of previous work. Key aspects are:

- Predicted patronage data provided by TransLink has been used as a basis for determining an operations plan. However, it must be noted that the data provided are based on a 25 minute journey time and that a longer journey time will reduce patronage;
- Predicted patronage demand to 2041, the economic life of vehicles purchased in 2011, can be met and an adequate level of service provided by the proposed system operations plan;
- Journey time is estimated at approximately 35 minutes between University Hospital and Broadbeach South stations and this was used in the vehicle and staff estimates;
- The journey time has been developed using GHD’s journey time model and will need to be reviewed once more detailed modelling is available from TransLink;
- A fleet purchase plan has been devised and staff requirements assessed. 2011 requirements are for 15 x 35 metre vehicles and 37 drivers;
- Stations will provide side platforms;
- Details of the ITS system and security and safety proposals are detailed; and
- A commissioning strategy and Incident Management Plan are provided.

9.2 Recommendations

The following are recommended:

- 35 metre vehicles are recommended to avoid the operational issues with a mixture of vehicle sizes;
- Prior to purchasing replacement vehicles the operation system should be reviewed to test patronage and the possibility of adopting reduced headway;
- The efficacy of the Operations Plan should be retested once the patronage model has been refined;
- Spatial requirements have been determined; key points are:
  - A design corridor width of 8.65 metres is recommended and 7.05 at stations;
  - A combination of vehicle refuges, crossovers and specialist towing equipment is recommended to manage vehicle breakdowns; and
  - Stations will provide side platforms and should be designed to accommodate one LRT vehicle. Recommended platform length is 50 metres to accommodate future longer vehicles.
Appendix A
LRT Section Attributes

The following maps show the three sections for Stage 1 of the LRT system with the following information:

- Station locations and classifications;
- Intersection locations and classifications; and
- Design speeds.

This information was used in the journey time calculations.
- 40 km/h speed zone only applies on school days at designated times.
Appendix B

Capacity Analysis

Presented are:

- Diagrams showing:
  - The variation of stage 1 patronage over the system for every five years between 2011 and 2041;
  - System operations and capacity; and
  - The variation of reserve capacity over the system for every five years between 2011 and 2041. The sections in which the standee density is greater than 3 passengers per square metre are also identified.

- Histograms showing a comparison of peak capacity with both standee density 4 passengers per square metre and 3 passengers per square metre and Stage 1 patronage for every five years between 2011 and 2041; and

- Graphs showing a detailed comparison of Stage 1 and Stage 2 patronage with capacity with standee densities of both 4 passengers per square metre and three passengers per square metre for AM, PM and DT peaks for years 2016, 2026 and 2041.
### Predicted Demand (pxh/ax)

<table>
<thead>
<tr>
<th>Location</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Coast University</td>
<td>162</td>
<td>162</td>
<td>162</td>
<td>162</td>
<td>162</td>
<td>162</td>
<td>162</td>
<td>162</td>
</tr>
<tr>
<td>Griffith University</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>156</td>
<td>156</td>
</tr>
<tr>
<td>Helensvale</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Cavendish</td>
<td>145</td>
<td>145</td>
<td>145</td>
<td>145</td>
<td>145</td>
<td>145</td>
<td>145</td>
<td>145</td>
</tr>
<tr>
<td>Surfers Paradise</td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Broadbeach South</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td>Griffith University</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>Helensvale</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Griffith University</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Helensvale</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>Griffith University</td>
<td>110</td>
<td>110</td>
<td>110</td>
<td>110</td>
<td>110</td>
<td>110</td>
<td>110</td>
<td>110</td>
</tr>
</tbody>
</table>

### AM and PM Peak Hours

<table>
<thead>
<tr>
<th>Location</th>
<th>AM 7:00-9:00</th>
<th>AM 9:00-11:00</th>
<th>AM 11:00-1:00</th>
<th>AM 1:00-3:00</th>
<th>AM 3:00-5:00</th>
<th>PM 5:00-7:00</th>
<th>PM 7:00-9:00</th>
<th>PM 9:00-11:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Coast University</td>
<td>1,300</td>
<td>1,350</td>
<td>1,400</td>
<td>1,450</td>
<td>1,500</td>
<td>1,550</td>
<td>1,600</td>
<td>1,650</td>
</tr>
<tr>
<td>Griffith University</td>
<td>1,200</td>
<td>1,250</td>
<td>1,300</td>
<td>1,350</td>
<td>1,400</td>
<td>1,450</td>
<td>1,500</td>
<td>1,550</td>
</tr>
<tr>
<td>Helensvale</td>
<td>1,100</td>
<td>1,150</td>
<td>1,200</td>
<td>1,250</td>
<td>1,300</td>
<td>1,350</td>
<td>1,400</td>
<td>1,450</td>
</tr>
<tr>
<td>Cavendish</td>
<td>1,000</td>
<td>1,050</td>
<td>1,100</td>
<td>1,150</td>
<td>1,200</td>
<td>1,250</td>
<td>1,300</td>
<td>1,350</td>
</tr>
<tr>
<td>Surfers Paradise</td>
<td>900</td>
<td>950</td>
<td>1,000</td>
<td>1,050</td>
<td>1,100</td>
<td>1,150</td>
<td>1,200</td>
<td>1,250</td>
</tr>
<tr>
<td>Broadbeach South</td>
<td>800</td>
<td>850</td>
<td>900</td>
<td>950</td>
<td>1,000</td>
<td>1,050</td>
<td>1,100</td>
<td>1,150</td>
</tr>
<tr>
<td>Griffith University</td>
<td>700</td>
<td>750</td>
<td>800</td>
<td>850</td>
<td>900</td>
<td>950</td>
<td>1,000</td>
<td>1,050</td>
</tr>
<tr>
<td>Helensvale</td>
<td>600</td>
<td>650</td>
<td>700</td>
<td>750</td>
<td>800</td>
<td>850</td>
<td>900</td>
<td>950</td>
</tr>
<tr>
<td>Griffith University</td>
<td>500</td>
<td>550</td>
<td>600</td>
<td>650</td>
<td>700</td>
<td>750</td>
<td>800</td>
<td>850</td>
</tr>
</tbody>
</table>

### Standee Density

- Standee Density more than 4 pax per sq m
- Standee Density between 3 and 4 pax per sq m
- Standee density less than 3 pax per sq m

### Variation in Reserve Capacity (%)

<table>
<thead>
<tr>
<th>Location</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Coast University</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Griffith University</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Helensvale</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Cavendish</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Surfers Paradise</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Broadbeach South</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Griffith University</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Helensvale</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Griffith University</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Helensvale</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Griffith University</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### LRT Operations

- AM: 05:00-07:00
- PM: 17:00-19:00

### Standee Density

- Standee Density more than 4 pax per sq m
- Standee Density between 3 and 4 pax per sq m
- Standee density less than 3 pax per sq m

### Notes

- Forecasts for 2021, 2022, 2023 & 2024 are extrapolated or interpolated from 2018, 2019, & 2020 modelled volumes.
### LRT Operations

#### DT and NT Peak Hours

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standee Density more than 4 pax per sq m</td>
<td>Standee Density between 4 and 8 pax per sq m</td>
<td>Standee density less than 4 pax per sq m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Predicted Demand (pax/hour)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Griffith University</td>
<td>631</td>
<td>633</td>
<td>721</td>
<td>849</td>
<td>594</td>
<td>427</td>
<td>385</td>
<td>324</td>
<td>294</td>
<td>260</td>
<td>230</td>
<td>198</td>
<td>170</td>
</tr>
<tr>
<td>Gold Coast Hospital</td>
<td>228</td>
<td>210</td>
<td>195</td>
<td>150</td>
<td>105</td>
<td>90</td>
<td>75</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Griffith University</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
<td>797</td>
</tr>
<tr>
<td>Gold Coast University - Broadbeach South</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
</tr>
<tr>
<td>Gold Coast University - Broadbeach North</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
</tr>
</tbody>
</table>

#### Variation in Reserve Capacity (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Griffith University</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Gold Coast University</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Gold Coast University - Broadbeach South</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Griffith University - Broadbeach North</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
</tbody>
</table>

#### Capacity based on standee density 4 pax/sq m

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Griffith University</td>
<td>797</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
</tr>
<tr>
<td>Griffith University - Broadbeach South</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
<td>997</td>
</tr>
</tbody>
</table>

#### Variation in Reserve Capacity (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Griffith University</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Gold Coast University</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Gold Coast University - Broadbeach South</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Griffith University - Broadbeach North</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
<td>91%</td>
</tr>
</tbody>
</table>
2016 AM Peak LRT Capacity Analysis

- Passengers Onboard
- Stage 1 Patronage NB
- Stage 1 Patronage SB
- Onboard Capacity with 3 ppsm
- Stage 2 Patronage NB
- Stage 2 Patronage SB
- Onboard Capacity with 4 ppsm

Stations:
- Helensvale
- Gaven
- Parkwood West
- Parkwood
- Griffith University
- Southport Primary
- Gold Coast Hospital
- Southport
- Scarborough Street
- Broadwater
- Main Beach
- Paradise Waters
- Cypress Avenue
- Cavill Avenue
- Surfers Paradise
- Northcliffe
- Florida Gardens
- Broadbeach North
- Broadbeach South
2016 DT Peak LRT Capacity Analysis

Passengers Onboard

Station

- Helensvale
- Gaven
- Parkwood West
- Parkwood
- Griffith University
- Southport Primary
- Gold Coast Hospital
- Southport
- Scarborough Street
- Broadwater
- Main Beach
- Paradise Waters
- Cypress Avenue
- Cavill Avenue
- Surfers Paradise
- Northcliffe
- Florida Gardens
- Broadbeach North
- Broadbeach South

- Stage 1 Patronage NB
- Stage 1 Patronage SB
- Onboard Capacity with 3 ppsm
- Stage 2 Patronage NB
- Stage 2 Patronage SB
- Onboard Capacity with 4 ppsm
Appendix C

Estimated Staffing Requirements
### Table 19 Operations Staff Estimate

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Staff</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- General Manager</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Secretary</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Public relations</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Accounts</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>- Finance Manager</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Safety Officer</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Human resources</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Marketing/commercial</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Drivers &amp; Driver Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Drivers</td>
<td>37</td>
<td>37</td>
<td>51</td>
<td>73</td>
<td>81</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>- Team Managers</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Operational Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Operations Manager</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Operations Administrator</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Operations Staff</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>- Day Driver Rostering</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Line Control</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Cleaners</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Ticket Inspectors/Customer Service Officers</td>
<td>8</td>
<td>8</td>
<td>11</td>
<td>15</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>- Security Guards</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Vehicle Maintenance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Manager</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Foreman</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>- Technician</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>- Team Manager</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>- Worker</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td><strong>Track and Overhead Line Maintenance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Manager</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
### Gold Coast Rapid Transit Project

**Volume 7 Technical Report: Light Rail Transit Operations Assessment Stage 1: Helensvale to Broadbeach**

#### Yearly Employment 2011-2041

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Organisation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>- Overhead Line Technician</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Team Manager</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Worker</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**Ticket Machine Maintenance**

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ticket Machine Servicing &amp; Maintenance</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>91</td>
<td>91</td>
<td>114</td>
<td>155</td>
<td>167</td>
<td>169</td>
<td>169</td>
</tr>
</tbody>
</table>
Appendix D

Indicative Cross Sections
This Drawing must not be used for Construction unless signed as Approved.

Date

Check

Drafting

Date

Approved

Drawn

Revision No

A1

Original Size

Title

Project

Client

Condition of Use.

This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

DO NOT SCALE

Note: * indicates signatures on original issue of drawing or last revision of drawing.

CLIENTS   PEOPLE   PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000
F 61 7 5557 1099
E bnemail@ghd.com.au
W www.ghd.com.au

Plot Date: Cad File No: 14 December 2007 - 3:21 PM C:\Arenium_Projects\41-16445_Gold_Coast_Rapid_Transit\CADD\Drawings\41-16445-C001-C010.dwg

PRELIMINARY

AS SHOWN

HASSELL

41-16445-C001

PRELIMINARY

S.O'BRIEN S.O'BRIEN

NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
This Drawing must not be used for Construction unless signed as Approved.

Date
Check
Drafting

Scale

Design

Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

DO NOT SCALE

Note: * indicates signatures on original issue of drawing or last revision of drawing.

CLIENTS   PEOPLE   PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000
F 61 7 5557 1099
E infoemail@ghd.com.au
W www.ghd.com.au

Plot Date: Cad File No: 14 December 2007 - 2:55 PM
C:\Arenium_Projects\41-16445_Gold_Coast_Rapid_Transit\CADD\Drawings\41-16445-C001-C010.dwg

PRELIMINARY

AS SHOWN

HASSELL

41-16445-C002

PRELIMINARY

AS SHOWN

S.O'BRIEN

NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.

TYPICAL SECTION

NERANG STREET (HOSPITAL STATION)

TYPICAL SECTION

NERANG STREET (HIGH ST. INTERSECTION)

TYPICAL SECTION

NERANG STREET (HIGH ST. TO DAVENPORT ST.)

PRELIMINARY
This Drawing must not be used for Construction unless signed as Approved.

Date
Checked
Drafting

Designed
Approved
Drawn

Scale

Conditions of Use:

This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

DO NOT SCALE

Note: * indicates signatures on original issue of drawing or last revision of drawing

CLIENTS   PEOPLE   PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T
61 7 5557 1000
F
61 7 5557 1099
E
bnemail@ghd.com.au
W
www.ghd.com.au

Plot Date: Cad File No: 14 December 2007 - 2:56 PM C:\Arenium_Projects\41-16445_Gold_Coast_Rapid_Transit\CADD\Drawings\41-16445-C001-C010.dwg

PRELIMINARY
AS SHOWN
HASSELL
41-16445-C003
PRELIMINARY
AS SHOWN
S.O'BRIEN S.O'BRIEN

NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.

PRELIMINARY
This Drawing must not be used for Construction unless signed as Approved.

Date
Check
Drafting

Date
Approved
Drawn
Revision No

Original Size
Title
Project
Client

Check
Designed

Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

DO NOT SCALE

Note: * indicates signatures on original issue of drawing or last revision of drawing

CLIENTS   PEOPLE   PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000
F 61 7 5557 1099
E bneemail@ghd.com.au
W www.ghd.com.au

Plot Date: Cad File No: 14 December 2007 - 2:57 PM
C:\Arenium_Projects\41-16445_Gold_Coast_Rapid_Transit\CADD\Drawings\41-16445-C001-C010.dwg

PRELIMINARY

AS SHOWN

HASSELL

41-16445-C006

PRELIMINARY

AS SHOWN

41-16445-C003

PRELIMINARY

AS SHOWN

S.O'BRIEN S.O'BRIEN

NOTES
REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
TYPICAL SECTION
BEACH ROAD INTERSECTION

TYPICAL SECTION
GOLD COAST HIGHWAY

TYPICAL SECTION
GOLD COAST HIGHWAY, FERN STREET INTERSECTION

NOTES
REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
NOTES

REFER TO STRUCTURAL DRAWINGS FOR TYPICAL CROSS SECTIONS OF TRACK SLAB.
Appendix E
Cross Over Locations
The following presents potential crossover locations in Sections 2 and 3 that will facilitate bidirectional operation:

Section 2 of the RT alignment is approximately 6.1 km long. Three possible crossover locations are proposed within this section, at the following locations:

- Crossover 2A – Stabling at University Hospital;
- Crossover 2B – Entrance to RT depot facility;
- Crossover 2C – Queen Street between the Southport Primary Station and the Gold Coast Hospital Station; and
- Crossover 2D – Scarborough Street between Southport Station and Southport South Station, opposite Southport Central.

Section 3 of the RT alignment is about 7.2 km long. Seven possible crossover locations are proposed within this section, at the following locations:

- Crossover 3A – Between Main Beach Station and Paradise Waters Station, near Macintosh Island. This crossover is to be a spur line with a turnout at each end;
- Crossover 3B - Between Paradise Waters Station and Cypress Avenue Station, opposite Gold Coast International Hotel;
- Crossover 3C – Surfers Paradise Boulevard between Cypress Avenue Station and Cavill Avenue Station. This crossover is required during Indy 300 to ensure that the GCRT can continue to operate during this event. During the Indy 300 races, a section of the track between Cypress Avenue and Elkhorn Avenue will be shut down. This crossover will allow northbound LRT vehicles to be switched onto the southbound track and turned around;
- Crossover 3D – Surfers Paradise Boulevard between Cavill Avenue Station and Surfers Paradise Station;
- Crossover 3E – Gold Coast Highway between Northcliffe Station and Florida Gardens Station;
- Crossover 3F – Gold Coast Highway between Florida Gardens Station and Broadbeach North Station; and
- Crossover 3G – Gold Coast Highway between Broadbeach South Station and Terminus.

The location of the potential LRT crossover locations are described in greater detail in Table 20.
### Table 20  Description of LRT Crossover Points

<table>
<thead>
<tr>
<th>Description</th>
<th>Crossover No</th>
<th>Chainage (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of Line</td>
<td></td>
<td>19,080</td>
</tr>
<tr>
<td>University Hospital</td>
<td>Crossover 2A</td>
<td>19,230</td>
</tr>
<tr>
<td>RT Depot</td>
<td>Crossover 2B</td>
<td>20,840</td>
</tr>
<tr>
<td>Southport Primary</td>
<td>Crossover 2C</td>
<td>22,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22,143</td>
</tr>
<tr>
<td>GC Hospital</td>
<td></td>
<td>22,980</td>
</tr>
<tr>
<td>Southport</td>
<td>Crossover 2D</td>
<td>23,540</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23,890</td>
</tr>
<tr>
<td>Southport South</td>
<td></td>
<td>24,160</td>
</tr>
<tr>
<td>Broadwater</td>
<td></td>
<td>24,540</td>
</tr>
<tr>
<td>Main Beach</td>
<td></td>
<td>30,400</td>
</tr>
<tr>
<td></td>
<td>Crossover 3A / Spurline</td>
<td>30,666</td>
</tr>
<tr>
<td>Paradise Waters</td>
<td></td>
<td>31,420</td>
</tr>
<tr>
<td></td>
<td>Crossover 3B</td>
<td>31,910</td>
</tr>
<tr>
<td>Cypress Ave</td>
<td></td>
<td>32,260</td>
</tr>
<tr>
<td></td>
<td>Crossover 3C</td>
<td>32,550</td>
</tr>
<tr>
<td>Cavill Ave</td>
<td></td>
<td>32,820</td>
</tr>
<tr>
<td></td>
<td>Crossover 3D</td>
<td>33,180</td>
</tr>
<tr>
<td>Surfers Paradise</td>
<td></td>
<td>33,380</td>
</tr>
<tr>
<td>Northcliffe</td>
<td></td>
<td>33,790</td>
</tr>
<tr>
<td></td>
<td>Crossover 3E</td>
<td>34,190</td>
</tr>
<tr>
<td>Florida Gardens</td>
<td></td>
<td>34,610</td>
</tr>
<tr>
<td></td>
<td>Crossover 3F</td>
<td>35,710</td>
</tr>
<tr>
<td>Broadbeach North</td>
<td></td>
<td>35,800</td>
</tr>
<tr>
<td>Broadbeach South</td>
<td></td>
<td>(36,520 - 36,850)</td>
</tr>
<tr>
<td></td>
<td>Crossover 3G</td>
<td>South of 36,850</td>
</tr>
</tbody>
</table>

The location of the LRT crossovers is shown diagrammatically in Figure 6.
FIGURE 6

LRT Crossovers
Section 2 and 3

SECTION 2
SECTION 3

Legend

- LRT Crossover
- Depot Stabling
- Terminus Stabling
- RT Station
- Section 2
- Section 3

Source: Aerial Photography Supplied by GCCC (2006)
Approximate route options digitised by GHD current to Dec 2007, maybe subject to change.
Projection: MGA56 (GDA94)
Date Printed: 26-08-2008
File: G:\41\16445\GIS\MAP\GCRT\20080122\LRT Map.mxd