



**Gladstone Regional Council**  
**Boyne Island Second River Crossing (Hoddinott Bridge)**  
**100 % Detailed Design Report**

August 2015



# Executive summary

This project relates to the provision of a Second Boyne River Crossing (Hoddinott Bridge), by way of a four-lane road between Boyne Island Road and Tannum Sands Road, at Pioneer Drive.

The project includes the provision of separate bridge crossings of the Boyne River and Boyne River Bifurcation.

A Link Planning Study has been previously carried out by GHD on behalf of The Department of Transport and Main Roads (TMR) in 2012. This Report, denoted "Rev B - Final" and dated July, 2012 forms the basis for this detailed designs described herein.

The project objectives are:

- Progress planning of key infrastructure and seek to provide an alternate route;
- Provide the ability for Council to respond to Development Applications from surrounding developers;
- Provide Council with a level of cost surety and enable funding to be confidently pursued; and
- Provision of detailed design for a proposed four lane dual carriageway link between Boyne Island Road and Tannum Sands Road.

The purpose of this Detailed Design Report is to document the design process and associated design solutions, including:

- Issues that arose during this detailed design phase of the Project; and
- Identifies issues remaining to be addressed, such as Approvals and Services Relocations, noting the anticipated 10-year timeframe until Project Startup.
- Identify the issues to be investigated and resolved during the construction phase.

This document acts as a record of the evolution of the design process.

As the 100% Detailed Design Report, this report:

- Outlines the background, issues identified, assumptions and decisions made through the Detailed Design phase.
- Clarifies any limitations, or scope exclusions and associated risks and actions required by Council, before progressing the Project to actual Construction

# Table of contents

|      |   |    |
|------|---|----|
| 1.   | Introduction.....   | 1  |
| 1.1  | Background.....   | 1  |
| 1.2  | Purpose of this Report.....                                       | 1  |
| 1.3  | History.....  | 1  |
| 1.4  | Project Objectives.....   | 1  |
| 1.5  | Assumptions.....  | 2  |
| 1.6  | Final Layout and Drawings.....                                    | 2  |
| 2.   | Stakeholder Engagements.....                                      | 3  |
| 3.   | Public Utility Plant (PUP).....                                   | 4  |
| 3.1  | Introduction.....   | 4  |
| 3.2  | Dial Before You Did.....  | 4  |
| 3.3  | General.....  | 4  |
| 3.4  | GRC Water and Sewerage.....                                       | 5  |
| 3.5  | Communications.....   | 5  |
| 3.6  | Electricity.....  | 5  |
| 4.   | Environmental.....  | 6  |
| 4.1  | Background.....   | 6  |
| 4.2  | Physical Environment.....   | 6  |
| 4.3  | Ecological Environment (Flora and Fauna).....                     | 7  |
| 4.4  | Social Environment.....   | 7  |
| 4.5  | Cultural Heritage.....  | 7  |
| 4.6  | Legislative Requirements.....                                     | 8  |
| 5.   | Hydraulic Analysis.....   | 9  |
| 5.1  | Background of Modelling.....                                      | 9  |
| 5.2  | Validation.....   | 10 |
| 5.3  | Completed Works.....  | 10 |
| 5.4  | Remaining Works.....  | 10 |
| 6.   | Geotechnical Investigation.....                                   | 11 |
| 7.   | Geotechnical Design.....  | 13 |
| 7.1  | Specifications and Standards.....                                 | 13 |
| 7.2  | Geotechnical Design Report.....                                   | 13 |
| 7.3  | Bifurcation and Boyne River Bridges Foundation Design Report..... | 15 |
| 8.   | Traffic Analysis.....   | 18 |
| 9.   | Site Surveys.....   | 19 |
| 10.  | Design Vehicles.....  | 20 |
| 11.  | Road Alignment and Geometry.....                                  | 20 |
| 11.1 | General.....  | 20 |

|      |  |    |
|------|--|----|
| 11.2 | Superelevation .....   | 20 |
| 11.3 | Vertical Grading at Change in Surfacing .....  | 21 |
| 12.  | Intersections .....  | 22 |
| 12.1 | Scope .....  | 22 |
| 12.2 | Existing Dennis Street – CH75 .....  | 22 |
| 12.3 | Dennis Park/New Industrial Precinct Access – CH300 .....                                   | 22 |
| 12.4 | Riverstone Rise / Crematorium Access – CH 750 .....  | 23 |
| 12.5 | Crematorium - CH 135 on Riverstone Rise Access .....                                       | 23 |
| 12.6 | Sewerage Treatment Plant – CH 2130 .....   | 24 |
| 12.7 | Roundabout – CH 3450 .....   | 24 |
| 12.8 | Further Consideration by Council .....   | 24 |
| 13.  | Road Cross Sections .....  | 25 |
| 14.  | Pedestrian and Cycle Pathways .....  | 26 |
| 15.  | Pavement Design .....  | 27 |
| 15.1 | General .....  | 27 |
| 15.2 | Design Traffic .....   | 27 |
| 15.3 | Design CBR .....   | 27 |
| 15.4 | Recommended Pavement Designs .....   | 28 |
| 16.  | Road Cross Drainage .....  | 31 |
| 16.1 | Cross Drainage .....   | 31 |
| 16.2 | Catchment B5 – Ch 3845 -4200 (MC01) LHS .....  | 31 |
| 16.3 | Gully Filling Ch 1550 RHS (MC01) .....   | 32 |
| 16.4 | Combined Culverts at end of Project Ch 4650 - 4800 .....                                   | 32 |
| 16.5 | Longitudinal Drainage .....  | 32 |
| 16.6 | Surface Drainage .....   | 33 |
| 16.7 | Subsoil Drainage .....   | 33 |
| 16.8 | Culvert End Structures .....   | 33 |
| 16.9 | Table Drains .....   | 33 |
| 17.  | Road Lighting Design .....   | 34 |
| 17.1 | Technical Parameters .....   | 34 |
| 17.2 | Coordination with Existing and Planned Ergon Overhead Relocations and Other Services ..... | 34 |
| 17.3 | Power supply .....   | 35 |
| 17.4 | Existing Road Lighting Infrastructure .....  | 35 |
| 18.  | Traffic Signals Design .....   | 36 |
| 18.1 | Electrical Coordination .....  | 36 |
| 18.2 | New Industrial Precinct Access Signals .....   | 36 |
| 18.3 | Crematorium Access .....   | 36 |
| 18.4 | Communications Connection .....  | 36 |
| 19.  | Safety Barrier System .....  | 37 |

|      |  |    |
|------|--|----|
| 19.1 | General .....  | 37 |
| 19.2 | Maintenance Access Ch 1375 .....                           | 37 |
| 20.  | Signage and Linemarking .....                              | 38 |
| 21.  | Land Acquisitions .....                                    | 39 |
| 21.1 | General .....  | 39 |
| 21.2 | Basis of Road Reservation Width .....                      | 39 |
| 21.3 | Council Considerations .....                               | 40 |
| 21.4 | Lot 1 RP614595 .....                                       | 40 |
| 21.5 | Lot 1 SP252843 – Future Ergon Substation Site .....        | 40 |
| 21.6 | Lot 22 SP199256 .....                                      | 40 |
| 22.  | Road Safety Audit .....                                    | 40 |
| 22.1 | Road Safety Audit – Concept Stage Review .....             | 40 |
| 22.2 | Road Safety Audit – Detailed Design .....                  | 41 |
| 23.  | Boyne River Bridges .....                                  | 42 |
| 23.1 | Bridge Summary .....                                       | 42 |
| 23.2 | Bridge Superstructure .....                                | 42 |
| 23.3 | Bridge Substructure / Foundations .....                    | 42 |
| 23.4 | Bridge Barriers .....                                      | 43 |
| 23.5 | Bridge Lighting .....                                      | 43 |
| 23.6 | Bridge Drainage .....                                      | 43 |
| 23.7 | Abutment Protection .....                                  | 43 |
| 23.8 | Bridge Elements Durability and Service Life Criteria ..... | 43 |
| 23.9 | Further Clarification .....                                | 44 |
| 24.  | Constructability .....                                     | 45 |
| 24.1 | Background .....   | 45 |
| 24.2 | General Considerations .....                               | 45 |
| 24.3 | Program .....  | 45 |
| 24.4 | Outcomes .....   | 45 |
| 25.  | Risk Management .....                                      | 46 |
| 25.1 | Introduction .....   | 46 |
| 25.2 | Methodology .....  | 46 |
| 25.3 | Risk Assessment .....                                      | 46 |
| 25.4 | Work Status .....  | 47 |
| 26.  | Estimate of Costs .....                                    | 48 |

# Table index

|   |    |
|---|----|
| Table 1 - Summary of Geotechnical Boreholes .....                                       | 11 |
| Table 2 - Test Pit Summary.....   | 12 |
| Table 3 - Geotechnical Units .....  | 13 |
| Table 4 - Bifurcation Bridge Pile Details.....  | 16 |
| Table 5 Boyne River Bridge Pile Details .....   | 17 |
| Table 1 Areas requiring additional survey.....  | 19 |
| Table 6 Design Traffic Loading .....  | 27 |
| Table 7 Engineer Fill Improvement Layer Requirements .....                              | 28 |
| Table 8 Design Sections – Pioneer Drive and Pioneer Drive Extension .....               | 28 |
| Table 9 Design Sections – Various Side Roads .....                                      | 28 |
| Table 10 Recommended Pavement Designs – Pioneer Drive and Pioneer Drive Extension ..... | 29 |
| Table 11 Recommended Pavement Designs –Various Side Roads .....                         | 29 |
| Table 12 Cross Drainage Parameters.....   | 31 |
| Table 13 Land Acquisitions .....  | 39 |
| Table 4 Expected design life of components .....  | 43 |

# Figure index

|   |    |
|---|----|
| Figure 1 Extent of 2D Model Domain..... | 9  |
| Figure 2 – Cost Estimate to Date .....  | 48 |

# Appendices

|  |  |
|--|--|
| Appendix A – Design Drawings                             |  |
| Appendix B – Functional Design Specification (FDS)       |  |
| Appendix C – Design Decisions Table                      |  |
| Appendix D – Road Safety Audit – Detailed Design         |  |
| Appendix E – Project Risk Report and Risk Register       |  |
| Appendix F – Public Utility Plant (PUP) Report           |  |
| Appendix G – Bridges Report                              |  |
| Appendix H – Environmental and Cultural Heritage Reports |  |
| Appendix I – Geotechnical Design Report                  |  |
| Appendix J – Geotechnical Bridge Foundation Report       |  |

Appendix K – Pavement Design Report

Appendix L – Constructability Report

Appendix M – Construction Report

Appendix N – Hydrology and Hydraulics Report



# 1. Introduction

## 1.1 Background

The Gladstone Regional Council (GRC) has commissioned GHD to conduct the Detailed Design for the Boyne Island Second River Crossing project known as the Hoddinott Bridge Project.

The Detailed Design Phase of the project relates to the provision of a four lane median divided dual carriageway road along Pioneer Drive between Boyne Island Road and Tannum Sands Road on approximately the alignment of the existing Pioneer Drive and sewerage treatment plant access road. The project includes the provision of bridge crossings of the Boyne River and Boyne River Bifurcation with separate bridge structures planned for each carriageway.

The TMR Intersections at either end, located on Boyne Island Road and Tannum Sands Roads, were removed from Project Scope in August 2014. These Intersections were re-introduced in January, 2015 as Concept Designs only and are therefore not included in this Detailed Design Report.

## 1.2 Purpose of this Report

The purpose of this Detailed Design Report (The Report) is to document the design process and associated design solutions, including;

- Issues that arose during this detailed design phase of the project and
- Identify the issues to be investigated and resolved prior to and during the construction phase.

This document acts as a record of the evolution of the design process

## 1.3 History

A Link Planning Study has been previously carried out by GHD on behalf of The Department of Transport and Main Roads (TMR) in 2012

The Original Draft Study was updated to Final Report, Revision B in July 2012. In the Final Report, the majority of intersections were upgraded from the initial roundabout configurations to signalised intersections. This Final July 2012 Rev B Report forms the basis for the detailed design described herein.

## 1.4 Project Objectives

The project objectives are outlined below:

- Progress planning of key infrastructure to facilitate identified growth potential for the greater Gladstone area and seek to provide alternate route planning for an already constrained State Controlled Network;
- Provide the ability for Council to efficiently and confidently respond to Development Applications from surrounding developers and condition developments according to trunk infrastructure need;
- Provide Council with a level of cost surety and enable funding to be confidently pursued as potential sources become available; and
- Provision of detailed design for a proposed four lane dual carriageway link between Boyne Island Road and Tannum Sands Road.

## 1.5 Assumptions

Designs are based generally upon the following:

- Construction will be as a single, 4-lane road system. No allowance has been made for staging by constructing an initial 2-lane road as part of the design process;
- Traffic data as outlined in Section 8 is based on Traffic Figures taken from the 2012 TMR Link Study as directed by GRC in response to GHD RFI #004 dated 29/09/2014; and
- The Road will open in 2024 and has a design life of 20 years

Detailed Design Assumptions are listed in the following attached documents:

- Design Decisions Register in Appendix C; and
- Functional Design Specification in Appendix B.

## 1.6 Final Layout and Drawings

Final Layout Drawings and Sections are attached in Appendix A.

## 2. Stakeholder Engagements

Key Stakeholders for this Project have been identified as:

- Gladstone Regional Council as Project Owner;
- Adjacent impacted Landowners (land acquisitions etc);
- Affected adjacent businesses, particularly the GRC Crematorium;
- Government Approvals Agencies, including Department of Transport and Main Roads (TMR), Maritime Safety Queensland (MSQ) / Harbourmaster, Gladstone Ports Corporation Limited (GPCL), Department of Infrastructure, Local Government and Planning (DILGP), Department of Environment and Heritage Protection (DEHP) and Department of Agriculture and Fisheries (DAF). (Refer to the Approvals Scoping Study in Appendix H for a complete List)
- Aboriginal Groups – Port Curtis Coral Coast (PCCC) native title claimant group;
- Service Providers – Ergon, Telstra, GRC and others as identified in the PUP Report in Appendix F; and
- Project Consultants and sub-consultants.

Other Stakeholders include:

- Adjacent Land Developments;
- Emergency Services;
- The Media;
- Political Representatives and related Funding Bodies;
- Local Boyne Island and Tannum Sands Residents and the travelling Public generally;
- Other Council Consultants – legal, valuers etc; and
- The Civil Construction Contractor

Community Consultation is being undertaken by Gladstone Regional Council. This has predominantly been negotiations with affected Landowners along the route, to obtain permission to access for the purposes of Surveys, Cultural Heritage walkover and Geotechnical investigations. Some landowners have been approached to brief and negotiate on proposed property acquisitions.

Council was unable to obtain a response from the owners of Lots 22 and 23 at the Tannum Sands end. Formal Notice to Enter was issued under the Local Government Act and the necessary surveys were carried out.

GHD's Stakeholder Engagement is limited to liaison with relevant Service Providers, Government Authorities and other bodies as detailed elsewhere in this Report.

## 3. Public Utility Plant (PUP)

### 3.1 Introduction

Based on the desktop study, a number of service clashes were identified with respect to the proposed Hoddinott Bridge project and the construction of a four lane dual carriageway road link. TMR intersections of these roads are not currently included in the scope of works.

The full PUP Report is attached in Appendix F. The following is a summary of key points:

### 3.2 Dial Before You Dig

The Initial Dial Before You Dig (DBYD) searches and discussions with Public Utility Plant (PUP) providers (including Mosaic searches) have identified on the corridor:

- Electrical Reticulation
  - Ergon LV
  - Ergon HV
- Water and Sewerage
  - Gladstone Regional Council
- Communications Infrastructure
  - Telstra
  - Opticomm
  - National BroadBand Network Co. (NBN Co)

### 3.3 General

The existing locations of PUP and associated relocation are shown on the following drawings:

- 42-18562-C700
- 42-18562-C701
- 42-18562-C702
- 42-18562-C703
- 42-18562-C704

As it is depicted in the drawings, there are significant clashes at both end limits of the road. The Boyne Island Road Pioneer Drive intersection and Tannum Sands Road Pioneer Drive intersection have both been excluded from the current scope of Detailed Designs, as directed by Council. However, it is highlighted that a significant amount of infrastructure transverse each of the intersections and further investigation is required as significant cost and delays to the project are expected due to service relocations.

The design of services and service re-locations at clashes has been removed from the scope of the detailed designs. This design work will be required to be undertaken by the service providers such as Ergon Telstra and Council when the project is ready to proceed. A number of locations of potential services clashes have been marked on the Drawings for Council's attention and action, however there may be other locations and services not indicated.

### 3.4 GRC Water and Sewerage

A number of water main and sewer relocations are required for the length of the project. These include:

- Water relocation along Pioneer Drive from the intersection of Boyne Island Road to the Crematorium, including along the Crematorium / Riverstone Rise Access Road
- A 450mm diameter water main from Tannum Sand intersection to chainage 2700 is required to be moved to the south and encased in an envelope under the newly designed roundabout off Pioneer Drive.
- The existing STP has a number of existing and future rising mains that require relocation to the south to suit the new four lane design.

It is highlighted that Gladstone Regional Council will relocate their plant before commencement of construction, as directed in the project meeting #019 item number 4.4.5 on 04/06/2015.

### 3.5 Communications

Telstra and communication cables are affected minimally by the upgrade of Pioneer Drive and the Hoddinott Bridge compared to other services. The following services have been identified as requiring relocation:

- A new Telstra line is likely to be required from the intersection of Boyne Island Road to service the Crematorium.
- The Sports Park roundabout on Pioneer Drive - the depth of the service and/or protection measure are to be investigated and designed (by Others)

Although there are other communication clashes at the TMR intersections, this is currently outside of GHD's scope. It is emphasised that additional costs and construction delays may occur due to the NBN Co and Opticomm infrastructure clashes at the intersections. This includes relocation of a RIM (Remote Integrated Multiplexer) which combines the separate signals from multiple lines into a single signal which is transmitted through the trunk cables back to the Boyne Island exchange.

### 3.6 Electricity

GHD has made contact with a number of Ergon personnel with respect to high voltage (HV) and low voltage (LV) reticulation in the corridor including Andrew Blair (LV), Noel Crosbie (LV), Gordon Kelsey (property) and George Schultenkamp (HV). The HV lines are currently in the design phase and due to early communication with Ergon, these have been designed to take into account the new Pioneer Drive four lane design and as such it not thought to effect the road design. A number of LV service lines require relocation for the construction of the road including:

- Low voltage lines along Pioneer Drive from Dennis Street to the Crematorium with a number of reconnections required for the Dennis Park Sport Grounds, Dennis Street industrial estate, and the Crematorium.
- Relocation of the overhead electricity feed to the the sewerage treatment plant

The new bridge design has made allowance for conduits under the bridge to support LV electrical lines so that can still be serviced. However some consideration will be required to maintain feed to the sewage plant during construction of the bridge as the overhead line will be a potential risk to the piling and craneage operations.

## 4. Environmental

### 4.1 Background

As part of the Hoddinott Bridge Project, GHD has reviewed and updated the Approvals Scoping Study that was prepared in 2013. The Approvals Scoping Study is presented as Appendix H. The aims of the study are to identify environmental and planning constraints that may be need to be taken into account during detailed design and subsequent project planning stages, and to identify the approvals and permits that will be required for the Project to proceed past design.

A desktop assessment and preliminary field survey were undertaken to determine existing environmental site conditions. The assessment of existing environmental conditions was then utilised in the review of legislative requirements and the identification of required approvals/permits.

GHD organised and attended a pre-lodgement meeting with key government departments, namely the Department of Infrastructure, Local Government and Planning, Department of Environment and Heritage Protection and the Department of Agriculture and Fisheries. The meeting confirmed the findings of the Study, with emphasis on the following:

- Any environmental/planning applications made will require justification and a detailed review of options considered during design
- The status of the land tenure, i.e. when a road reserve is dedicated, may impact upon the approvals required
- Approvals for any temporary works can be applied for before engagement of a Contractor, if the Contractor then wishes to alter the design of the temporary works a permissible change application can be lodged
- Legislative triggers and supporting information may be amended before construction commences.

### 4.2 Physical Environment

The Project involves construction of a bridge over the Boyne River, where the Boyne River is a major River and catchment south of Gladstone. The Boyne River at the project location is tidally influenced, dammed upstream by Awoonga Dam and is identified as part of the Great Barrier Reef World and National Heritage Properties. The Boyne River Bifurcation is also tidally influenced and due to its shallow nature, has mudflats and areas that may provide foraging for migratory birds.

Detailed design considered flooding and physical aspects of the area as applicable. During construction the Project will also require the development and implementation of management plans for the management of impacts, including erosion and sediment control and acid sulfate soils. The physical environment of the study area is further described within the Environmental Report included in Appendix H (sections 2.2 and 2.3). Further assessment to characterise the Boyne River or the Bifurcation are recommended, including water quality and acid sulfate soils.

### 4.3 Ecological Environment (Flora and Fauna)

The ecological environmental characteristics, flora and fauna, were assessed via desktop assessment and rapid field assessment techniques, refer to Appendix H (sections 2.5, 2.5 and 2.6). The key findings include:

- Regulated vegetation mapping is partly incorrect. While areas of remnant vegetation border the study area and may be impacted, no endangered regulated vegetation was identified;
- Land about Tannum Sands Road is mapped as essential habitat for the Koala (Lot 22). Further assessment may be required about the Tannum Sands Road intersection as design progresses (this is out of GHD's scope for these design works however).
- Due to site conditions it was determined that there is a low risk of encountering protected flora or fauna species, however special least concern flora species were identified in one location;
- Marine plants will be disturbed by the Project, including mangroves and saltmarsh species. Further field surveys to determine extent of impact will be required. The survey identified that the area of saltmarsh does not meet the conditions of the Threatened Ecological Community under the *Environment Protection and Biodiversity Conservation Act 1999*; and
- There was a high proportion of weed species in the study area and as such weed management will be a key concern.

### 4.4 Social Environment

The majority of the extent of works is within GRC owned land and partly follows the existing Pioneer Drive and access road to the Tannum Sands Wastewater Treatment Plant. It is anticipated that works will directly impact upon industrial areas near the intersection with Boyne Island Road and the Dennis Park Sports Complex. Indirect impacts associated with noise, vibration, visual amenity and air quality during construction and operation may be felt at a number of nearby sensitive receptors.

Therefore, it is recommended that further assessment of noise and vibration impacts be undertaken and management measures be implemented to minimise noise, vibration, visual amenity and air quality impacts during construction and operation. For further information refer to Appendix H (sections 2.1, 2.7 and 2.8).

### 4.5 Cultural Heritage

A Cultural Heritage Assessment was undertaken by Converge Heritage + Community, refer to Appendix H. A subsequent letter was provided by Gidarjil Development Corporation Ltd (Port Curtis Coral Coast (PCCC)) confirming that works can proceed provided that mitigation measures are enacted. In summary, the Cultural Heritage Assessment recommended:

- The Project be split into three zones, where disturbed areas require implementation of a New Finds procedures, areas with some potential for finds have a member of PCCC present during initial ground disturbance, and areas unable to be surveyed due to poor conditions further surveys be undertaken.
- A formal cultural heritage agreement with the PCCC People be entered into as there are areas proposed to be disturbed that have limited evidence of past

disturbance. This has since been reviewed by PCCC and a MOU proposed an lieu for a formal agreement;

- Induction training be undertaken for all personnel that includes information pertaining to cultural heritage.

#### 4.6 Legislative Requirements

Following the assessment of existing site conditions, a review of legislative requirements was undertaken for the project. The review identified a number of permits and supporting information requirements that will be required for the Project. Key findings are summarised as follows:

- The works are located within the Coastal Management District, as such prescribed tidal works approval, removal of quarry material and disposal of dredge spoil are likely required under the *Coastal Protection and Management Act 1995*;
- Under the *Environmental Protection Act 1994* the removal of material from under water, for example for bridge piles/pylons may constitute an Environmentally Relevant Activity (ERA) for dredging and as such a Material Change of Use and Environmental Authority;
- The *Environmental Offsets Act 2014* may be applicable for the Project, further assessment, including development of an Offset Strategy has been recommended;
- Under the *Fisheries Act 1994* two approval requirements are triggered.
  - Due to the Boyne River and the Boyne River Bifurcation being mapped as tidal waterways, approval for waterway barriers will be required for the bridges. Construction works may also trigger the self-assessable code and/or further approvals for waterway barrier works.
  - Marine plants are present, mangrove and saltmarsh species, as such approval for the removal, damage or destruction of marine plants is required.
- It is unlikely that protected (endangered, vulnerable or near threatened) flora or fauna will be impacted by the Project and as such approval under the *Nature Conservation Act 1992* is unlikely to be required; and
- Exemptions for clearing regulated vegetation under the *Vegetation Management Act 1999* have been determined to be applicable for this Project.

The process for obtaining approvals including potential timeframes and supporting information requirements are outlined in Appendix H (sections 3 and 4). The advice provided is subject to change if legislation reform is undertaken.



# 5. Hydraulic Analysis

## 5.1 Background of Modelling

The existing URBS hydrology model used in the GAWB Awoonga Dam study has been extended to include the downstream catchments.

The existing cross sections from the previous Sunwater Dam Break and Flood Modelling Study (circa 2003) have been used as the basis for the establishment of the MIKE 11 (1D) design domain downstream of Awoonga Dam. As noted in the 20% design workshop, these cross sections are based on the original river bathymetry on the basis that no later bathymetric information is available. Although the GAWB model and associated hydrology is based on an Awoonga Dam FSL of RL 40m, the URBS model has been updated to account for an FSL of 45 m AHD.

GHD has constructed a 2D MIKE 21 model for a distance of approximately 2km upstream and 1km downstream of the proposed bridge crossings, as shown by the blue box in Figure 1 below. The 2D domain is based on the latest available LiDAR terrain model (2013) provided by GRC. The 2 models (MIKE 21 & MIKE 11) are dynamically linked.

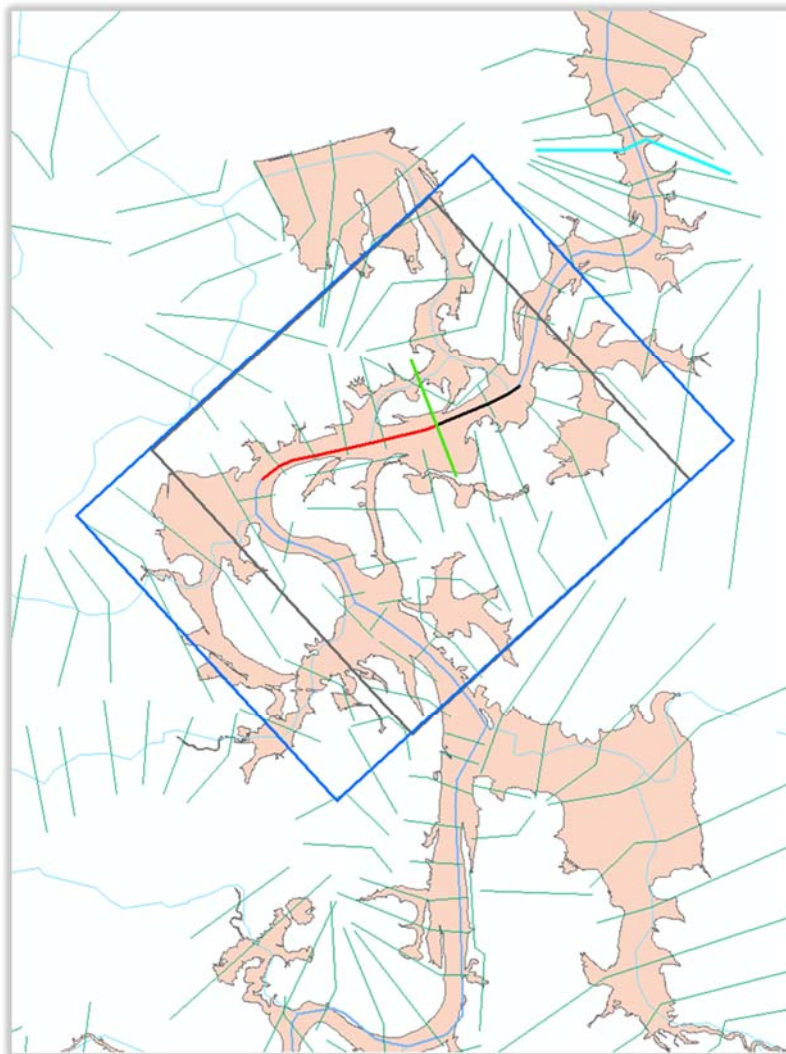


Figure 1 Extent of 2D Model Domain

Due to the availability of data there are anticipated to be limitations with the model and resultant outputs. A memo outlining the “Limitations and Assumptions” has been prepared and forwarded to GRC.

## 5.2 Validation

The model has been calibrated against the 2013 flood event (i.e available anecdotal flood level information).

Anecdotal evidence of water levels from the 2013 Flood Event has been gathered independently by GHD. Sources include:

- GAWB survey after the flood event, downstream of Awoonga Dam to Benaraby
- Actual water level surveys along Riverston Development provided by Devine Pty Ltd
- Numerous photos and meetings with local residents throughout the Boyne River catchment downstream of Awoonga Dam

## 5.3 Completed Works

### 5.3.1 Regional Flood Study

The following suite of requested flood exceedance probabilities have been modelled: 100%, 50%, 20%, 10%, 5%, 2%, 1%, 0.05% and 1% plus 20% increase in rainfall intensity in combination with the following tidal conditions:

- MHWS
- HAT
- Storm Surge

Discussion between GHD and Council confirmed that the PMF, SDF and DCF events are not required as these are more relevant to the dam break failure assessment.

### 5.3.2 Hydraulic Study

The proposed bridge structures, as outlined in Section 19 and Appendix G have been put into the model. The critical storm events for the key AEP's of 2%, 1%, and 0.05% has been simulated with the bridges to assess water levels and the associated afflux to identify any related issues.

The design report is complete and is located in Appendix N.

## 5.4 Remaining Works

All modelling is completed and hydraulic work required for the bridge designs has been completed.

GHD are currently completing maps etc to finalise the separate Regional Flood Study.

## 6. Geotechnical Investigation

The geotechnical investigation has two (2) components:

- Land based investigation for the roads – test pitting generally; and
- Drilling investigation over water and tidal areas for the bridges

Whilst the end Boyne Island Road and Tannum Sands Road TMR intersections are out of Design Scope, the geotechnical investigation has been extended to cover these areas.

The geotechnical investigations were carried out by Cardno Construction Sciences Pty Ltd between 9<sup>th</sup> December 2014 and 10<sup>th</sup> April 2015, with the final *Factual Geotechnical Investigation Report (2015)* delivered on 14<sup>th</sup> May 2015.

The geotechnical investigations carried out by Cardo comprised the following field work:

- 12 boreholes, including Standard Penetration Test (SPT) and undisturbed (U50) sampling at pier and abutment locations for the Bifurcation Bridge (BH01 to BH12)
- One borehole, including SPT and U50 sampling on the Boyne River Bifurcation (BH13)
- 16 boreholes, including SPTs and undisturbed (U50) sampling at pier and abutment locations for the Boyne River Bridge (BH14 to BH29)
- 13 geotechnical test pits (GTP1 to GTP13), target depth of 4.0m, with bulk samples and Dynamic Cone Penetrometer (DCP) testing adjacent to each test pit. Two scheduled test pits not carried out due to access issues (GTP14 and GTP15)
- 10 pavement test pits (PTP2 to PTP11) target depth of 1.5m, with bulk samples and DCP testing adjacent to each test pit. One scheduled test pit not carried out due to access issues (PTP1)
- Laboratory testing on recovered samples.

Geotechnical investigations were not carried out for the side roads being Dennis Industrial Access and Riverston Access. These areas will need further geotechnical investigation prior to the Project proceeding to construction.

The completed test pit and borehole details are summarised in Table 1 and Table 2. All locations are based on handheld GPS readings, with surface elevations estimated from topographic survey, (Accuracy +/-0.5m).

Table 1 - Summary of Geotechnical Boreholes

| Borehole ID        |      | Drilled Depth (m) | Surface RL (mAHD) | Bridge | Adjacent Pier/Abutment |
|--------------------|------|-------------------|-------------------|--------|------------------------|
| Bifurcation Bridge | BH1  | 26.1              | 3.52              | BR01   | Superseded Abut A      |
|                    | BH2  | 23.5              | 3.52              | BR01   | Superseded Abut A      |
|                    | BH3  | 25.0              | 1.94              | BR01   | Abutment A – Sth       |
|                    | BH4  | 20.95             | 1.94              | BR01   | Abutment A – Nth       |
|                    | BH5  | 20.7              | 1.645             | BR01   | Pier 1 – Sth           |
|                    | BH6  | 19.0              | 1.645             | BR01   | Pier 1 – Nth           |
|                    | BH7  | 20.15             | 0.44              | BR01   | Pier 2 - Sth           |
|                    | BH8  | 13.7              | 0.44              | BR01   | Pier 2 - Nth           |
|                    | BH9  | 11.85             | 2.56              | BR01   | Pier 3 - Sth           |
|                    | BH10 | 12.6              | 5.436             | BR01   | Pier 3 - Nth           |
|                    | BH11 | 14.6              | 5.73              | BR01   | Abutment B – Sth       |

|                    |      |       |       |                  |                  |
|--------------------|------|-------|-------|------------------|------------------|
|                    | BH12 | 14.5  | 5.733 | BR01             | Abutment B – Nth |
|                    | BH13 | 26.25 | 6.2   | Local depression |                  |
| Boyne River Bridge | BH14 | 26.5  | 7.7   | BR02             | Abutment A – Sth |
|                    | BH15 | 32.0  | 7.7   | BR02             | Abutment A – Nth |
|                    | BH16 | 19.1  | -0.89 | BR02             | Pier 1 – Sth     |
|                    | BH17 | 18.95 | -0.89 | BR02             | Pier 1 – Nth     |
|                    | BH18 | 19.56 | -1.88 | BR02             | Pier 2 - Sth     |
|                    | BH19 | 19.6  | -1.88 | BR02             | Pier 2 - Nth     |
|                    | BH20 | 17.7  | -1.92 | BR02             | Pier 3 - Sth     |
|                    | BH21 | 17.5  | -1.92 | BR02             | Pier 3 - Nth     |
|                    | BH22 | 15.75 | -1.91 | BR02             | Pier 4 - Sth     |
|                    | BH23 | 14.45 | -1.91 | BR02             | Pier 4 - Nth     |
|                    | BH24 | 12.0  | -4.38 | BR02             | Pier 5 - Sth     |
|                    | BH25 | 14.9  | -4.38 | BR02             | Pier 5 - Nth     |
|                    | BH26 | 6.6   | 0     | BR02             | Pier 6 - Sth     |
|                    | BH27 | 5.6   | 0     | BR02             | Pier 6 - Nth     |
|                    | BH28 | 12.0  | 8.65  | BR02             | Abutment B – Sth |
|                    | BH29 | 14.0  | 8.65  | BR02             | Abutment B – Nth |

Table 2 - Test Pit Summary

| Test Pit ID | Chainage (MCB1) | Surface RL (mAHD) | Termination Depth (m) |
|-------------|-----------------|-------------------|-----------------------|
| GTP14       | 0               |                   | #                     |
| GTP15       | 0               |                   | #                     |
| PTP01       | 40              |                   | #                     |
| GTP01       | 280             | 9.0               | 4                     |
| PTP2        | 310             | 7.2               | 1.5                   |
| GTP2        | 430             | 5.1               | 2.9                   |
| PTP3        | 560             | 5.4               | 1.5                   |
| GTP3        | 745             | 3.2               | 4                     |
| GTP13       | 820             | #NA               | 4                     |
| GTP4        | 850             | 5.3               | 4                     |
| GPT5        | 1025            | 6.7               | 4                     |
| GTP6        | 1370            | 7.8               | 4                     |
| GTP7        | 1980            | 14.0              | 2.4                   |
| GTP8        | 2125            | 8.2               | 4                     |
| GTP9        | 2380            | 7.8               | 4                     |
| PTP4        | 2630            | 6.6               | 2                     |
| PTP5        | 2870            | 6.7               | 1.5                   |
| GTP10       | 3030            | 5.6               | 4.0                   |
| PTP6        | 3235            | 5.8               | 1.5                   |
| PTP7        | 3470            | 8.0               | 1.5                   |
| PTP8        | 3790            | 9.9               | 1.5                   |
| PTP9        | 4090            | 16.1              | 0.9                   |
| PTP10       | 4400            | 14.7              | 1.5                   |
| GTP11       | 4834            | 13.2              | 1.7                   |
| PTP11       | 4834            | 13.2              | 1.5                   |
| GTP12       | 4834            | 13.5              | 2.5                   |

Note: # Test pit not completed

# 7. Geotechnical Design

Two geotechnical design reports have been prepared, and included in the Appendix I of this report. The topics covered in each report, and the status of the key design element including outstanding items is discussed below.

- Geotechnical Design Report - Appendix I (1)
- Bifurcation and Boyne River Bridges Foundation Design Report – Appendix I (2)

## 7.1 Specifications and Standards

Unless otherwise stated, the following order of precedence has been applied in the design:

- Department of Transport and Main Roads (TMR) Geotechnical Design Standard – Minimum Requirements, February 2015
- Department of Transport and Main Roads (TMR) Design Criteria for Bridges and Other Structures, August 2014
- TMR Technical Standards
- Australian Standards
- Standards Australia handbooks
- Other reference documents and standards

## 7.2 Geotechnical Design Report

The geotechnical design report presents the geotechnical design of all elements of the project except the bridge foundations, which are covered in a separate report. This report provides and interpretation of the site investigation data and summarises the detailed geotechnical design of embankments and drainage features, including assessment of unsuitable material, ground surface treatments and material re-use.

### 7.2.1 Geological Model

A geotechnical ground model has been developed for the project, with the encountered soil and rock classified into geotechnical Units, as summarised in Table 3. It should be noted that Units 1 to 4 are all from the same Quaternary age alluvial deposits and classification into differentiable units with differing geotechnical properties is difficult.

Table 3 - Geotechnical Units

| Geotechnical Unit | Description   |
|-------------------|---|
| Fill              | Clayey Sandy Gravel (FILL)  |
| Unit 1            | Silty Sand and Clayey Sand (Alluvium): Low plasticity, fine to coarse grained sand, loose.  |
| Unit 2            | Clayey Sand and Sandy Clayey Gravel (Alluvium) – Upper layer of coarse grained alluvial deposits, typically consisting of medium dense, fine to coarse sub-angular gravel, and fine to coarse sand with low to medium plasticity clay fines. Identified across both bridges |
| Unit 3            | Clay and Clayey Sand (Alluvium) - Low to medium plasticity, medium dense to dense, fine to coarse grained sand.   |
| Unit 3M           | Silty Clay (Marine Sediment) – Medium plasticity, firm clay with trace of fine sub-angular gravel.  |
| Unit 4            | Clayey Sandy Gravel and Gravelly Clayey Sand (Alluvium)- Low plasticity fines,  |

|         |  |
|---------|--|
|         | fine to medium gravel and fine to coarse sand  |
| Unit 5a | Residual Soil (RS) to Highly Weathered (HW) Siltstone. Very low to medium strength, highly fractured, some zones of high strength highly fractured |
| Unit 5b | Distinctly Weathered (DW) to SW Siltstone – High to very high strength, and moderately to highly fractured.  |
| Unit 6a | RS to HW Phyllite – Very low to medium strength, highly fractured with clay and quartz infill.   |
| Unit 6b | MW to SW Phyllite – Medium to very high strength, moderately to slightly fractured with clay and quartz infill in joints                           |

### 7.2.2 Embankment Slope Stability

In accordance with direction from Gladstone Regional Council, all embankments will be constructed with a batter slope no steeper than 1V:4H (for safety and to facilitate maintenance). There is insufficient cross sectional area to implement zoned embankments, so all road embankments will be homogeneous fill embankments constructed with Class A/B fill as per Table 14.3.1 of MRTS04, compacted to a minimum 95% relative compaction, with foundation treatment limited to the removal of all unsuitable material from embankment foundations to a subgrade of  $s_u > 50$  kPa.

Stability analysis of a representative embankment section (CH 1420) was carried using the limit equilibrium out using SLOPE/W 2007, with the Morgenstern-Price method of analysis adopted, as advised in the Geotechnical Design Standard. The modelled embankment satisfied all long and short term stability requirements; therefore it is reasonable engineering judgement to accept that all embankments for this project will satisfy stability requirements without the need for additional location specific analysis.

### 7.2.3 Cut Slope Stability

Cut batter slope of 1V:3H will be adopted for all cut slopes, primarily to reduce erosion and scour on cut faces rather than due to stability concerns. The only major cut is located between CH 1940 and CH 2060, with a maximum height of 3.6 m. The test pit at this location (GTP7) reached refusal at 2.4m depth, in DW rock, after encountering XW rock from 0.7 m depth. Engineering judgment indicates that cut slopes of 1V:3H in this material will be stable, and no additional slope stability assessment is required.

A steeper batter of 1:1 with 1:2 for the top 2m has been nominally adopted for the large cutting in the Dennis Access Road. There is currently no geotechnical information available in this area, thus further site geotechnical investigation is required to confirm, prior to construction.

### 7.2.4 Embankment Settlement Analysis

The geotechnical investigations did not identify any compressible material in the embankment foundations, including the bridge abutments and along the main alignment. Alluvial soils (Units 1 to 4) were predominately granular and medium density or stronger, with the finer grained Unit 3 typically stiff or very stiff. All settlement caused by embankment construction is expected to be immediate elastic compression and with no post-construction Primary or Secondary consolidation expected. No specific settlement analysis has been carried out.

### 7.2.5 Embankment Foundation Treatment

Foundation treatment beneath the embankments will be limited to stripping of topsoil, then removal and replacement of unsuitable material where encountered. Due to the site location in an alluvial flood plain the soils are variable in composition and strength topsoil generally described as clayey sand or sandy silty is present across most of the site, and an upper layer of

low plasticity silty sand / clayey sand (Unit 1) was also encountered across the site, particularly across the bifurcation island.

The current assessment of topsoil stripping depth indicates an average topsoil thickness of 200 mm across the site. The assessment of the suitability of topsoil for re-use has been completed.

Unsuitable material identified in the test pits is primarily very loose silty sand, with a major non/low plasticity fines component, and is primarily located across the Bifurcations and locally just east of the cut to the east of the Boyne River Abutment B. Based on the assessment a preliminary volume of 28,000 m<sup>3</sup> of Unsuitable material will require removal and replacement. Due to the volume and the cost of fill material in Gladstone, an assessment of the options for re-using this material through blending with imported fill or other methods has been considered, with a memorandum prepared looking at re-use options.

#### 7.2.6 Material Re-use

The only significant cut on site located between CH 1940 and CH 2060, with a maximum depth of 3.6 m. This cut is expected to produce some Unsuitable material from the upper layer, with the lower 2m in weathered rock that may produce some Class A /B type fill.

As mentioned in 7.2.5 a separate memorandum was prepared, presenting the findings of desktop study into options to allow the re-use of Unsuitable material. Options considered were:

- Onsite blending with imported fill to make a material conforming to MRTS04 (the project earthworks specifications).
- Material modification through blending with lime or cement.

It was concluded that that blending with suitable (Class B or better) imported material is the best identified option for re-use of the Unsuitable material encountered on site. A pug mill would be required to ensure thorough blending of the materials, followed by strict quality control testing of blended material would be required. The only area where stockpiling and blending could be carried out is on the opposite site of the Boyne River to the source of most of the Unsuitable material, so road transport and multiple handling operations would be required.

At the time of this desktop review, it is considered unlikely that blending is an economically viable option for the project, but this may change if imported fill prices increase, or additional laboratory testing including trials alters the assumptions made at the time.

#### 7.2.7 Acid Sulphate Soil Assessment

Testing for Actual Acid Sulphate Soils (AASS) and Potential Acid Sulphate Soils (PASS) was carried out as part of the geotechnical testing, with field and lab testing indicating localised low sulphide soils which may require lime treating. A detailed assessment and treatment plan has not been completed yet.

### 7.3 Bifurcation and Boyne River Bridges Foundation Design Report

This report presents the geotechnical assessment and geotechnical Detail Design of foundations for both bridges. This report covers the design of bridge pile foundations subject to general bridge loading. The design of all other bridge elements, including the structural design of the bridge foundations and geotechnical design of abutments and associated ground treatment are covered in separate reports.

### 7.3.1 Foundation Arrangement

The adopted substructure consists of two 1500 mm dia bored cast in-place piles with permanent steel liners. Piles will be socketed into the underlying weathered rock units, with the socket depth varying across the structures. Piles will be extended to the headstock as columns of the same diameter.

Due to the variable nature of the geology with deep alluvial gravels in places and shallow bedrock in places across both bridges bored piles were adopted as the lowest risk foundation arrangement. Driven steel tubular piles of the same diameter, with a steel driving shoe to improve driveability through the gravel layers are a valid alternative for the locations listed below, and may be considered in further detail by the construction contractor if it is considered reasonable to adopt differing foundation arrangements:

- BR01- Abutment A
- BR01 – Pier 1
- BR02 – Abutment A
- BR02 Pier 1 to 3.

### 7.3.2 Design Methodology

The detailed design for the piled foundation has been carried out in close interaction with the Structural Design Team. Geotechnical modelling of pile behaviour has been carried out using an upgraded version of the commercially available program DEFPIG (DEFPIG computer code that has been incorporated in Microsoft Excel spreadsheet, as well as additional features to model pile groups subject to bi-axial lateral loads and different pile types within a pile group; the new DEFPIG version has been verified with the analytical approach as described in Hull (2008)).

Specific ground models have been developed for each pier and abutment location based on the available geotechnical borehole data. The parameters for pile design, including shaft friction  $f_s$ , end bearing  $f_b$ , lateral yield pressure  $p_y$ , Young's modulus  $E_v$  for vertical loading and Young's modulus  $E_h$  for horizontal loading have been assessed based on the adopted  $s_u$  and  $\phi'$  for soils and unconfined compressive strength (UCS) for rocks via empirical relationships.

Pile socket lengths have been calculated for both axial load and lateral loads, with a minimum socket length of 2D adopted, except where very high strength rock (>75 MPa) is encountered and socket length may be reduced, at the geotechnical assessors discretion.

### 7.3.3 Bored Pile Design Results

The details of the bored piles are presented in Table 4 and Table 5.

Table 4 - Bifurcation Bridge Pile Details

| Location            | Pile Cut-off Level (mRL) <sup>1</sup> | Estimated Liner Length (m) <sup>1</sup> | Estimated Liner Level (mRL) | Estimated Pile Length (m) <sup>1</sup> | Estimated Pile Toe Level (mRL) |
|---------------------|---------------------------------------|---|-----------------------------|--|--------------------------------|
| Abutment A          | 4.2                                   | 20.2                                    | -16.0                       | 24.2                                   | --20.0                         |
| Pier 1              | 4.2                                   | 18.2                                    | -14.0                       | 21.2                                   | -17.0                          |
| Pier 2 <sup>3</sup> | 4.2                                   | 18.7/10.2 <sup>3</sup>                  | -14.5/-6 <sup>3</sup>       | 21.7/13.2 <sup>3</sup>                 | -17.5/-9 <sup>3</sup>          |
| Pier 3 <sup>3</sup> | 4.3                                   | 6.7/4.7 <sup>3</sup>                    | -2.4/0.4 <sup>3</sup>       | 9.5/7 <sup>3</sup>                     | -6.9/-2.6 <sup>3</sup>         |
| Abutment B          | 4.6                                   | 5                                       | -0.4                        | 9.6                                    | -5                             |

Notes:1. Adopted pile cut-off level for each location, used to estimate pile and liner lengths, actual length varies for each pile



2. Socket length may be reduced to 1.5 m if Very High strength rock is encountered
3. Pier 2 and 3 pile details for South Bound/North Bound structures.

Table 5 Boyne River Bridge Pile Details

| Location            | Pile Cut-off Level (mRL) <sup>1</sup> | Estimated Liner Length (m) <sup>1</sup> | Estimated Liner Level (mRL) | Estimated Pile Length (m) <sup>1</sup> | Estimated Pile Toe Level (mRL) |
|---------------------|---------------------------------------|---|-----------------------------|--|--------------------------------|
| Abutment A          | 5.8                                   | 24.7                                    | -19.3                       | 28.3                                   | -22.9                          |
| Pier 1              | 5.8                                   | 17.7                                    | -11.9                       | 21.2                                   | -15.4                          |
| Pier 2 <sup>2</sup> | 5.9                                   | 18.4/21.8 <sup>2</sup>                  | -12.5/-15.9 <sup>2</sup>    | 21.4/24.8 <sup>2</sup>                 | -15.5/-18.9                    |
| Pier 3              | 6.0                                   | 19.9                                    | -13.9                       | 22.9                                   | -16.9                          |
| Pier 4              | 6.1                                   | 17.5                                    | -11.4                       | 20.5                                   | -14.4                          |
| Pier 5 <sup>2</sup> | 6.2                                   | 17.6/20.6 <sup>2</sup>                  | -11.4/-14.4 <sup>2</sup>    | 20.6/23.6 <sup>2</sup>                 | -14.4/-17.4 <sup>2</sup>       |
| Pier 6              | 6.3                                   | 6.3                                     | 0                           | 10.8                                   | -4.5                           |
| Abutment B          | 6.5                                   | 2.0                                     | 4.5                         | 6                                      | 0.5                            |

Notes:1. Adopted pile cut-off level for each location, used to estimate pile and liner lengths, actual length varies for each pile

2. Socket length may be reduced to 1.5 m if Very High strength rock is encountered

3. Pier 2 and 5 pile details for South Bound/North Bound structures

## 8. Traffic Analysis

Further detailed Traffic Analysis was removed from the scope of this design brief.

Council has instructed that the previous traffic numbers and analysis from the TMR Link Study (Rev B, dated July, 2012), be adopted for these detailed designs. These traffic parameters were summarised in RFI #004 as follows:

| Year                  | AADT  |  | %CV |
|-----------------------|---|--|-----|
|                       | Boyne Island Road to Industrial Precinct Access | Pioneer Drive Heidelberg Access to Tannum Sands Road |     |
| 2024 (opening year)   | 19,050 - 24,350                                 | 13,150 – 18,650                                      | 5.0 |
| 2044 (design horizon) | 34,450 – 41,000                                 | 25,935 – 32,600                                      | 5.0 |

The above traffic figures have been approved by GRC for the basis of these detailed designs. It is however acknowledged by Council that all traffic assumptions will be required to be revisited and designs altered accordingly prior to construction activities commencing.

These assumptions and associated issues have been added to the Project Risk Register. The need for further traffic studies at the time the Project is ready to proceed has been added to the Issues Register on Drawings 42-18562 – G-010, 011 and 012 on Appendix A.

## 9. Site Surveys

Survey was provided for the site by Fredriksen Maclean & Associates Surveyors which did not include data over Lots 22 and 23 at the Tannum Sands end due to legal access not available at the time of field survey work.

Whilst the Boyne Island Road and Tannum Sands Road TMR intersections are out of Design Scope, the surveys cover these areas.

Further survey will be required prior to construction of the project to confirm the design in the areas listed in Table 6 below. This is required as Lidar survey information had to be relied on in these areas due to survey being deficient

Table 6 Areas requiring additional survey

| Control Line & Chainage   | Location                              | Description  |
|---------------------------|---------------------------------------|--|
| MC40 – Ch 87.00 - 185.064 | Industrial Access                     | Private property requiring survey (Lot 32 RP 615071)   |
| MC20 – Ch 218.00– 280.238 | Riverstone Rise Access                | Extent of design in this location shown as future  |
| MC60 - Ch 105.0 - 120.788 | Crematorium Access                    | Tie into existing access   |
| MC01 – Ch 4350 - 4600     | Main Alignment LHS<br>(Pioneer Drive) | Private property requiring survey for road design (Lot 23 RP 199256)   |
| MC02 – Ch 3500 - 4800     | Main Alignment RHS<br>(Pioneer Drive) | Private property requiring survey for service relocations and road design (Lot 22 RP 199256)                       |
| MC02 – Ch 1600            | Existing Gully RHS                    | Filling of existing gully extends approx. 170m to the west away from the road. Current design based on Lidar data. |

## 10. Design Vehicles

Both Boyne Island Road and Tannum Sands Road are currently designated as B-Double routes and as advised by Council Pioneer Drive is to be designed to cater for B-Double to provide a link between the two roads and improve access.

All intersections/accesses within the project are designed for a 19m semi with a check vehicle being a B-Double.

## 11. Road Alignment and Geometry

### 11.1 General

Proposed road alignment and geometry is illustrated on the Detailed Design Drawings included in Appendix A. These are generally based on:

- The layouts from the TMR Link Study (Revision B dated 04/07/2012);
- Amended as per suggestions from Road Safety Auditor;
- Functional Design Specification included in Appendix B; and
- Other general design developments throughout the Detailed Design Phase and progress workshops with Council.

Prior to construction and when the state controlled intersection design for both the Boyne Island Road and Tannum Sands Road are developed, further consideration will be required for the horizontal and vertical alignment at the connection to the intersections which will depend on the final form and geometry of the intersection. This will need to be undertaken in conjunction with the Department of Transport and Main Roads as the owner of the state controlled intersection

Minor changes to the vertical alignment have been made from the TMR Link Study with a major change between chainage 700 – 900 which seen the road height reduced which

- Significantly reduced the amount of fill required between the two sets of bridges on the island
- Reduced the impact and encroachments of the bridge spillthroughs on the waterways in particular Bifurcation bridge abutment B and Boyne River Bridge abutment A
- Facilitate removal of a span from the Bifurcation Bridge.

Changes the road grading at this location also considered the required MSQ clearances to the navigable waterway and flood heights.

### 11.2 Superelevation

In accordance with Austroads Guide to Road Design Part 3 Section 7.8 and as adopted by the Department of Transport and Main Roads, adverse crossfall is suitable for horizontal curves R900 or greater with 90km/h design speed and horizontal curves R300 or greater with a 70km/h design speed which has been adopted in this project. Adoption of adverse crossfall has also removed aquaplaning issues associated with the development of superelevation on flat grades.

The exception to this rule is the R268 horizontal curve located on the northbound carriageway, in a 60km/h speed zone at Ch. 4650. The R268 suits a design speed of approx. 65km/h with adverse crossfall and as it is located immediately after the turn off from Tannum Sands road. As the speed in this location is expected to be low with some acceleration following negotiation of

the intersection, perception of and negotiating the curve at an appropriate speed should be intuitive to the driver. Therefore it is considered that a design speed of 65km/h is acceptable in this location.

### 11.3 Vertical Grading at Change in Surfacing

At changes in surfacing from asphalt to bitumen seal interim asphalt ramps have been provided to allow a 50mm asphalt overlay over the bitumen seal in the future. The interim ramps ensure and the final desired vertical grading results at the time of overlay.

Vertical grading shown on the design drawings is to the future overlay surface.

# 12. Intersections

## 12.1 Scope

Council directed that:

- The TMR intersections with Boyne Island Road and Tannum Sands Road at either end of the project be removed from detailed design scope, with the extents of the project being Ch 186.813 – 4718.066 (MC01);
- Intersection layouts and locations as per the TMR strategic link study;
- One (1) concept intersection and cost estimates be developed for Boyne Island Road;
- Three (3) concept intersection and cost estimates be developed for Tannum Sand Road, and;
- Further traffic modelling of the intersections is not in scope.

The following intersections are included in the design scope. Key issues identified during the design are outlined below.

## 12.2 Existing Dennis Street – CH75

This intersection is to be closed and access to the existing industrial subdivision will be altered such that access to Dennis Street will be via a new link from a new intersection at the existing Dennis Sports park Complex access (Ch 300). The section of Pioneer Drive currently fronting the industrial subdivision is proposed be converted to a cul-de-sac service road with no direct access to Pioneer drive.

Provision of the Cul-de-sac is out of design scope and prior to construction when the state controlled intersection design for the Boyne Island Road are developed, further consideration will be required for the arrangement of this area which will depend on the final form and geometry of the intersection. This will need to be undertaken in conjunction with the Department of Transport and Main Roads as the owner of the state controlled intersection

## 12.3 Dennis Park/New Industrial Precinct Access – CH300

The existing access to Dennis Park is to be converted to a four way signalised intersection with the new western leg providing access to the existing industrial estate and potential future industrial land further to the west.

Following are outcomes of the Road Safety Audit (RSA) and various workshops with Council which have been incorporated into the intersection layout;

- Left turn anytime with care added to the entry into the Dennis Park Sports Complex
- Pedestrian crossing provided on the eastern leg (Dennis Park Sports Complex), western leg and the Southern leg of Pioneer Drive; and
- New access connection to existing Dennis Street from the new Industrial access road to be an unsignalised ‘T’ intersection with priority to the existing Dennis Street leg.

Vertical grading of the new link access road (Pioneer Drive to Dennis Street) indicates that steep grading is required with significant depth of cut to the west. On Council advice a 70kmh design speed has been adopted and used to set the vertical curve radius relative to intersection sight distances.

As the new road is intended to also provide access to a future industrial estate to the west as part of the Riverstone Rise development, a number of assumptions have been made with regard to the vertical grading and horizontal alignment as no information was available for the future development. Accordingly prior to construction Council will need to confirm the suitability of the design against development designs if available.

Depending on the form adopted for the state controlled intersection with Boyne Island Road, amendment to the intersection design may be required. Prior to construction when the state controlled intersection design for the Boyne Island Road is developed, further consideration will be required for the arrangement of this area. This will need to be undertaken in conjunction with the Department of Transport and Main Roads as the owner of the state controlled intersection

#### 12.4 Riverstone Rise / Crematorium Access – CH 750

The existing access to the Crematorium off Pioneer Drive will be a signalised 'T' intersection with the western leg forming the future 4 lane (Heidelberg) access into future stages of the Riverstone Rise Development.

Following are outcomes of the RSA and various design workshops with Council which have been incorporated into the intersection layout

- Left turn anytime with care added to the left turn onto Pioneer Drive;
- Pedestrian crossings provided on the northern and western legs; and
- Four lane design for Riverstone Rise Access to extend to immediately past the proposed Crematorium Access
- Two right turn lanes into Pioneer Drive reduced to one in accordance with the TMR strategic link study (additional right turn lane added in error during the 20% design)
- Riverstone access road radii increased to 200m on the north bound lanes to achieve 60kmh design and posted for Minimum radii with adverse crossfall.
- Curve widening provided for design 19m semitrailer
- 1.5m shoulder provided on left turn lanes due to expected high cycle uses
- Cyclist refuge added to shoulder to allow cyclist to stop and cross left turn lane and make a right turn onto Pioneer Drive.
- Riverstone access road realignment to be parallel to and be within Riverstone Rise property boundaries

As the new road is intend to also provide access to a future residential estate to the west as part of the Riverstone Rise development, a number of assumptions have been made with regard to the vertical grading and horizontal alignment as no information was available for the future development. Accordingly prior to construction Council will need to confirm the suitability of the design against development designs if available.

#### 12.5 Crematorium - CH 135 on Riverstone Rise Access

The crematorium access is located to connect onto the 4 lane Riverstone Rise access road as an unsignalised all movement tee intersection. This intersection has been moved west from the original TMR strategic link plans to provide improved geometry.

Following are outcomes of the RSA and various design workshops with Council which have been incorporated into the intersection layout

- Maximise the distance between Riverstone Rise signalised intersection and the Crematorium access (RSA); and

- Design the Crematorium access as a full intersection with a dedicated right turn lanes in and out. (GRC)

## 12.6 Sewerage Treatment Plant – CH 2130

All movement access is provided into the existing sewerage treatment plant (STP). Provision is made for a gravel access opposite on the southern side of the road into a future treatment plant expansion via shoulder widening. Access is also proposed to be utilised by Ergon for entry to the adjacent Ergon easement.

Access to the STP is designed to cater for 19m semi-trailer movements.

## 12.7 Roundabout – CH 3450

A dual lane 4 leg roundabout has been provided at this location to service the future sports park and provide a common access point for any future residential development to the north or south of Pioneer Drive.as well as provide access to the future Ergon Substation site.

Legs are design as short length stubs and a number of assumptions have been made with regard to the vertical grading, accordingly, prior to construction Council will need to confirm the suitability of the design against development designs if available.

Roundabout is located in an 80km/h posted speed zone therefore approach reverse curves have been provided on the eastern and western legs to reduce speeds prior to the roundabout. These have been signed in accordance with the latest advice in the Department of Transport and Main Roads Traffic and Road Use Manual.

## 12.8 Further Consideration by Council

It is recommended that prior to construction Council consider undertaking additional traffic modelling to confirm the form adopted for the intersections are suitable as well as carry out an options analysis to determine if the solutions designed are the best option.

This is particularly relevant to the new industrial estate access which could potentially have negative impacts on businesses within the estate. An options analysis would assist in determining if other suitable access arrangements are possible which reduce and/or remove negative impacts on the existing businesses.



# 13. Road Cross Sections

Type Cross Sections have been adopted for the projects – Refer to Drawing 42-18562-C010 to C013 in Appendix A.

These sections generally correspond with the proposed posted speed zones being:

- Urban Arterial – Existing Pioneer Drive between Boyne Island Road and south of the Boyne Tannum Memorial Parkland (Crematorium) intersection– 60km/h posted speed (70km/h design)
- Divided Rural Arterial - Pioneer Drive extension south of the Boyne Tannum Memorial Parkland (Crematorium) intersection to Tannum Sands Road – 80km/h (90km/h design).

Specific details for the various elements of the type sections are provided in the functional design specification included in Appendix B.

The proposed posted speed limits are shown on the Signage and Linemarking Drawings 42-18562-C600 to C067 in Appendix A.

## 14. Pedestrian and Cycle Pathways

In addition to the on-road cycle lanes, detailed designs provide for off-road shared pedestrian and cycleways.

The layout for these off-road shared pathways, generally follows the arrangement shown in Figure 12 from the TMR Link Study (Refer to Appendix A – Drawings), with the following clarifications or modifications as requested by Council:

- The main pathway follows the northern side of the south bound lanes (refer to drawings) for the full extent of Pioneer Drive;
- As per this alignment, only the south bound (downstream) bridges have a footpath for cycles and pedestrians (refer to sections in Bridge Report, Appendix G);
- Between the bridges, the pathway is elevated to the level of the main roadway, and will be separated from the road by a W-Beam safety barrier;
- At the Dennis Park (CH300) pedestrian crossings are provided on three legs and at the Crematorium signalised intersections (CH750) pedestrian crossings are provided on two legs,
- Away from the bridges to the south a separate off-road shared pathway will be designed/provided by council in the future and is currently not included in this design scope.

In the interim the shared path off abutment B of the Boyne River Bridge transitions to the 2.5m wide road shoulder.

# 15. Pavement Design

## 15.1 General

The pavement design has been developed in conjunction with Gladstone Regional Council. Full details of the pavement design are provided in the Pavement Design Report attached in Appendix J.

## 15.2 Design Traffic

Design Traffic has been calculated in accordance with Austroads methodology as detailed in Section 7 of 'Part 2: Pavement Structural Design' of the Austroads Guide to Pavement Technology (2012).

The design traffic (DESA) over a twenty (20) year design period for the various design sections is shown in Table 7.

**Table 7 Design Traffic Loading**

| Design Section   |  | Design Equivalent Standard Axle Loading (DESA) |
|--|--|--|
| Pioneer Drive and Pioneer Drive Extension                    | Boyne Island Road to Heidelberg Access<br>Ch 0 – Ch 750    | 8.18 x 10 <sup>6</sup>                         |
|  | Heidelberg Access to Tannum Sands Road<br>Ch 750 – Ch 4840 | 8.51 x 10 <sup>6</sup>                         |
| Boyne Island Road at Intersection of Pioneer Drive           |  | 2.33 x 10 <sup>7</sup>                         |
| Industrial Park Access                                       |  | 9.34 x 10 <sup>5</sup>                         |
| Sports Park Access   |  | 3.99 x 10 <sup>4</sup>                         |
| Riverstone Rise Access                                       |  | 6.87 x 10 <sup>5</sup>                         |
| Tannum Sands Road at Intersection of Pioneer Drive Extension |  | 3.07 x 10 <sup>7</sup>                         |

## 15.3 Design CBR

A design CBR of 5% has been adopted for all design sections.

Subgrade strength testing will need to be undertaken during construction to a depth of 1.5 m below the exposed subgrade material after the topsoil is removed. Testing will need to be undertaken by an approved geotechnical engineer and results confirmed by an RPEQ pavements engineer.

If the subgrade is found to have a CBR of less than 5%, a working platform of the thickness stated in Table 7 will need to be provided. Due to the majority of the works having a design level considerably higher than existing, the likelihood of a subgrade of low strength CBR not having enough cover over subgrade is low. However, a nominal amount for this subgrade treatment of a working platform will need to be allowed for in the tender schedule.

Table 8 Engineer Fill Improvement Layer Requirements

| CBR   | 1%  | 2%  | 3%  | 4% | 5% |
|---|-----|-----|-----|----|----|
| Required thickness of Working Platform (mm) | 500 | 200 | 100 | 0  | 0  |

## 15.4 Recommended Pavement Designs

### 15.4.1 Design Sections

Design Sections developed for Pioneer Drive and the Pioneer Drive Extension are summarised in Table 8. A summary of design parameters for the side road designs is also included in Table 9.

Table 9 Design Sections – Pioneer Drive and Pioneer Drive Extension

| Design Section | Surfacing Type | Chainage (m) | Description                        | Traffic Loading (ESAs) | Design CBR (%) |
|----------------|----------------|--------------|------------------------------------|------------------------|----------------|
| Section A      | Asphalt        | 0 – 750      | Start of road to Heidelberg Access | 8.18 x 10 <sup>6</sup> | 5              |
| Section B      | Asphalt        | 750-1080     | Heidelberg Access to first bridge  | 8.51 x 10 <sup>6</sup> | 5              |
|                |                | 1280-1680    | Between the two bridges            |                        |                |
|                |                | 1910-1967    | End of Second Bridge to Ch1967     |                        |                |
|                |                | 3234 - 3700  | Roundabout                         |                        |                |
| Section C      | Spray Seal     | 1967 - 3234  | Ch1967 to Roundabout               | 8.51 x 10 <sup>6</sup> | 5              |
|                |                | 3700 - 4840  | Roundabout to End of Road          |                        |                |

Table 10 Design Sections – Various Side Roads

| Road                   | Surfacing Type | Description                                      | Traffic Loading (ESAs) | Design CBR (%) |
|------------------------|----------------|--|------------------------|----------------|
| Boyne Island Road      | Asphalt        | Adjacent Intersection of Pioneer Drive           | 2.33 x 10 <sup>7</sup> | 5              |
| Industrial Park Access | Asphalt        | Adjacent Intersection of Pioneer Drive           | 9.34 x 10 <sup>5</sup> | 5              |
| Sports Park Access     | Asphalt        | Adjacent Intersection of Pioneer Drive           | 3.99 x 10 <sup>4</sup> | 5              |
| Riverstone Rise Access | Asphalt        | Adjacent Intersection of Pioneer Drive Extension | 6.87 x 10 <sup>5</sup> | 5              |
| Tannum Sands Road      | Asphalt        | Adjacent Intersection of Pioneer Drive Extension | 3.07 x 10 <sup>7</sup> | 5              |

#### 15.4.2 Recommended Pavement Designs

The recommended pavement designs for each design section are summarised in Table 10 and Table 11.

Table 11 Recommended Pavement Designs – Pioneer Drive and Pioneer Drive Extension

| Design Section | Recommended Pavement Design  |
|----------------|--|
| Section A      | 50 mm DG14 (A5S)<br>10 mm Single Coat Spray Seal (C170)<br>AMC00 Prime<br>175 mm Cement Modified Type 2.1 Granular Material (Target 1MPa<UCS <2MPa)<br>150 mm Cement Stabilised Type 2.1 Granular Material (Target UCS 3.5MPa) |
| Section B      | 50 mm DG14 (A5S)<br>10 mm Single Coat Spray Seal (C170)<br>AMC00 Prime<br>175 mm Cement Modified Type 2.1 Granular Material (Target 1MPa<UCS <2MPa)<br>150 mm Cement Stabilised Type 2.1 Granular Material (Target UCS 3.5MPa) |
| Section C      | 14/7 mm Double Coat Spray Seal (S0.3B)<br>AMC00 Prime<br>190 mm Cement Modified Type 2.1 Granular Material (Target 1MPa<UCS <2MPa)<br>200 mm Cement Stabilised Type 2.1 Granular Material (Target UCS 3.5MPa)                  |

Table 12 Recommended Pavement Designs –Various Side Roads

| Design Section         | Recommended Pavement Design  |
|------------------------|--|
| Boyne Island Road      | 50 mm DG14HS (A5S)<br>160 mm DG20HM (C600)<br>SAMI (S4.5S Polymer Modified Binder)<br>AMC00 Prime<br>200 mm Cement Stabilised Type 2.1 Granular Material (Target UCS 3.5MPa)<br>10 mm Single Coat Spray Seal (C170)<br>AMC0 Prime<br>150 mm Cement Modified Type 2.1 Granular Material (Target 1MPa<UCS <2MPa) |
| Industrial Park Access | 50 mm DG14 (A5S)<br>10 mm Single Coat Spray Seal (C170)<br>AMC0 Prime<br>150 mm Type 2.1 Granular Material   |

| Design Section         | Recommended Pavement Design  |
|------------------------|--|
|                        | 225 mm Type 2.3 Granular Material  |
| Sports Park Access     | 50 mm DG14 (A5S)<br>10 mm Single Coat Spray Seal (C170)<br>AMC0 Prime<br>150 mm Type 2.1 Granular Material<br>150 mm Type 2.3 Granular Material  |
| Riverstone Rise Access | 50 mm DG14 (A5S)<br>10 mm Single Coat Spray Seal (C170)<br>AMC0 Prime<br>150 mm Type 2.1 Granular Material<br>215 mm Type 2.3 Granular Material  |
| Tannum Sands Road      | 50 mm DG14HS (A5S)<br>170 mm DG20HM (C600)<br>SAMI (S4.5S Polymer Modified Binder)<br>AMC0 Prime<br>200 mm Cement Stabilised Type 2.1 Granular Material (Target UCS 3.5MPa)<br>10 mm Single Coat Spray Seal (C170)<br>AMC00 Prime<br>150 mm Cement Modified Type 2.1 Granular Material (Target 1MPa<UCS <2MPa) |

# 16. Road Cross Drainage

## 16.1 Cross Drainage

As per TMR Drainage Manual and GRC requirements, cross-road Drainage has been designed for a Q50 rainfall event using a combination of hydraulic modelling software packages Mike 11 and Mike 21. (Refer to Functional Design Specification, Appendix B)

The stormwater drainage catchments contributing to the proposed cross road culverts are shown on Dwg 42-18562-C207 (Refer Appendix A)

A summary of the catchments and cross drainage are provided in below.

Table 13 Cross Drainage Parameters

| Chainage (MC01) | Catchment ID | Catchment Area (ha) | Q50 Peak Discharge (m <sup>3</sup> /s) | Existing Culvert | New Culvert        |
|-----------------|--------------|---------------------|--|------------------|--------------------|
| 487             | A2           | 14.4                | 3.95                                   | 2/900 RCP        | 9/600 RCP          |
| 768.5           | A3           | 5.8                 | 1.75                                   | Nil              | 1200 RCP           |
| 3190            | B1           | 139.7               | 16.3                                   | 4/1800x600 RCBC  | 15/1200 x 600 RCBC |
| 3504.711        | B2           | 4.0                 | 1.86                                   | Nil              | 3/600 RCP          |
| 3629            | B3           | 13.1                | 6.00                                   | 1350 RCP         | 5/1200 x 600 RCBC  |
| 3815            | B4           | 16.5                | 5.05                                   | 1800 x 600 RCBC  | 4/1200 x 600 RCBC  |
| 4671            | B6A          | 68.0                | 16.0                                   | Nil              | 13/1200 x 600 RCBC |

### 16.1.1 Alternative culvert configurations

During the constructability workshop Council requested GHD investigate alternative culvert options for the large culvert structures using deck planks, increasing the height and/or daylighting the culverts by breaking them through the median. These options were considered but not deemed viable for the following reasons:

- Breaking the culverts in the median would result in a safety hazard being created due to the headwalls being in close proximity to each other and within clear zones of opposing traffic. A drop in the median would also be required to meet the culverts invert levels.
- Due to the flat grades of the culverts breaking the culverts in the median will have an impact on head losses.
- Prohibitive cost of supplying and transporting deck units
- Increasing the height of the culverts will effect performance as the culverts are on flat grades and require head to drive the flow through the culverts. Allowable head heights are also fixed by the road levels and freeboard.

### 16.2 Catchment B5 – Ch 3845 -4200 (MC01) LHS

The road adjacent to catchment B5 is located in the natural gully and a defined drainage path is not present to convey water across the road from this catchment. Accordingly due to the limitations in the width to the adjacent property boundary, existing services and a restriction on land acquisitions from the adjacent lot, a catch drain above the table drain in this location is not

viable. In this design the table drain has been designed to cater for the Q50 runoff from the B5 catchment with rock protection provided to prevent scour in the table drain.

### 16.3 Gully Filling Ch 1550 RHS (MC01)

Between the bifurcation bridge and the Boyne River Bridge at approx. Ch1550 the road crosses a significant gully at an acute angle. The local catchment is relatively small with a Q50 peak discharge of 0.2m<sup>3</sup>/s.

Catering for the flow across the road at this location would require approx. 80m of small diameter pipe, under 5m of fill, with extensive outlet earthworks. To avoid such a structure the approach gully is to be filled and vegetated such that the flows will fall away from the road towards the Boyne River. Filling of the gully will also make it traversable for maintenance and Ergon access purposes.

Drawing No. 42-18562-C219 in Appendix A.

### 16.4 Combined Culverts at end of Project Ch 4650 - 4800

The existing scenario at this location is a combined catchment B6 & B6A of approx. 185ha with a peak Q50 flow of 56.7m<sup>3</sup>/s and existing 5/1800x600 RCBC located at Ch 4810. Review of the catchment suggests that the catchment is actually two catchments for which catchment B6A enters the road at Ch 4670 and flows longitudinally along the existing road to the culverts at Ch 4810, thereby combining into one catchment. Evidence on site and hydraulic modelling also suggests the road is overtopped at this point in large flow events

This design splits this catchment into two which reinstates the original flow paths, resulting in two large culverts structures being located in close proximity. With the catchment B6 culvert located outside the scope of work for this project.

Prior to construction and when the state controlled intersection design for Tannum Sands Road is developed, further consideration will be required for combining catchment B6A cross drainage structure with the structure for required for catchment B6. The viability of this will depend on the final form and geometry of the intersection. This will need to be undertaken in conjunction with the Department of Transport and Main Roads as the owner of the state controlled intersection.

### 16.5 Longitudinal Drainage

#### 16.5.1 General

Longitudinal drainage has been design to cater for the Q10 storm event with Q100 roadway capacity checks and/or overland flow paths provided.

#### 16.5.2 Medians

In locations where the rural depressed median drains are below 0.5% in grade a concrete invert Type 28 in accordance with TMR Standard Drawing No. 1033 has been provided.

#### 16.5.3 Connection to existing industrial estate system

A new longitudinal drainage network is required to cater for water captured by the new access road connecting to existing Dennis Street which connects into an existing system within the industrial estate development.

It has been assumed that the system has capacity based on minimal increase in the area contributing to the system. Accordingly no design check has been undertaken on the existing system which conveys stormwater through to Boyne Island Road cross drainage infrastructure.



Council to confirm if the existing system has been designed for a Q10 event.

## 16.6 Surface Drainage

### 16.6.1 Aquaplaning

Adoption of adverse crossfall on the horizontal curves has removed aquaplaning issues associated with the development of superelevation on flat grades.

Where superelevation has been applied on the approach curves to the roundabout at Ch 3450, aquaplaning has been assessed and comply with film depth requirements.

## 16.7 Subsoil Drainage

Subsoil drainage as per TMR Type B have been included under the kerb and channel at the extremities of the urban type cross section (60 posted speed zone).

Cross subsoil drains have also been provided at the interface of new and existing pavements and change of pavement types/depeths.

## 16.8 Culvert End Structures

Generally the road formation is low height and the embankment batters adopted are 1 on 6 for safety and maintenance reasons. A number of the culverts end structures require wingwalls which combined with the 1 on 6 batters results in undesirably long wingalls.

To reduce the length of the wings the wingwalls have been design based on 1 on 2 embankment batter slopes requiring localised embankment steepening to transition to the shorter wingwalls.

## 16.9 Table Drains

Due to the scouring nature of the existing materials on site, 2m wide flat bottom table drains are adopted to minimise the concentration of flows which would occur in a V drain or similar.

# 17. Road Lighting Design

The lighting design includes the intersections and lead in and out lighting on the through route as well as cross roads associated with the upgrade from chainage 150 to 4700.

Continuous through route lighting has not been provided for the entirety of the works, however provision has been made for lighting on bridges across the Boyne River and Boyne River Bifurcation and the road section in between if lighting is required for these sections in the future. Lighting in these areas have been detailed as rate 3 (owned and maintained by GRC) as Ergon do not offer the design and installation of lighting on bridges as the installation does not meet their standard detailing.

Joint use poles pits and conduits at signalized intersections have been specified where they coincide with traffic signal post locations, noting these lights will be provided from a separate rate 3 supply as per Ergon Energy's preferred arrangement

## 17.1 Technical Parameters

Lighting parameters have been determined as follows (noting Ergon Energy have not provided any design advice regarding rate 2 lighting provisions):

- General Lighting - Rate 2 (Ergon owned);
- Joint use Lighting - Rate 3 (GRC owned);
- Bridge Lighting – Rate 3 (GRC owned);
- Category V3 to AS/NZS 1158.1.1; and
- AS/NZS 3000.

Nominally 250W luminaires mounted on 10.5m tapered steel poles for a mounting height of 12m have been utilized to provide an optimum arrangement. Typically outside arrangement has been utilized, with single sided and inside arrangement in specific locations where required due to services and pedestrian footpath locations.

Intersections have generally been lit to a V3 category for AS/NZS 1158.1.1 with a minimum of 2 spacings of lead-in lighting. Minor entries have been provided with flag style lighting.

## 17.2 Coordination with Existing and Planned Ergon Overhead Relocations and Other Services

The road is largely in unbuilt areas, there however do exist service crossing both under and overhead and the lighting design will consider this in placement. Where rate 2 is approved by Ergon and co-location with existing Ergon infrastructure (eg shared poles) is possible and economical has been included.

Commonly due to the location of services (particularly overhead) and lighting performance requirements there will be either a need to underground the service or where not cost effective make dispensations to AS1158 and Austroad recommendations. These dispensations can include:

- Use of rigid poles in areas where frangible are recommended due to line clearance; and
- Increased luminaire spacing to meet overhead service clearance requirements.

### 17.3 Power supply

Lighting design drawings show indicative locations for point of supply for both rate 2 and rate 3 lighting. Final locations will require coordination with Ergon design team prior to construction of the road lighting system.

The proposed conduit routes to supply new road lighting equipment are indicatively shown on the preliminary drawings, however these will need to be confirmed by the Ergon design.

As a guide the process from application to installation of new infrastructure takes approximately 9 to 12 months, in this case much of the works are likely to depend on some part of the road construction being commenced or at least a detailed survey being completed. It is likely that the constructor will need to coordinate and grant access to the site for Ergon to undertake their works.

It is suggested that the civil works associated with the new road lighting including installation of conduits, pits and road lighting footings be built by the constructor to Ergon requirements, the details of which are to be confirmed with Ergon.

### 17.4 Existing Road Lighting Infrastructure

Where there is existing lighting along the route, if possible, this will be integrated into the new road lighting design.

# 18. Traffic Signals Design

Signals are provided at the intersection with Dennis Park and the new New Industrial Precinct Access (~CH300) and the Crematorium access intersection (~CH750).

Signals have been documented in accordance with relevant TMR Technical Standards and Austroads recommendations as appropriate.

As a traffic study has not been undertaken as part of the design works, phasing priority has been based on TMR standard phasing arrangements and StandardTRAFF implementation for diamond overlap and double diamond overlap where suitable.

No provision for CCTV has been included at this stage however where determined appropriate this may be incorporated.

No provision for ITS has been included at this stage however where determined appropriate may be incorporated.

## 18.1 Electrical Coordination

Where appropriate, lighting and signals have been coordinated to include the use of shared pits and poles.

It is proposed that the point of supply for each of the signal controllers be separate from lighting in accordance with the TRUM. No response has been provided from Ergon at this stage. It is anticipated that Form A's will be submitted by the installation contractor (as part of the construction contract) to effect this requirement for independent signal controller connection. Preferred point of supply locations have been detailed on the traffic signals drawings.

## 18.2 New Industrial Precinct Access Signals

The design for the industrial access intersection is based on standard TMR phasing arrangements. Overhead 300mm aspects have been provided in primary signal post locations on the main Pioneer Drive through route. Advanced loop detectors are provided on Pioneer drive for both through lanes, and presence detection located on all other approaches. Push buttons are provided for the bike lane on the Western approach. Count loops are provided on all exits for interface with STREAMS.

## 18.3 Crematorium Access

The design for the Crematorium access intersection is based on standard TMR phasing arrangements. Overhead 300mm aspects have been provided in primary signal post locations on the main Pioneer Drive through route. Advanced loop detectors are provided on pioneer drive for both through lanes, and presence detection located on all other approaches. Push buttons are provided for the bike lane on the Western approach. Count loops are provided on all exits for interface with STREAMS.

## 18.4 Communications Connection

Connection of network communications for the interfacing to the STREAMS network will need to be determined during prior to construction, and will depend on the level of infrastructure near each of the intersections mentioned above. Wireless connection methods may be considered in lieu should a physical connection not be available.

# 19. Safety Barrier System

## 19.1 General

Road safety barriers in the form of W-Beam guardrail with Thrie Beam connections to the bridges have been provided to:

- Protect pedestrians and cyclists on the shared path located adjacent the roadway between the bridges within the 80km/h speed zone
- Shield 1 on 2 embankment batters on the approach to the bridges
- Shield spillthrough protection and batter slope between the bridges
- Restrict public access to the island area either side of the roadway between the bifurcation and Boyne River bridges to remove safety issues associated with traffic entering/exiting the roadway, slowing/stopping in the 80km/h posted speed environment,

Outside of the areas mentioned above the batters adjacent the road are 1 on 6 in table drain or low embankment situations and 1 on 4 at embankments higher than 1.5m. These slopes are deemed to be traversable/recoverable and don't require consideration of guardrail.

Assessment on the need for barriers at major culvert end structures has been determined using the TMR RISC program which provides a benefit cost ratio (BCR) based comparing the cost, probability and severity of an accident against the costs of installing, maintaining and crash repairing guardrail installed to shield the culvert headwall. BCR's of zero resulted with no guardrail required.

## 19.2 Maintenance Access Ch 1375

The inclusion of guardrail both sides of the roadway between the Bifurcation Bridge and the Boyne River Bridge results in access to the adjacent island area being blocked for emergency and maintenance access due to the tidal nature of the bifurcation.

To provide access breaks in the guardrail have been provided together with removable/lockable bollards at the location where the road embankment height is minimal and the batter are traversable. An area is also provided in front of the guardrail break for vehicles to pull off the road to allow removal of bollards and subsequent access.

Refer Drawings 42-18562-C507 & C508 in Appendix A.

## 20. Signage and Linemarking

Signage and pavement marking has been provided in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) and the Department of Transport and Main Roads Traffic and Road Use Manual (TRUM)

Guide signage and pavement marking has been included on the drawings however as these have been developed in isolation to the designs for the state controlled intersections at either end of the project. Prior to construction reassessment of the signs and pavement marking will be required to ensure they complement that designed for the intersection with Boyne Island Roads and Tannum Sands Road.

Guide signage for the roundabout at CH 3450 doesn't include destination names for the northern and southern leg which will require reassessment prior to construction.

# 21. Land Acquisitions

## 21.1 General

Land acquisitions will be required from a number of freehold, leasehold, easements and Council owned properties throughout the project for the purpose of road reservation.

The land acquisitions areas required are shown on Drawings 42-18562-SK210 to SK216 (Refer Appendix A). It should be noted that these drawings do not form part of the project construction documentation and are provided for the purpose of allowing Council to undertake consultation and/or negotiation with the various land holders. No consultation has been undertaken by GHD with affected land holders. The drawings are not intended for use in the official process of acquiring the land, full cadastral surveys should be undertaken to determine the actual boundary locations and land requirements for this purpose.

A summary of the land acquisitions required is provided in Table 14 below.

Table 14 Land Acquisitions

| Lot Description   | Tenure   | Owner   | Approximate Total Lot Area (ha) | Approximate Area Required (ha) | Approximate Area Remaining (ha) |
|-------------------|----------|---------|---------------------------------|--------------------------------|---------------------------------|
| Lot 32 RP615071   | Freehold | Private | 0.425                           | <b>0.425</b>                   | 0                               |
| Lot 1 RP614595    | Freehold | Private | 4.550                           | <b>0.901</b>                   | 3.649                           |
| Lot 1 RP612614    | Freehold | Council | 17.272                          | <b>1.374</b>                   | 15.898                          |
| Lot 9502 SP260470 | Freehold | Private | 54.400                          | <b>1.309</b>                   | 53.091                          |
| Lot 35 CTN1238    | Freehold | Council | 57.282                          | <b>8.250</b>                   | 49.032                          |
| Lot 21 SP252843   | Freehold | Council | 318.400                         | <b>20.838</b>                  | 297.562                         |
| Lot 22 SP199256   | Freehold | Private | 872.310                         | <b>2.741</b>                   | 869.569                         |
| Lot 23 SP199256   | Freehold | Private | 58.190                          | <b>0.188</b>                   | 58.002                          |

Notes:

1. Title searches or names and addresses have not been determined for the project
2. Easements in favour of Ergon are present in some of the lots and land acquisitions which will need to be extinguished as part of the land acquisition process.
3. Lease arrangements over Council owned lots will need to be considered as part of the land acquisition process.
4. Various lots at either end of the project will require additional and/or new land acquisitions as part of the intersection designs on the state controlled road. Further consideration will need to be given to this when the design are completed in the future. Land acquisition area shown in the table above only cover this project only.

## 21.2 Basis of Road Reservation Width

Generally the road reservation width has been determined based on providing 5m clearance from the toe/top of earthworks batters for provision of maintenance access, services, catch drains etc. or a minimum reserve width of 60m as advised by Council.

Where the road reservation width is driven by earthworks batters the boundary alignment has been rationalised to provide reasonably long straight lengths, minimise large angle changes and short chord lengths for fencing purposes as well as considering aesthetic and practical use of remaining land.

### 21.3 Council Considerations

Should land acquisitions not be carried out in the near future, prior to construction of the project Council will need to confirm the lot descriptions, tenure and areas are still applicable.

For the purpose of this design it has been assumed that all land acquisitions and associated works such as building removal etc. will be undertaken by Council prior to construction of the project.

Land acquisitions shown are for this project only. Prior to construction and when the state controlled intersection design for both Boyne Island Road & Tannum Sands Road is developed, further consideration will need to be given to the land acquisition requirements which will depend on the final form and geometry of the intersection. This will need to be undertaken in conjunction with the Department of Transport and Main Roads as the owner of the state controlled intersections. Accordingly additional land may be required from the properties in the vicinity of the intersections at either of the project.

### 21.4 Lot 1 RP614595

Land acquisitions shown for this lot do not fully contains the road design accordingly the earthworks batters encroaching into the property. Council requested this be the case and discussion will be held with the land owner with regard to future development of the lot and how it will merge into the road design.

### 21.5 Lot 1 SP252843 – Future Ergon Substation Site

Road design earthwork table drain associated with the southern leg of the roundabout at this location encroaches into the property on the eastern side of the lot. Ergon advised this to be acceptable and they will also use the drain in the future for drainage of the site.

### 21.6 Lot 22 SP199256

Along the northern boundary of lot 22 SP199256 a 20m strip of land exists which is landlocked by an Ergon easement which traverses through lot in an east west direction.

This strip of land will need to be acquired for the purpose of relocating the existing 450 dia. water main and 180 dia sewerage rising main which is located under the new northbound carriageway of the road.

The 20m strip of land is relatively unusable for any future development and acquiring the land will place the Ergon easement directly adjacent the road reservation.

## 22. Road Safety Audit

### 22.1 Road Safety Audit – Concept Stage Review

An initial high level road safety audit (RSA) was carried out on the Concept Layouts in the TMR strategic link concept design to identify potential issues. A number of matters were identified. Some included:

- Horizontal curves superelevation combined with very low grades may cause aquaplaning issues;
- Adjustments to the proposed intersection to the Sewerage Treatment Plan, including visibility and acceleration deceleration lengths;
- Crest curve overlapping with the bridge;



- Some crest curves and distances between reverse curves too short for the design speed; and
- Other adjustments, predominantly at the intersections, as listed in Section 10

## 22.2 Road Safety Audit – Detailed Design

A detailed design RSA has been completed as attached in Appendix .

Where applicable issues raised have been addressed and adjustments made which are reflected in the Detailed Design Drawings in Appendix A.

Issues raised that have not been addressed have been responded to as listed in the RSA report.

## 23. Boyne River Bridges

### 23.1 Bridge Summary

GHD has completed a conceptual design of the Hoddinott Bridges over the Boyne River and the Bifurcation and then progressed this to detailed design based on the approved concepts.

GHD, through value engineering identified the potential design options, then completed a qualitative comparison of the various options to arrive at a preferred solution that:

- Satisfies the functional design requirements;
- Is aesthetically acceptable to Council;
- Utilises industry standard construction techniques; and
- Represents the best value for money.

### 23.2 Bridge Superstructure

The bridges have been designed with the use of 35m 'T' Roff precast concrete girder construction. The typical girder cross sections of each bridge have been standardise to essentially yield the same bridge cross section.

The girders will have a composite cast in situ deck poured over them to tie them together and form the deck surface. It is envisaged that the deck will have a minimum thickness 70mm asphaltic wearing course applied over.

### 23.3 Bridge Substructure / Foundations

Two options were considered for the bridge substructure:

- The bridge substructure can be constructed using a pile cap and concrete piers to headstock level. This allows the piers to be constructed to any reasonable shape and may have greater aesthetic value; and
- The second option is to extend the piles right up to headstock level with no pile cap. This solution is easier to construct and thus represents better value for money and is preferred.

The three options for the bridge foundations were considered:

- Driven concrete piles would be an option but these will only penetrate into the gravel layers and may not be able to be driven deep enough to withstand the bridge loads;
- Bored piles would be preferred as these can be bored down to the expected level of the rock and socketed into the rock. Boring through gravels will require the pile shafts to be lined; and
- A third option was considered, that of driven steel tubes. The steel piles can be driven to the rock and then bored out internally. The steel lining will be cut off at river bed level leaving a formed concrete pier rising to headstock level.

Consideration was given to a number of facets of the design including constructability. The resultant outcome was the adoption of driven steel tubular piles and then construction of continuous single piles up the headstock level with a full height permanent steel liner.

Two columns / piles will be adopted per headstock per bridge.

## 23.4 Bridge Barriers

Bridge traffic barriers are provided along the edges of structures for protection of vehicular traffic, pedestrians and cyclists, and containment of errant vehicles within the bridge carriageway, as appropriate. Reinforced concrete barriers have been adopted as requested by Council.

The construction of bridge barriers is dependent on the required barrier performance level. The procedure follows a selection method based on the AASHTO Guide Specification for Bridge Railings procedure with minor modifications for local Australian data and traffic conditions. This selection method leads to a recommendation for low, regular or medium performance level barriers.

The concrete barriers have been designed on that basis.

## 23.5 Bridge Lighting

Bridge lighting, has been typically detailed with a cantilever mast supported off the internal bridge barriers. The posts are located near to headstocks to prevent any undue deflection from bounce in the girders under traffic.

## 23.6 Bridge Drainage

The Hoddinott Bridge roadway has a single cross fall of 3% to the outside of the carriageway and has a vertical grade of 0.3%. Due to the individual bridge lengths of 140 metres and 245 metres it is not viable to drain the surface water via excess capacity in the roadway shoulders. Therefore, bridge deck drainage has been provided at nominally 3.5m centres. These scuppers drain directly to the water way below.

The shared path has also incorporated scuppers at 3.5m crs.

The downstream ends of the bridges will incorporate a kerb inlet to cater for higher intensity rainfall events.

## 23.7 Abutment Protection

Spill through sloped embankment protection is proposed at all abutments. The face grouted rock protection will be engineered to offer embankment scour resistance for up to 100 year ARI flood events and detailed in accordance with the TMR standard detailing practices.

## 23.8 Bridge Elements Durability and Service Life Criteria

The expected design life requirements for bridge components are listed in Table 15, and are based on the requirements from Clause 3.7.1. of *Design Criteria for Bridges and Other Structures (TMR, June 2012)*.

Table 15 Expected design life of components

| Component   | Expected minimum design life (years) |
|---|--------------------------------------|
| Bridge works  | 100                                  |
| Retaining walls   | 100                                  |
| Steel traffic barriers, balustrades and bridge safety rails       | 50                                   |
| Elastomeric bearings and neoprene strips, expansion joint housing | 40                                   |
| Rubbers in expansion joints                                       | 20                                   |
| Light poles on bridge   | 50                                   |

|  |    |
|--|----|
| Paint finishes to wall                                   | 30 |
| Protective coatings to steelwork (excluding galvanising) | 25 |

### **Design life definition**

Clause 3.7.1 of *Design Criteria for Bridges and Other Structures (TMR, June 2012)* defines the design life as follows:

*The design life shall be interpreted so as to provide a probability of 95 % that during the design life the structure or element:*

- *Will not require major maintenance or replacement of elements*
- *Will be fully functional*
- *Will require minimal maintenance*
- *Will blend and harmonise with the existing surrounds and planned landscaping*

*For steelwork, surface coating shall be considered from:*

- *Minimum cost for whole of life perspective availability*
- *Permitted hours of road closures on repainting including due point.*

### **23.9 Further Clarification**

The design of the bridge elements will be progressed to construction issues, however a number of assumption's and key considerations have been made during the design process. These assumptions and key considerations will need to be tested, resolved and agreed prior to the commencement of tendering of the works for construction.

The considerations are as follows:

- Bridge Piers have not been designed to cater for barge impact
- Maritime Safety Queensland's requirements have not been considered at the moment and will need to be once they provide their review comments to a formal Application
- The number and extent of services that are supported under the bridge will need to be confirmed and planned.
- The design of the services need to be carried out by suitably qualified engineers while considering the interaction with the bridge structure
- Envelopers under the relieving slabs need to be considered as being sufficient and complete for the proposed future services.

## 24. Constructability

### 24.1 Background

The Constructability Review was undertaken for the 80% detailed design of the Boyne Island 2nd River Crossing (Hoddinott Bridge). The Constructability Report in Appendix K considers only the scope of the project that has been designed by GHD in 2014/15. It is limited to the chainages nominated on the drawings (GRC scope) and the 4 lane configuration. An initial review was undertaken based on the Design Drawings provided to the reviewer in late June 2015. Subsequent to this initial review, a Constructability Workshop, was held in Gladstone on 30 June 2015. The completion of the constructability review is currently being completed on these 100% detailed design documents and will be finalised next week. The outcomes of the Constructability review are provided in the Report contained in Appendix K.

### 24.2 General Considerations

The project can generally be considered as a 'greenfield' site, with very little consideration needed in order to cater for public traffic. The only provisions needed for public traffic during the course of the construction, will be the access to the sporting complex, STP and Crematorium. There may be a future requirement to permit access from the adjacent residential area (Riverstone Rise), through the crematorium intersection, however this has not been considered in the review. The current configuration of the 4 lane design is very suitable for maintaining access during construction, as one of the carriageways overlays the existing access roads. This will make it easier to sequence the works by building one carriageway and then the other, over the footprint of the existing access.

### 24.3 Program

A construction program has been developed (refer Appendix L). This indicates a construction period of 17 months.

### 24.4 Outcomes

The outcome of the Constructability Workshop, was that all parties agreed that the construction of the project was feasible within the identified constraints of the site. Detailed consideration was provided on a number of aspects of the project, and this has now been incorporated into this 100% project documentation.

# 25. Risk Management

## 25.1 Introduction

Ultimate success of this project, as stated in GHD's Proposal for the Boyne Island Second River Crossing, will be measured upon the team's ability to deliver within the desired timelines whilst working closely with Gladstone Regional Council (GRC) throughout the project. Working within timelines requires foresight of potential occurrences that could delay the project in any way, and management of these occurrences in order to mitigate their effect. As requested GHD undertook a collaborative investigation with GRC to determine the viable risks associated with the construction of Hoddinott Bridge that comprises of the section of Pioneer Drive extending from CH 186 to CH 4718, Boyne Island Road and Tannum Sands Road respectively. These works include provision of a new bridge, section of road realignment and intersection works at chainages 285, 760 and 3450.

## 25.2 Methodology

Established risks were listed coinciding to the construction of these predetermined works and measured according to the likelihood and consequence of their event. The product of this was a Risk Register that complied with *AS/NZS ISO 31000:2009, Risk Management- Principles and Guidelines*, (Appendix E). The register outlays 70 risks to date that have been noted, a number that will develop the further we advance through the project due to inputting factors, further awareness and greater degree of certainty. The risks were categorised according to their relevance, Political, Financial, Stakeholder, Project Management, Design/Technical, Environmental, Safety, Tender and Construction, descriptions of each category can be seen in Table 1 of Appendix E (Risk Report and Risk Register).

The Report covers the basis and methodology behind establishing the Risk Register and summarises the current results. The risk assessment was undertaken on the basis that the establishment and analysis of such risks associated with Hoddinott Bridge development was selective not exhaustive using the knowledge and understanding available at that time of risk determination by GRC and GHD collaboratively. The methodology adopted aligned with that of clause 5. *AS/NZS ISO 31000:2009, Risk Management- Principles and Guidelines* (section 2.0, Appendix E- Risk Report). This provides a gateway approach to establishing the risks from establishment to treatment and monitoring, see Figure 1 Appendix E (Risk report).

## 25.3 Risk Assessment

The two main criteria used to quantify the risks were consequence and likelihood, Table 3 and Table 4 respectively in Appendix E (Risk Report) which utilised ratings and classifications. Using the table's descriptive classification to determine scale along with the associative risk rating system that suggested resulting actions, Table 4, Appendix E (Risk Report), a risk resultant was able to be established for that event. The next task was to propose mitigated measures to reduce the severity of this risk and result in a predetermined residual risk that will be evident if the suggested action/s were undertaken. From the register it was established that 47 residual risks remained within the 'Moderate' to 'High' range with only 4 holding a 'High' status, Table 5, Appendix E (Risk Report). These greater residual risks will require continual observation and re-evaluation as Project develops,

## 25.4 Work Status

The Design Group met with the Project Risk and Cost Managers and reviewed the preliminary risk ratings and proposed risk mitigation measures. Risks have been separated into Planned and Unplanned Risks. Where possible to do so, estimates have made of costs and likely range of costs associated with the risks. Based on this 100% documentation, this information is now being input into the Project P90 Cost Estimate to develop a Risk-Adjusted Total Out-turn Project Cost next week.

## 26. Estimate of Costs

An initial high-level Strategic Cost Estimate was prepared for the 80% Workshop. This is presented below in Figure 2 and indicates an initial over-arching project cost of \$170M.

Figure 2 – Cost Estimate to Date

| Cost Estimate to date  |                                  |
|--|----------------------------------|
| <p><b>Below is a high level draft P90 estimate (inclusive of escalation, risk and contingency) for the preferred alignment, based on the defined scope as of July 2015. This cost estimate will be refined progressively as a more detailed understanding of the project is developed.</b></p> |                                  |
| Date   | Amount (Strategic estimate only) |
| 30/06/15 (Total out-turn cost - total project)   | ~\$170M (2015 \$'s)              |
| Boyne Island Intersection (ultimate)   | ~\$35M (2015 \$'s)               |
| Pioneer Dr and Hoddinott Bridges (4 lane)  | ~\$120M (2015 \$'s)              |
| Tannum Sands Intersection (2 lane roundabout)  | ~\$15M (2015 \$'s)               |

This high-level Strategic Cost has been progressed to include refinements to the above costing which include:

- Updates to include latest design documentation

Below the line costs will be itemised and estimated by Council. (In the initial estimate above, below the line costs are estimated by a simple global percentage markup.)

- Incorporate actual quantities taken from these detailed designs and
- Include Planned and Unplanned Risks estimated from the Risk Register and “@Risk” Monte Carlo analysis.

This formal P90 Cost estimate will be prepared next week .



# Appendices

# Appendix A – Design Drawings

# Appendix B – Functional Design Specification (FDS)

# Appendix C – Design Decisions Table

# Appendix D – Road Safety Audit – Detailed Design

# Appendix E – Project Risk Report and Risk Register

# Appendix F – Public Utility Plant (PUP) Report

# Appendix G – Bridges Report



# Appendix H – Environmental and Cultural Heritage Reports

# Appendix I – Geotechnical Design Report

# Appendix J – Geotechnical Bridge Foundation Report

# Appendix K – Pavement Design Report

# Appendix L – Constructability Report

# Appendix M – Construction Report

# Appendix N – Hydrology and Hydraulics Report





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