John Gorton Drive Stage 3C

Preliminary Sketch Plan Design Report

IA216800.-RP-RD-125_RevA_Final PSP Design Report | Rev A

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Infrastructure Delivery Partners Group

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Executive Summary

The following report documents the Preliminary Sketch Plan (PSP) of the John Gorton Drive Extension Stage 3C (JGD3C) and the Molonglo River Bridge. This report will serve as a source document for the Molonglo River Bridge and JGD3C in future delivery stages. The PSP design is focused on mitigating the risks associated with the next stage of commission, the Design & Construction (D&C) phase. This includes, but is not limited to, undertaking detailed geotechnical investigations, obtaining the relevant environmental approvals and gathering in principle approvals, where possible, from utility authorities.

A summary of the key design elements from the PSP Design are outlined below:

Road Design

The horizontal geometry of the alignment has remained consistent to the 2018 Jacobs Concept Design, with the continued emphasis to minimise the impact on the surrounding environment. The vertical geometry is consistent with the Concept Design which has fixed constraints of both the JGD2A and JGD3B projects that form the tie-in points. The cross-sectional properties adopted during the Concept Design phase of the project have been altered slightly. The verge width on both carriageways has been widened to match the JGD3B 10m verge, transitioning to an 8m verge at the tie-in with JGD2A. The rationale behind this, is to allow adequate width for provision of the utility corridor over the length of JGD3C. The transition distance from the 10m verge to an 8m verge occurs over 150m.

The road alignment has a consistent 12m median which is future-proofed for light rail. During the PSP, it was confirmed by TCCS and Roads ACT that the right-turn lanes at both the Molonglo Town Centre (MTC) intersection and Sculthorpe Avenue will be designed inside the 12m median. The Sculthorpe Avenue longitudinal gradient has been designed to avoid a vertical design change along the JGD3C main alignment, which is constrained by the close proximity of the tie-in point with JGD3B.

Investigations into a left-only local road access to the south-eastern side of the bridge before the MTC intersection, and the emergency/maintenance vehicle gated access to the existing Coppins Crossing road alignment along the northbound carriageway of JGD3C, have been captured in the road design section of this report.

The clear zone on JGD3B is aligned to an 80km/h design speed and 70km/h design speed respectively. JGD3C forms the missing link between the JGD2A and JGD3B projects, leading Jacobs to adopt a conforming design criterion (5.5m clear zone for the verge and 2.6m for the central median) for the landscape design and tree installation. This has been captured in the road design and landscape design sections of this report.

The JGD2A design report and "work as executed drawings" were reviewed by Jacobs and it was noted that the offset to the trees in the central reserve is 3m on this project, which is assumed to be attributed to the central reserve being only 7m wide (only allowing for a single tree to be installed). It is Jacobs observation that wire rope barriers are shown indicatively and have not been designed as part of the 2A project (note on the JGD2A drawings "to be designed and installed by others"). Jacobs have adopted a consistent 12m median for JGD3C and considers the 3m clear zone from the JGD2A to be non-desirable. The 2.6m central median clear zone adopted on JGD3C has eradicated any requirement of safety barriers along the mainline (only being required on the approach to the bridge structure and adjacent to the combined road and pond embankment).

Architectural Design

Following from Cox’s Concept phase architectural and material recommendations to the engineering team, this section of the PSP is focused on the design of three key elements within the overall project – the shaping of the pier headstock, the safety screen / balustrade design and the integration of low-level lighting for the bridge deck surfaces. Focus has been on advancing the design of these specific issues as they will be central to a positive perception of the bridge, by both bridge users and observers of the bridge in the landscape. The design of these elements is architecturally important as they expand on the strict structural and transit performance requirements of the infrastructure to outline how this bridge will also create considered and humanistic user experiences through expressive design.

Bridge Design

The concept three-span composite weathering steel girder bridge option has been further developed as part of the PSP and endorsed as the preferred bridge solution. The industry consultation with a steel fabricator, contractors and temporary works designer provided valuable feedback and in principle they had no objection to this preferred bridge option. Further engineering of the bridge structure has been completed in close consultation with the architects to provide the reference design and set clear design guidelines for the next D&C phase. Similarly, other discipline coordination has progressed including, utilities, drainage, pavement and future light rail.

The constructability of the bridge structure has been a key focus during the PSP phase of the project due to the importance of mitigating the risk for the D&C commission. A specialist crane company has demonstrated that the installation of the girders by crane lifting is possible. Other installation options for the girders including launching the steel girders and the key factors, benefits and constraints of each option have been investigated.

Environmental Considerations

An application has been made for a Section 211 Environmental Impact Statement (EIS) Exemption under the *Planning and Development Act 2007* (the P&D Act) for the entire JGD3C Project Area. A Development Application (DA) will be prepared and lodged while the s211 is being assessed.

Should the Section 211 EIS exemption not be approved, the EPSDD will provide an EIS Scoping Document and preparation will commence for the EIS to support the DA.

A biodiversity assessment has been completed and concluded that the proposal:

- is unlikely to result in a significant impact requiring an EIS,
- can be compliant with the NES plan, and
- can be adequately assessed with existing studies to justify a s211 exemption.

A report delineating the nature and boundaries of geological heritage site (G2) has been prepared by the Jacobs geologist and confirmed by the geological society. Ongoing liaison will be undertaken with the geological society as part of the DA to determine potential impacts and mitigation measures.

The DA will include a commitment to undertake salvage of the remaining identified Aboriginal heritage items.

Construction of the project will require preparation of a Construction Environmental Management Plan (CEMP) and Contamination Management Plan (CMP) that will require EPA Accredited Site Auditor endorsement. A commitment to this will be included in the DA.

Cost Estimate

A construction cost estimate has been prepared based upon the design outputs of the Final PSP design. There have been a number of scope change/development aspects since the submission of the Concept Design Construction Cost estimate in 2018 (by Jacobs). These include significant features, such as two signalised intersections, a pedestrian underpass, realignment of the existing Coppins Crossing Road and permanent water detention ponds. This has inevitably led to an increase in the updated construction cost estimate. However, it should be noted that Jacobs have spent extensive time identifying optimisation measures to reduce the construction cost. The notable cost savings have been accomplished through reducing the pavement profile, and optimisation of the drainage design. For a detailed breakdown of the construction cost estimate, please refer to Section 19 of this report.

Glossary of Terms

Term	Definition
AADT	Average Annual Daily Traffic
ACT	Australian Capital Territory
AEC	Areas of Environmental Concern
AEP	Annual Exceedance Probability
AGRD	Austroads Guide to Road Design
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff Rainfall
AS	Australian Standards
ASD	Approach Sight Distance
BA	Burra
BEDC	Bridge Earthquake Design Category
BH	Borehole
Bindubi Street Extension	A proposed extension of Bindubi Street south from William Hovell Drive to perpendicular to John Gorton Drive at JGD3B.
BOM	Bureau of Meteorology
Butters Bridge	A recently constructed pedestrian bridge that spans the Molonglo River on the west side of John Gorton Drive.
CBR	California Bearing Ratio
CEMP	Construction Environmental Management Plan
CH	Chainage
CIRIA	Construction Industry Research and Information Association
CMP	Contamination Management Plan
CMTEDD	Chief Minister, Treasury and Economic Development Directorate
Cotter Road	A dual carriageway arterial road that links the Tuggeranong Parkway to John Gorton Drive
CSTM	Canberra Strategic Transport Model
DA	Development Application
D&C	Design & Construction
DBYD	Dial Before You Dig
DEM	Digital Elevation Model
DLWC	Department of Land and Water Conservation
DTMR	Department of Transport and Main Roads
D%	Dispersibility Percentage Soil Data
DoS	Degree of Saturation
DR	Document Readiness
EAT	Emerson Aggregate Test
EIS	Environmental Impact Statement
ELZ	Extra Low Zone
EMC	Event Mean Concentrations
EPA	Environmental Protection Agency
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Term	Definition
EPSDD	Environment, Planning and Sustainable Development Directorate
ESO	Environmental Significance Opinion
EWA	East-West Arterial
EWP	Elevated Work Platform
Fr	Froude Number
GI	Geotechnical Investigations
GI CMP	Geotechnical Investigations Contamination Management Plan
GPT	Gross Pollutant Trap
Ha	Hectare
Haunched	A varied cross section over the length.
HS3	Haunch and Side Support
HSID	Health Safety in Design
HV	High Voltage
IDPG	Infrastructure Delivery Partners Group
IFC	Issued for Construction
IPT	Inter-Town Public Transport
ITS	Intelligent Transport Systems
Jacobs	Jacobs Group (Australia) Pty Ltd
JGD1D	John Gorton Drive Stage 1D – a previous upgrade of John Gorton Drive to the south of JGD2A
JGD2A	John Gorton Drive Stage 2A - a previous upgrade of John Gorton Drive to the south of JGD3C, near the suburbs of Denman Prospect, Molonglo, Wright and Whitlam.
JGD3A	John Gorton Drive Stage 3A – a previous upgrade of John Gorton Drive to the North of JGD3C, at the intersection of William Hovell Drive
JGD3B	John Gorton Drive Stage 3B - a previous upgrade of John Gorton Drive to the north of JGD3C and to the south of JGD3A
JGD3C	John Gorton Drive Stage 3C - the most recent upgrade of John Gorton Drive, the design of which is detailed in this report.
JGD	John Gorton Drive - An arterial road through the suburbs of Molonglo, Denman Prospect and Whitlam, which joins Coppins Crossing Road and Cotter Road.
John Gorton Drive Extension	A multi-stage upgrade of John Gorton Drive. This report details the design of the latest upgrade, JGD3C.
LIDAR	Light Detection and Ranging
LoS	Level of Service
LUMS	Land Use Management Systems
LV	Low Voltage
LZ	Low Zone
MARFS	Molonglo Arterial Roads Feasibility Study
MIJ	Monolithic Isolation Joints
MIS	Municipal Infrastructure Standards
Molonglo 2	Includes the Molonglo Group Centre Precinct and Denman Prospect. Molonglo 2 refers to the region between the Molonglo River and the suburbs of Coombs and Wright. Molonglo 2 is currently under development.

Term	Definition
Molonglo 3	Refers to the suburb of Whitlam and the area to the East of John Gorton Drive currently under development. Molonglo 3 is generally defined as the area between Molonglo River and William Hovell Drive.
Molonglo River Bridge	A future bridge crossing the Molonglo River that is currently under development, with the design detailed in this report.
MRPM	Molonglo River Park Masterplan
MNES	Matters of National Environmental Significance
MPC	Major Projects Canberra
MTC	Molonglo Town Centre
MVIS	Molonglo Valley Interceptor Sewer
NAASRA	National Association of Australian State Road Authorities
NB	Northbound
NBN	National Broadband Network
NC Act	Nature Conservation Act 2014
NCDRP	National Capital Design Review Panel
NES	National Environmental Significance
P&D Act	Planning and Development Act
Pert-Alt	Pert Alternate
PSP	Preliminary Sketch Plan
RCP	Reinforced Concrete Pipe
RFT	Request for Tender
RMS	Roads and Maritime Services
RUSLE	Revised Universal Soil Loss Equation
SAR	Site Audit Report
SAS	Site Audit Statement
SB	Sediment Basin
SBd	Southbound
Sculthorpe Avenue	Collector road providing access into Whitlam from John Gorton Drive
SFP	Stromlo Forest Park
SHE	Statement of Heritage Effect
SID	Safety in Design
SISD	Safe Intersection Sight Distance
SPT	Standard Penetration Test
S&LI	Soil and Land Information
SSD	Stopping Sight Distance
TCCS	Transport Canberra and City Services
TCD	Traffic Control Device
TCF	The Capital Framework
TCLR	Transport Canberra Light Rail
TCS	Traffic Control Signals
TN	Total Nitrogen
TP	Test Pit

Term	Definition
TPh	Total Phosphorus
TRITS	Trunk Road Infrastructure Technical Specifications
TSS	Total Suspended Solid
Tuggeranong Parkway	An 11km major highway providing a north-south connection in Canberra, east of John Gorton Drive.
V/C	Volume Capacity Ratio
Whitlam	A new suburb located north of the Molonglo River and to the west of JGD.
William Hovell Drive	An arterial road with dual carriageway and two lanes in each direction.
WSUD	Water Sensitive Urban Design
1D	One-dimensional
2D	Two-dimensional

1. Introduction

1.1 Background

Infrastructure Delivery Partners Group (IDPG) have engaged Jacobs Group (Australia) Pty Ltd (Jacobs) to deliver the Preliminary Sketch Plan (PSP) design for the proposed Molonglo River Bridge and John Gorton Drive Extension Stage 3C (JGD3C) in the Molonglo Valley, ACT. This commission includes the future proofing of the Molonglo River Bridge for possible light rail implementation, connectivity between John Gorton Drive (JGD) stages 2A and 3B and access to both Whitlam and the Molonglo Town Centre.

The purpose of this report is to outline the JGD3C PSP design development thus far into one single document. This report will be an important component for the Design & Construction (D&C) tender phase of the project.

1.2 Study Area

JGD3C is in the Molonglo Valley, connecting the southern JGD stage 2A to the northern JGD stage 3B. JGD3C is the final section of the arterial road and significant services link. The project will include a bridge which crosses the Molonglo River adjacent to the existing low level Coppins Crossing bridge. The study area is indicated in Figure 1.1

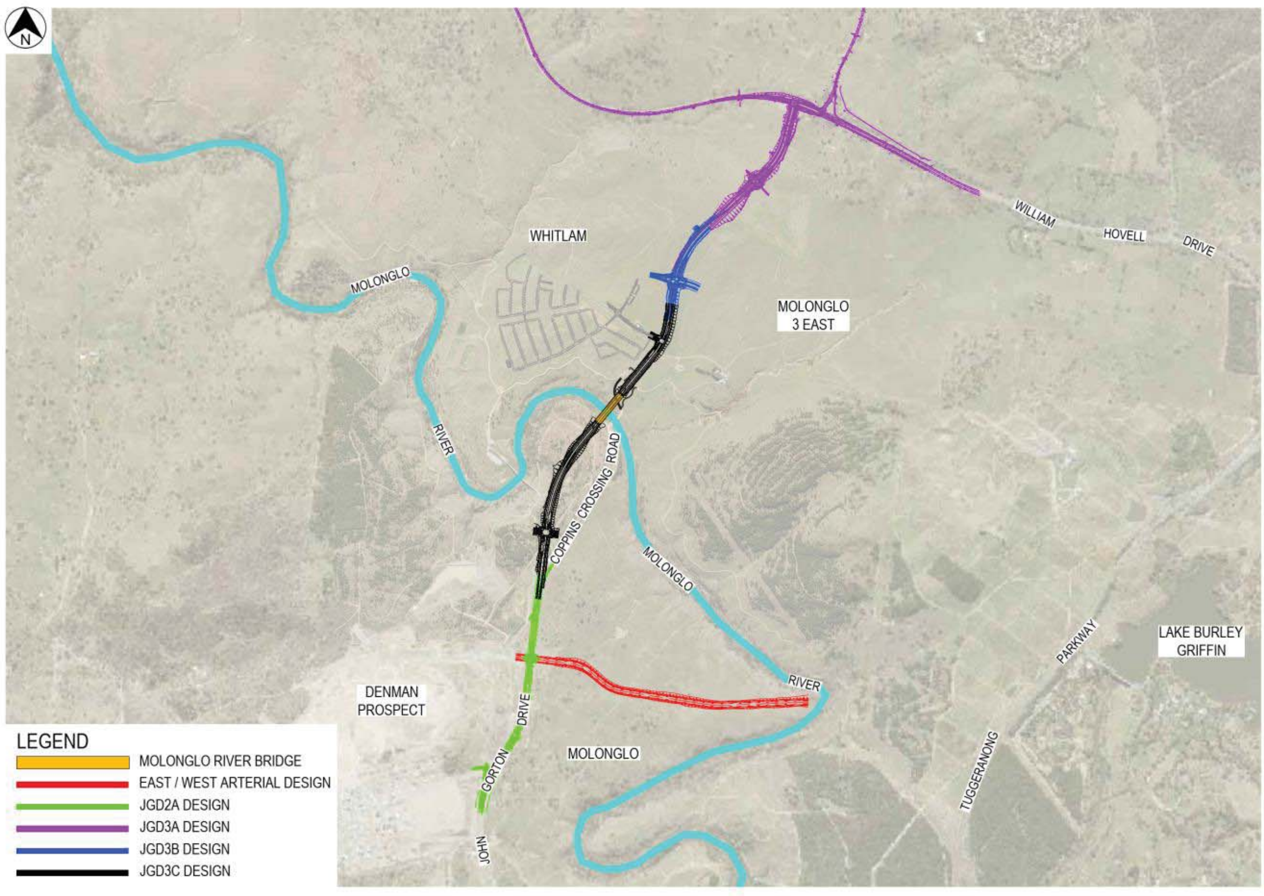


Figure 1.1 Location of John Gorton Drive (JGD3C)

1.3 Project Description

JGD3C and the Molonglo River Bridge are a vital part of the Molonglo Valley Urban Development which will provide a major arterial road link, significant utility services and a transport corridor. The delivery of JGD3C will complete the 7.2km arterial road link of JGD from William Hovell Drive, in the north, to Cotter Road, in the south.

The upgrade will include provision for future light rail in the alignment, which will support the population growth generated by the development of the suburb Whitlam and other expansions over the next 30 years.

JGD3C is proposed to include a three span haunched steel girder bridge, approximately 227.6m long over the Molonglo River with 1km of proposed arterial road approach from the south of the Molonglo River and 0.7km to the north of the Molonglo River.

1.4 Project Objectives

The JGD Extension and the Molonglo River Bridge will seek to deliver the following project objectives:

- To develop the existing Concept Design to a stage where a Design and Construction (D&C) tender can be undertaken including relevant development approvals. This project supports the Land Release Program, specifically in the Molonglo Valley, for the new suburbs of Whitlam, Molonglo and Denman Prospect;
- To mitigate and decrease the risks for the Phase 2 – D&C component of the project. Risks will be mitigated by undertaking detailed and targeted geotechnical investigations, obtaining in principle design approvals from service authorities, where possible, and delivering Territory development approvals. Addressing these risks will provide significant cost savings to the Territory by increasing clarity and certainty for Phase 2;
- Deliver road infrastructure to improve safety and enhance and replace the substandard Coppins Crossing Road;
- Provide the final transport link between the northern and southern suburbs in the Molonglo Valley region that will cater for public transport (including light rail) and active travel, as well as allowing regular bus connections;
- Provide significant flood immunity at Coppins Crossing/Molonglo River, allowing for a reliable and safe public transport passage for motorists;
- Provide services connectivity between Molonglo 2 and 3, particularly electricity, communications and gas;
- Provide a bridge which is aesthetically pleasing to the Molonglo Valley area and matches the architectural properties of the existing Butters Bridge to comply with the “Family of Bridges” concept;
- Accommodate future transport planning including light rail and / or road infrastructure linkage to the future developments.

2. Review of Previous Studies & Concept Design

2.1 Previous Studies

Since the development of the JGD3C Concept Design, there has been some additional studies which have impacted the design of the JGD3C project. The table below was initially completed by Jacobs during the Concept Design phase of the project and provides a summary of the previous studies which have aided the design progression to date. This table has been updated to include the additional studies since the Jacobs Concept Design submission in 2018.

Table 2.1 – Previous Studies

Study Name	Release Company & Date	Objectives	Key Outcomes
2010 Structure Plan Molonglo and North Weston	2010	This structure plan sets out the principles and policies that apply to the Molonglo and North Weston future urban area in accordance with section 91 of the Planning and Development Act 2007.	Framework document for development in Molonglo.
Molonglo Valley Plan for the Protection of Matters of National Environmental Significance (NES)	Sep 2011	The NES Plan reflects the development activities proposed for the Molonglo Valley as set out in the Molonglo and North Weston Structure Plan (the Structure Plan). The document also establishes the ACT Government's commitments to protect matters of national environmental significance (MNES) within the strategic assessment area.	This plan documents the approval under the EPBC Act and the various conditions which need to be met.
John Gorton Drive Stage 2A, Document Readiness (DR) Report	Calibre, 2012	Details the strategy to provide access to the Molonglo 2 development area, including the proposed Group Centre, via the extension of John Gorton Drive with a future IPT route (Light Rail). This DR documentation adopts the proposed changes to the road network around the Group Centre and incorporates PSP comments.	The report provides the detail of the road design to be matched into the Southern limit of works, including the Molonglo Group Centre.
Molonglo Arterial Roads Feasibility Study (MARFS)	SMEC, 2013	Assesses alternative alignment options for John Gorton Drive, particularly its connection with Coulter Drive Extension and Bindubi Street Extension.	Details the preferred road design for John Gorton Drive from Ch15100 to Ch18500 (encompassing JGD3C). Also details the preferred bridge design for the Molonglo River crossing.
Molonglo 2 Urban Edge Landscape Master Plan and Feasibility Study	Indesco, 2014	Details proposed landscape treatment along the Molonglo River corridor, including water quality control ponds and service crossings.	This report encompasses the Molonglo 2 Group Centre, which will determine some aspects of the JGD3C design. It also details the landscape strategy to be matched into the Southern limit of works.
Molonglo 3 Sewer Master Plan Report	GHD, Dec 2014	Forms part of the Molonglo 3 Hydraulic Services Master Plans and Concept Designs. This report details	This report identifies a proposed trunk sewer main running along both sides of the John Gorton Drive alignment,

Study Name	Release Company & Date	Objectives	Key Outcomes
		both the immediate and long-term management requirements to facilitate the installation and implementation of sewer infrastructure for Stage 3 of the Molonglo Valley Development.	and a proposed stormwater pod adjacent to John Gorton Drive in the vicinity of the Molonglo Valley Interceptor Sewer (MVIS) crossing. Both of these aspects will be incorporated into the JGD3C design. Jacobs has also been advised by Icon Water that *"Due to the change in road alignment, Icon Water is waiting for a revised masterplan from GHD. Icon Water can't comment on what assets will be required until the report is reviewed and accepted.* *Please note GHD is reviewing the masterplan for the Government and the timing of the report is unknown at the moment."*
Report on Geotechnical Investigation, Proposed John Gorton Drive Bridge, Molonglo River, Molonglo	Douglas Partners, 2015	This report presents the results of a geotechnical investigation undertaken for the proposed bridge over the Molonglo River. The investigation was commissioned by Calibre Consulting (ACT) Pty Ltd, consulting engineers for the project.	This report, which includes key information including borehole investigation, will be used to conduct geotechnical gap analysis with Jacobs' own geotechnical study.
Transport Canberra Light Rail Network Master Plan	ACT Government, 2015	This report presents the draft future stages of light rail for Canberra, including potential light rail corridors.	This report details a light rail corridor going through the Molonglo development, which will interface with the JGD3C project. It will be used to provide context for the provision of light rail, which was a key requirement for the project.
Molonglo 3 Road Access and Molonglo River Bridge, John Gorton Drive (North) and Bindubi Street Extension (West) Feasibility Report	AECOM, Jul 2015	Identifies the preferred road alignments, intersection arrangements and staging strategy for the Molonglo 3 area.	The feasibility report identifies many options for the road alignment and bridge type, including preferred options which will be taken as a base case for this design.
Molonglo 3 Water Supply Strategy Draft Concept Design Report	GHD, Dec 2015	Forms part of the Molonglo 3 Hydraulic Services Master Plans and Concept Designs. This report presents the water supply concept design to serve the proposed Molonglo 3 development.	Proposed a distribution main within Molonglo 3 that crosses John Gorton Drive on the Northern side of Molonglo River.
The Capital Framework (TCF) Guidance Update 2.0	ACT Government, 2016	The Capital Framework (TCF) is used to support the successful delivery of capital projects in the ACT.	This document will be used as a for guidance, particularly Stage 5 (Implementation).
Molonglo 3 Road and Intersection Infrastructure – Stage 1 Development Application	Calibre, Nov 2016	Discusses the development of the design for the Molonglo Stage 1 Road and Intersections Infrastructure.	Provides detail of the road design to be matched into at the JGD3B Northern limit of works.

Study Name	Release Company & Date	Objectives	Key Outcomes
Molonglo 3 Roads and Intersections Tender Drawings	Calibre, Dec 2016	These drawings supplement the Molonglo Road and Intersection Infrastructure – Stage 1 Development Application.	Provides detail of the road design to be matched into at the JGD3B Northern limit of works.
Molonglo 3 HV Relocation Segments Plan	Calibre, May 2017	Forms part of the Molonglo 3 Major Electrical Infrastructure Relocation Feasibility Study.	Jacobs was provided with drawing 15-004531-100_SEGMENTS. dwg_15-004531#100+# which details the proposed future high voltage services in the area. None of these services are within the JGD3C project area. Evoenergy (owner of the 132kV transmission line which crosses the project area) has advised that *"The overhead 132 kV transmission line will be replaced with underground cables approx. 2020. The proposed 132 kV cable route will be well away from the bridge site."*
JGD3A Document Readiness Report	Calibre, May 2017	The objective of this report was to discuss the development of the Document Readiness design prepared for the John Gorton Drive 3A (JGD3A) works.	This document includes key information regarding the design of JGD3A, which ties in to the North of JGD3B.
Procurement Options and Delivery Model Study – Phase 1 Review of Previous Studies	Indesco, Dec 2017	The objectives of this report were to familiarise the project team with previous works undertaken by the ACT government and summarise relevant information from previous works to clarify the parameters that would frame the Procurement Options and Delivery Model Study.	This report was used to gain an understanding of the background reports and previous studies that will have an impact on the JGD3C design, including design details and parameters.
Ecological Impact Assessment	Capital Ecology, Feb 2018	The objective of this report was to determine and assess the impacts of the proposed development upon habitat for terrestrial flora and fauna species and ecological communities listed as threatened pursuant to the ACT Nature Conservation Act 2014 (NC Act).	This document showed that for JGD3B, the proposed development will not impact upon a listed ecological community or significantly impact upon habitat for any listed threatened flora or fauna species. It is likely that JGD3C will have a similar impact to JGD3B due to the close proximity of works.
JGD3B Preliminary Sketch Plan (PSP) Report	Calibre, Mar 2018	The objective of this report was to discuss the development of the Preliminary Sketch Plan design prepared for the John Gorton Drive 3B (JGD3B) works.	This document includes essential information regarding the design of JGD3B, which ties in to the North of JGD3C. Key information includes design parameters for the tie-in, to ensure a consistent design approach across the JGD works.
Molonglo 3 Water Supply Main – Revised Pipe Sizes and Layout	GHD, June 2018	This technical memorandum provides an update to GHD's Molonglo 3 Neighbourhoods 1 & 2 (Whitlam	This technical memorandum provided updated information on the Molonglo 3 Water supply strategy. Jacobs has also been advised by Icon Water that *"Due to the change in road alignment,*

Study Name	Release Company & Date	Objectives	Key Outcomes
		Estate) Water Supply Strategy Concept Design Report dated January 2017.	*Icon Water is waiting for a revised masterplan from GHD. Icon Water can't comment on what assets will be required until the report is reviewed and accepted.* *Please note GHD is reviewing the masterplan for the Government and the timing of the report is unknown at the moment."*
JGD3B Detailed Design Document Readiness Report	Calibre, Feb 2019	The objective of this report was to discuss the development of the Document Readiness design prepared for the John Gorton Drive 3B (JGD3B) works.	This document includes key information regarding the design of JGD3B which ties into the North of JGD3C
Molonglo 2 Commercial Centre – Investigation Study – Final Draft Report V3	Indesco, March 2019	The objective of the report is to provide an updated staging masterplan for Molonglo 2. It also identifies the broad scope of civil infrastructure works and timeframes required to enable the first stage of land to be released. This report is accompanied by drawings that display the previous hydraulic masterplans in relation to the staging boundaries.	The document includes and defines interface requirements between the two projects.
Molonglo Town Centre Environs Growth Servicing Plans Investigation Study – Draft Report & Drawings	Indesco, January 2020	The objective of this report is to provide a high-level view of the trunk infrastructure (water, sewer and stormwater) that will be required to service the Molonglo Town Centre in the longer term. This report is accompanied by drawings that provides details for the water, sewer and stormwater locations.	This document includes key information for water, sewer and stormwater infrastructure in the Molonglo Town Centre precinct.

2.2 Concept Design

The Concept Design completed by Jacobs in 2018 has been used as the basis during the PSP design development. During various stakeholder meetings and additional requirements from multiple government directorates, the Concept Design has been adjusted accordingly. Examples of where the PSP design has changed from the Concept Design are as follows:

- Intersections north of the Molonglo River – The Concept Design had 2 left in/left out intersections adjacent to Whitlam and Molonglo 3 East. During the PSP, this has changed to a single 3-way signalised T-intersection which will provide access to Whitlam from both carriageways on JGD. No access will be provided to Molonglo 3 East. This T-intersection includes slip lanes at the entry and exit points to Sculthorpe Avenue.
- Intersections south of the Molonglo River – A new intersection has been included in the Molonglo Town Centre precinct. Analysis on a future left-only turning lane into Molonglo 2 East, at CH16000 in between the southern end of the bridge and the MTC intersection, has been noted on the drawings and included in the road design section of this report.

- Construction Staging – The construction staging has changed due to the new revised layout of the intersections. This impacts the temporary realignment of Coppins Crossing road which was proposed during the Concept Design. The JGD3B temporary alignment and pavement is proposed to remain in place until the final stage of construction.
- Architecture, Bridge/Structures – The previous Concept Design has been adopted without significant change. This has been further refined and developed through greater collaboration with other engineering disciplines.
- Cost Estimate – The PSP cost estimate has increased from the Concept Design due to the inclusion of 2 signalised intersections, a surplus of earthworks due to the existing topography at the MTC intersection, inclusion of permanent detention ponds and the addition of the pedestrian underpass beneath the main carriageway. More information on the cost estimate can be found in section 19 of this report, and in Appendix AA, Appendix BB and Appendix CC.

3. Other Relevant and Interfacing Projects

3.1 John Gorton Drive Extension Stage 3A

The John Gorton Drive Extension Stage 3A (JGD3A) roadworks were the first stage of the Molonglo 3 JGD Upgrade. Located to the north of the river, the project involved the replacement of 900m of the existing two lane Coppins Crossing Road directly south of William Hovell Drive, with a dual carriageway arterial road. This project also encompassed an upgrade of the William Hovell Drive intersection at JGD which included additional lanes on William Hovell Drive and a new intersection approximately 500m south to provide vehicle access into the new suburb, Whitlam.

3.2 John Gorton Drive Extension Stage 3B and Bindubi St Extension

The John Gorton Drive Extension Stage 3B (JGD3B) is the second stage of the Molonglo 3 JGD upgrade. The project involves the replacement of 500m of the existing two lane Coppins Crossing Road south of JGD3A, with a dual carriageway arterial road. JGD3B includes a new four-way signalised intersection on JGD approximately 1.3km south of William Hovell Drive along with a left-in / left-out intersection approximately 970m south of William Hovell Drive.

The four-way signalised intersection on JGD included in the JGD3B project scope provides an entrance to Whitlam on the western side of JGD and access to Molonglo 3 development to the eastern side of JGD via the Bindubi Street Extension. This extends to the east through the Molonglo Valley and then north to connect to the Bindubi Street Junction on William Hovell Drive. The length of the stub on the eastern side of the Bindubi Street Extension for JGD3B has been minimised to increase the flexibility for future land use and development of the Molonglo 3 East area.

The design report for JGD3B and the Issued for Construction (IFC) design models, completed by Calibre Consulting, have been referred to in the development of the JGD3C PSP design.

3.3 John Gorton Drive Extension Stage 2A and Molonglo Town Centre

The John Gorton Drive Stage 2A (JGD2A) is the most recent stage of the Molonglo 2 JGD upgrade located to the south of the Molonglo River. The project involved the construction of northbound and southbound carriageways with two lanes of general traffic and provision for on road-cycling in each direction. JGD2A also included the construction of four signalised intersections and a connection to the existing John Gorton Drive Stage 1D (JGD1D). The northern end of JGD2A directly ties in with JGD3C on the southern side of the Molonglo River.

The Molonglo Town Centre (MTC) is proposed to be at the intersection of John Gorton Drive and Commercial Street, part of the Molonglo Valley Stage 2 development. It is expected to include the principal commercial and civil centre for the Molonglo Valley district and aims to accommodate a portion of the residents expected for the Stage 2 development. The development of the MTC is currently still in planning with the Environment Planning and Sustainable Development Directorate (EPSDD).

Brown Consulting (now Calibre Consulting) completed the JGD Extension to Molonglo 2 Forward Design Document Readiness Report in July 2012, which has been referred to in the development of the PSP design. This report incorporates the whole of the Molonglo Valley Stage 2 development, which includes JGD2A and the MTC.

3.4 Butters Bridge

The Butters Bridge is a recently constructed pedestrian bridge that spans the Molonglo River on the west side of JGD. As the development of the Molonglo Valley progresses, it will form an important part of the active travel network for pedestrians and cyclists which includes access to the MTC south of the river. It carries a 600mm sewer pipeline to connect the Molonglo Valley Interceptor Sewer (MVIS) to the Denman Prospect urban development.

Butters Bridge was the first bridge crossing delivered within the 'Family of Bridges' concept and will be taken as the informing structure when documenting architectural requirements for the Molonglo River Bridge.

3.5 East-West Arterial Road & Bridge

A new East-West Arterial road from JGD to the Tuggeranong Parkway has been proposed, which will include a bridge crossing the Molonglo River. The East-West Arterial (EWA) Bridge will complete the "Family of Bridges" concept for the Molonglo Valley. Architectural aspects of the existing Butters Bridge, and the Molonglo River Bridge as part of this PSP will ultimately inform the type of EWA Bridge. EWA has been identified as being required in the medium term and as such is currently at the strategic design stage.

3.6 Whitlam

Whitlam is a new suburb currently in the early stages of design as part of the Molonglo Valley Stage 3 development. Located between JGD and the Kama Nature Reserve, it is adjacent to JGD3A, JGD3B and JGD3C. The design of JGD3C will incorporate the Whitlam Concept Masterplan and the early stages of design development by the design consultant, Calibre Consulting. The Whitlam planning includes a school, residential properties and a number of open space areas. Residents are expected to move into Whitlam during 2021.

3.7 Molonglo River Corridor Masterplan

The Molonglo River Park Masterplan (MRPM) details the concept for a new 650-hectare park that will follow the Molonglo River and serve the residents of the new Molonglo development. The park will stretch 13 kilometres from Scrivener Dam to Kama Nature Reserve. The Molonglo River Park Concept Design Report (Hassell 2012), will be incorporated into the JGD3C PSP. This will be achieved by making sure the MRPM can still be fulfilled despite the inclusion of the JGD3C project. A new edition of the MRCM is currently being revised to ensure the development since 2012 is captured.

3.8 Canberra Light Rail

The Transport Canberra Light Rail (TCLR) master plan is a 25-year vision that details the future stages of the Canberra light rail network. This plan includes a major transit corridor connecting Molonglo and Weston to Woden and Canberra City with a large component of this corridor running along the JGD alignment. The PSP design for JGD3C follows the same approach as the concept design for future light rail:

- Bi-directional light rail will ultimately feature in the central median between both JGD3C carriageways;
- Light rail will cross the Molonglo River via an additional bridge structure which will be situated between the proposed bridges for the road carriageways but will be supported by the piers associated with the JGD3C road bridges.

4. Road Design

4.1 Existing Topography

The current topography from CH15000 to CH16000 declines consistently towards the north-west from the south-east until the Molonglo River Bed. From the northern side of the river bed, the land rises towards the north west to tie-into JGD3B at CH16975.

4.2 Constraints

The road design has multiple constraints that define the alignment of JGD3C which are explained in detail below.

4.2.1 John Gorton Drive Extension Stage 2A (JGD2A)

At CH15000, located south of the river corridor is the northern limit of JGD2A. The typical cross-section width of JGD3C is 50m including a 12m future proofed median for light rail and a 10m verge. The fixed vertical and horizontal alignment of JGD2A requires the JGD3C road design to transition to the JGD2A cross-section width of 45m which includes an 8m verge and a 7m wide median. This transition is completed over approximately 150m.

4.2.2 Whitlam Development

At CH16750, located north of the river corridor is an intersection to link JGD3C and the Whitlam development. This intersection is a fixed constraint to ensure a smooth and efficient transition between both projects. The final Whitlam Stage 3 design has been used to determine the vertical tie-in level for the JGD3C road design. The Sculthorpe Avenue longitudinal gradient has been optimised, by Jacobs and Calibre Consulting (Whitlam design consultant), to 7% which ensures a vertical alignment change on JGD3C is avoided. The cross-section provided by Calibre Consulting has determined the width of the carriageway into Whitlam.

4.2.3 John Gorton Drive Extension Stage 3B (JGD3B)

At approximately CH16975, located north of the river corridor is the commencement of JGD3B which is currently under construction. This project is a fixed parameter that defines the JGD3C design. The cross-section width in JGD3B is 50m including a 10m verge and a 12m median hence the JGD3C cross-section has adopted the same dimensions. The right-turn lanes at the Bindubi Street intersection have extended into the JGD3C road design across a length of 30m. Both right-turn lanes are located inside the 12m median which is a fixed constraint. This impacts the requirement of completely future proofing the 12m median for future light rail construction as required in the project brief. This has been communicated to TCCS/IDPG and accepted as the preferred design approach.

4.2.4 Light Rail

To accommodate the efficient operation of the future light rail, the vertical grade of JGD3C must be less than 5% as defined by Transport Canberra Light Rail (TCLR). From a horizontal alignment perspective, a 12m median is required to accommodate light rail to travel in each direction. This width is fixed and cannot be reduced.

Following a meeting with TCLR at the initial stage of the PSP design it was confirmed that there are no further updates required to the *JGD3B Future Light Rail Design Criteria memo* (August 2018), based on the available information to date. The 12m reserve has been agreed with TCLR and has been accommodated within the JGD3C PSP design.

The JGD3B Future Light Rail Design Criteria Memo can be viewed in Appendix A.

Each intersection along the JGD3C main carriageway has right-turn lanes inside the 12m median. These right-turn lanes will need to be either removed or relocated if light rail is to be constructed in the future. This design approach was approved by TCCS and Roads ACT in a meeting on Wednesday 31 October 2019. More information about the provision of these intersections can be found in section 4.8 of this design report.

There are significant restrictions on widening the road corridor at both the MTC and Whitlam intersections for the future provision of light rail to reduce the impact on these collector roads during light rail construction in approximately 20 years' time. This is due to the fixed constraints of JGD2A (operational), Whitlam (construction planned from September 2020) and JGD3B (currently under construction), This will need to be re-assessed as part of the future light rail works.

4.2.5 Molonglo Valley Interceptor Sewer (MVIS)

A large interceptor sewer crosses the JGD3C alignment. To ensure no protection works are required over this sewer, the reduced level of the JGD3C road design should not change. The approach from the Concept Design has been adopted for the PSP and is consistent with the Molonglo 3 Road Access and Bridge Feasibility Study completed in 2015. Refer to section 11 of this design report for further details around the MVIS.

4.2.6 Molonglo Town Centre (MTC)

The MTC is currently in the early stages of planning and design. This is a variable constraint where the MTC is using the development of JGD3C as the precedent to continue to develop the planning for this area.

At CH15400, located to the south of the river corridor is an intersection within the proposed MTC precinct. This intersection will be used to dictate future planning for the MTC and the surrounding commercial development. The current location of the intersection increases the amount of cut material that will need to be excavated from the existing topography. The location of this intersection has been confirmed and approved by EPSDD in a meeting held on Wednesday 23 October 2019. The posted speed in the MTC precinct will be reduced to 60km/h, from CH16050, to accommodate the anticipated heavy pedestrian environment. Further development and planning of the MTC is required to determine the extent of further traffic calming measures including the sequencing of traffic signals and road blisters. The shared path and landscape design in the MTC precinct will match the JGD2A precedent to ensure consistency across both projects.

4.3 Design Criteria

4.3.1 John Gorton Drive

The following design criteria for the JGD3C PSP design has been adopted by Jacobs after a design criteria meeting with Roads ACT and other stakeholders on Friday 3rd May 2019.

Table 4.1 Design Criteria

Criterion	Value	Comment
Road Classification	Arterial	
Design Speed	80km/h	
Posted Speed	70km/h (CH 16050 to CH 16975) 60km/h (CH 15000 to CH 16050)	Reduced to 60km/h from the JGD2A boundary to 50m before the southern bridge abutment for safety around the MTC precinct.
Normal Crossfall	3%	Consistent with other sections of JGD.
Batter Slope	4:1 Fill 2:1 Cut	

Criterion	Value	Comment
Vehicular Lane Width	3.5m	Consistent with adjoining road designs and the MIS.
Median Width	12m – General	12m from lane edge to lane edge.
	8.5m – Intersections	Right-turn lanes located inside the 12m median.
Shoulder Width	Nearside 2m for exclusive bicycle lane Offside 1m on bridge	Austroads Guide to Road Design (AGRD), Part 3 Geometric Design, Section 4.8.7 Exclusive Bicycle Lanes.
Verge Width	10m	Consistent with JGD3B. Transition into JGD2A will occur over approximately 150m.
Design Vehicle	19m Semi-Trailer and Steer Tag Bus	
Checking Vehicle	26m B-double	
<u>Vertical Alignment</u>		
Minimum Desirable Longitudinal Grade	1%	Minimum longitudinal grade is 2%.
Maximum Desirable Longitudinal Grades	General – 5-7%	Maximum longitudinal grade is 5%.
	IPT Main Line – 5% maximum	Canberra Light Rail Scope and Performance Requirements Appendix 17 – Trackwork.
Minimum K Values	Crest – SSD=23.9, ASD=48.5 Sag – 10 Comfort, 22 Headlight	AGRD, Part 3 Geometric Design, Table 8.7 & Part 4A Table 3.1 and Table 3.2.
Minimum Sight Distance	SSD=103m, ASD=103m	AGRD, Part 3 Geometric Design, Table 8.7 & Part 4A Table 3.1 and Table 3.2.
<u>Horizontal Alignment</u>		
Desirable Minimum Radius	400m	Based on 3% (max – 5%) Superelevation. AGRD, Section 7.7.2 Linear Method of Superelevation.

This design criteria does not apply to Sculthorpe Avenue. This small section of road has fixed constraints from the Whitlam development and the JGD3C carriageway. As a result, the longitudinal gradient is approximately 7%. The cross-section for Sculthorpe Avenue has been tied-in with the JGD3C design to provide a smooth transition between adjoining projects.

4.3.2 Coppins Crossing Road

The design/posted speed for the realignment of Coppins Crossing Road is 40km/h. Reducing the realignment to a 5m rural track from the current 7.5m dual carriageway was considered but with the requirement for the road to be open during construction and prior to the construction of the northern bridge abutment, the same lane widths have been adopted. A verge of 1.5m width has been retained with a batter slope of 4:1 on the northern side and a batter slope of 2:1 on the southern side. It is proposed to use concrete jersey kerbs as a safety barrier on the southern side.

4.3.3 Fire Access Track

The current realignment of the fire access track has been designed in between the toe of batter from JGD and permanent basin B7 with a crossing over the WSUD swale. A vertical gradient of 15% can be achieved for this access track which is less than the maximum gradient noted in *Access for fire brigade vehicles and firefighters Version 05 Section 7.6, NSW Government (October 2019)* and AS 2890.2:2018. Further refinement and optimisation of this fire access track can be undertaken during the Detailed Design phase of the project.

4.4 Design Speed

The design speed of 80km/h was adopted during the Concept Design phase of the JGD3C project with a posted speed of 70km/h. The same design speed and posted speed has been used to progress the JGD3C design through the PSP phase. At CH16050, the posted speed will be reduced from 70km/h to 60km/h for safety through the MTC. This design criteria is different on the adjoining projects. The design/posted speed for JGD3B is 90km/h and 80km/h respectively, and for JGD2A the design/posted speed is 80km/h and 70km/h respectively.

Adopting a design speed of 80km/h for JGD3C, from the interface of JGD3B, does not provide a continuous posted speed along John Gorton Drive.

It is possible to increase the design speed to 90km/h and posted speed to 80km/h along the northern section of JGD3C to match that of JGD3B. However, it should be noted that there will be design implications to the current alignment. Design changes required to JGD3C incurred by increasing the design speed to 90km/h from JGD3B to CH16050 include the following:

- The mainline radius will increase from 400m to 430m for the section adjacent to Whitlam at CH16750;
- The main alignment will shift 1m towards the Whitlam;
- The mainline crossfall will increase from the preferred 3% to a minimum of 5%.
- Sculthorpe Avenue will have an increase in longitudinal gradient. The gradient is currently +7%. This is acceptable for a residential access road; however, it is not advisable to increase further over 8%.

The impact these changes will have to the overall design are outlined below:

- The clear-zone will increase to at least 7m (1.5m more than the current design). For the existing 5.5m clear-zone to remain, an approved non-conformance will be required;
- Restricted space for a robust urban and landscape design in the median and the verges;
- Additional drainage pits required due to the increased speed and crossfall;
- Aquaplaning issues to be addressed in the drainage design;
- The utilities design will require adjustment in a constrained corridor at the Whitlam interface;
- Reduced space for a possible noise wall (to be designed by others) between the verge of JGD3C and the Whitlam boundary;
- The tie-in to Whitlam will have a higher longitudinal gradient due to the JGD3C alignment moving closer to the Whitlam access point. This tie-in level will be lower due to an increased crossfall. This gradient is currently 7% and is likely to raise above 8% with this change;
- Desirable super-elevation at intersections may not be achieved, leading to a non-conformance.

At a meeting held on Thursday 20 February 2020, TCCS & IDPG instructed Jacobs to adopt a design speed of 80km and a posted speed of 70km/h.

4.5 Horizontal Alignment

The horizontal alignment that was adopted during the Concept Design stage of the project has predominately remained the same. The only changes that have occurred during the PSP development include:

- The verge width extending to 10m to tie-in with JGD3B from 8m;
- The shoulder width on the offside of the bridge extending to 1m from 0.5m to align with the desirable Austroads guidelines.

4.6 Vertical Alignment

The Molonglo 3 Road Access and Bridge Feasibility Study (AECOM, 2015) is the basis for the vertical alignment arrangement. These guidelines were adopted by Jacobs during the Concept Design phase of the JGD3C upgrade and have generally remained the same for the PSP. The key reasons why this is the case are as follows:

- Tie-in with the constraints of JGD2A (operational) and JGD3B (under construction).
- The finished surface level of the MVIS is to be similar to the existing ground level to minimise cutting and disruption in the vicinity of the MVIS. This will also minimise any additional stress to the MVIS pipe.
- A low point to be located close to the southern abutment to enable the bridge deck to be launched uphill.
- The full length of the bridge to be located within a constant vertical radius.
- A maximum vertical gradient of 5% due to light rail design criteria (designed by others).
- Retain the existing Coppins Crossing Road to keep traffic moving during construction.
- Ensure the finished surface level of the bridge is above RL522.050 (Dam Break Flood Level).

The intersection into Whitlam (Sculthorpe Avenue) required some minor level adjustments from the Concept Design commission to ensure a smooth transition into the new development.

4.7 Typical Cross-Section

The typical cross section for the PSP design has been guided by the adjacent projects of JGD3B and JGD2A. JGD3B has a 10m verge which differed from the Jacobs Concept Design which adopted an 8m verge. This verge contains a 3m shared path which is common on both sides of the carriageway. Two 3.5m traffic lanes, a 2m shoulder for an on-road bicycle lane and a 12m central median are also included in the typical cross-section. As noted in section 4.5, a 10m verge has been adopted for the PSP design.

The figures below are a typical section on the northern side of the bridge and the southern side of the bridge.

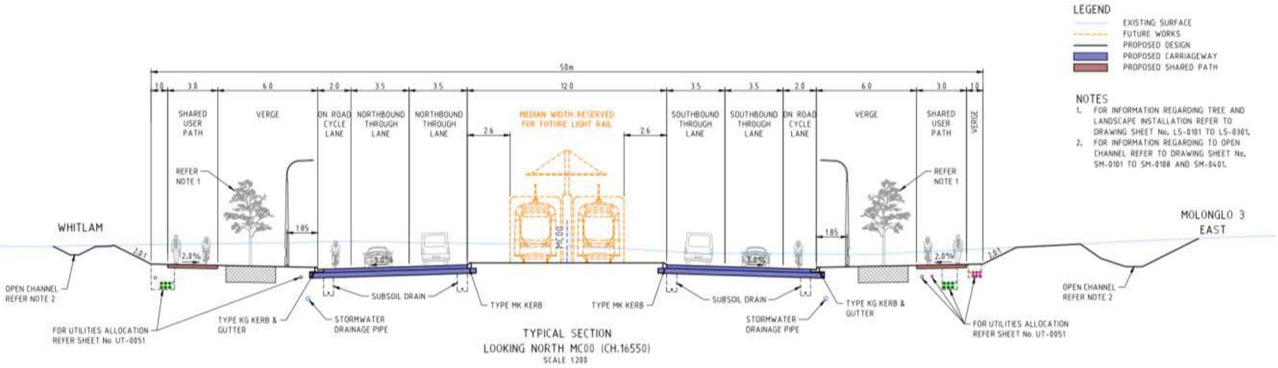


Figure 4.1 Typical Cross-Section North of the Bridge

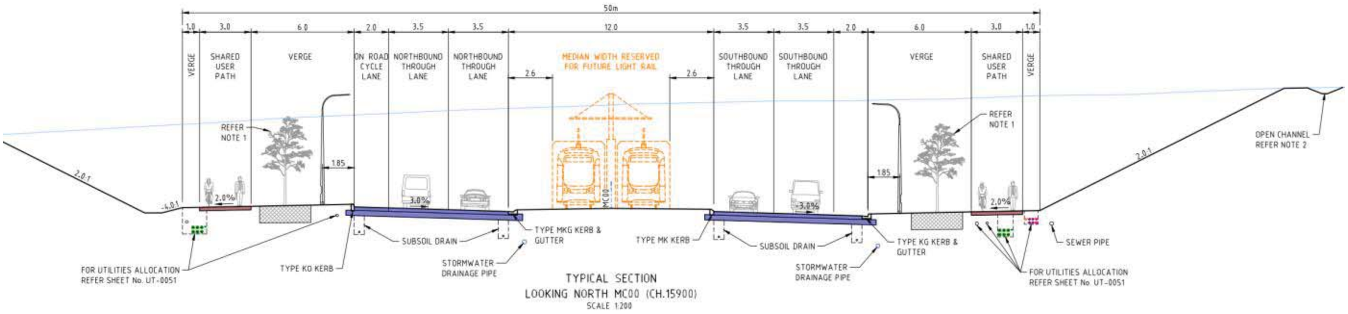


Figure 4.2 Typical Cross-Section South of the Bridge

4.8 Provision of Intersections

The intersection arrangements for JGD3C have amended since the Concept Design stage of the project. Originally, there were two left in/left out intersections to provide access to Whitlam and Molonglo 3 East. The PSP design now includes 2No. signalised intersections. One signalised 3-way T-intersection north of the Molonglo River and a 4-way signalised intersection to the south of the Molonglo River to access the MTC precinct.

4.8.1 Whitlam Intersection

The provision of two left in/left out intersections from the Concept Design adjacent to Whitlam and Molonglo 3 East have been refined to capture one signalised 3-way T-intersection. This intersection will incorporate a 140m right-turn lane in the southbound carriageway to provide vehicular access off JGD travelling south from William Hovell Drive.

The typical cross-section of Sculthorpe Avenue has one lane in each direction, a northbound left-turn lane and a 2m shoulder. Slip lanes have been included at both the exit and entry points into Sculthorpe Avenue to enhance traffic flow. The exit point from Sculthorpe Avenue will be controlled by traffic signals for both left and right turns. For vehicles turning left, this will reduce the risk of collisions for traffic that will enter JGD to cross over both lanes, to turn right into Bindubi Street.

4.8.2 Molonglo Town Centre

During the progression of the PSP design, a signalised 4-way intersection has been incorporated into JGD3C. This is an important component of the JGD3C design as it will provide access and the basis for design for the planning and development of the future MTC. The design includes two lanes in each direction on both sides of the intersection at a width of 3.5m and a 2m shoulder/on road cycle lane. Slip lanes have been included at entry and exit points to the side roads to enhance traffic flow.

As mentioned in section 4.2.6 of this report, the MTC intersection location was approved by EPSDD on Wednesday 23 October 2019. The collector roads on either side of the JGD3C carriageway clash with the proposed permanent detention basin outside of JGD3C project boundary as per the *Molonglo 2 Urban Edge Landscape Master Plan*. These basins will require adjustment and/or relocation to accommodate the MTC intersection requirements.

Due to future design development of the future MTC precinct, and absence of proposed surface levels or tie-in details. The PSP intersection has been designed as a stub arrangement. This is intended to minimise abortive works during the concurring Detailed Design phase and allow innovation through development of the MTC internal road network. The verge widths have been assumed as 5m for intersection stubs. Left-Only Access into Molonglo 2 East

The *Molonglo 2 Urban Edge Landscape Master Plan, Indesco 2014* highlights that a left-turn only intersection is to be located in between the MTC intersection and the bridge along the southbound carriageway. Instruction was received at the EPSDD meeting on Wednesday 23 October 2019 to determine the feasibility of a left-turn only intersection at CH16000 which is 125m south of the southern abutment.

With the design speed along JGD3C 80km/h, a deceleration lane of 100m with 20m of storage is required for this left-only intersection. To avoid a clash with the end of the bridge, moving the access point an additional 20m south would be sufficient to accommodate an adequate deceleration lane under this design speed. This is not part of the JGD3C project and will be completed by others in a future project.

4.9 Pedestrian and Cyclist Facilities

The road design has catered for both pedestrian and cyclist facilities, with a 3m shared path in both the eastern and western verge, as well as a 2m dedicated cycle lane in each JGD carriageway. It is envisaged that these facilities will become well used once the neighbouring suburbs are fully developed and provide the means for resident connectivity in the valley.

The shared path is located 8m from the edge of the traffic lanes for both carriageways. This complies with the minimum requirements for clear zones as stated in *AGRD Part 6 Table 4.1* with Design ADT between 1501-6000 vehicles.

As per the warrant system located in *MIS05 – Active Travel Facilities Design Table 5-21*, the on-road cycle lane approaches to the MTC and Whitlam intersections require coloured pavement treatment. This is in accordance with *ACTSD-3540*.

The location of a pedestrian underpass at approximately CH15595 has been included in the PSP design. This location has been optimised to comply with connectivity with the Butters Bridge and the JGD northbound bus stop. Design checks and clash detection with aspects such as the proposed drainage and utilities design have determined the precise applicable location for the pedestrian underpass. A typical section of the pedestrian underpass is included on drawing RD-054 which assumes a culvert width of 3.6m and a height of 3m across the length of the verge for purely cost estimation purposes only. The size of the culverts, the associated drainage and lighting approach is to be further developed and designed during the D&C phase of the project in accordance with the relevant ACT standards and specifications, including, but not limited to *MIS14 Street Lighting* and *AGRD Part 6a*.

4.10 Bus Stops

Following advice received at the EPSDD coordination meeting on Wednesday 23 October 2019 and the Roads ACT meeting on Thursday 31 October 2019, the provision for two bus stop locations have been included in the JGD3C road design. These bus stops are located on the exit arms of the MTC intersection on both sides of the carriageway. A dedicated bus bay has been designed to ensure traffic disruption is minimised at each location. No bus stops/bus bays have been designed adjacent to the Whitlam.

The final location of bus stops will be guided by the MTC development and Transport Canberra during the DA process. Bus bay dimensions are to be in accordance with ACTSD-3510.

JGD2A (operational) and JGD3B (under construction) have not adopted bus priority or bus jumps into the design. As such, to enable consistency along the JGD carriageway, bus priority and bus jumps have not been included in the JGD3C PSP design.

4.11 Earthwork Quantities

The Concept Design report completed by Jacobs in 2018 noted that the cut to fill balance for the earthworks was to be minimised. This was possible at that stage of design progression given there was no intersection located in the MTC precinct.

During the development of the PSP design, the inclusion of a 4-way signalised intersection south of the bridge adjacent to the MTC and the inclusion of three permanent ponds across the project has resulted in a surplus of material due to the existing land topography. An estimate completed after the intersection was designed noted that the surplus of material would equate to approximately 96,552m^3. The assumptions from this estimate include the following:

- Topsoil replacement depth of 150mm;
- Pavement boxing based on the Final PSP pavement drawings to the subgrade level

4.12 Clear Zones

As shown on the typical sections in section 4.7 of this report, the clear-zone adopted for the JGD3C carriageway is 2.6m in the central median (to the edge of the future light rail vehicle) and 5.5m from the edge of the traffic lane. This was an instruction received from TCCS at the Roads ACT meeting on Thursday 31 October to proceed with matching the JGD3B clear-zone. In reference to *Austroads Guide to Road Design – Part 6: Roadside Design, Safety and Barriers*, this is a non-conformance and has been included in the non-conformance register located in Appendix EE.

JGD3B has no safety barriers proposed. JGD3C has inherited the same assumption and was been agreed in the Design Review Workshop; "safety barriers will be designed and installed by others" (if applicable during the future design phase). It should be noted that the PSP Road Safety Audit did not specify or comment on the requirement of safety barriers along the JGD3C mainline alignment (containing safety barriers to the bridge entry and exists only)

4.13 Site Compound & Construction Footprint

The PSP design has included consultation with various contractors about the constructability of the project, in particular the Molonglo River bridge. One contractor has provided some guidelines on the approximate size for a site compound and other facilities within the project boundary. Indicative locations for the site compound have been included in the road series drawings. These locations are within the approved project boundary which minimises the impact on the surrounding environment. The final site compound location is to be confirmed by the contractor prior to construction commencing on site. The size of the required compound is assumed to be approximately 13,500m^2 which includes the following items:

- Office and crib rooms;
- A workshop;
- Parking for approximately 100 cars;
- A laydown area.

4.14 Traffic Control Devices

Drawings for the Traffic Control Devices (TCD) have been included in the PSP design. The sequencing of traffic signals has been based on the SIDRA analysis which can be found in Appendix B. Further refinement and optimisation of the TCD's is to be undertaken during the D&C phase of the project.

5. Traffic and Transport

This section of the design report undertakes a review of the traffic and transport implications of the project including a description of the scope, existing conditions, forecast traffic volumes, assessment of intersections and construction traffic.

5.1 Scope

The scope of the project is to construct JGD3C which will be a dual carriageway arterial road replacing the existing Coppins Crossing Road. The road will be two lanes in each direction with a speed limit 70 km/h from the JGD3B project interface to CH16050 and a speed limit of 60km/h from CH16050 to the JGD2A project interface.

The scope features a signalised 3-way intersection north of the Molonglo River bridge that will provide access to residential developments in Whitlam. A signalised 4-way intersection to the south of the bridge adjacent to the MTC. Immediately north of the project will be a new intersection with the proposed Bindubi Street extension (designed by others).

5.1.1 Limitations of assessment

In preparing this assessment the following has been assumed:

- Traffic forecasts have been determined from the Canberra Strategic Transport Model (CSTM) for 2031 and 2041.
- A new priority-controlled intersection is proposed as part of a future project at CH16000, which will provide access to Molonglo 2 East. The side road has been assumed to be accessed from the southbound carriageway with a left-in, left-out access arrangement based on the CSTM data.
- The forecasts completed for the Sculthorpe Avenue intersection, provided by Calibre Consulting, do not reflect the layout of Sculthorpe Avenue and therefore the traffic modelling has assessed nominal traffic volumes at this location. These volumes should not be assumed to replace a more accurate assessment of traffic generation. It is recommended that a more detailed estimate of traffic volumes based on land use and likely distribution into and out of Sculthorpe Avenue is undertaken during the next phase of the project when clarification on traffic volumes is available.

5.2 Existing conditions

JGD2A currently ends south of the project and joins Coppins Crossing Road. Coppins Crossing Road is a two-way, two lane rural road with a speed limit of 80km/h. It currently carries in the order of 4000 vehicles per day. Coppins Crossing Road crosses the Molonglo River via a low-level bridge.

The key local roads are:

- Tuggeranong Parkway – A dual carriageway freeway with two lanes in each direction and speed limit of 100km/h. It connects Drakeford Drive to Caswell Drive and features grade separated interchanges at Cotter Road and William Hovell Drive.
- William Hovell Drive - An arterial road with dual carriageway and two lanes in each direction and a speed limit of 80km/h.
- Cotter Road - A dual carriageway arterial road that links the Tuggeranong Parkway to John Gorton Drive.
- John Gorton Drive – A dual carriageway arterial road that will connect Cotter Road to William Hovell Drive. When John Gorton Drive 3C is constructed, it will become a critical 7.2km arterial road link.

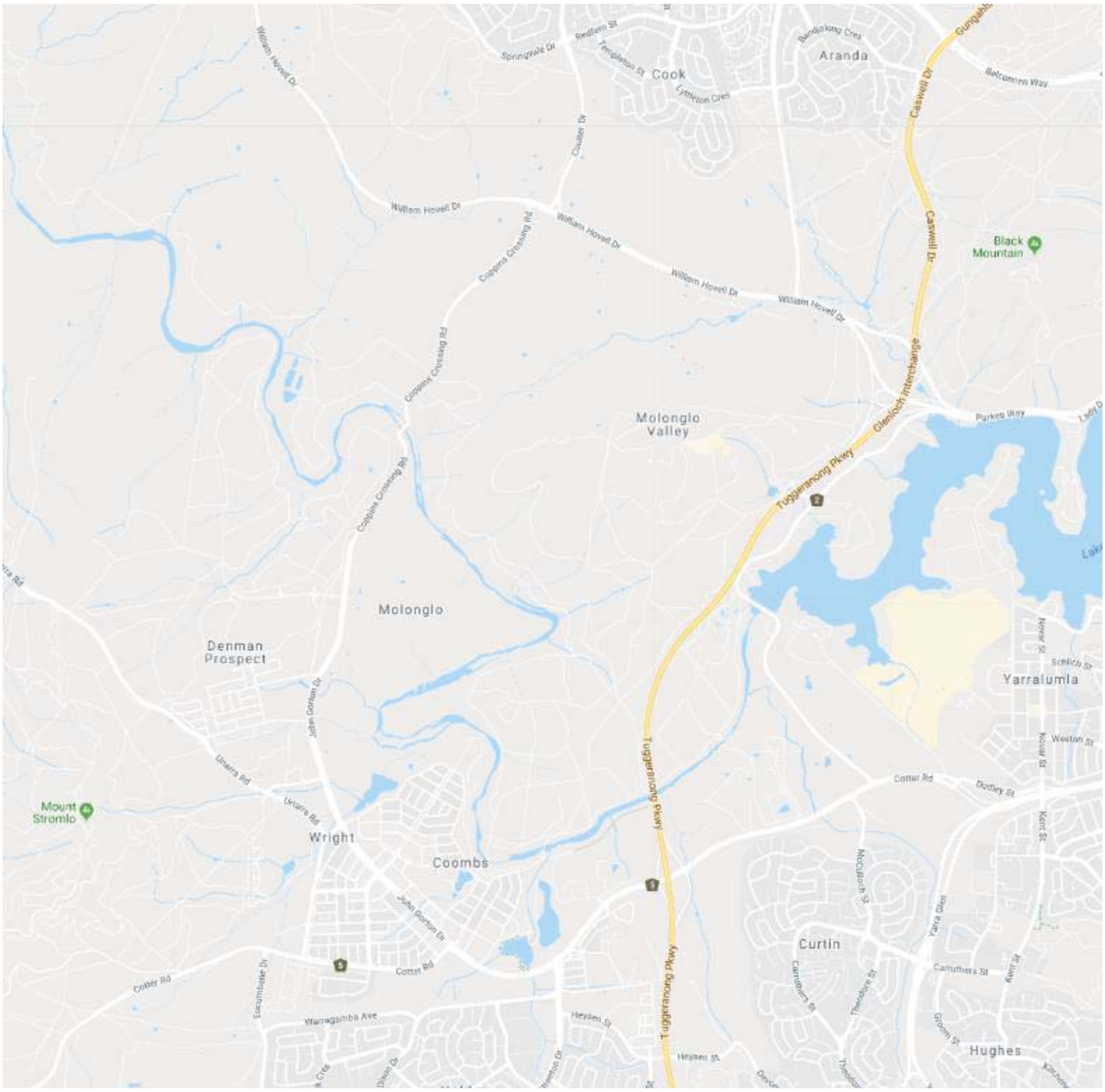


Figure 5.1 Road network

5.3 Forecast traffic volumes

Traffic forecasts have been based on the Canberra Strategic Transport Model. The forecast volumes are shown in Table 5.1 and

Table 5.2 for 2031 and 2041 respectively.

Table 5.1 2031 Peak hour traffic volume forecasts

	Morning Peak Hour	Evening Peak Hour
Northbound	1,050	1,565
Southbound	1,509	1,123
Combined	2,559	2,688

Table 5.2 2041 Peak hour traffic volume forecasts

	Morning Peak Hour	Evening Peak Hour
Northbound	704	1,669
Southbound	1,670	827
Combined	2,374	2,496

The forecast traffic volumes for 2041 are predicted to decrease relative to the volumes of 2031. In addition, the peak direction is more distinct in 2041 than 2031. This is likely due to the construction of local roads that would allow traffic to access the broader arterial road network directly and not need to use JGD. The forecasts are counter intuitive as the peak flow directions are south in the morning peak and north in the evening peak.

5.4 Operational performance

5.4.1 Volume capacity ratio

Volume to capacity (V/C) ratio has been used to provide an assessment of the assuming a capacity of 1000 veh/hour/lane. The performance evaluation criteria are shown in Table 5.3.

Table 5.3 V/C Performance Evaluation

V/C Value	Performance
V/C <= 0.85	Under capacity
0.85< V/C <= 0.95	Near capacity
0.95< V/C <=1.00	At capacity
V/C >1.00	Over capacity

Source: HCM (1994)

The results of the V/C analysis are provided in Table 5.4 for 2031. It shows that JGD3C would operate near capacity in the peak flow directions.

Table 5.4 2031 Volume capacity ratio

	Morning Peak Hour	Evening Peak Hour
Northbound	0.62	0.92
Southbound	0.89	0.66

The results of the V/C analysis are provided Table 5.5 for 2041. It shows that JGD3C would continue to operate near capacity.

Table 5.5 2041 Volume capacity ratio

	Morning Peak Hour	Evening Peak Hour
Northbound	0.41	0.98
Southbound	0.98	0.49

5.4.2 Intersection performance

Intersection performance has been assessed using SIDRA intersection models. The following has been assumed for the modelling assessment:

- 75 vehicles per turn per hour on side streets in the morning peak and 50 vehicles per hour per turn for movements into and out of Sculthorpe Avenue (Whitlam access). Vice versa in the evening peak period.
- Traffic volumes at all other intersections derived from the Canberra Strategic Transport Model.

Three new intersections have been assumed as shown in Figure 5.2, Figure 5.3 and Figure 5.4.

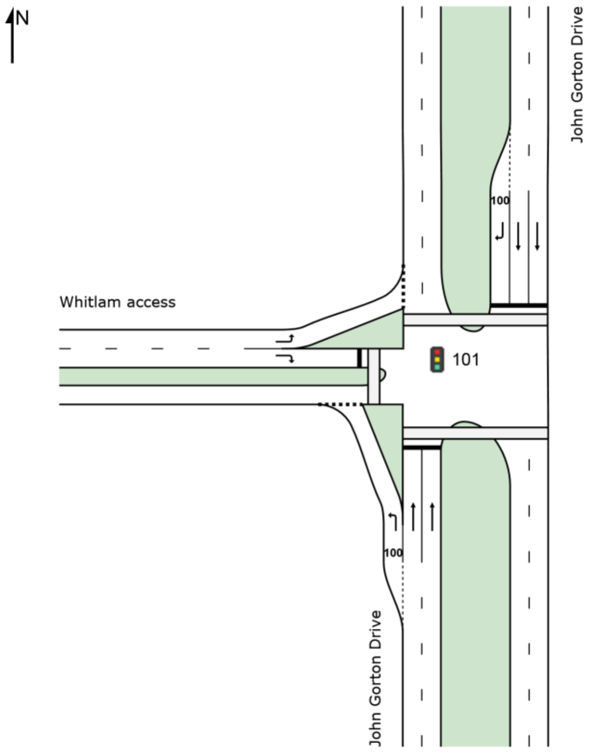


Figure 5.2 Sculthorpe Avenue (Whitlam access)

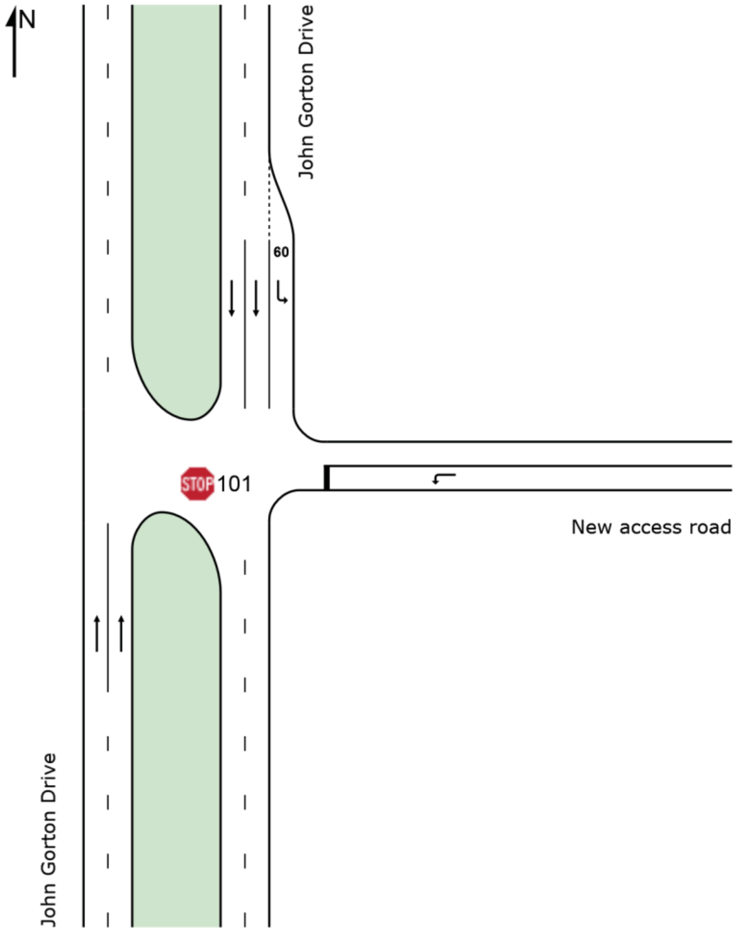


Figure 5.3 Molonglo 2 East - New access road (by others)

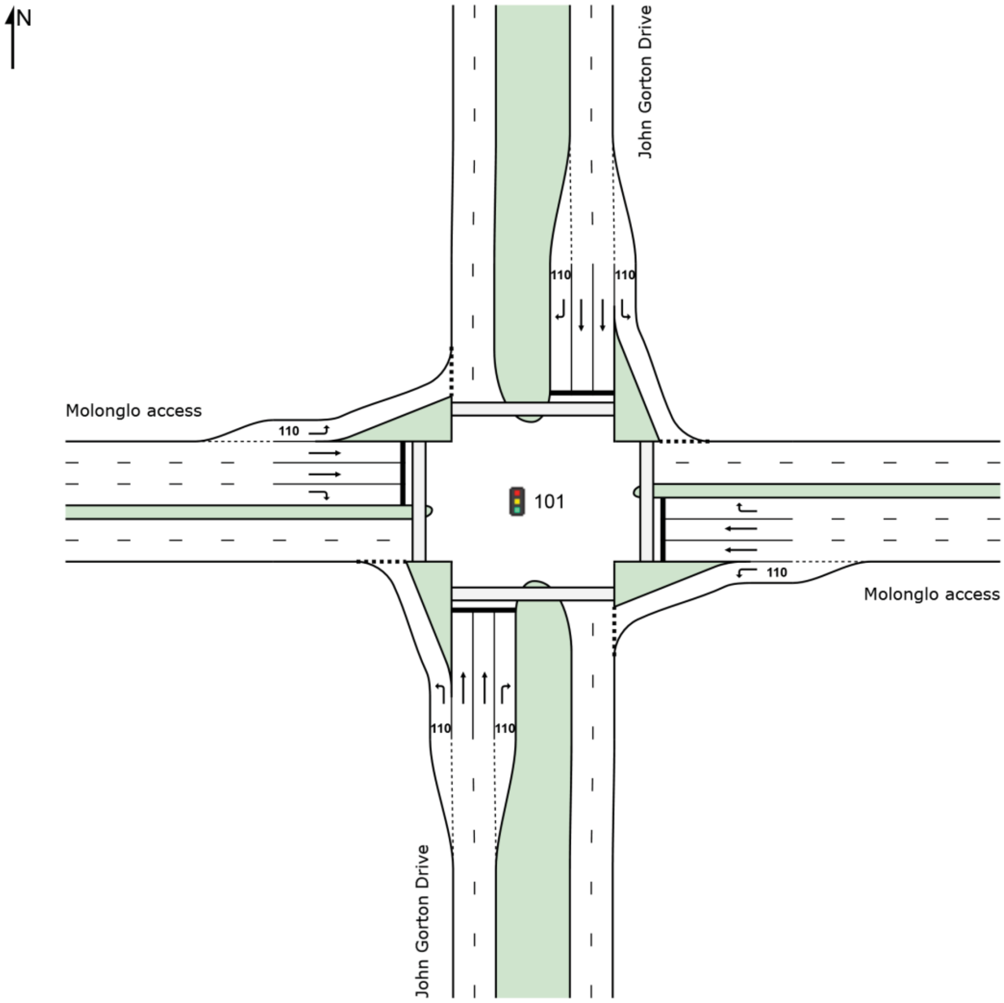


Figure 5.4 MTC Intersection (Local access intersection)

The assessment the of road network has been based on the performance of the intersections. The average delay assessed for the 2 signalised intersections is for all movements, and for priority (sign-controlled) intersections is for the worst movement and is expressed in seconds per vehicle. It is generally accepted that the target Level of Service (LoS) for intersection performance should be D or better. However, when assessing each intersections performance for parts of the road network that already experience substantial congestion over the course of the day or with future demand, achieving LoS D or better may not represent good value for money, or not be physically possible within the constraints of JGD3C. In these locations, consideration needs to be given to whether achieving LoS D is practical within the constraints of the project (Refer to Appendix B for SIDRA analysis).

Table 5.6 Level of service definitions

LoS	Average delay per vehicle (seconds / vehicle)	Traffic signals and roundabouts
A	Less than 10	Good operation
B	10 to 20	Good with acceptable delays and spare capacity
C	20 to 35	Satisfactory
D	35 to 50	Operating near capacity
E	55 to 80	At capacity; at signal,
F	Over 80	Extra capacity required

Degree of Saturation is defined as the ratio of demand (arrival) flow to capacity (also known as volume to capacity ratio. Degree of Saturation above 1.0 represent oversaturation conditions (demand flow exceeds capacity), and Degree of Saturation below 1.0 represent undersaturated conditions (demand flows are below capacity). The results of the SIDRA intersection modelling are presented in Table 5.7 and Table 5.8.

Table 5.7 SIDRA intersection modelling results 2031

Intersection	Peak hour	Average Delay	LoS	DoS
Sculthorpe Avenue (Whitlam Access)	Morning	10	A	0.72
	Evening	10	A	0.76
Molonglo 2 East Access (by others)	Morning	16	B	0.44
	Evening	12	A	0.50
MTC Intersection	Morning	12	A	0.73
	Evening	45	D	0.96

Table 5.8 SIDRA intersection modelling results 2041

Intersection	Peak hour	Average Delay	LoS	DoS
Sculthorpe Avenue (Whitlam Access)	Morning	10	A	0.80
	Evening	31	C	0.95
Molonglo 2 East Access (by others)	Morning	18	B	0.49
	Evening	10	A	0.64
MTC Intersection	Morning	10	A	0.71
	Evening	>100	F	>1

As shown in the tables above, all intersections are forecast to operate at an acceptable level of service except for the MTC intersection which is likely to approach capacity in 2031 and deteriorate to a poor level of service by 2041. This is based on the assumption that all vehicles which would perform a right turn from the proposed Molonglo 2 East Access onto the JGD3C northbound carriageway would instead perform the right turn at the MTC intersection.

A sensitivity test during the evening peak hour was undertaken to determine the proportion of vehicles that would undertake a right-turn at the Molonglo 2 East Access intersection that could be accommodated at the MTC intersection via a westbound right turn, with the remaining vehicles assumed to travel further south to perform the right turn. Results of the sensitivity test is shown in Table 5.9.

Table 5.9 MTC Intersection – sensitivity test

Intersection	Year (peak hour)	Average Delay	LoS	DoS
MTC Intersection	2031 (evening)	40	C	0.96
	2041 (evening)	42	C	0.93

During the 2031 evening peak hour, the westbound right-turn at the MTC intersection could accommodate 75 per cent of these vehicles. During the 2041 evening peak hour, the westbound right-turn at the MTC intersection could accommodate 25 per cent of the vehicles.

5.5 Public transport

Refer to section 4.2.4 and section 4.10 for detailed information on future light rail and bus stops respectively along the JGD3C alignment.

5.6 Pedestrians and cyclists

The typical cross-sections along the JGD3C alignment, Sculthorpe Avenue and the MTC Link Roads provide provision for a 2m on-road cycle lane. This matches the fixed constraints of JGD3B, JGD2A and the Whitlam development. A standard shared path arrangement is also included on both sides of all carriageways to provide a safe, off-road pedestrian and cycling option.

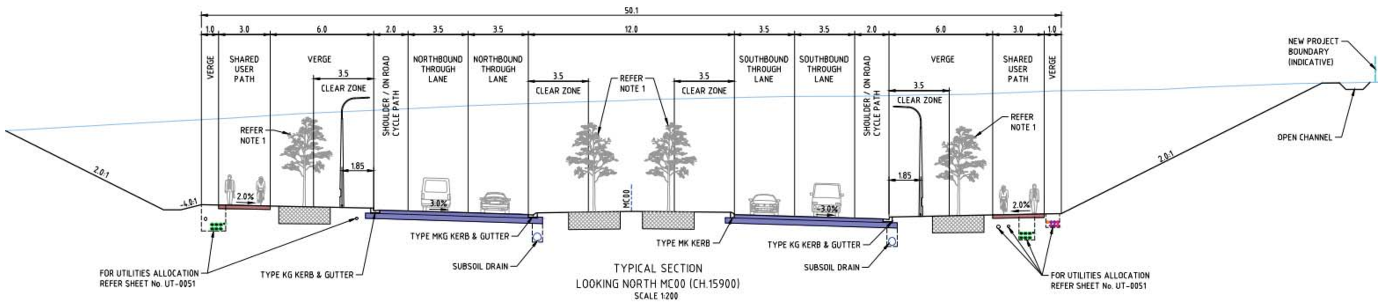


Figure 5.5 Typical Cross Section Standard Crossfall

5.7 Construction impacts

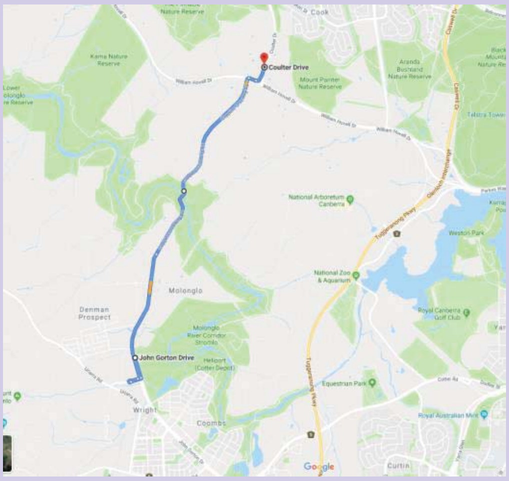
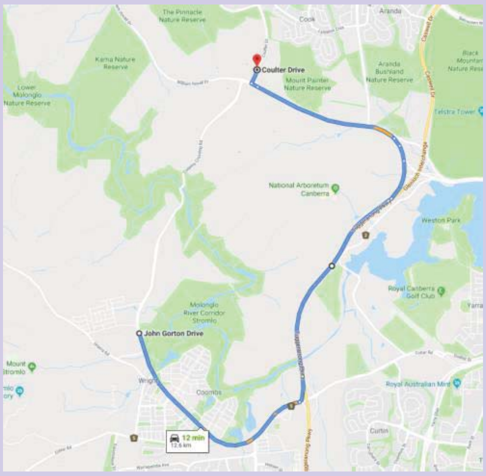
Refer to section 7.6.1 for construction sequencing of the bridge and section 18 for construction staging which outline the impact the construction phase of the project has on existing traffic conditions along JGD and Coppins Crossing Road.

5.7.1 Closure of Coppins Crossing Road

During construction of the bridge there may be short periods where Coppins Crossing Road will need to be closed to traffic to allow for cranes to operate over the road. At these times, traffic would need to be diverted via the Tuggeranong Parkway.

A vehicle travelling from Denman Prospect south of the project to Coulter Drive would be diverted along Cotter Road, the Tuggeranong Parkway and William Hovell Drive. In this example the direct route vs the diversion route is compared in Table 5.10.

Table 5.10 Diversion route comparison

	Direct route	Diversion Route
		
Time	7 minutes	12 minutes
Distance	5.6 km	12.6km

In this example the diversion route would increase the travel time by 5 minutes and the distance by 7km. It is assumed for this example that the relative speed limits on each road are adopted. It may appear that the diversion route is quick, but this averages out to be at an average speed of 63km/h in comparison to an average speed of 48km/h via the direct route from the same starting point.

A construction traffic management plan will need to be completed once the construction planning is undertaken to manage the impacts of construction on traffic.

6. Road Safety Audit

A Road Safety Audit has been undertaken, with a designer response to each safety point raised. The RSA report can be viewed in Appendix C.

7. Molonglo River Bridge Structures Design

7.1 Bridge Geometry

Both sides of the valley fall towards to the river at approximately 4% before steepening to a gorge of approximately 30m depth and 450m width at the crossing point. The proposed vertical alignment for JGD cuts through the tops of the gorge and crosses the river at approximately 23.6 metres above river level. The alignment is above the existing ground level for approximately 363 metres. The proposed bridge has an overall deck length of 227.5m with approximately 96.25m of embankment on the southern side and 39.25m long embankment on the northern side to spill through abutments.

The road is on a straight plan alignment on the river crossing and an 368m vertical sag curve with the low point approximately 28m behind the southern abutment.

The road bridges are required to support two 3.5m wide traffic lanes with 2.0m and 1.0m shoulders on the outside and inside of the lanes respectively. As shown in Figure 7.1 below, the bridges are also required to support 3m wide shared paths with a traffic barrier separation between the shared path and the roadway due to the speed of the traffic on the roadway. With this traffic barrier, external traffic barrier and parapet and screen on the outside of the shared path, the bridges will have an overall width of 14.65m. The width of the future light rail bridge is taken to be 10m wide with nominal 300mm gaps to the road bridges based on a road alignment of 12m between inside kerbs.

There is an environmental and urban design preference to maintain some space between the light rail bridge and the road bridges to allow some light to pass between the bridges. A width of 3m was discussed in the Architectural workshop on 10 April 2018 and a similar width was also discussed in the NCDRP meeting on 22 May 2019. There is however a cost penalty with the bridge pier and abutment construction, possible added complexity with the installation for the light rail bridge girders (if they are craned in from the adjacent road bridges) and cost and space implications for the approach road construction the wider the carriageways are spaced apart. It was confirmed with IDPG, after the review panel workshop, to maintain the 12m width between the inside of the kerbs on each road bridge for these reasons and the height for the bridge decks above the river allowing plenty of light under the bridges during the day. Refer to Figure 7.1.

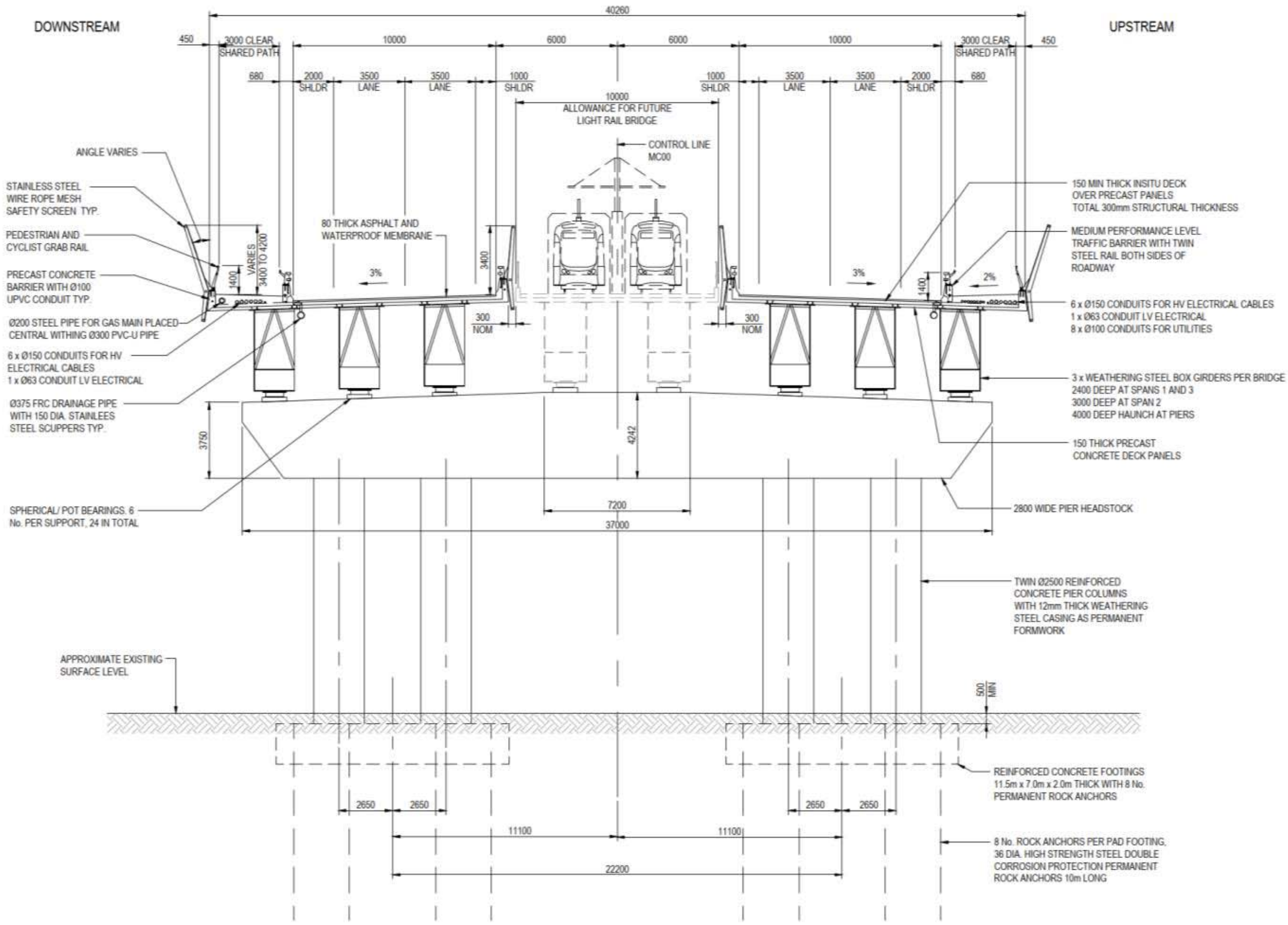


Figure 7.1 Molonglo River Bridge Cross Section

7.2 Design Criteria

The design criteria for the project are specified in the following documents:

- The Project Engineering Brief;
- TCCS Municipal Infrastructure Standards;
- Austroads Guides;
- Australian Standards including AS5100 Bridge Design Code 2017, AS4678-2002 Earth-Retaining Structures and AS2159 Piling-Design and Installation;
- Standards Australia Handbooks;
- RMS Construction Specifications; and
- Other reference documents and standards.

7.2.1 Road traffic loads

The new bridge structures shall be designed for SM1600 loads and associated dynamic load allowance factors in accordance with AS5100.2 Section 6. The 10m wide carriageways will need to be designed for 3 design lanes.

7.2.2 Heavy load platform loading

JGD is expected to be designated as a heavy haul route, the bridge structures will need to be designed for the HLP400 Heavy Load Platform positioned centrally (±1.0m) on each carriageway.

7.2.3 Construction vehicles

Given the construction works will be largely completed before the bridge is opened to traffic, the loading of any construction vehicles that will use the bridge are not expected to exceed the design SM1600 or HLP400 loadings.

The possible exception to this will be the provision for truck and crane loadings on one or both road bridges for the construction of the future light rail bridge. A requirement should be written into the criteria to demonstrate how the light rail bridge could be constructed and that the road bridges can support the expected loadings associated with the proposed methodology. This will limit the risk of costly temporary works being required for the light rail bridge construction that could be avoided or limited by including provisions in the road bridge design for the expected methodology and loadings.

7.2.4 Pedestrian and Cycle Path loads

The new bridge structures shall be designed for live loads on the shared path in accordance with AS5100.2 Section 8. The dynamic behaviour of the bridge shall be in accordance with AS5100.2 Section 13.

7.2.5 Traffic barrier loading

The selection method for the road barrier performance level has been completed for Molonglo Bridge in accordance with AS5100.1 Appendix A. The risk assessment indicates that the required performance level for the bridge is Medium Level therefore the traffic barriers on the bridge deck shall be designed for Medium Barrier Performance Level in accordance with AS5100.2 Section 12.

7.2.6 Flood Loads

The bridge will need to be designed to withstand floods up to the 2000-year Average Recurrence Interval (ARI) event without collapse or loss of structural integrity. Water flow forces including debris loading and impact will need to be considered for floods up to the 1 in 2000-year ARI event. Consideration should be given to scour but given the piers are to be founded on bed rock, scour is unlikely to be an issue. Scour will need to be considered at both abutments as they extend below this 2000-year flood level. The scour will be able to be managed with scour protection measures such as stone pitching or paver treatment.

7.2.7 Earthquake Loads

The bridge will need to be designed for earthquake loading in accordance with AS5100.2 Section 15. The Bridge Earthquake Design Category (BEDC) needs to be set for the bridge. The bridge would be classed as BEDC-3 unless TCCS/IDPG define that it essential to post earthquake recovery.

7.3 Constraints

7.3.1 Existing Road

The existing Coppins Crossing Road is a two-lane road that crosses the Molonglo River on a causeway structure just upstream from the proposed bridge crossing. The northern approach to the river passes to the west of the proposed JGD alignment before passing under the proposed bridge as it heads down to the crossing point. The southern approach remains on the eastern or upstream side of the alignment until it meets the alignment at the end of the completed JGD2A.

The proposed northern abutment of the bridge sits partially on the existing Coppins Crossing Road and the spill through batter extends over the road. The road will therefore need to be realigned in this area prior to commencing the bridge construction. The road will need to be realigned to connect into the new road network for the suburb of Whitlam, but the extent of this realignment is increased by the abutment positioning. The constraints on moving the abutment off the current roadway is also discussed in more detail in Section 7.4.1 below. The required realignment of Coppins Crossing Road, and the position of the northern abutment achieves a balanced solution given the constraints on the bridge span length, aesthetics and maintenance access and construction safety adjacent to an operating road.

The road will need to be closed for short periods during the road realignment works and the installation of the girders and the decking for the bridge. The number of closures is addressed in the constructability section 7.6. These closures will need to be managed to minimise disruption to traffic using the roadway and may need to be scheduled for the middle of weekdays or the weekend. The closures could also be undertaken at night but this would increase the cost and safety risks of the work. This would need to be considered against the level of disruption to the traffic with the daytime road possessions. The detour for the closures would be via the Tuggeranong Parkway and would add up to an additional 6 kilometres and approximately 14 minutes of travel time to journeys between William Hovell Drive and Coombs. Approval of proposed road closures from the relevant traffic authorities in the ACT will need to be coordinated and managed by the successful contractor to suit their construction methodology and program.

The existing Coppins Crossing Road has the following features:

- Two lanes carriageways with one traffic lane in each direction;
- Posted speed of 80 km/h;
- Unsealed shoulder;
- A number of tight curves with reduced speed limits and advisory signs;
- Low level river crossing with steep grade and tight horizontal curve at both approaches of the river crossing; and
- Utilised by cyclists to access Stromlo Forest Park (SFP).
- Once operational, the proposal would provide improved access for the growing community of Molonglo Valley. The upgrade will also include provision for future light rail in in the alignment, which will support the population growth generated by the development of the suburb Whitlam and other expansions over the next 30 years. However, any construction activities would need to consider how continued access between William Hovell Drive and JGD to the south of the Molonglo River would be provided to local road users. Further discussion of potential construction sequencing to maintain access is provided in Section 7.6.

7.3.2 Molonglo River

The hydrology and hydraulic assessment have been completed to define the flooding behaviour in the Molonglo River in the proximity of the project, refer to Section 16 for details. The flood loadings on the bridge are expected to be relatively small and are not expected to govern the pier designs over other loadings such as live loads and earthquake loads.

The river is approximately 80 metres wide at the crossing point and consists of 3 channels separated by rocky outcrops between the channels. The water depth is shallow, and the river bed is rock.

A summary of the flood levels is provided in Table 7.1 and includes previous values adopted from the 2015 AECOM report for comparison.

Table 7.1 Flood levels at bridge site

Flood Event	Flood Level Final PSP Design	Flood Level AECOM 2015 Report
10 year ARI	N/A	RL 509.82
100 year ARI	RL 512.5	RL 513.33
2000 year ARI	RL 514.1	N/A
Dam break Flood Level	N/A	RL 522.05

Construction access across the river would be relatively straight forward. Temporary crushed rock pads could be built out into the river for access with pipes placed within the fill to maintain the low flow in the river. The rock could be placed on geofabric to assist with its removal at the completion of any pier construction in the river. The platforms would however require the removal of existing vegetation within the river, so it would be preferable from an environmental and urban design perspective to avoid placing piers or crane platforms within the river. The use of rock pads in the river has been included in the EIS exemption application. The need for platforms in the river is discussed below and in more detail in Section 7.6 on Constructability.

The Coppins Crossing Causeway floods on average around 2 times per year. Any platform within the river would therefore have the potential of being closed by flooding during construction. After the flood waters recede, the platforms may also require repairs before being reopened for construction to recommence. This would add further delay to the construction and cost to the temporary works. Piers adjacent to the river are also susceptible to flooding but require fewer temporary works and would be founded at a higher level so they would be less susceptible to flooding than piers within the river.

The Contractor undertaking the bridge construction should be required to prepare a flood mitigation plan for the works as part of their planning documentation prior to construction. Such a plan would need to include protocols to monitor the weather for potential flooding and communications with the National Capital Authority on the operation of Scrivener Dam. Appropriate planning and implementation will ensure they have sufficient time to evacuate their personnel and plant from the area and secure the pier construction areas prior to inundation. Prefabrication of elements such as reinforcement cages should also be considered to minimise the duration of the construction of the footings or lower sections of the pier columns. Hold points should also be included on some of the construction activities so they do not proceed if heavy rain is forecast in the Molonglo River Valley during the works.

A proposed construction methodology for the bridge includes the positioning of a large 750 tonne crawler crane over the southern channel of river on crushed rock crane pad. The crane pad within the river including the crane itself would need to be managed as part of the flood mitigation plan discussed above.

7.3.3 Geotechnical

A geotechnical investigation by Jacobs was undertaken between the 2nd to 11th September 2019 and included geological mapping of the pier locations and surrounding area, borehole drilling and laboratory testing including rock strength and soil and groundwater chemistry. The Geotechnical Investigation Report is included in Appendix Z.

A previous geotechnical investigation was undertaken at the bridge site in 2015 and the findings of this investigation are documented in the report prepared by Douglas Partners of June 2015. A list of all the relevant geotechnical information available is listed below:

- Geology Map, 1:100 000 prepared for Canberra, by the Geological Survey of NSW (Sheet 8727, edition 1)
- (AECOM, 2015) Feasibility Design Report, Molonglo 3 Access and Molonglo River Bridge, John Gorton Drive (North) and Bindubi Street Extension West prepared by AECOM dated July 2015.
- (Douglas, 2015a) Geotechnical Investigation Report, Proposed John Gorton Drive Bridge Molonglo River prepared by Douglas Partners dated June 2015. (BH8, BH9, BH12, BH13, TP7, TP10, TP11, TP14, TP15 and TP16)
- (Douglas, 2017) Geotechnical Investigation Report, Proposed Road Extension John Gorton Drive 3A, Molonglo prepared by Douglas Partners dated December 2017. (TP1 to TP9)

The site is underlain by Mount Painter Volcanics with the ground profile adjacent to the river consisting of top soil, silty sands and gravels overlying residual soils and rock. The abutment area, top of bank, is located over moderate depth (3 to 5m) of soil and weathered rock, extremely weathered to slightly weathered, over dacite bedrock, medium strength or better. The base of the creek/bank appears to have been eroded, with outcropping of good quality dacite bedrock, medium to high strength.

The relatively shallow rock encountered at the proposed pier locations suggest pad footings would be the most practical foundation system given the difficulty of socketing piles into the underlying medium to high strength rock and provided groundwater ingress is controlled. At the abutments where there is a greater depth of soil and weathered rock piled foundations consisting of bored cast-in-place piles socketed into the bedrock would be suitable.

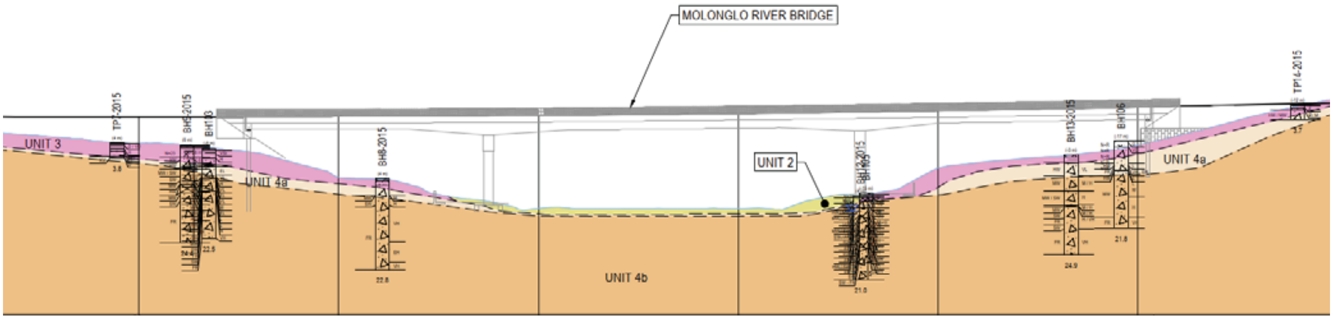


Figure 7.2 Geotechnical Long Section

7.3.4 Utilities

Refer to Table 7.2 for a summary of the utilities that the bridge will need to incorporate. For more detail, see Section 11.

Table 7.2 Utilities on the bridge.

Utility	Requirement
Electrical	6x150mm dia. conduits & 1x63mm dia. conduit for 11kV and 400V cables on both NB and SB shared path. 63mm conduits required for LV street lighting
Gas	300mm diameter PVC-U pipe to house 200mm steel gas main on NB carriageway
Communications	Shared bank of 8 x 100mm conduits on SBd shared path, including: 4 x 100mm conduits for Telstra. 2 x 100mm conduits for ICON 1 x 100mm conduit for INET 1 x 100mm conduit for ITS
Light Rail	Provision for combined services route to be included in light rail bridge cross section

7.4 Bridge design

Several bridge forms have been considered during the concept design for the bridge crossing as documented in *IA183100-RP-AD-0015_Rev04_Concept Design Report*. These include Super-T bridges, incrementally launched, precast segmental or cast in situ concrete balanced cantilever or steel composite construction. After conducting detailed options assessment and extensive workshops, the three-span steel composite bridge was accepted as the preferred option and further developed in this PSP design stage.

The PSP Stage has included industry consultation and further design development to refine the design of the preferred three span steel composite bridge. The outcomes of the consultation and the design development are discussed in the sections below.

7.4.1 Span Configuration

The bridge is proposed to have a span configuration from south to north of 60 metres, 93 metres and 72 metres for an overall length of 225 metres between abutment bearings as shown in Figure 7.3 below.

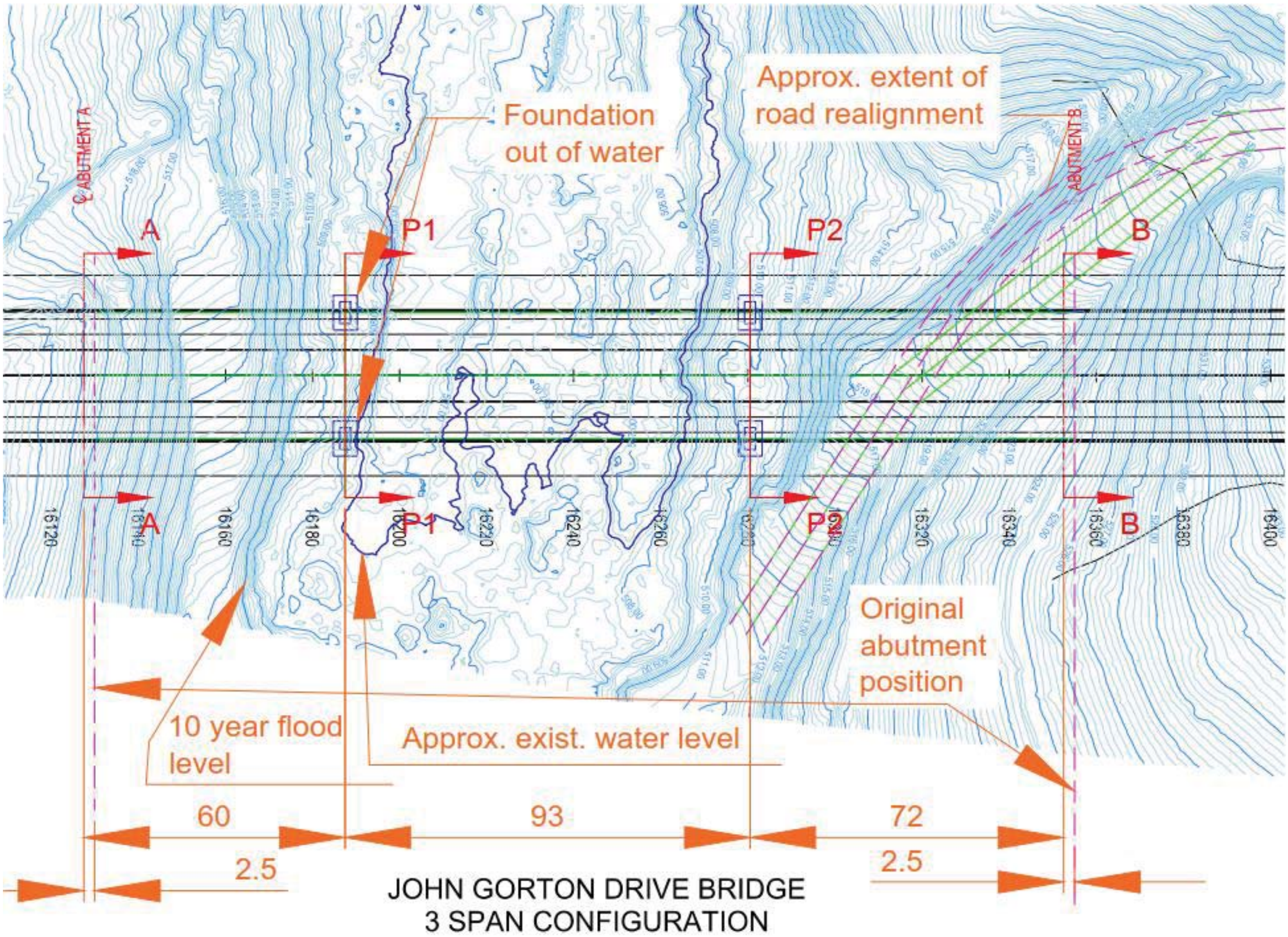


Figure 7.3 Preliminary plan set out of the bridge piers

The span configuration was set from the pier positions adjacent to the river. Pier 2 was positioned in the relatively flat area between the river bank and the embankment to the existing Coppins Crossing Road.

Pier 1 was placed on the southern bank of the river. Moving this pier further away from the river bank was investigated however this longer span would add further weight to the bridge girders and create an unfavourable span ratio of the main span to the end span adjacent to Abutment A leading to excessive uplift at Abutment A. Abutment A could be moved further to the south to address this uplift issue but that would add additional cost to the bridge structure and therefore was not considered further at this PSP stage. At the next D&C tender stage, the positioning of the pad foundations could be revisited by the Contractors and their designers to ensure the Pier 1 footing is practical to construct in its current position given the close proximity to the river edge. The position of Abutment B was also investigated to move it off the existing road alignment, but it would create an unfavourable span ratio which would add further weight to the steel girders in the end span. It is considered more beneficial to provide a local realignment of Coppins Crossing Road to provide space for the spill through Abutment B. This was discussed during the Industry Consultation and the Contractors involved supported this view.

7.4.2 Abutments

The Abutments A and B are proposed to be conventional cast in-situ reinforced concrete spill through abutments supported on bored cast-in-place concrete piles. It should be possible to support the vertical loads and retain the earth pressure and surcharge lateral loadings on the abutment with a single row of 1200mm diameter piles socketed into the underlying bedrock. The rock in this area has a sufficiently deep weathering profile, which means that the socketing should be achievable however the piling foundation contractors would need to make their own assessment during tender of the size of piling rig and auger bit required to achieve the socket. The abutments will likely consist of a headstock 2m wide by 1.5m deep with a 350mm wide curtain wall and approx. 6m long wing walls. The typical abutment cross section is shown in Figure 7.4 below.

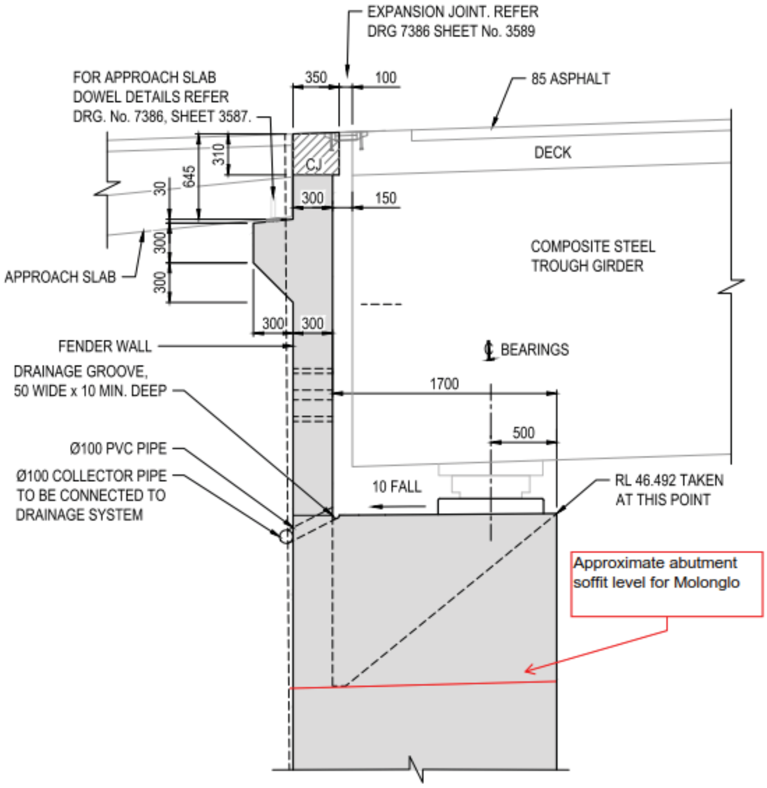


Figure 7.4 Typical Abutment Cross Section

A 1m wide flat bench would be provided in front of both abutments approximately 300mm above the bottom of the headstock level to allow access at a suitable level for the inspection and maintenance of the abutment bearings. Handrails would be required for fall protection along with access stairs from verge level down to the maintenance shelf. Both abutments will be susceptible to graffiti attack, so it will be important to fence off these areas to restrict access to the abutments and the weathering steel girders where they are less than 3 metres from ground level.

7.4.3 Piers

The piers are founded on pad footings due to the shallow depth of the medium to high strength rock, which is expected to be within a metre of ground level. The pad footings are likely to be in the order of 7m wide by 11.5m long and 2.0m deep. Passive or prestressed rock anchors may be used to hold the pad footings down under some load cases. The anchors would be used to help reduce the overall size of the pad footings. The bottom of the Pier 1 footings will be close to, or just below, the river level therefore controlling the water in the pad footing excavations needs careful attention. The Pier 2 footings are at a higher level and water ingress will be less of an issue.

The environmental impact with temporary crane pads in and around the river was considered and included in the Section 211 EIS exemption application (see Section 14.4).

The excavation will need to be undertaken with rock sawing and breakers due to the strength of the rock with a concrete blinding used to provide a level surface for the placement of the pad footing reinforcement cage. The cage can be prefabricated to minimise the time between placing the cage and casting the footings to reduce the risk of flooding during this work.

The pier columns are proposed to be a pair of circular reinforced concrete columns in the order of 2.5m diameter under each of the road bridges. The columns are proposed to be housed in weathering steel (REDCOR WR350) casings to adopt a similar appearance to the Butters Bridge piers as part of the formation of the family of bridges and be consistent with the finish on the girders in the bridge superstructure. The weathering steel casing would not be considered as a permanent structural element however would be detailed to achieve the 100 year bridge design life. The headstock is proposed to be cast in-situ reinforced concrete with a width of 2.8m and depth around 3.75m to 4.24m depth. The width is set by the clearance to the 2.5m diameter piles rather than the width required to fit the bearing and jacking positions for the bearing replacement. The headstock flat soffit and square ends with or without a tapered profile is the preferred urban design outcome providing a simplified headstock shape to emphasise the weathering steel girders and their haunch profile.

During the Tender, the option to adopt precast concrete formwork shells could be considered to avoid the need for traditional formwork at the top of the approximately 17-metre-high piers. The advice during the industry consultation was however that cost of setting up the casting and handling of the precast shells is unlikely to be competitive given the small number of piers and the pier construction probably not being on the critical path.

From an architectural standpoint on alternative pier designs, all tenderers are to provide compliant tenders to allow for accurate comparison. Any alternative approaches should be put forward separately and in addition to the compliant tenders, for ease of comparison and assessment. Consideration will be provided to alternative approaches that are put forward separately on their architectural and functional merits. Any alternative proposals that undermine the aesthetic (formal and material) or functional objectives of the design will not be considered.

7.4.4 Bearings and Expansion Joints

The bridge girders will be continuous, and each girder supported on a pot bearing/spherical bearing at each abutment and pier support. The bridge articulation proposed is for a fixed bearing at Pier 2 to resist the horizontal longitudinal loads and free/guided bearings at abutments and Pier 1. The bearings would be detailed to allow for future replacement with the use of attachment plates. Access to the pier bearings for inspection and maintenance would be from elevated work platforms or underbridge inspection units from deck level. The details including methodology and equipment would need to be provided as part of detailed design Inspection and Maintenance Plan. Access to the abutment bearings is from the horizontal maintenance bench provided directly in front of the abutment headstock.

To allow for thermal expansion and contraction of the bridge expansion joints in the deck are provided at each abutment. These can be can proprietary finger or saw tooth joints. The risk to cyclists on narrow road tyres will need to be considered in the final selection of the expansion joint type.

7.4.5 Steel girders

Steel trough girders are proposed with a variable depth from 2.4m deep at the abutments and 3m midspan to 4.0m at the piers. Three variable depth girders are proposed under each carriageway bridge with vertical web profiles. This arrangement provides an efficient design due to the depth being more targeted to where the highest bending in the girders will occur and for aesthetic reasons of keeping the girder as shallow as possible at midspan and deepening the girders where they land on the pier supports. Three girders also balance the constraints with regards to reducing the weight for handling and lifting into position, as well as limiting the width and depth of the girders for transportation. The use of three girders also works well for the proposed permanent precast formwork system that is being recommended for the bridge (refer to Section 7.4.6 for discussion) and will allow two of the girders of similar design to be used for the narrower future light rail bridge.

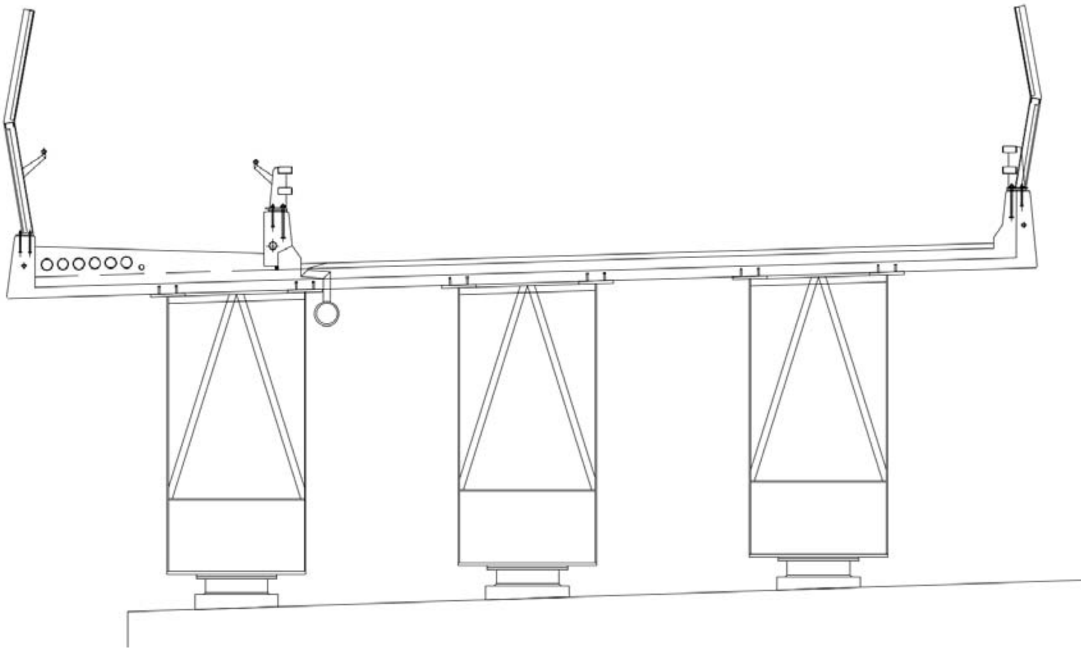


Figure 7.5 Typical Bridge Cross Section with Variable Depth Steel Girders

The manufacture and handling of the girders is an important consideration in the design development of the bridge. The girders could be manufactured in Sydney, Melbourne, Northern Tasmania or South Australia. They will be brought to Canberra on trucks and the depth needs to be minimised, so they will fit under the bridges over the Hume and Barton or Federal Highways. For this reason, the maximum depth of the girders has been limited to 4.05 metres with the 200mm high shear studs on these deeper pier sections having to be installed on site prior to lifting the girders into place to further control the height during transporting.

The girders are proposed to be 2000mm wide with 600mm wide top flanges to give an overall width of 2600mm. The depth will vary from 2400mm deep in the end spans to 4000mm deep at the piers and 3000mm deep at midspan on the main span over the river. The flange and web plate thickness has been varied along the span of the girders in proportion to the loading demand required. Plate thickness in the web vary from 16 to 25mm and in the flanges vary from 25 to 80mm. The total weight of the girders will be in the order of 495 tonnes (single girder with overall length of 226.4m) or 1485 tonnes per road bridge (3 girders with overall length of 226.4m) and approx. 990 tonnes for the future light rail bridge (2 girders with overall length of 226.4m).

The girders will need to be brought to site in a series of segments that are spliced together on site with bolted splices. This could either be a series of 8 segments up to 33 metres long with a maximum weight of 80 tonnes for the pier sections or longer 5 segments up to 48 metres with a maximum weight of 115 tonnes. The shorter sections will have a higher fabrication cost and work on site for the splice connection but reduced handling and transport costs due to their shorter length and reduced weight. The decision on the preferred segmentation of the girders would need to be made with the Contractor and their Fabricator during detailed design. The proposed methodology for the installation of the girders is provided below in Section 7.6.3.

The main structural plate elements of the girders are weathering steel, REDCOR WR350 complying with AS/NZS 3678. To cater for loss of structurally effective material due to the development of rust patina during the 100 year design life of the bridge a 1.0mm per surface corrosion allowance is to be considered for exposed surfaces and 0.5mm for interior surfaces as per AS5100.6. With limited availability of hot rolled weathering steel products the bracing elements, typically angle sections, would be conventional Grade 300 hot rolled sections. These internal bracing members of the girders would require a protective coating only while all other elements both interior and exterior would be the weathering steel with no protective coating. Alternatively, fabricated sections or bent plates in weathering steel may be considered to replicate the hot rolled sections in detailed design.

Inspection and maintenance of the bridge and in particular the steel girders is proposed to be carried out using a number of methods. A visual inspection could be undertaken using Elevated Work Platform (EWP) from ground level, an under-bridge inspection unit parked on the bridge deck, or remotely operated drones with digital imaging recording devices. Internal access into each steel girder will be provided with an access hole through the bottom flange at each abutment end and openings within the pier diaphragms allowing access throughout. Consideration needs to be given to how much scope the tenderers can have to provide alternative girder designs for aesthetic or construction reasons as this will need to be addressed in the tender documents. From the discussions during the design development, concrete alternatives will be ruled out for the superstructure because the weathering steel girder has been accepted as the preferred form for aesthetic reasons and to minimise construction activity during the installation of the future light rail bridge. The girders should also be as shallow as possible at midspan and increase in depth to land on the piers. The tender documents should therefore specify that the tenderers provide a haunched weathering steel girder superstructure as a conforming tender.

It is however recommended that consideration be given to accepting non-conforming tenders with constant depth weathering steel girders if this is proposed by the contractors. Although this will provide an inferior aesthetic outcome, there is likely to be a cost saving with constant depth girders. Firstly, by allowing the full bridge deck to be launched into place with smaller cranes and/or less temporary works than the haunched option. Secondly, if the girders are launched, two girders could be used allowing a potential saving in overall steel tonnage due to the reduced requirements for internal stiffening and bracing compared to the three girder PSP design. The heaviness of the girders in the back spans and midspan could be partially offset by using a tapering web.

The cost saving may not be sufficient enough to justify moving away from the preferred haunched design, but it would allow a value for money decision to be demonstrated if constant depth girder alternatives are allowed to be submitted.

7.4.6 Bridge Deck

The bridge deck will be required to act compositely with the steel girders to maximise the strength and stiffness of the superstructure. A cast in situ concrete connection will need to be made between the deck and girders to achieve the composite action. A fully cast in situ deck system would be costly and introduce working at height risks with the installation and removal of the formwork. For these reasons a cast in situ deck constructed on a precast concrete permanent formwork system is recommended for the bridge. This could either be a proprietary system from one of the major precasters such as Humeslab from Holcim and Transfloor from Hanson Precast or a bespoke system developed by the Contractor with a local precast supplier.

Figure 7.6 Humeslab being used on Airport Link in Brisbane

Figure 7.7 Bespoke decking system being used on the Darlington Upgrade in Adelaide.

The bespoke deck units worked well on the Darlington Upgrade Project to form a safe working platform for the completion of the reinforcement and the casting of the bridge deck and traffic barriers. The construction of the deck units was a two-stage process with the parapets being cast flat with the outside face down in the mould. The parapet units were then stood up for the casting of the deck slab section of the unit. Pockets were cast into the deck for the shear studs required for the composite action. The barriers on the inside face of the parapets and the shared path slab were cast after the deck slab was cast and reached sufficient strength for composite action with the girders. This process allowed a consistent high-quality finish to be achieved in the parapets as shown in Figure 7.7.

For the Molonglo River Bridge, a pair of L shaped units are proposed for the wider road bridges and single unit similar to the Darlington Upgrade for the Light Rail Bridge. The use of this type of deck would be reliant on having a Precaster in the Canberra-Queanbeyan area with the capability and capacity to make the units or the Contractor setting up their own casting facility for these elements. Given the cost of setting up a casting facility, the Contractor is expected to adopt the proprietary systems with separate precast concrete barriers connected to the completed deck due to the reduced handling and transport costs of these systems.

The deck is expected to be in the order 300mm thick including precast and cast in-situ thickness. The shared path would be a separate pour with the level set higher to accommodate the combination of 150mm and 100mm conduits for the HV and communications cables and 300mm conduit to house the gas main within the slab.

7.4.7 Barriers and Screens

A barrier risk assessment to determine the required performance level for the bridge has been undertaken in accordance with AS5100.1. The assessment considers the road grade and curvature, deck height and land use below the bridge to calculate an adjusted Average Annual Daily Traffic (AADT) which is then used together with the design speed and percentage of commercial vehicles to determine the barrier performance level from the relevant figure. The outcome of this assessment indicates medium performance level barriers are required. Refer to Appendix D for the barrier risk assessment. The proposed bridge barriers are a truncated Type-F concrete barrier with twin steel rails like the Malcolm Fraser Bridge. It is provided on the median side of the bridge deck and in between the road carriageway and the shared path.

The need for safety screens on the bridge has been assessed based on the risk assessment contained within RMS BTD2012/01, refer to Appendix D. Given the proposed future development of the surrounding area several assumptions have been made with respect to the proximity of pedestrian traffic generators such as schools, clubs, sporting venues etc. Taking conservative assumptions, the assessment indicates safety screens are required. Other factors which the assessment does not consider is potential for self-harm and the proximity of the future light rail structure, if we take these into account the recommendation is to provide safety screens on the bridges. A parapet with low height concrete kerb, is provided on the shared path with a screen as per architect's recommendations. Rub rails at 1400mm high on the screen and the back of the twin steel rail traffic barrier to the roadway protect the cyclists by minimising the risk of impact with the screen and barrier. The screen height has been set at a minimum 3.4m high so the top of the screen is 2 metres above the top of the traffic barrier and cyclist rub rail to reduce the risk of the screens being climbed.

Figure 7.8 Proposed screen arrangement

The design criteria for the screens needs to be a coordinated with urban design input. The detailing requirements set out in the RMS BTD2012/01 may not provide the best aesthetic outcome and therefore ongoing design and coordination of the screens is required during detailed design to set the design criteria. The preferred screen arrangement, materials and finishes are provided in Architecture drawing package and discussed further in Section 7.5 below.

7.4.8 Utilities and Drainage

As noted in Section 7.3.4, the bridge will be required to support electrical and communications services, and a gas main. As also noted in Section 7.3.4, the intention is for the high voltage cables to be housed within the shared path slab with electrical conduits placed in the traffic barriers for the street lighting.

Scuppers and a drainage pipe will be required to collect the stormwater runoff from the road and shared path and direct it to the southern Abutment A where it can be discharged into a collection pit and then into the approach road drainage. The road will fall towards the shared path and the stormwater pipe will be located on the inside of the edge girders.

7.4.9 Lighting

The bridge lighting will be important to meet the Lux levels required on the roadway and shared path while not detracting from the appearance of the bridge and to minimise the light spill and subsequent effect to the Stromlo observatory. Please refer to section 11.3.8 and Appendix S for further details.

7.5 Architecture

The detailed architectural assessment for the bridge crossing is contained in the Architectural Statement of Requirements. The statement builds on the ACT Government Inter-Directorate workshop held on 10th April 2018 that included the ACT Government Architect and agreement on the 3-span option moving forward. A summary of these requirements is provided below.

7.5.1 Architectural input into the bridge design process

The purpose of identifying the architectural parameters for a bridge design is primarily to ensure the overall design responds to the aesthetic, environment and scale of the particular context within which the bridge is to be constructed. This includes recognising all the adjacent human activities anticipated as well as the conservation and celebration of the natural landscape affected by the bridge. Ideally, the final design of the bridge should improve rather than detract from the existing natural site conditions as well as the future urbanised adjacent development.

7.5.2 Background

Although the location of the proposed new bridge at Coppins Crossing is currently in an area of open degraded grassland on either side of the relatively untouched Molonglo River Valley, the context within which the bridge needs to be designed is quite different. With the imminent expansion of urban development on both sides of the Molonglo River Valley, the bridge will be a highly visible element immediately adjacent to a large Town Centre as well as the surrounding residential development. At the same time, the river valley corridor across which the bridge spans will become an important natural landscape focal point and recreational facility for the surrounding communities. The design therefore needs to respond architecturally to both the urban location as well as the natural landscape flowing beneath.

With one bridge in the area currently completed, the John Gorton Drive bridge imminent, and a third future bridge all within a few kilometres, the ACT Government has recognised both the aesthetic need for, as well as the economy of, establishing common design features to create a “family of bridges” appropriate for their shared unique context. The existing Butters Bridge provides some key elements from which the design principles for all three bridges can be based, while at the same time allowance will need to be made for the different structural and functional requirements of the two larger road bridges to come.

7.5.3 Summary of recommendations

1) Piers:

Location: The location and number of piers should be determined with a view to minimising the impact on the river below with due regard to the economy and efficiency of the spans between piers involved. Locating piers within the natural watercourse should be avoided.

Type: The existing circular Butters Bridge piers of permanent weathered steel formwork demonstrate an economical and aesthetically appropriate form and colour most sympathetic to the surrounding natural landscape. Low long-term maintenance of weathered steel is an additional advantage. Paired circular steel clad piers can be used where road bridges require significantly higher load capacity.

2) Headstock:

The headstock capping across piers supporting the larger road bridges are appropriate in natural off-form concrete (Class 2 finish in accordance with RMS B80 Specification finishes). This visually relates to the Butters Bridge piers connecting directly with the concrete spans while also recognising the structural loads the headstocks need to resolve.

3) Spans:

Structural Efficiency: With the need to avoid piers landing within the natural water course, a centre span of some 90 meters is required. The previously used incrementally launched concrete spans are limited to 50 metre spans. A viable structural alternate to achieve this greater span is to use boxed steel sections.

Material: Using prefabricated boxed steel span sections of weathering steel will further visually blend the bridge into the background of natural Australian landscape colouring.

Profile: To further introduce economy and structural efficiency as well an elegant visual impact, a haunched profile of the steel box beams will reduce the visual weight of the spanning beams.

4) Safety screens:

Functionality: The safety screens need to ensure the safety of people using the bridge. In addition, they need to allow views from the bridge rather than visually enclosing people on the bridge. The view of the bridge from afar should also be enhanced by maintaining as much transparency in the screens as possible.

Profile: The overall combination of height and cross-sectional profile needs to dissuade climbing while adding visual interest to the overall design.

Materiality: In order to reduce the visual weight of the screens, they should be light in colour, as transparent as possible, but be easily maintained and dissuade graffiti artists. Perforated metal as used on the Southern side of the Butters Bridge achieves these aims and can be used as a precedent for the subsequent bridges.

5) Lighting:

It is recommended that all lighting on the bridges be low level continuous strip lighting and that high level street lighting be avoided. This design approach is consistent with other important bridges in the ACT and will reduce the visual impact of the bridge at night as it crosses the natural landscape of the river valley as well as reducing light spill. If high level lighting is required on the bridge, it is recommended to use high pressure sodium lamps as implemented along John Gorton Drive stage 2A to minimise the light spill and subsequent effect to the Stromlo observatory.

7.6 Constructability

Industry Consultation was undertaken at the commencement of the PSP. Representatives from IDPG, TCCS and Jacobs met with the Steel Fabricator, S&L Fabricators and the Contractors, Lendlease and Fulton Hogan in Sydney on 21st May 2019 and with Peter Hawkins Engineering in Canberra on 26th June 2019. Advice was also sort from Boom Logistics on the cranage requirements to lift the steel girders into place. They provided a crane plan for the installation girders on 20th June 2019.

The purpose of the consultation was to obtain feedback on the three-span steel girder concept. The summaries of the feedback from the meetings on 21st May is contained in Appendix G. The Contractors questioned why an incrementally launched bridge or cast in-situ balanced cantilever bridge wasn't adopted. They accepted the reasons around aesthetics and installation of the future light rail bridge and advised that the steel option was viable although it was likely to cost more than the concrete alternatives. The main issue they have is with the installation of the steel girders in the main span. They wanted clear guidance in the tender documents on what alternatives would be considered and what constraints there are on temporary works around the river. This can be provided with confirmation that the conforming tender requires a three-span bridge using weathering steel girders with a haunched profile. Constant depth steel girders may be considered but concrete alternatives such as balanced cantilever or the inclusion of additional piers within the river will not be considered.

The options for the installation of the girders are to lift the girders in using a large crane from pads in the river and behind the piers or a partial or full launch of the steelwork. The installation measures are covered in the section below.

7.6.1 Construction Sequence

A possible sequence for the construction of the road bridges is provided below in Table 7.3, which should be read in conjunction with Figure 7.9 and Figure 7.10. The staging of the girder installation is further detailed in Section 7.6.3 of this report.

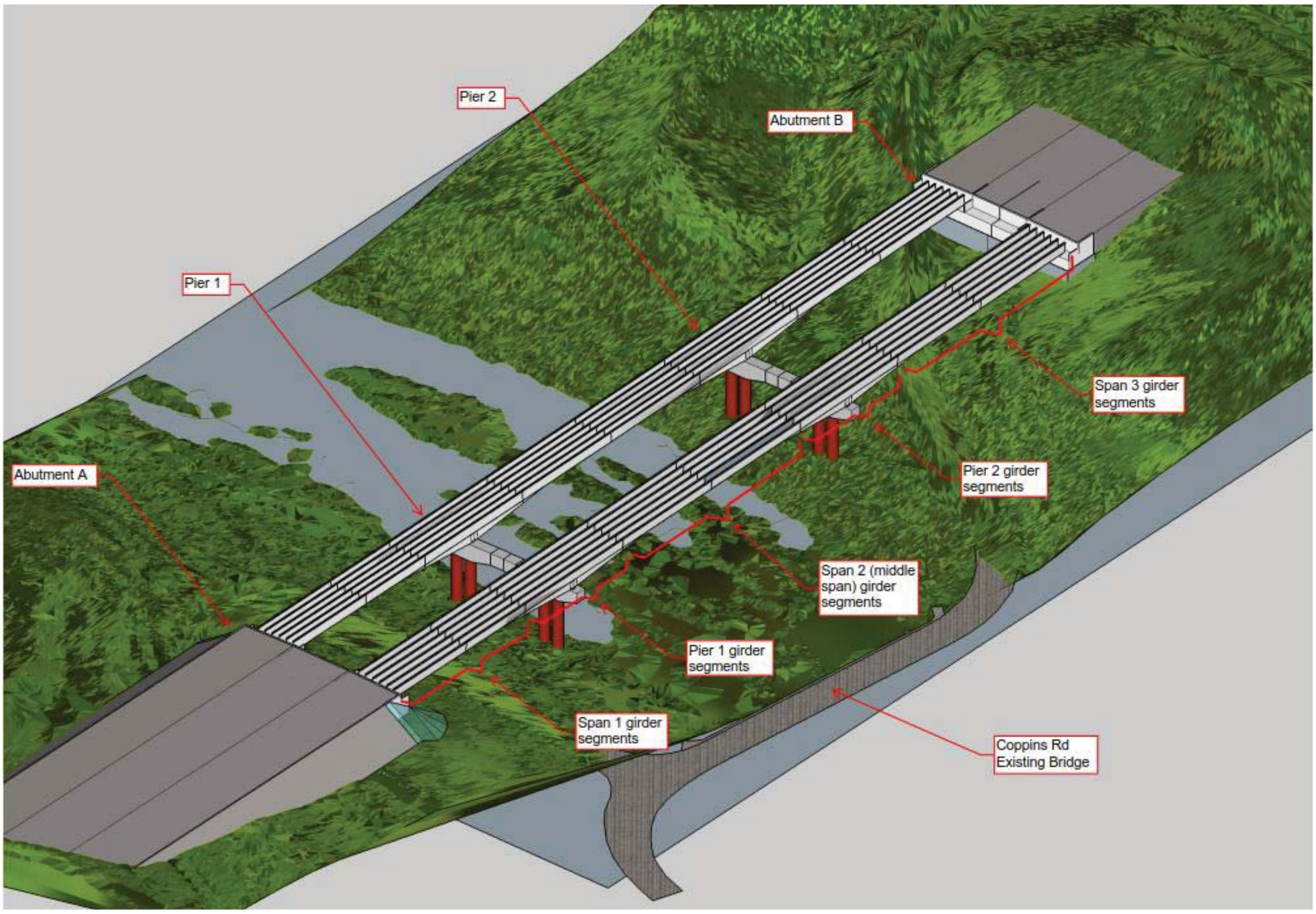


Figure 7.9 Girder Annotations

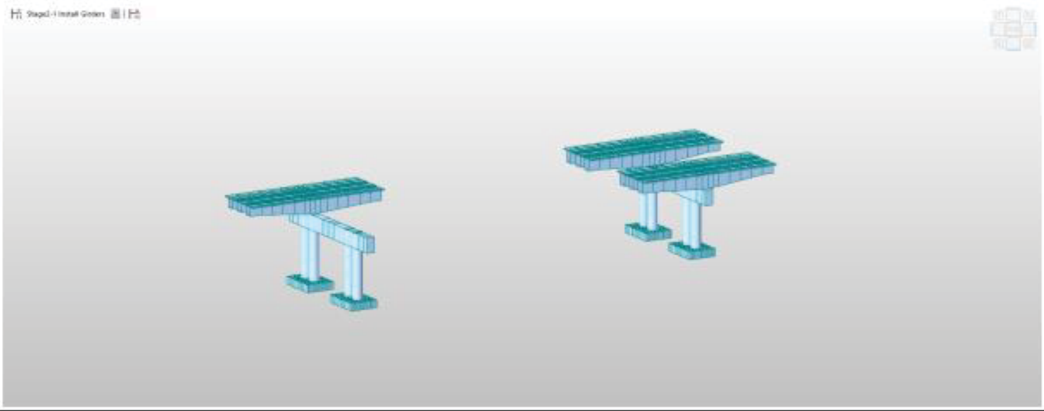
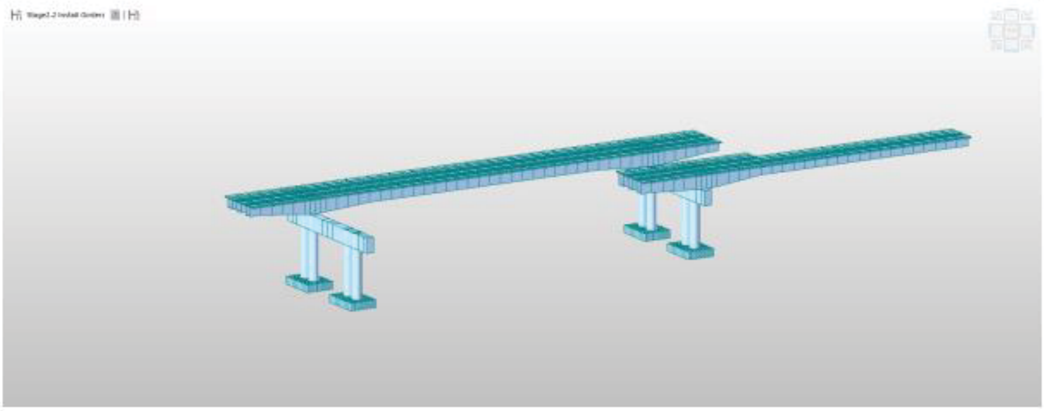
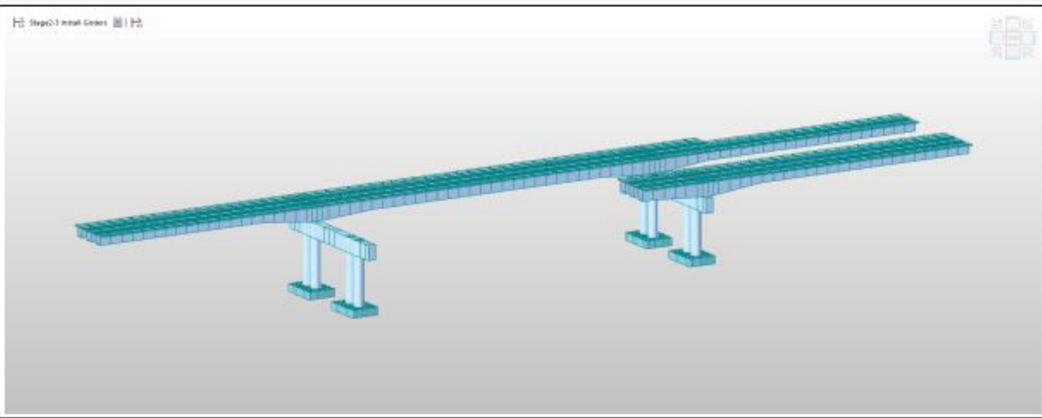
The sequence has been prepared based on the installation of the girders using a crane.

Table 7.3 Sequence of road bridges construction

	Activity	Road Closures
1	Site establishment	No
2	Construct access tracks from Coppins Crossing Road	Short closures for tie in of access track. Possibly reduce to one lane bi-directional for a weekend.
3	Commence realignment of Coppins Crossing Road	The road will need to be closed possibly for a weekend for the tie ins
4	Commence earthworks on the approaches	No
5	Switch traffic onto Coppins Crossing Road Realignment	Short closure of a couple of hours to make the switch. Probably undertaken on a weekend
6	Undertake the piling for the abutments	No
7	Excavate for pier pad footings and install concrete blinding	No
8	Cast the pier pad footings	No
9	Construct the abutments	No
10	Stand the steel casings and construct the pier columns	No
11	Construct the pier headstocks	No
12	Complete the backfilling to the abutments	No
13	Install the bridge bearings for the southbound bridge	No

	Activity	Road Closures
14	Bring in the pier 1 and pier 2 segments of the northbound bridge girders and pier 2 southbound girders and install them onto the piers with temporary tie downs/props to keep them stable.	This will require a 2-day weekend closure
15	Bring in the main span segments of the northbound bridge and (if required splice them together if two segments are used) then lift them into position and splice them to the pier segments	This will require a 1-day weekend closure
16	Bring in the northern end span segments of the southbound bridge and (if required splice them together if two segments are used) then lift them into position and splice them to the pier segments.	This may require a 1-day weekend closure or between 9am and 3pm on a weekday.
17	Bring in the southern end span segments of the northbound bridge and (if required splice them together if two segments are used) then lift them into position and splice them to the pier segments.	This may require a 1-day weekend closure or between 9am and 3pm on a weekday.
18	Bring in the northern end span segments of the northbound bridge and (if required splice them together if two segments are used) then lift them into position and splice them to the pier segments.	This will require a 1-day weekend closure or between 9am and 3pm on a weekday.
19	Commence the installation of the precast concrete deck units for the northbound bridge.	This will require a closure of 4 hours to lift the deck panels in across the road.
20	Bring in the pier 1 segments of the southbound girders and install them onto the pier with temporary tie downs/props to keep them stable.	This may require a 1-day weekend closure or between 9am and 3pm on a weekday.
21	Bring in the southern end span segments of the southbound bridge and (if required splice them together if two segments are used) then lift them into position and splice them to the pier segments.	This may require a 1-day weekend closure or between 9am and 3pm on a weekday.
22	Bring in the northern end span segments of the southbound bridge and (if required splice them together if two segments are used) then lift them into position and splice them to the pier segments.	This will require a 1-day weekend closure or between 9am and 3pm on a weekday.
23	Commence the installation of the precast concrete deck units for the southbound bridge.	This will require a closure of 4 hours to lift the deck panels in across the road.
24	Commence the casting of the deck for both northbound and southbound bridges using a series of deck pours working from the abutments to the middle of the bridge	This will require a closure of 4 hours to cast the deck over the roadway
25	Cast the traffic barriers, install the utility conduits and cast the shared path slab	No
27	Install the screens and lighting	This will require a closure of 4 hours to fit the screens over the road
28	Complete the finishing work on the road approaches	No
29	Shift the traffic onto the completed bridge	Short closure of a couple of hours to make the switch. Probably undertaken on a weekend
30	Complete the remediation work around the river to remove the crane platforms	No

The crane lifting diagrams prepared by Boom Logistics are contained in Appendix E.

Construction Stage	Configuration
Girder Installation Stage 1 - Pier 1 girder at NB - Pier 2 girders at both NB & SB	
Girder Installation Stage 2 - Span 2 girder at NB - Partial installation of Span 3 girders at SB	
Girder Installation Stage 3 - Span 1 girder at NB - Partial Installation of Span 3 girders at NB - Complete Span 3 girders at SB	

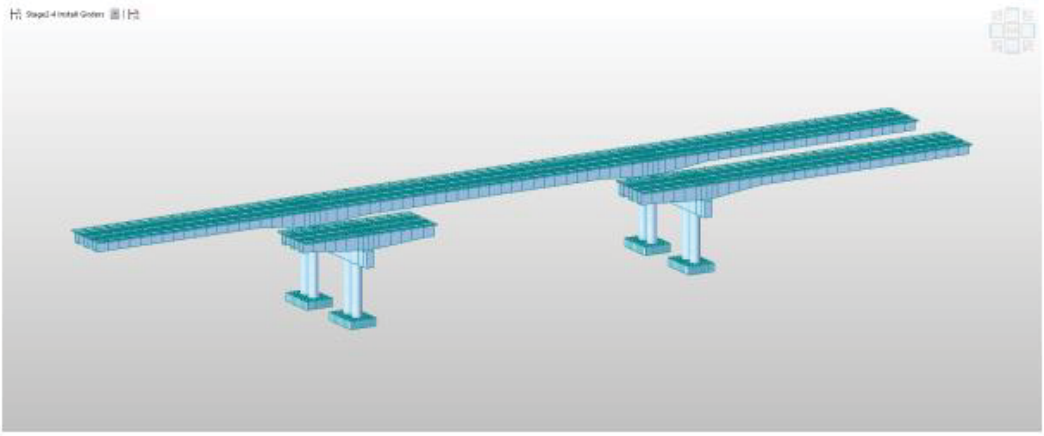
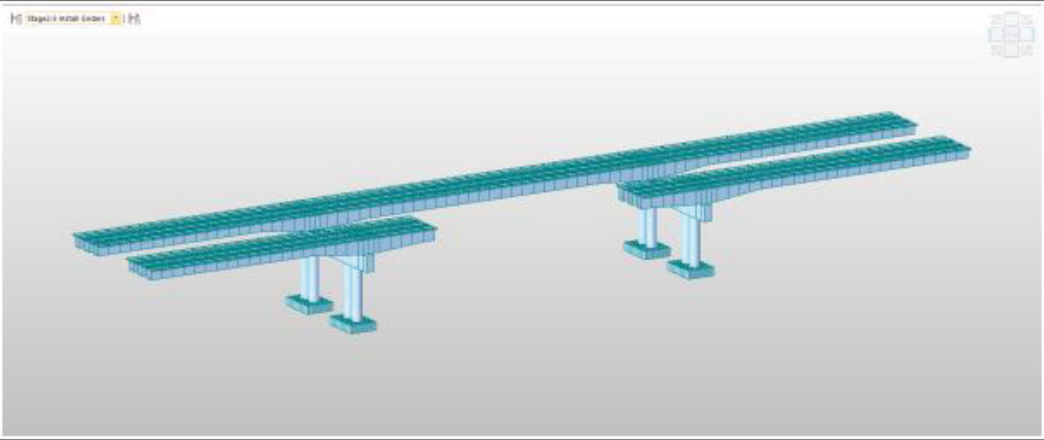
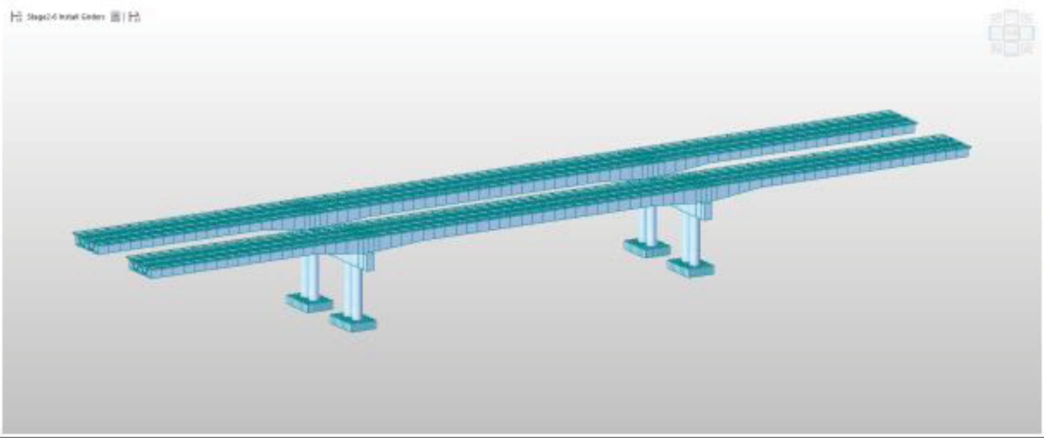
Construction Stage	Configuration
Girder Installation Stage 4 - Complete Span 3 girders at NB - Pier 1 girder at SB	
Girder Installation Stage 5 - Span 1 girder at SB	
Girder Installation Stage 6 - Span 2 girder at SB	

Figure 7.10 Girder Installation Stages

7.6.1.1 Alternative Launched Installation of Girders

The alternative is to partially or fully launch the superstructure. Sketches of the launching options are contained in Appendix F. The concept is to install Pier 2 and Span 3 segments (northern end span) using cranes following the sequence above. The southern sections of the steelwork would then be assembled progressively on temporary runway beams and support framing over Pier 1 and Span 1 then launched across Span 2. This option is considered feasible and avoids the need for the large crane in the river. It is recommended to launch the girders individually to provide more tolerance for the connection of the girders at Pier 2. It will however have the cost and time penalty of having to assemble the temporary works for the launching of the northbound bridge steelwork and then the disassembly of the temporary works and reassembling for the southbound bridge launch.

The extent of the temporary works required for a full launch would be less than a partial launch because the girders would be assembled behind one of the abutments and all three (or two) girders can be launched together with the cross bracing between the girders and the formwork panels installed for the sections beyond the cantilever sections. It would be too inefficient to launch the girders across the full 93 metres of Span 2, so a temporary pier or frames would be required at one or both of the piers to reduce the cantilever length down to around 60 metres. The full launch would however require constant depth girders to reduce the launching complexity. The issue of constant depth girders compared to the haunched girders is discussed in Section 7.5.3.

7.6.1.2 Construction Sequence for the Light Rail Bridge

A possible sequence for the construction of the light rail bridges is provided below in Table 7.4.

Table 7.4 Sequence of future light rail bridge construction

	Activity	Road Closures
1	Site re-establishment	No
2	Commence construction on the light rail approaches to the bridge	Single lane closures as required to set up access to the median for the light rail construction
3	Install the light rail bridge bearings	No
4	Temporarily close the bridges and bring the light rail bridge pier segments onto one of the bridges and use a crane on the other bridge to lift them into position. Use temporary props and tie downs to keep the segments stable.	These will probably need to be two-night closures for each of the piers or possibly a full weekend closure for both
5	Temporarily close the bridges and bring the light rail bridge end span segments onto one of the bridges and use a crane on the other bridge to lift them into position. The end span segment adjacent to the Northern abutment may sit a two-crane lift.	These will probably need to be two-night closures for each of the end spans or possibly a full weekend closure for both
6	Temporarily close the bridges and bring the light rail bridge main span segments onto one of the bridges and use a crane on the other bridge to lift them into position using a two-crane lift.	This will probably need to be a single night closure and Sunday closure
7	Commence the installation of the precast concrete deck units using a temporary closure of one the carriageways.	This can be undertaken using single carriageway weekday (10am to 3pm) or night closures
8	Commence the casting of the deck using a series of deck pours working from the abutments to the middle of the bridge. This could be completed with or without closures on one of the carriageways	This can be done using single carriageway weekday night closures. This can be coordinated between Items 7 and 8 to minimise the number of closures to possibly 8 in total. The other bridge could possibly be set up for single lane bi-direction travel during these times
9	Install the track and track slabs	No
10	Install the combined services and walkway(s)	No
11	Install the screens and lighting	No
12	Complete the finishing work on the track approaches	No

7.6.2 Substructure Construction

The spill through Abutment A construction should be relatively straight forward given that it is proposed to be a standard abutment form. The Abutment B has a similar construction form. In the concept design, it was detailed to be constructed behind a reinforced soil wall, but this was subsequently change to a spill through batter down to the realigned Coppins Crossing Road for urban design reasons to more closely align with Abutment A.

The access and the construction of the pad footings will require environmental controls to minimise disturbance around the river and to the water quality in the river. The pad footing soffit for Pier 1 is likely to be below the river level while Pier 2 is expected to be just above the water level. There is the potential for water ingress into the excavation. This should be able to be managed in construction and is being assessed in conjunction with the geotechnical investigation as part of the PSP design. Passive or prestressed anchors may be adopted in the design to control uplift of the footings to reduce their size. Specialist drilling Subcontractors would be required for this work. As discussed in Section 7.3.2, a flood mitigation plan should be required for these works to ensure the safety of the workers and minimise delays and damage from the flooding. It is recommended that the footing reinforcement cage is prefabricated in sections to minimise the construction time between placing the first of the reinforcement.

The pier column construction will be similar to the piers for the Butters Bridge with the installation of weathering steel casings and reinforced concrete infill. The headstocks are substantial cast in situ concrete elements. Precast concrete shells were considered to avoid the installation and removal of formwork at height, reduce construction time and improve the quality of the finish on the concrete. The advice in the industry consultation was that given the cost and complexity of manufacturing, transporting and installing precast shells, cast in-situ headstocks will be easier and cheaper.

Figure 7.11 Butters Bridge Pier Construction

7.6.3 Girder installation

The intention is to install the girders using cranes positioned on the embankments and within the river (Refer to Crane lifting diagrams Appendix E). Three girders rather than two girders have been proposed for the road bridges to minimise the weight of the crane lifts. The crane lifting plan provided however still requires a single large crane which needs to be reviewed by the contractors to ensure the crane is available when needed.

The pier segments are expected to weigh just over 80 tonnes each. For the northbound bridge, girder segments are proposed to be installed with cranes located on the Eastern or upstream side for pier 1 and on the Western side for pier 2. For the southbound bridge, the girder segments are proposed to be installed on the Eastern side for both piers. The trucks transporting the segments would be parked on Coppins Crossing Road for the lifts. These lifts will therefore require Coppins Crossing Road to be closed for a several hours for the installation of the three girders. The girders will require temporary support towers or temporary packers and tie downs on the piers to keep them stable.

The end span segments are expected to be just under 70 tonnes and around 85 tonnes for the southern and northern sections respectively. It is proposed that they are assembled on the approaches behind the abutments and lifted into position using cranes positioned behind the abutments. This will allow the southern span girders to be installed with Coppins Crossing Road remaining open and the northern span girders installed with a shorter closure of the road for the lifts only.

The main span girders are proposed to be delivered in two sections weighing approximately 55 tonnes each. They will need to be bolted together prior to be lifted together. The girders will then be driven down onto the causeway and lifted into position. The installation of the girder segments for the southbound bridge will be similar to the northbound bridge.

Using this sequence, the main span segments will need to be installed between the two pier segments and these pier segments will need to be positioned to a very tight tolerance for the fit up of the bolted splices to the main span segments. Cast in-situ concrete splices were mentioned during the industry consultation as a possible option to introduce more tolerance into these connections. An alternative to improve tolerance with bolted connections, would be to use temporary supports for one end of the Span 2 segments to allow these girders to be installed prior to the adjacent Pier segments with the segments installed from north to south from Pier 2 or south to north from Pier 1.

7.6.4 Deck Construction

The deck panels will be lifted into position and the joints between the units sealed to form a safe working platform to work over the road and river. Temporary screens will be required on both sides of the bridge due to the truncated barrier on the road side and the low kerb on the shared path side. The deck will be poured in a series of sections to suit the Contractor and the structural design as the deck design is affected by the sequence of when composite action is achieved along the bridge. This can be resolved in the detailed design Phase.

Road closures of several hours would be required for the lifting in of the deck panels over the roadway. The deck over the roadway can be cast with the road open below but it may be prudent to close it for the concrete pour directly over the roadway. The installation of the steel traffic barrier rails and screens would also require short road closures.

8. Molonglo River Bridge Architecture Design Report

The architecture design report for the draft PSP completed by Cox Architecture can be found in Appendix H. The National Capital Design Review Panel (NCDRP) workshop was held on 22nd of May 2019. This formed a basis for the current architecture design for the Molonglo River Bridge. The comments received from the NCDRP workshop have been collated and addressed which can be found in Appendix A in conjunction with the architecture design component of this report.

9. Drainage Design

9.1 Drainage Design Criteria

The design criteria has been developed for the drainage design of this specific project. These criteria are based on the TCCS Municipal Infrastructure Standards, Austroads Part 5, 5A & 5B, industry standard reference documents and experience by Jacobs on similar projects.

Any deviations from the design criteria will be identified as non-conformances and risks associated with this will be detailed in the project risk register.

9.1.1 Pavement Drainage Pipes

In designing the new pavement drainage pipes, the following criteria shall be applied:

Table 9.1 Pavement Drainage Criteria

Item	Criteria
Design ARI	▪ 10 years on grades ▪ 100 years in unrelieved sag sections
Max. velocity in RCP	▪ 6.0 m/s (TCCS Criteria)
Pipe Class	▪ Must be designed to suit construction traffic ▪ Comply with Concrete Pipe Association's "Concrete Pipe Selection and Installation Guide"
Installation	▪ Minimum HS3 Type Support
Minimum cover for Pipes	▪ 600mm to pavement subgrade level (TCCS Criteria) ▪ Maximum depth of pipelines to invert level shall be 6m (TCCS Criteria)
Minimum Size	▪ Pipes crossing the pavement - 300mm dia. ▪ Pipes not crossing the pavement - 300mm dia.
Maximum spacing between pits	▪ 80 metres (preferred) ▪ 120 metres (maximum)
Minimum Grade	▪ 1%
Maximum Grade	▪ 12.5%
Self-cleansing velocity	▪ 0.6 m/s in 1 year ARI
Pipe Blockage at inlet headwalls	▪ 0% for culverts greater than 600 mm diameter for RCP and 0% for culverts greater than 600 mm height ▪ 50% for culverts less than or equal to 600 mm diameter for RCP and 50% for culverts less than or equal to 600 mm height
Blockage Design at inlet pits	▪ 20% on grade pit ▪ 50% sag pits
Minimum freeboard at pit	▪ 150 mm in design ARI
Drainage Pits	▪ ACT standard pits
Road Flow Spread Criteria (10 year ARI)	Two through lanes in one direction ▪ Minimum 2.5m clear width in the adjacent travel lane (TCCS Criteria) One through lane in one direction ▪ Minimum 3.0m clear width in the travel lane (TCCS Criteria) At Medians

	▪ Minimum 2.5m clear width in the travel lane (TCCS Criteria) At Turn Lanes ▪ Minimum 3.0m clear width in the travel lane (TCCS Criteria) At Pedestrian Crossings ▪ Maximum 0.45m flow width in 1 year ARI (TCCS Criteria)
Road Flow Spread Criteria (50 year ARI)	▪ One full lane clear (TCCS Criteria)
Road Flow Spread Criteria (100 year ARI)	All Locations ▪ Depth of flow <=50mm above top of kerb (TCCS Criteria) ▪ V.D < 0.6 m^2/s
Aquaplaning Criteria	▪ Maximum 4mm water film depth allowed for 50 mm/hr intensity of rainfall

9.1.2 Culverts

In designing the culverts (pipes or boxes), the following criteria shall be applied:

Table 9.2 Culvert Design Criteria

Item	Criteria
Design ARI	▪ 100 years
Minimum Grade	▪ 1% (desirable)
Max. velocity in RCP	▪ 8.0 m/s
Pipe Class	▪ Must be designed to suit construction traffic ▪ Comply with Concrete Pipe Association's "Concrete Pipe Selection and Installation Guide"
Installation	▪ Minimum HS3 Type Support
Pipe Blockage at inlet headwalls	▪ 0% for culverts greater than 600 mm diameter for RCP and 0% for culverts greater than 600 mm height ▪ 50% for culverts less than or equal to 600 mm diameter for RCP and 50% for box culverts less than or equal to 600 mm height ▪ The design must consider the likelihood of partial or full blockage based on the catchment features (for both current and future land use) and the consequences of partial or full blockage on the project
Minimum cover for Culverts	▪ 600mm to pavement subgrade level (TCCS Criteria) ▪ Maximum depth of pipelines to invert level shall be 6m (TCCS Criteria)
Culvert Inlet and Outlet Scour Protection Design ARI	▪ 50 years
Maintenance Accesses	▪ Provide all weather access where culvert is outlet controlled and there is a risk of siltation

9.1.3 Open Channels

In designing new open channels, the following design criteria are adopted:

- Bank full capacity of the channel is to be greater than or equal to a 5 year ARI;
- Consideration to be given to impacts in the event of channel overflows and the channel capacity increased as necessary to appropriately manage the risk of adverse impacts. The channel capacity to be designed

for a 100 year ARI where overflows would affect the proposed road works or adversely impact on adjoining properties;

- Channel longitudinal grades for catch drains, toe drains and median drain to be minimum 0.5%;
- Channel longitudinal grades less than 0.5% is acceptable for realignment of natural water courses diversion channels and culvert inlet/outlet channels;
- The lining for the open channels will be provided based on the longitudinal grades as outlined in Table 9.3.

Table 9.3 Channel Design Criteria

Channel Grade	Channel Lining
< 0.50%	Concrete lined
0.50% to 5.0%	Jute Mesh with vegetation
> 5.0%	Rock or concrete lining

9.2 Drainage Design Assumptions

The following assumptions have been made for the pavement drainage design to the project:

- Local road and property drainage required for the future developments in the lands adjacent to the proposed road alignment will not connect to the proposed road drainage pit and pipe system.
- There is no requirement to provide on-site detention basin(s) to control the pavement drainage runoff from the project for flow attenuation. It is assumed that the flooding assessment will address the potential downstream/upstream impacts that may be caused by the projects works including the pavement drainage.
- The drainage design assumes that stormwater treatment to the pavement runoff received from areas outside the scope of work is not required.; For the swale from JGD3B connecting into the open channel from JGD3C at the Northern limits of work boundary, it is assumed that the JGD3B project has implemented WSUD strategies to treat the runoff before discharging into the open channel.
- Creek realignment to Molonglo River is not required.
- Due to the realignment of Coppins Crossing Road being at the provisional stage, Jacobs have not proceeded with any drainage requirements pending confirmation of the proposed realignment.
- Drainage design is to allow for future light rail works in the median.
- The permanent water quality basin B3 at CH15780 has been modelled based upon the information received from Indesco. The invert level of the basin B3 and the outlet culvert C15740 shall be confirmed in liaison with Indesco at the detailed design stage.
- The 100-yr water level at the basin B3 at CH15780, provided by Indesco has been relied upon to set the Invert level of Pedestrian underpass to provide 100 yr flood immunity to the underpass.

9.3 Proposed Pavement Drainage

As a part of the Final PSP design development and additional water quality requirements, several changes have been made. They are listed as follows:

- Two permanent water quality basins (B5 and B7) are provided at CH16060 and CH16360 on the eastern side of the main alignment, to achieve the WSUD targets for the pavement runoff before discharging to the Molonglo River and surrounding waterways. In addition to this, a 40-metre WSUD swale is provided to convey water from the pavement network outlet at CH16360 to basin B7.
- The pavement drainage network is separated from the cross-drainage network. The pavement drainage network now discharges at two locations, CH16060 and CH16360, directly into the water treatment structures. The overland surface runoff from external catchments is conveyed through a separate network of open channels and culverts.

- The pedestrian underpass has been moved approximately 115m south from its original location (CH15710) in the Final Draft PSP design, to CH15595 to avoid any potential clash with the pavement drainage network.

Road gutters, pits, pipes and open channels have been provided to collect and convey storm water runoff from the road carriageways and discharge into a WSUD treatment device before being discharged into a receiving waterway.

Typical ACT standard kerb side R-sumps and QS sumps have been used across the project. However, on the eastern verge from CH15055 to CH16010 typical kerb inlet sumps (KIS) have been used to avoid potential clashes with the water main pipe running closely behind the drainage pits and pipes.

Drainage pits, pipes and channels have been modelled in 12D software in 3-dimensions. The pavement drainage networks have been graded to provide a minimum 1% longitudinal grade to drainage pipes. Pipe inverts are set to provide a minimum 1100mm (typical) cover to the obvert of the pipe from the finished surface levels. This is required to make sure that the drainage pipes are located minimum 300mm below the bottom of the subbase layer for a 700mm thick pavement (typical).

Estimation of design flow rates has been carried out in accordance with Australian Rainfall & Runoff (ARR) 2019. The design rainfall data required for hydrological and hydraulic modelling has been obtained from the Bureau of Meteorology (BOM) website for Molonglo. Rainfall temporal pattern ensembles were obtained by downloading the data from the ARR Data Hub.

Hydrological calculations have been carried out using the ILSAX2 hydrology model built within the 12D software. The ILSAX2 hydrology parameters were selected to match results with the Initial Loss-Continuing Loss model recommended in ARR 2019. The following parameters have been adopted in the ILSAX2 model as recommended by 12D Solutions.

Table 9.4 Hydrological Calculations Input

Description	Value
Runoff method	ILSAX (matching with IL-CL model as specified in ARR 2019)
Pervious area depression storage	5 mm
Impervious area depression storage	1 mm
Soil type	3 (Type C: Slow Infiltration)
Antecedent moisture condition	3.2
Runoff loss model	Horton Initial loss= 0.8 mm/hr Final loss = 0.8 mm/hr
Manning's n for pipes	0.013 (concrete pipes)
Minimum time of concentration	5 minutes (Impervious areas) 10 minutes (Pervious areas)

Catchment areas to drainage inlets have been delineated in 12D based on the ground survey and design road surface models. Effective impervious areas are conservatively assumed to be 100% of the total impervious areas.

Pavement drainage of the existing JGD2A and JGD3B roads have been considered and relevant catchments have been incorporated in the pavement drainage design of this project.

Drainage pits have been placed on the road kerb and gutters at certain intervals on grade, at road low points and just before the road intersections to capture the pavement runoff and meet the flow width requirements on the road. Drainage networks have been built connecting the pits with pipes.

Pit inlet capacities have been determined from HEC-22 procedures, and pit hydraulic losses have been calculated from the built-in Hare-Missouri charts within 12D.

The pavement drainage networks have been designed and sized for the 10% AEP storm event in the 12D dynamic drainage mode.

The drainage design has been reviewed to minimise the number of pits for the Final PSP Submission. Road verge cross fall direction have been reversed to fall away from the carriageways and high inlet capacity pits such as Type R double sump have been utilised to reduce the number of pits in these areas. Elsewhere on the alignment, the pit placements have been reviewed against the allowable flow spread widths and the number of pits has been reduced significantly and presented in the design documentation accordingly.

However, at the road intersections, extra pits would be required due to traffic islands intercepting the road runoff and a pit would be required at each island where this situation has occurred. Similarly, due to the inclusion of auxiliary lanes and bus stops where reduced flow width criteria apply, extra pits have been provided to comply with the flow width requirements for the 10% AEP event. Refer to Appendix J for details.

Hydrological and hydraulic calculations in 12D have been run for the 10% AEP storm event and for several storm durations from 5 minutes to 180 minutes. The pipe design was carried out using the critical duration storm.

The drainage networks generally comply with the design criteria except for one (1) minor non-conformance that has been included in the list of non-conformances for the project.

9.4 Proposed Cross Drainage

Culverts have been provided where the road alignment traverses the existing drainage line or where a low point is created on the upstream side of the alignment by the road design.

Estimation of design flow rates has been carried out in accordance with ARR 2019 similar to the hydrological and hydraulic modelling undertaken for the pavement drainage.

The culverts have also been modelled in 12D software for checking consistency with the road geometry and potential clashes with services.

The culverts design has been reviewed as part of the Final PSP to incorporate the change to the permanent basin designs. The permanent basin as a part of Indesco's design (B3) has been modelled on the eastern side of the main alignment at the location of the existing pond at approximate CH15740. The culvert C15740 has been designed as a 2 cell, 1200mm x 600mm Reinforced Concrete Box Culvert, to function as an outlet culvert to this basin. Two permanent basins are located at CH16060 and CH16360 on the eastern side of the main road alignment. All other basins are temporary sediment basins for stormwater management during the construction phase which will be removed after completion of the project. The culverts sizes, lengths and invert levels have been amended due to catchment areas changes prompted by the changes to the basin design strategy.

The culvert design is also based on the strategy of separating the cross drainage from the road pavement drainage system. This strategy removes the risk of the cross-drainage system impacting adversely on the hydraulic performance of the pavement drainage should the cross drainage flows increase in the future due to developments on adjacent land. Separating the pavement drainage from the cross drainage is also necessary due to the requirement to treat the pavement drainage runoff.

A summary of the proposed cross drainage culvert design is provided in Table 9.5.

Table 9.5 Proposed Cross Drainage Culvert Design

Chainage (MC10)	Culvert Size (m)	Length (m)	Comment
15360	900 RCP	71.43	Culvert beneath Main Alignment
15380	1050 RCP	57.46	Culvert beneath Main Alignment
15595	3600(W) x 3600(H) RCBC	69.41	Pedestrian Crossing Culvert
15740	2 x 1200(W) x 600 (H) RCBC	104.98	Culvert beneath Main Alignment
16050	600 RCP	74.52	Culvert beneath Main Alignment
16150	3 x 600 RCP	18.73	Culvert beneath Coppins Crossing Road
16280	3 x 750 RCP	8.057	Culvert beneath Coppins Crossing Road
16350	750 RCP	9.61	Culvert beneath Fire Access Track
16360	2 x 750 RCP	11.13	Culvert beneath Coppins Crossing Road
16400	675 RCP	8.99	Temporary culvert
16500	450 RCP	9.686	Culvert beneath Fire Access Track
16770	900 RCP	71.50	Culvert beneath Main Alignment

Requirements for culverts across pedestrian crossings at the upstream and downstream ends of the crossing has not be provided at this stage. This is to be further investigated in the D&C tender stage of the project when the exact location and size of the pedestrian crossing is confirmed.

Culvert C16350 (750 RCP) have been provided to drain the road drainage across the proposed fire access tracks which will remain in the operational phase of the project. The design levels of the fire access track are not known at this Final PSP stage. The existing ground level for sizing the culvert dimensions and setting the invert levels has been assumed as the design surface level.

Culverts C16280 (3 x 750 RCP) and C16150 (3 x 600) have been provided to drain the drainage from the main JGD3C alignment across the existing Coppins Crossing Road. The culvert design has allowed for minimum 600mm cover under the road and provided batter chutes from the outlet headwalls to the river due to steep slopes of the batter.

Culvert C16360 (2 x 750 RCP) has been provided to drain the runoff across the proposed realignment of Coppins Crossing Road. The design level of the realignment works has not been finalised to this stage and as a result, the existing ground level for sizing the culvert dimensions and setting the invert levels has been assumed as the design surface level.

The culverts designed for the JGD3C main alignment cater for the 100 year ARI critical storm event. The culverts beneath Coppins Crossing Road and the fire access track have been sized to the 10 year ARI critical storm event. The temporary culvert has been sized to 2 year ARI standard.

9.5 Bridge Deck Drainage

The drainage requirements for the new bridge over the Molonglo River have been assessed.

The bridge deck has a two-way cross fall (3%) and falls longitudinally from north to south.

The bridge deck has been kerbed and there is a 2m shoulder. The drainage design has provided scuppers at 6m spacing over the entire length of the bridge to minimize the gutter flow encroachment into the adjacent traffic lanes.

Drainage scuppers of 100mm in diameter have been provided at the spacing mentioned above to capture the bridge deck drainage. The scuppers are connected by minimum 225mm to 300mm diameter carrier pipes that connect to the nearest road drainage pits. Future light rail track areas have been included in the bridge deck catchments.

The runoff from the shared path falling at 2% towards the bridge carriageway is directed towards the bridge deck via 100 diameter holes in the precast concrete barrier provided at 2m centres installed in the bridge and captured by the scuppers provided.

The bridge drainage network has been combined with the pavement drainage system and has been run in 12D dynamic drainage to assess the hydrological and hydraulic performances including the flow widths for the 10-year ARI design event.

9.6 Aquaplaning

The road design model was assessed in 12D software for aquaplaning risks. Critical locations such as super elevation transition areas, steep downhill sections and road intersections were checked for the aquaplaning risk using the Gallaway equation, also known as Texas method in the Guide to the Design of Road Surface Drainage (NAASRA).

The Gallaway equation used to calculate water film depth over the road surface is:

$$D = \frac{0.10286\ T^{0.11}\ L^{0.43} I^{0.59}}{S^{0.42}} - T$$

where,
D = Water film depth (mm)
T = Pavement texture depth (mm)
L = Length of flow path (m)
I = Rainfall intensity (mm/h)
S = Average Slope of flow path (%)

For asphaltic pavement wearing course, texture depth (T) of 0.5 mm has been used for the water film depth calculation in the above formula. Rainfall intensity (I) of 50 mm/hr has been used. Slope of the flow paths were calculated using equal area method.

Results of the aquaplaning assessment indicate that the depth of the water film for the project is within the allowable limit of 4mm. Refer to Appendix I for the results of the assessment.

9.7 Open Channels

Open channels are required to direct surface runoff away from the road pavements and direct flows from pavement drainage outlets to drainage culverts or downstream receiving waterways.

Channels have been provided at both the toe and the top of the new road embankment where the existing ground surface falls towards the embankment.

The design standard for a channel is 5 year ARI, however where channels are used to convey transverse drainage catchments or receive runoff from the upstream catchment on the top of road batter, a 1% AEP (100 year ARI) design standard has been applied. Typically, a standard open channel with 1000mm base width, 500mm depth, and 2 to 1 (H to V) batter slopes has been provided.

There is a significant catchment upstream of the northern limit of works which must be considered in the drainage design for JGD to allow for the JGD3B road drainage works to drain. The open channel design has incorporated the upstream catchments and sized the channels accordingly.

9.8 Scour Protection

Scour protection requirements have been assessed for each new and extended culvert outlet location and has been designed for a 50 year ARI standard.

Following criteria has been used to size the scour protection based on Austroads Guide to Road Design Part 5: 3.5:

- Where the Froude Number (Fr) is less than 1 and the outlet velocity is less than 1.7 m/s, no scour protection is required.
- Where the Froude Number (Fr) is less than 1.7 and outlet velocity is greater than 1.7 m/s but less than 5.0 m/s, an extended rock riprap apron is required.
- Where the Froude Number (Fr) is greater than 1.7 or outlet velocities are greater than 5.0 m/s, a riprap basin is required.

Scour protections have been shown schematically in the plans based on the scour protection design and the extent of the works determined from this has been used to inform the project boundary.

10. Erosion & Sedimentation Controls

10.1 Design Documentation

The erosion and sedimentation section of this design report has referred to the following designs drawings and reports:

- John Gorton Drive Stage 3C Concept Design Report, Jacobs, August 2018
- Road Geometry drawings, Final PSP June 2020
- Drainage drawings, Final PSP June 2020
- Bridge drawings, Final PSP June 2020
- Utilities drawings, Final PSP June 2020

10.2 Existing environment

10.2.1 Sensitive receiving waterways

The Molonglo River corridor is planned to be a recreational public park, in accordance with the Molonglo River Valley Corridor Strategy. It includes regional play facilities and picnic areas to the north and south of Molonglo River, and a visitors' centre. Depending on the timing of construction, works would need to be managed to minimise impacts on any surrounding sensitive receivers or recreational use of the area.

10.2.2 Soils / Geology

General soil information was obtained for the site area from the NSW Soil and Land Information (S&LI) database and the Soil Landscapes of the Canberra 1:100,00 sheet. The relevant soil landscape is 'Burra' (ba) for the Canberra soils data sheet, refer to Appendix M. This S&LI soil data confirms that the erosion hazard is moderate to high. The erodibility of the soils has already been taken into consideration in the design criteria and for sizing the proposed sediment basins for the construction phase.

The Soil Landscapes of the Canberra 1:100,000 sheet (DLWC) indicates that the proposal is located in undulating to rolling low hills and alluvial fans on Silurian volcanic Lowlands, with highly weathered bedrock. The vegetation is almost completely cleared woodland with some remaining Eucalyptus trees, shrubs and grasses.

The predominant soil landscapes in the project area is "burra' (ba) with the following profile:

- ba1 - 0 to 8 cm, dark brown loam, with moderate erodibility;
- ba2 - 8 to 28 cm, dull yellow orange silty loam, with high erodibility;
- ba3 - 28 to 84 cm, dark reddish-brown medium-heavy clay, with high erodibility;
- ba4 - 8 to 28cm, dull yellow orange silty loam, with moderate erodibility.

The above soil description would also suggest that the subsoils in this area are dispersible soils. Dispersibility percentage soil data (D%) and Emerson Aggregate Test (EAT) results are not available to confirm this, however it is recommended that provision for flocculation be provided during the construction stage. Flocculation with super fine gypsum is the preferred flocculation method and should be adopted on this project with an aim of achieving the required Total Suspended Solid (TSS) concentrations which are normally 50mg/L at the outlet of the basins.

10.2.3 Existing and proposed services

There are currently no clashes between the proposed temporary sediment basins and erosion and sediment controls with existing services to remain or with proposed utilities; however, there is a risk that any design changes at later stages of the project may introduce a clash. As such, the erosion and sediment control measures would need to be coordinated against the existing and proposed utility locations at the detailed design stage.

10.3 Erosion and sediment control design considerations

10.3.1 Sediment basins

Seven temporary sediment basins have been deemed necessary for this project. The sizes of the basins vary depending on catchment size and locations and will need to be coordinated with other disciplines for space constraints. Refer to Section 9.5 for the sediment basin sizes.

The design criteria for the sizing of temporary sediment basins used during the construction phase are aimed at achieving the project water quality objectives. They are based on the requirements of:

- TCCS MIS08 - Stormwater
- Managing Urban Stormwater, Soils and Construction guidelines, Volumes 1 (Landcom, 2004) and 2 (2008) (known as the Blue Book).
- Managing Urban Stormwater, Volume 2D: Main Road Construction (DECC, 2008).

10.3.2 Batter design recommendations

Chapter 4 of the Blue Book provides recommendations for batter gradients, benching and maximum slope length. Table 10.1 and Figure 10.1 provide further details.

Assuming a K-Factor of 0.05, the Blue Book recommends the maximum slope lengths before benching is required, as shown in Table 10.1. For instance, if the batter gradient is 2:1 (H:V), then the maximum slope length for the construction phase is approximately 22m. This is especially applicable for the construction stages when the potential soil losses are greater.

As a sensitivity check, even if the K-Factor was higher at a value of k=0.06, the maximum slope length is approximately 17m.

There are no parts of the project where 2:1 batters are expected to exceed the 17m limit and hence benching would not be required for the construction phase.

Table 10.1 Maximum slope length recommendations (Blue Book, 2004)

Batter gradient (H:V)	Recommendations for benching
2:1	Every 17m
2.5:1	Every 22m
3:1	Every 27m

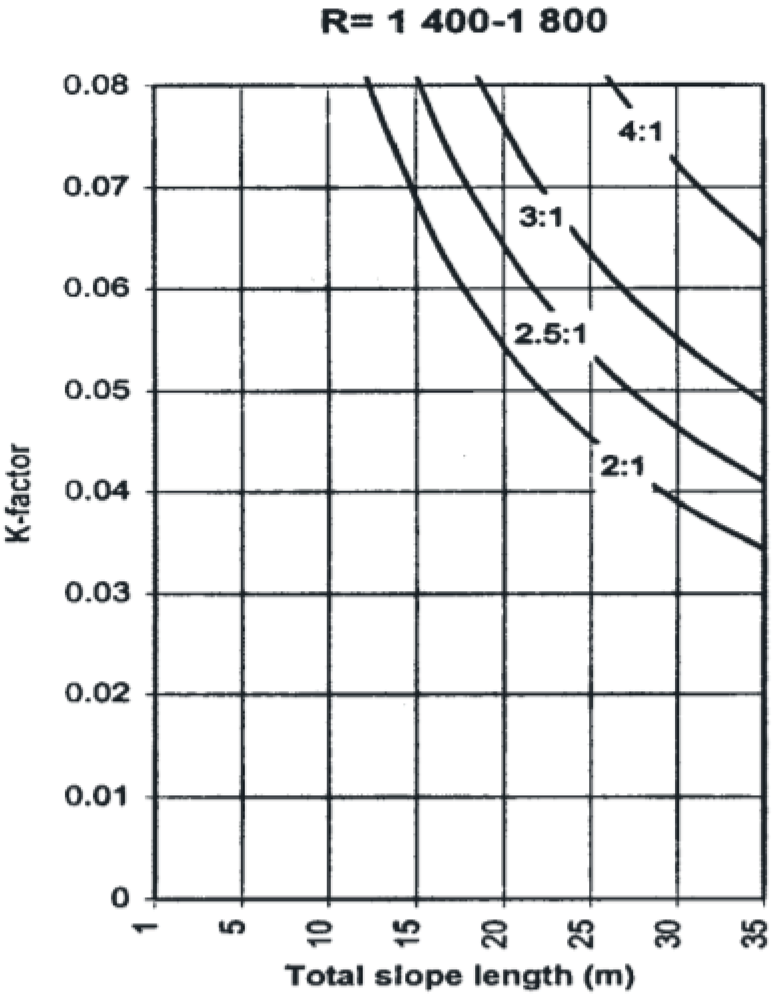


Figure 10.1 Maximum batter gradient (H:V) where the R-factor is 1,400- 1,800 (Landcom, 2004)

10.4 Erosion and sediment control strategy

10.4.1 Design approach

Erosion and sediment controls need to be designed for the construction phase including temporary sediment basins where they are needed to intercept road construction runoff before discharging into the receiving waterways and Molonglo River.

Water quality would be managed within the area bounded by the project site, including, but not limited to:

- Access and haulage tracks.
- Earthworks stockpile and storage areas.
- Vegetation stockpile areas.
- Compound areas, such as the Contractor's and the Principals facilities.
- Wash-down facilities.
- Temporary sediment basins.

During construction, temporary sediment basins would be provided as the primary mechanism to capture and treat all runoff from all disturbed areas within construction footprint before discharging into the receiving waterways.

10.4.2 Erosion and sediment control strategy

The overall erosion and sediment control design strategy for the proposal is to prevent or reduce erosion and sediment impacts during construction. Where erosion does occur, the aim is to capture it as close to this source as practicable.

The proposed erosion and sediment control measures to be implemented during each construction stage of the project should be based on four principles:

1. Controlling the occurrence of erosion.
2. Diverting offsite “clean” water away from construction areas.
3. Diverting onsite “dirty” water towards a sediment basin.
4. Capturing sediments that are transported through diversion drains in basins.

To achieve these principles, water quality during construction would be managed using:

- Procedural controls.
- Site managed erosion controls measures.
- Physical sediment control measures.
- Treatment with sediment basins.
- Monitoring and maintenance.

10.4.3 Site managed erosion controls measures

Construction activities would be sequenced and managed by the construction contractor to minimise potential water quality degradation due to erosion. Management would include:

- Minimising the extent and duration of exposed topsoil by retaining topsoil cover, grassed drainage lines and shrub cover on the soil surface for as long as possible.
- Progressively rehabilitating or sealing of all disturbed and regraded areas as soon as possible.
- Minimising the lengths of slopes through limiting the extent of excavations and the use of diversion drains to reduce water velocity over disturbed areas.
- Designation of ‘no go’ zones for construction plant and equipment.
- Shaping of land to minimise slope lengths and gradients and improve drainage, e.g. benching.
- Employment of appropriate measures to prevent wind-blown dust entering waterways.
- Creation of diversion banks at the upstream boundary of construction activities to ensure diversion of upstream runoff around exposed areas.
- Creation of catch drains at the downstream boundary of construction activities where practicable to ensure containment of sediment-laden runoff and diversion toward treatment areas to prevent flow of runoff to downstream undisturbed areas.
- Specification of construction procedures that minimise water flow velocities and avoid excess velocities such as implementation/construction of level spreaders, check dams, bank and channel linings.
- Where possible, cleared native vegetation and native mulch would be used to reduce erosion and contain sediment during construction through use of small vegetation filter windrows placed across the contour in drainage lines, below fill batters, below cutting works at the head of cleared minor drainage lines and before the inlet to sediment basins and waterways. Mulch should not be used for surface cover or sedimentation controls in any low-lying areas of the site that remain consistently wet. Alternative controls such as Geofabric (for surface protection), hydro mulching or sediment fences will be required in these areas. Unprotected mulch sediment controls should not be placed in concentrated flow lines where the mulch may be washed away. Mulch may be protected by wrapping it with Geofabric or other materials to provide a stable control. All temporary catch dams constructed from mulch must have a stable outlet to minimise the washing away of mulch in high rainfall events, and the possible failure of the control.
- Where possible, constructing working platforms from rock fill so that bare earth is not exposed.

- Installing stabilised vehicle exit points to remove sediments from vehicles leaving site areas.
- In addition to these general erosion control measures, specific management measures are required for site compounds, stockpiles, works near waterways and spills.

10.4.3.1 Site compound management

In general, mitigation would be similar to general construction site mitigation, with additional factors, such as:

- Restricting vehicle movements to designated pathways where feasible.
- Paving areas that would be exposed for extended periods where feasible.
- Diverting offsite runoff around stockpiles sites where required.
- Designation of areas for plant and construction material storage within the site compound.
- If the above local controls are not implemented, and where required, treating onsite runoff with a construction or compound-specific sediment basin. Monitoring the sediment basin for parameters such as dissolved oxygen levels and organics would be required to determine suitable discharge to the environment. Such basins would be considered once compound locations have been finalised.

10.4.3.2 Stockpile management

The maintenance of established stockpile sites during construction is to be managed in order to prevent erosion of the stockpile flowing into downstream waterways. These management measures include:

- Diverting runoff around stockpiles sites where required.
- Minimising the number and size of stockpiles.
- Lining the base of stockpiles if they are located over shallow water tables.
- Treating stockpiles at the source by covering with plastic sheets.
- Establishing effective sediment control works to contain any runoff including cut-off drains, vegetation and silt fences to minimise risk of sediments entering waterways.

10.4.3.3 Managing spills

Sediment basins must be designed to include provision for spill containment. Spill management procedures during construction, including an Emergency Spill Plan, would be developed and incorporated into the CEMP prior to construction. This would include measures to avoid spillages of fuels, chemicals, and fluids into any waterways.

Procedures would include:

- All fuels, chemicals, and liquids would be stored at least 50m away from any waterways or drainage lines and would be stored in an impervious bunded area within the compound site.
- Bunded areas for refuelling and wash-down.
- Spill kits.
- Training of staff.

10.4.3.4 Maintenance of erosion and sediment controls

Regular maintenance of all erosion and sediment controls on site is required after each storm event (more than 2mm of rainfall) to remove trapped sediments and repair eroded areas. Accumulated sediments in the basins need to be checked every 2 months and removed when the sediment depth reaches 300mm.

10.4.4 Physical sediment control measures

Whilst the installation of appropriate erosion control measures would greatly reduce the quantity of soil eroded from a construction site, some erosion would inevitably occur, and measures are therefore required to ensure that eroded material is trapped and retained. Such measures include catch and diversion drains, check dams, level spreaders, sediment fences, constructed drainage and sediment basins.

10.4.4.1 Catch and diversion drains

Either individually or in combination, these structures are used to intercept and direct runoff water to a desired location. By doing so, sheet flow is converted to concentrated flow, and the time of concentration for runoff is decreased. There are two types of drains for clean and dirty runoff used during the construction phase, and they are often used in conjunction with level spreaders and check dams:

Upslope runoff diversion drain (catch drain)

- This diversion drain is an earth channel with lining designed to intercept and direct clean runoff from the undisturbed upstream catchment and divert it to an existing waterway, so that it does not enter the construction site. Drains would be lined with biodegradable organic fibre mesh hydro seeding and anionic bitumen emulsion spray. Other suitable linings can also be used.

Onsite runoff diversion drain

- A temporary earth bank installed at the downstream end of disturbed areas to convey contaminated runoff to sediment basins.

All temporary drains would be constructed to avoid trees and other permanent infrastructure, where feasible.

10.4.4.2 Check dams

A check dam is a small, temporary dam built across a swale or diversion drain. Its primary function is to reduce the velocity of flow in the channel and thus reduce erosion of the channel bed. The entrapment of sediment behind these structures is a secondary function. Check dams can be used:

- To protect a grass lined channel during initial establishment of vegetation.
- As a substitute for channel lining in a temporary channel.

Check dams can be constructed by using any materials on the site that can withstand the flow of water. Rock, logs and sandbag check dams can be the sturdiest if these materials are correctly placed in position. Wire netting, woven brush and straw bales can also be used.

Although check dams are not primarily intended as sediment trapping devices, larger-sized particles would inevitably accumulate behind them. This sediment should be removed before it accumulates to one-half of the original height of the dam and placed where it would not be washed back into the drainage system.

10.4.4.3 Level spreaders

A level spreader is an excavated outlet constructed with zero grade. It converts an erosive, concentrated flow of runoff into sheet flow, and discharges it at a non-erosive velocity onto an undisturbed area stabilised by vegetation.

Level spreaders may be used as outlets for diversion or perimeter banks or channels, where storm runoff has been intercepted and diverted to stable areas. They should be used only where the spreader can be constructed on undisturbed soil. The area directly below the spreader sill should be uniform in slope and well vegetated, allowing water to spread out as sheet flow.

The cross-sectional area and length of the level spreader would be designed by the contractor to be sufficient to discharge the design flow from the selected frequency rainfall event.

10.4.4.4 Sediment fencing and filters

Sediment fences/ filters act as sediment mitigation measures for small disturbed areas where it is impracticable to direct the runoff to sediment basins by diversion drains. Sediment fences/ filters function by intercepting and filtering small volumes of runoff, which mainly occur as sheet flow.

Sediment fences would be selected that use woven polypropylene and cotton / geotextile thread with a flow rate greater than 110 L/m2/s to Australian standards AS3706.9.

If straw bales are used in conjunction and in addition to sediment fencing, the straw bales should be weed free to ensure that weeds are managed appropriately and not spread.

Relevant typical Erosion and Sediment Control details have been extracted from the NSW Soils and Construction manual and are provided in Appendix K and Appendix L provide standard details for the temporary management of proposed cross drainage and related erosion and sediment controls.

10.4.5 Sediment basins

10.4.5.1 Design criteria for sediment basin sizing

The design criteria for the temporary water quality treatment controls used during the construction phase are aimed at achieving the Project's water quality objectives.

The sediment basins have been designed as Type D basins, as per the Blue Book (Landcom, 2004 and DECC, 2008) classifications and the site-specific soil test results. The basin design provides a volume for settling and storage. The settling zone volume has been estimated using the appropriate design rainfall depth and catchment areas. The storage zone has been estimated using the Revised Universal Soil Loss Equation (RUSLE). The parameters that have been used to size the sediment basins are outlined in Table 10.2.

Table 10.2 JGD3C design criteria for sizing the sediment basins (Landcom, 2004 and DECC, 2008)

Parameter	Value	Comments
Rainfall Parameters		
Rainfall depth duration (days)	5 day	**5 day adopted** as standard duration
Rainfall percentile	80^{th} or 85^{th}	**85th has been adopted** due to the sensitive receiving waterways. This is a conservative assumption.
Rainfall depth (mm) – 5 day	25.8	For Queanbeyan and Canberra 21.3 mm for the 80^{th} Percentile and 25.8 mm for the 85^{th} percentile.
Volumetric Runoff Coefficient, cv	Varies (0.5 to 0.56)	**0.56 has been adopted**
Rainfall intensity for 2 year ARI, 6 hr duration in mm/hr	6.91 (1987 BOM data) to 6.48 (2016 BOM Data). Refer to Appendix N.	**6.91 mm/hr and has been adopted.** This is a conservative assumption Also refer to derived rainfall erosivity in this table.

Table 10.3 JGD3C design criteria for RUSLE parameters used in the sizing of sediment basins

RUSLE Parameters		
Soil/sediment type	C, D or F	Varies along the route. Predominantly type D for fine and dispersible. Type D was adopted.
Erodibility, k	0.03 to 0.06 assumed	K=0.05 was adopted as a reasonable value for the typical soils found at Molonglo.
Rainfall erosivity, R	Approximately 1450 from Chapter B of the blue book, and 1235 from the rainfall intensity which is smaller than Blue Book Maps	R= 1450 was adopted. This is a conservative assumption
Hydrologic soil group	C and D	D adopted for high runoff potential
Soil cover, C	1	Corresponding to expected type of activities on site
Soil conservation Practices, P	1.3	Corresponding to expected type of activities on site
Length slope factors, LS	Variable	Determined separately for main road way; and steeper embankment and batter areas (cut and fill)
Sediment yield time period (months)	2 to 6 months	4 months adopted as a reasonable period that accounts for the likely maintenance frequency during construction for the removal of captured sediments.

10.4.5.2 Methodology for sediment basin sizing

The design methodology and the relevant equations used in the sizing of sediment basins are described in the following sections of the Blue Book:

1. RUSLE which estimates annual soil loss amount: pages A1 to A11 of Appendix A of the Blue Book.
2. Settling zone volumetric requirements: pages 6-22 to 6-25 of Chapter 6
3. Rainfall erosivity estimation: Appendix N
4. Volumetric runoff coefficient (Type D): pages F1 to F4 of Appendix 4

The required volume of each sediment basin was determined according to the maximum catchment area that would drain to the basin during the various stages of construction and the parameters listed in Section 10.4.5.1. The required basin volume includes the volume for both the settling zone and the sediment storage zone. The sediment storage zone volume was estimated using the RUSLE equation, and the settling zone volume was estimated using the parameters mentioned in Table 10.2.

To confirm sediment basin footprints, an assessment of the selected sediment basin locations and their derived volumes was undertaken using the 12D modelling software. The locations of the sediment basins were selected to provide for the maximum runoff captured from catchments throughout the construction process using gravity driven diversion drains to divert runoff to the sediment basins. The results of the sediment basin sizing and locations are listed below in Table 10.4.

Table 10.4 Sizes of temporary sediment basins

Sediment Basin Name (Refer to note 1 below)	Road Chainage location in m (Refer to note 2 below)	Receiving Waterway	Sediment basin water volume (m^3)
SB 1	L15,350	Molonglo River	150
SB 2	R15,345	Molonglo River	140
SB 3	L15,725	Molonglo River	245
SB 4	Not needed		
SB 5	R16,150	Molonglo River	350
SB 6	L16,310	Molonglo River	100
SB 7	R16,330	Molonglo River	110
SB 8	R16,650	Molonglo River	300

Note 1: R=right side and L= left side, looking in the direction of increasing road chainages

All sediment basins are temporary sediment basins only, except for basin 3, basin 5 and basin 7 which will remain as permanent basins that will provide water quality treatment (WSUD) for road pavement runoff.

10.4.5.3 Sediment basin characteristics

The sediment basins would consist of:

- Compacted earth embankments with a nominal slope of 2:1 (H:V) and a minimum crest width of one metre, or up to three metres where space is available.
- An excavated storage area that allows a maximum water depth of typically two metres.
- One or more inflow points.
- A primary outlet spillway and protection to reduce erosion downstream.
- A basin dewatering device and provision for gypsum flocculation.
- Access to the basin for maintenance so that sediment build-up can be retrieved.
- Freeboard of 500mm.

In general, sediment basins have been located where they will collect a high proportion of sediment-laden runoff from disturbed areas of the construction site, and where they are accessible for maintenance.

The ideal location of the sediment basins is on the downstream side of the proposed construction area and immediately upstream of proposed culvert crossings. However, in determining locations, consideration has also been given to minimising impact upon existing or proposed utilities, property owners, and environmental exclusion zones or existing trees and vegetation.

The location, size and shape of permanent pond B3 has been inherited from the Indesco Masterplan (January 2020). The drainage design has all pavement and trunk drainage entering two permanent ponds, one on each side of the bridge, prior to entering the Molonglo River Corridor. This has enabled optimisation of the temporary pond arrangement. The temporary and permanent pond arrangements have mitigated any potential environmental and topography clashes.

11. Utility Services

11.1 Utility Authorities

11.1.1 Dial Before You Dig (DBYD)

A request for DBYD within the project area was carried out on the 20th May 2019 to identify the subsurface utilities and their respective utility providers. The following utility service providers have been identified in the DBYD search.

- Evoenergy (Gas and Electricity);
- Icon Water (Water, Effluent and Sewer);
- Telstra (Telecommunications); and
- Transport Canberra and City Services (TCCS).

Refer to Appendix O for DBYD results.

11.1.2 Utility Model

A 3D Utility Model of the project area has been provided by Steger Associates in July 2018. The quality level of the model as per AS 5488-2019 Classification of Subsurface Utility Information ranges from QL-B to QL-D. There were no QL-A assets within this model, which is the highest quality level and is usually carried out to verify the existing utility by potholing works or similar.

A potholing plan was therefore developed and data received from site on 16 September 2019 has been included in the utility model with associated locations updated to QL-A. Some assets were also electro-magnetically traced to supplement the potholing data, and these assets were upgraded to a QL-B. The following updates to the existing model occurred following potholing results:

- PH1 (Telstra asset) was unable to be located at nominated location based in the existing utilities model. This asset was located crossing further north at approximately Ch16380 – Ch16420. Location and level data updated in the existing utilities model. This line was included as a QL-B.
- PH2 (TCCS street lighting asset) was located in the nominated location. Level data updated in the existing utilities model. This line remains as a QL-B.
- PH3 and PH4 (Telstra asset) was located crossing John Gorton Drive in the nominated location. The second Telstra crossing to the north of PH3 / PH4 was also potholed. Level data updated in the existing utilities model. This existing Telstra asset crossing from Ch16430 to Ch16460 was upgraded to a QL-B. The existing Telstra crossing to the north from Ch16450 to Ch16480 remains as a QL-B.
- PH5 / PH6 (MVIS Sewer asset) could not be potholed as the asset was too deep at the nominated locations (i.e. greater than 2m). Levels at two manholes either side of John Gorton Drive were measured plus an additional location (close to PH4) was potholed to determine approximate vertical alignment underneath the main alignment. Level data updated in the existing utilities model. This line remains as a QL-C.

Refer to Appendix P for the potholing plan and response from the site investigations.

11.1.3 Gap Analysis

Table 11.1 summarises the comparison between the DBYD investigation and the 3D utility model.

Table 11.1 DBYD and 3D model comparison

Authority	Utility	Location	Comments
Evoenergy	11kV overhead	• Ch15280-Ch15420 • Ch16800-Ch16830	DBYD matches model provided
	LV overhead	• Ch15620-Ch15630 • Ch16610-Ch16640	DBYD matches model provided
	132kV overhead	Ch16350	DBYD matches model provided
Jemena	Gas main	N/A	No gas assets on DBYD within the project works area. Some shown in model provided outside of the project works.
TCCS	Street lighting conduits	Ch16280-Ch16610	DBYD matches model provided
Icon Water	Sewer gravity main	Ch15610 (western side)	DBYD matches model provided
	Sewer rising main	Ch15620 (eastern side)	Sewer does not appear on DBYD however was included in the model. Following communications with Icon Water, this sewer does not exist and has been removed from the model.
	Sewer gravity main MVIS	Ch16450	DBYD matches model provided
Telstra	100mm PVC conduit	Ch16330-Ch16760	Model has been updated to include additional Telstra line north of the bridge that has appeared on DBYD.
	63mm PVC conduit 50mm PVC conduit	Ch16400-Ch16460	

For each of the above utility authorities and service providers, a Utilities Conflicts Register had been developed and is shown in Appendix Q This register summarises:

- Expected impacts;
- Proposed relocation or adjustment strategies; and
- Details on the likely organisation responsible for managing the necessary adjustments for each impact.

The location of utilities either directly or indirectly impacted by the proposed works is detailed in the Utilities Coordination drawings.

11.1.4 Consultation with Utility Authorities

Table 11.2 below shows the contact details for each utility provider.

Table 11.2 Utility providers' contact details

Name	Utility Provider	Phone Number	Email
Pat Clark	ACT Government (ITS)	(02) 6207 7369	pat.clark@act.gov.au
Danny Tantri	Evoenergy	(02) 6293 5162-	Danny.Tantri@evoenergy.com.au
Matthew Bethke **Gregory Whitnall**	ICON – Department of Finance	(02) 6215 1846 -	matt.bethke@finance.gov.au gregory.whitnall@finance.gov.au
Jaime Paa **Tim Elliott**	Icon Water	(02) 6180 6014 (02) 6180 6072	Jaime.Paa@iconwater.com.au tim.elliott@iconwater.com.au
Tom Amrein	Jemena	(02) 9867 7032	tom.amrein@jemena.com.au
Andy Every	NBN	(02) 9031 3167	andyevery@nbnco.com.au

David Charles	Telstra	(02) 42602075	David.W.Charles@team.telstra.com
Wayne Read	TPG / AAPT / iiNet	(02) 6229 8072	w.read@staff.iinet.net.au

11.2 Approach to Utility Services Design

11.2.1 Investigation Strategy

The investigation phase design activities have included:

- A Dial Before You Dig search;
- A review of the supplied 3D utility survey model;
- Identification and documentation of missing information / gaps within the Utilities Conflicts Register; and
- Meetings / consultation with utility authorities to gather detailed requirements on affected services.

11.2.2 Design Strategy

PSP design phase activities have included:

- Contacting utility providers to understand conflicts and develop concept design based on DBYD
- Engaging a lighting designer (Ahern Consulting Engineers) to provide advice on street lighting design;
- Preparation of PSP designs for relocation and / or protection of services in consultation with the client and utility authorities at Draft and Final design phase milestones;
- Coordination of relocation / protection designs with roadwork and drainage designs;
- Developing designs that are coordinated with the proposed construction staging strategy for the project;
- Documenting design / conflict issues in the Utilities Conflict Register; and
- Coordination with utility authorities to discuss concept designs as required.

The consultation with utility authorities has aimed to:

- Confirm that the requirements of each service authority are considered and fully documented during the design development;
- Confirm that opportunities for the sharing of utility service corridors are considered and implemented where appropriate;
- Establish requirements for the provision of future utility services;
- Consider all options for avoidance, adjustment, protection and/or replacement of utility services; and
- Minimise utility services conflicts and construction risks.

A Water Service designer will be engaged at detailed design to provide advice on the design for water assets. Telstra will be engaged at detailed design to provide designs for their assets.

11.3 Utilities and Recommended Strategy

The impact of earthworks, drainage, bridge and road construction activities on services has been assessed in the Utilities Conflicts Register contained in Appendix Q. The location of utilities either directly or indirectly impacted by the project is shown in the Utilities Coordination Drawings.

The management strategy for further development of the affected public utility infrastructure is outlined in this section for each of the respective utility authorities.

All proposed strategies for the Final PSP design have been nominated internally by Jacobs. A draft set of utility sketches demonstrating these strategies were provided to each authority via email. Any preferences communicated to the Jacobs team have been implemented where possible, with all relevant communications included in Appendix R.

11.3.1 Utilities Allocation

The utilities allocation on eastern verge and western verge of the road has been nominated based on tie-in information from the southern John Gorton Drive stage 2A to the northern John Gorton Drive stage 3B.

Figure 11.1 and Figure 11.2 below depicts the Utilities Allocation under the shared path on the bridge.

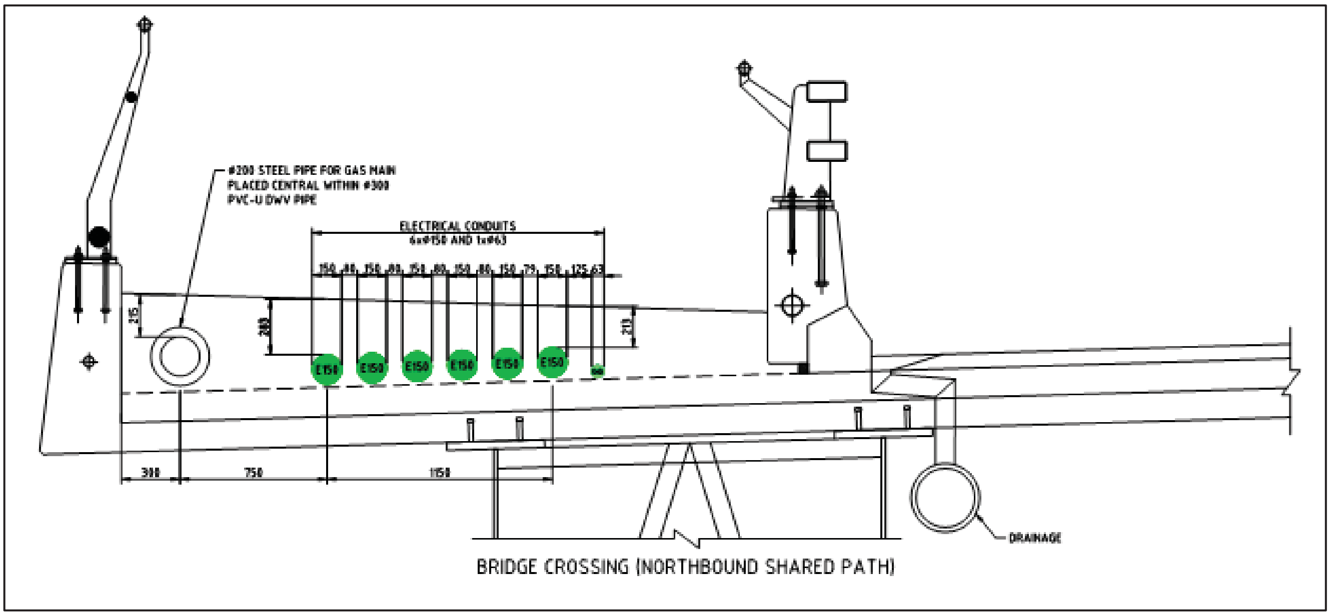


Figure 11.1 Northbound Shared Path

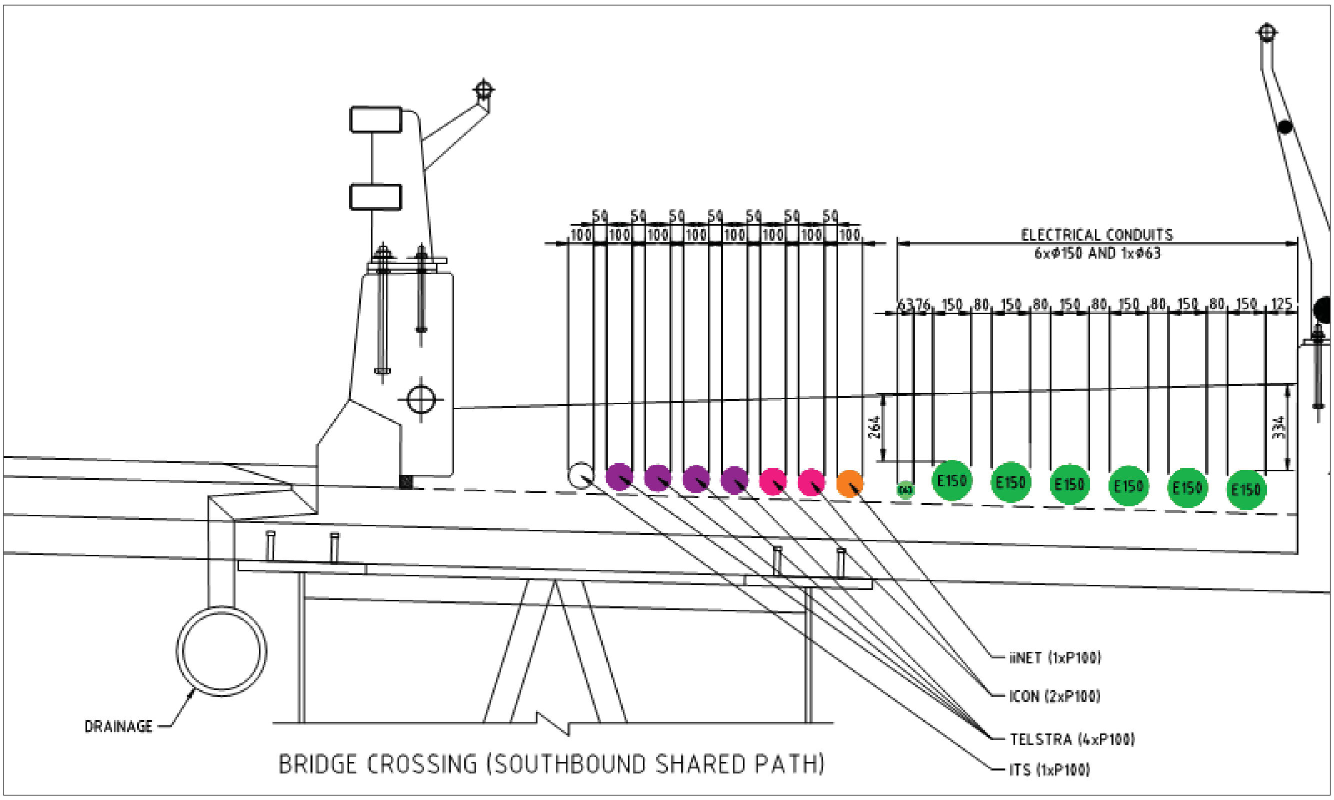


Figure 11.2 Southbound Shared Path

11.3.2 Electricity

The following existing Evoenergy electrical assets are located within the project area:

- 2 x 11kV (HV) overhead electrical lines
- 2 x 400V (LV) overhead electrical lines
- 1 x 132kV (HV) overhead electrical line

The 11kV and 400V overhead assets will require removal due to conflicts with the project works. The existing 132kV overhead and associated towers will be removed as part of a separate project and will be replaced with underground 132kV cables outside of the JGD3C site. This is scheduled to occur prior to construction, in March 2021.

Evoenergy have requested 6x150mm conduits and 1x63mm conduits in both the eastern and western verges for the extent of the project including the proposed bridge. These conduits will be used to replace the 11kV and 400V overhead lines that are being removed. These trenches are to align with the Stage 3B and Stage 2A electrical trenches to the north and south respectively, however these trenches do not include a 63mm conduit. It is also noted that the eastern verge of Stage 2A does not contain an electrical trench, therefore the JGD3C eastern electrical trench must be terminated at the southern limit of works.

The seven electrical conduits within the trench must transition to a side-by-side arrangement for the bridge crossing due to spatial constraints underneath the shared path. (Refer to Figure 11.1 and Figure 11.2).

Evoenergy have not nominated any specific overhead assets that must be relocated as early works at this stage. However, they have noted that the relocation works must be managed based on each specific area of the network. Once the staging plans are sufficiently developed at the next phase of design, Evoenergy can provide more specific comments on how the network can be reconfigured.

Evoenergy have also noted that it is not advisable to have outages for long periods of time. The preferred approach is to remove overhead network and energise new cable one section or area at a time. Coordination may also be required with relocation of other sections of the Black Mountain feeder (off the main trunk) as part of the Whitlam estate development.
Refer to Appendix R for utility authority correspondence.

11.3.3 Gas

There are no existing gas mains within the project area.

Jemena have communicated that they require continuation of the 200mm steel gas main through the eastern verge of Stage 3C to connect to southern Stage 2A and northern Stage 3B. Jemena have also noted that they require space for the continuation of the 160PE gas main through the western verge, and this has been shown in Shared Trench 2 (ST2).

Jemena have requested that the gas main be located underneath the shared path crossing the bridge adjacent to other utilities and is not to be underbored. However, due to spatial constraints on the eastern verge the gas main must cross John Gorton Drive at Ch16075 and run underneath the western verge shared path before crossing back to the eastern verge at Ch 16400. Jemena have been consulted in detail relating to the gas main underneath the shared path. Jacobs have proposed a 300mm PVC-U pipe to encase the 200mm steel gas pipe. The steel gas pipe for corrosion protection could be one of the following options:

1. Stainless steel; or
2. Have a protective coating plus external wrapping.

The steel gas pipe will be central with spacers provided and the annulus left unfilled (on the basis that one of the options above provide the corrosion protection). Just off the bridge the steel pipe would be required to bend down to achieve the required cover and this zone would be completely concrete encased to provide protection. The following sketch was provided to Jemena on 24 October 2019:

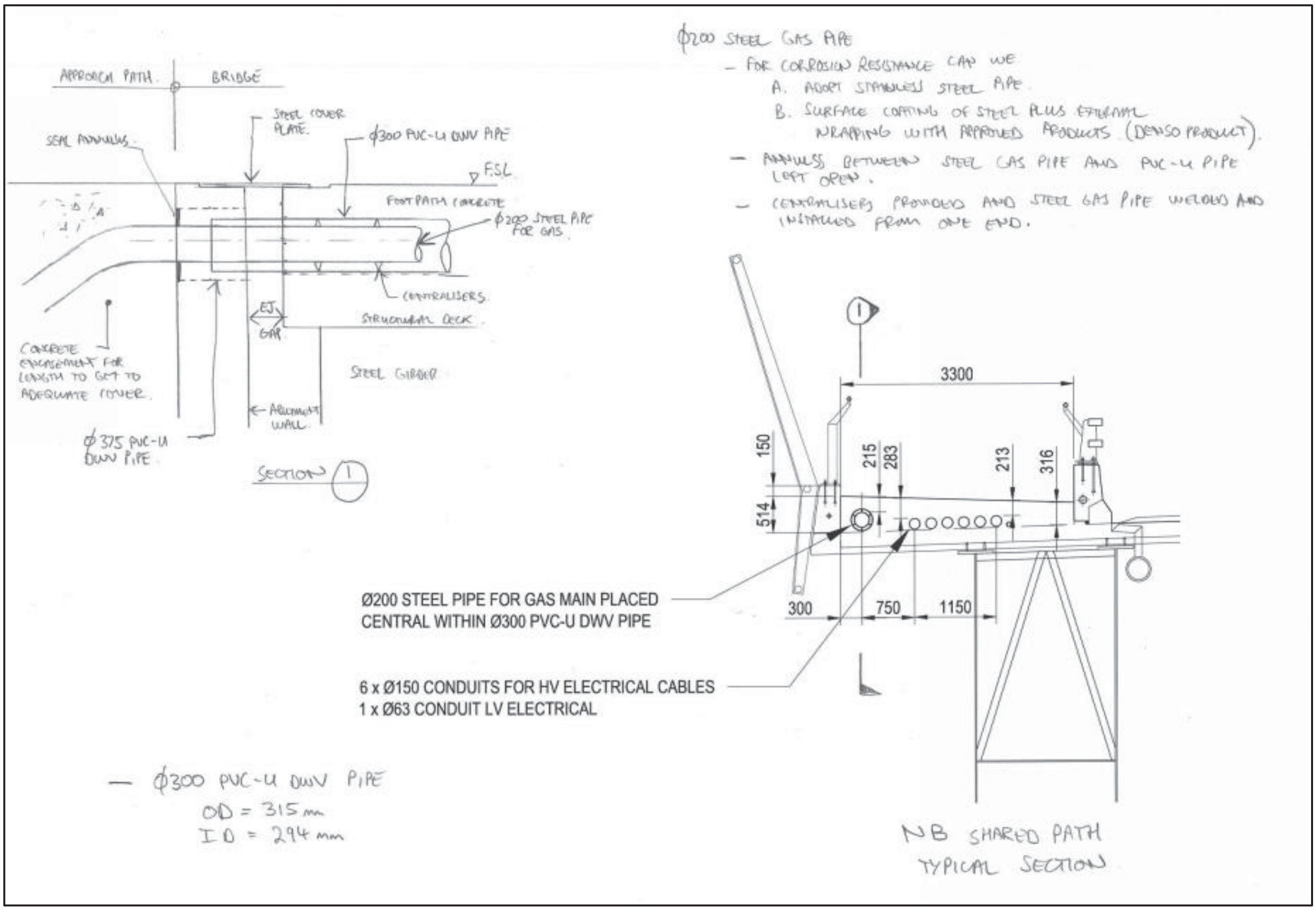


Figure 11.3 Jacobs' proposed gas main design solution under the bridge

Jemena responded on 25 November 2019 accepting the proposal in theory, however noting that additional consultation will be required throughout the next design phase to ensure that the pipe is maintenance free.

200mm isolation valves have been provided either side of the bridge, noting that monolithic isolation joints (MIJ) will also be required at each end of the bridge installed near the valves.

The two gas crossings must be contained within a 375 diameter RCP.

On 11 June 2020, following the receipt of the Final PSP drawings, Jemena approved the current proposed utility design shown in the Final PSP Design submission. It should be noted that Jemena requested that the following caveats will be taken through to the concurring Detailed Design/ D&C phase:

- This stage forms "Approval in Principle" only;
- Reassessment of the Molonglo Master Plan area is currently underway and is not yet complete/ approved;
- Future changes to the gas main(s) may occur in the future depending on the outcome of the Molonglo Masterplan Review.

Official approval and Design certification is required from Jemena at the Detailed Design/ D&C phase.

Refer to Appendix R for utility authority correspondence.

11.3.4 Telecommunications

11.3.4.1 Telstra

The following existing Telstra assets are located within the project area:

- 100mm PVC conduit
- 63mm PVC conduit (optical fibre)
- 50mm PVC conduit (optical fibre)

These three assets are proposed to be removed. Existing Telstra assets within and at the Stage 2A interface shown on DBYD have been assumed to have already been removed by Stage 2A works and are therefore not called up in this project.

Telstra have advised that they require 4x100mm PVC conduits through the eastern verge. These conduits will be located within the telecommunications trench, aligning with the 4x100mm Telstra conduits within the Stage 3B telecommunications trench to the north, and the 4x100mm Telstra conduits within the Stage 2A telecommunications trench to the south.

The three Telstra cables will require temporary relocation during construction. This relocation is shown in the Figure below, designed by Calibre. This alignment allows for the Whitlam Stage 3 works to progress and does not preclude the JGD3C works from being constructed. This work has been approved by Telstra with works expected to be completed by mid-August 2020.

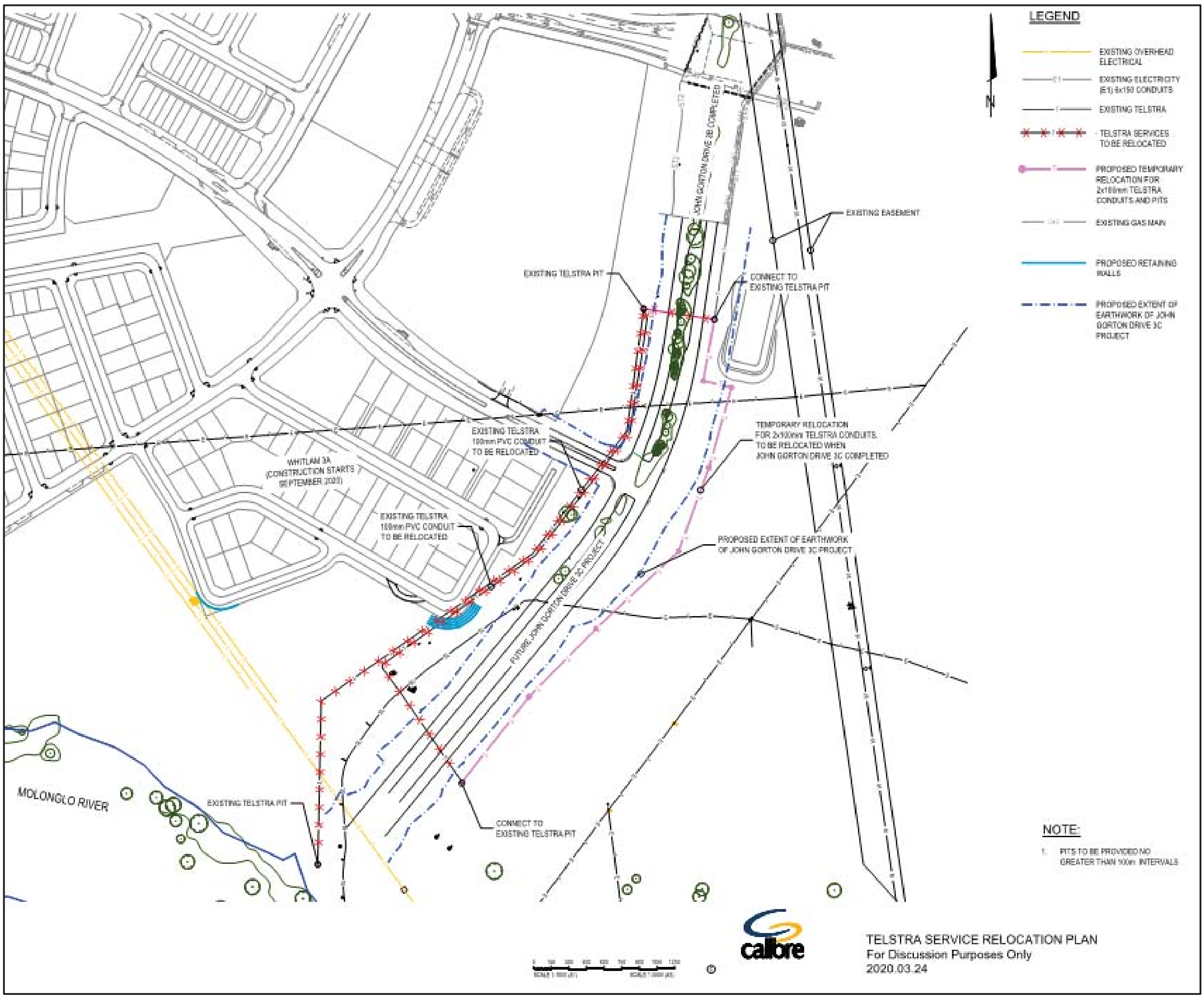


Figure 11.4: Calibre Telstra Relocation Plan

Refer to Appendix R for utility authority correspondence.

11.3.4.2 NBN

There are no existing NBN conduits within the project area.

Stage 2A eastern verge contains 1x100mm NBN conduit while Stage 3B eastern verge contains 2x100mm NBN conduits. NBN advised Jacobs on 11 October 2019 that no NBN conduits are required through the Stage 3C eastern verge, therefore these have not been included in the design.

Refer to Appendix R for utility authority correspondence.

11.3.4.3 ICON (Communications)

There are no existing ICON conduits within the project area.

The Stage 2A eastern verge contains 2x100mm ICON conduits, and Stage 3B eastern verge contains 2x100mm ICON conduits. ICON have confirmed that continuity of these 2x100mm conduits is required through the eastern verge of Stage 3C.

Refer to Appendix R for utility authority correspondence.

11.3.4.4 iiNet

There are no existing TPG (AAPT), TransACT or iiNet conduits within the project area.

It is noted that when attempting to contact TPG / AAPT, the design team were directed to a contact at iiNet. Wayne Read from iiNet noted that TPG (AAPT) assets include TransACT and iiNet.

iiNet confirmed that 1x100mm conduit is required through the eastern verge to service iiNet, TPG (AAPT) and TransACT. This will be noted as iiNet on the drawings. This 100mm conduit provides continuity from the Stage 2A 1x100mm conduit. Note that there is no equivalent conduit in the Stage 3B telecommunications trench, therefore this asset must be terminated at the northern limit of works.

iiNet have requested to be contacted throughout the remaining design phases and when the IFC design is being finalised.

Refer to Appendix R for utility authority correspondence.

11.3.4.5 Telecommunications across the bridge

The telecommunications trench is required to transition from the back of verge towards the front at approximately Ch16100, in a side-by-side arrangement as opposed to the verge configuration (refer to Utilities Drawing set and Bridge Drawing set). This change in alignment is essential due to spatial constraints across the bridge under the shared path. The telecommunications trench then transitions to the back of verge again at approximately Ch16375 to align with Stage 3B to the north. (Refer to Figure 11.1 and Figure 11.2)

Refer to Appendix R for utility authority correspondence.

11.3.5 Water

There are no existing water mains within the project area.

11.3.5.1 Molonglo 3 Area

A 225mm water main is required through the western verge and ties into the water main at the Whitlam estate intersection as per CAD files provided by Calibre on 3 March 2020 and shown in Figure 11.5. A new 300mm diameter crossing at the Sculthorpe Avenue intersection has also been included, in accordance with Calibre mark-ups from a design meeting held on 3 May 2019.

Figure 11.5: Tie in to Whitlam Estate utilities

TCCS advised on 20/05/2020 that the updated Master Plan for the Molonglo 3 area is still under development and is therefore outside of the scope for this project at this stage.

11.3.5.2 Molonglo 2 Area

The updated Master Plan for the Molonglo 2 area was received from TCCS on 10/02/2020, with a small update to the water Master Plan received from Icon Water on 10/03/2020. An extract of this water Master Plan is shown in the figure below.

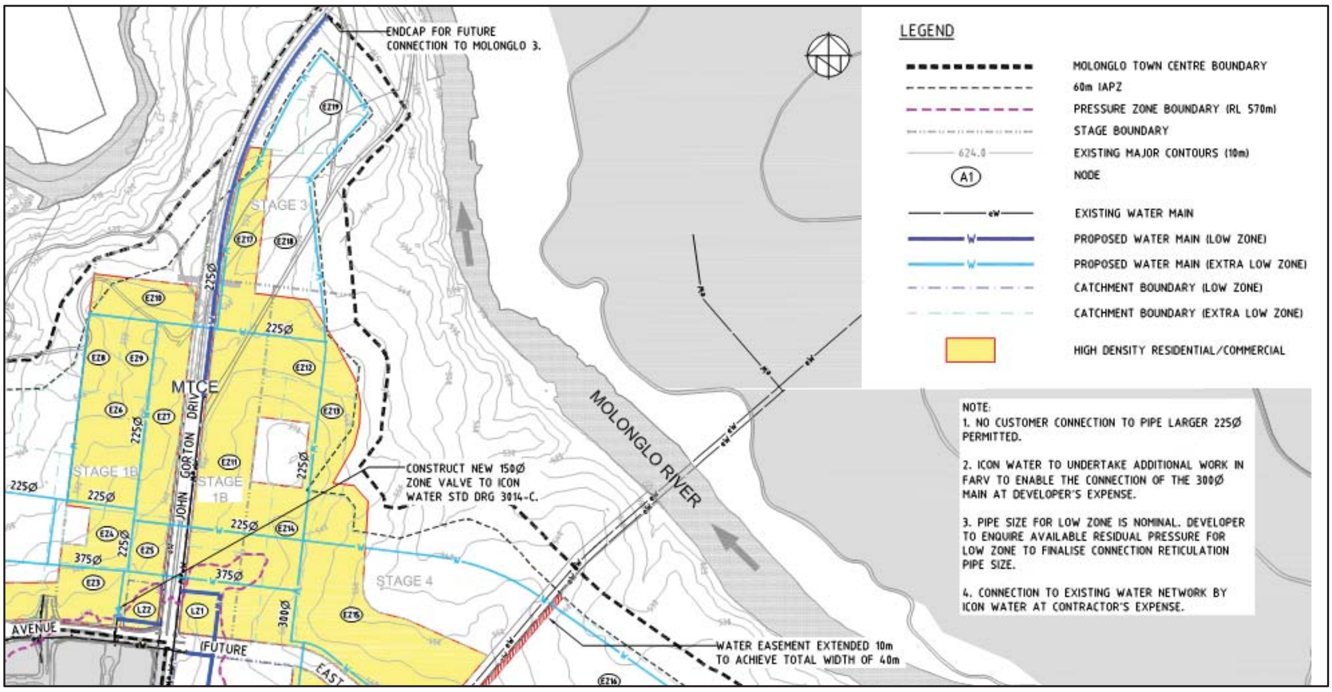


Figure 11.6: Molonglo 2 Water Master Plan

This plan shows a 225mm 'low zone' (LZ) water main running through the eastern verge and terminating prior to the bridge for future connection to Molonglo 3.

A 225mm 'extra low zone' (ELZ) water main crosses the JGD3C alignment at approximately Ch15300. Another ELZ runs parallel (approximately) with the alignment outside of the eastern verge works until it turns east towards the future proposed development. However, it is noted that a portion of this ELZ has had to be shifted closer to the main alignment from approximately CH15680 to CH15850 to avoid Basin B3.

Refer to Appendix R for utility authority correspondence.

11.3.6 Sewer

The following existing Icon Water sewer assets are located within the project area:

- Sewer gravity trunk main west of the proposed alignment, south of the bridge.
- Sewer gravity main MVIS which crosses the proposed alignment north of the bridge.

Both existing sewer assets are to remain.

11.3.6.1 Molonglo 3 Area

The MVIS is approximately 2.55m in diameter. The proposed road design in this area has been kept as close to existing levels as possible to avoid the need for protection slabs or remediation works to the MVIS, and currently offers over 2m of cover.

The proposed sewer crossing at approx. CH16800 ties into the Whitlam sewer main as per CAD files provided by Calibre on 3 March 2020 and shown in Figure 11.5. This crossing was proposed by Calibre in their letter 'Molonglo 3 Sewer Concept – Phase 2' on 01/07/2019 shown below.

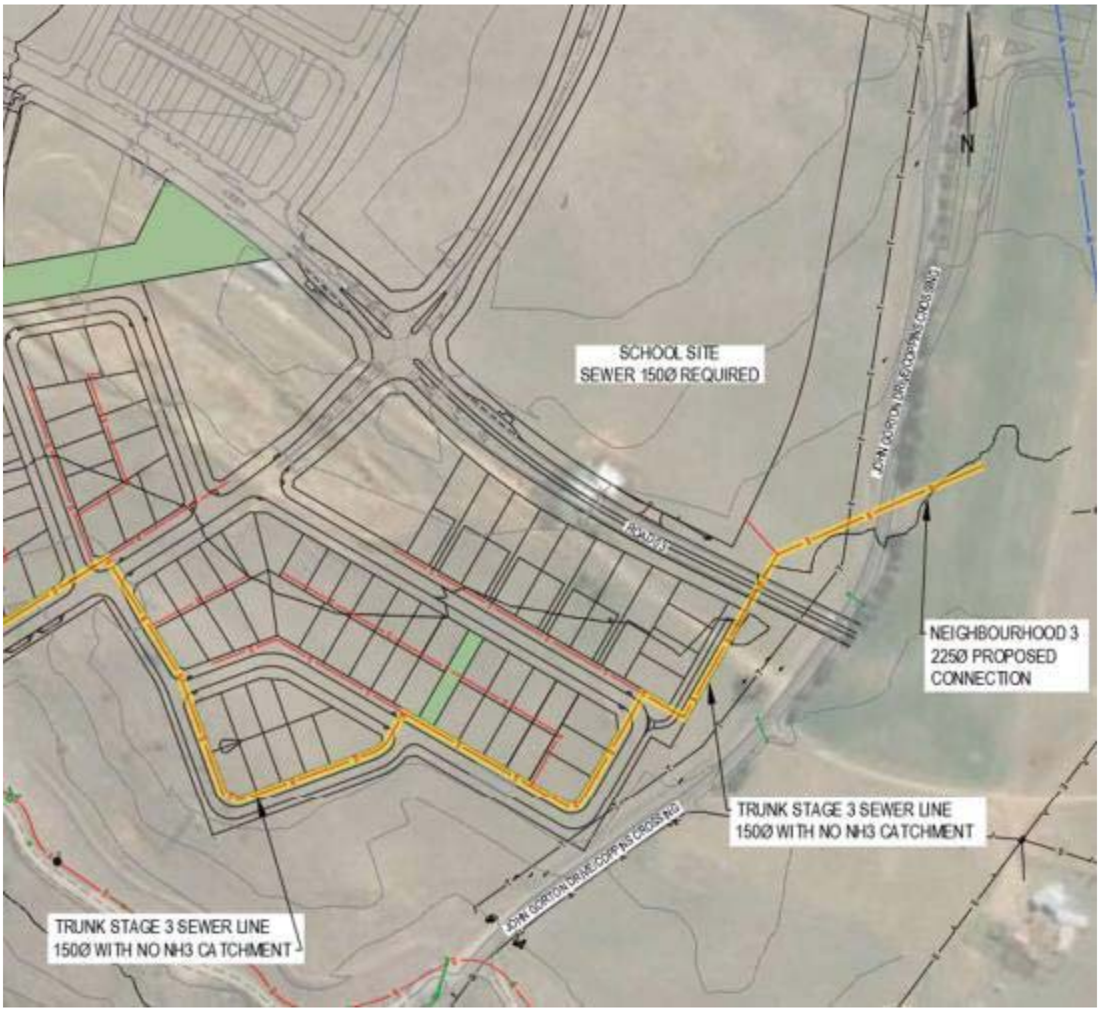


Figure 11.7: Molonglo 3 Sewer Crossing

MVIS Protection

Following the Final Draft PSP submission, Icon Water requested that Jacobs investigate if the additional live loads over the MVIS warrant a protection structure. The following is a summary of the structural analysis completed.

Based on Icon Water's MVIS102 pipe specification, the pipe is a rubber ring jointed reinforced concrete sewer pipe of 2591mm internal diameter and 178mm wall thickness with design concrete compressive strength of 25MPa. The road design level matches the existing surface level so there is negligible permanent load change on the pipe, therefore only traffic live load effects were considered. The vertical pressures on the pipe as per AS1597.2 equates to 13kPa for SLS and 26kPa for ULS considering SM1600 loading. The analysis found that the addition of this live load pressure resulted in a bending stress equivalent to 9% of the SLS and 16% of the ULS cracking capacity of the concrete pipe. On this basis the recommendation is that no protection structure is required. This was communicated to Icon Water on 27 May 2020.

The analysis assumptions include:

- Reinforcement has not been considered in assessing the cracking capacity to give a conservative result.
- A modulus of subgrade reaction of 40,000 kN/m3 (which represents stiff to hard material) was used for this assessment.
- Side wall effect the ground will have on the pipe to reduce vertical bending stress has been ignored for a conservative result.

Details of this structural analysis are included in Appendix U. Icon Water in-principle approval relating to this assessment was received via email on 13 August 2020. Refer to Appendix R for utility authority correspondence.

11.3.6.2 Molonglo 2 Area

The sewer gravity trunk main in the survey model south of the bridge does not appear to align with Butters Bridge, as opposed to what is shown on DBYD. This sewer will require potholing at the next phase of design to confirm alignment.

The updated Master Plan for the Molonglo 2 area was received from TCCS on 10/02/2020, with an extract of this sewer Master Plan included below.

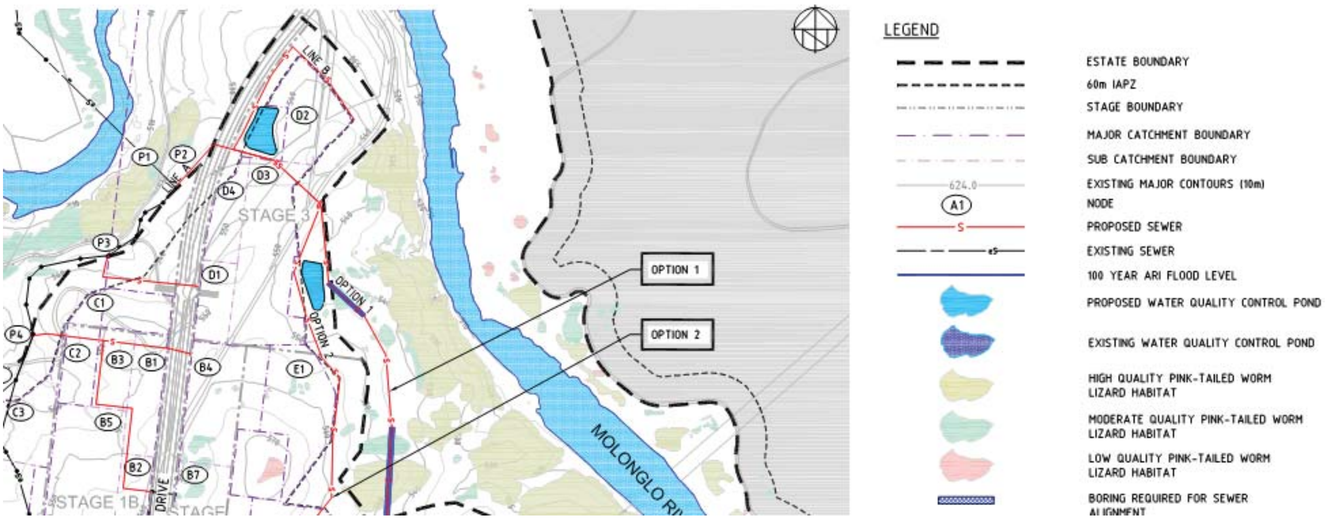


Figure 11.8 Molonglo 2 Sewer Master Plan

This plan shows three sewer crossings required across the JGD3C alignment at CH15270 (300mm), CH15410 (150mm) and CH15700 (375mm). The crossing at CH15700 connects from Butters Bridges to the eastern side of the alignment, where it runs north parallel to the road alignment before turning east towards the future proposed development.

Refer to Appendix R for utility authority correspondence.

11.3.7 Intelligent Transport Systems (ITS)

There are no existing ITS conduits within the project area.

The ACT Government have advised that they require 1x100mm conduit through the eastern verge of Stage 3C for ITS equipment. This conduit is to be a continuation of the Stage 3B ITS conduit to the north. It is noted that the eastern verge of Stage 2A does not contain an ITS conduit, therefore the JGD3C eastern ITS conduit must be terminated at the southern limit of works.

J8 type ITS pits are required at 200m spacing and at each road intersection.

Refer to Appendix R for utility authority correspondence.

11.3.8 Lighting

The existing street lighting along Coppins Crossing Road will be redundant and is therefore to be removed. New street lighting is required in both the eastern and western verges for the entire length of the project.

11.3.8.1 Road Lighting

The lighting level required by TCCS is Category V3. Road lighting shall utilise the same streetlight poles and luminaires to TCCS requirements as per the adjacent road lighting to the north of the works. 10.5 metre poles with 4.5 metre outreach arms shall be used with Pecan 158-Watt LED luminaires. Existing streetlight circuits will be extended to supply the new lighting with additional streetlight control cubicles installed at the Molonglo River Bridge to control the bridge lighting and to extend up John Gorton Drive in both directions to supply street lighting.

Street lighting has been offset 1.85m from the face of kerb to ensure consistency with Stage 3B to the north.

Refer to Appendix S for street lighting design undertaken by Ahern Consulting Engineers.

11.3.8.2 Bridge Lighting

The lighting level required by TCCS is Category V3. The bridge lighting is being designed in conjunction with Cox Architecture. TCCS have requested that no streetlight poles be used to illuminate the bridge roadway. Two options for the roadway lighting are provided.

The first option is to illuminate the paths adjacent the road way with hand rail mounted LED low level lighting, with architectural LED strip lighting used to illuminate the safety rail/balustrade. No lighting will be provided on the road way over the bridge other than spill lighting from the handrails and safety rail/balustrades. Hence, a Category V3 lighting cannot be achieved with this option and will need to be approved by TCCS as a non-conformance.

To provide some lighting for the roadway, a second option is to provide the same handrail LED lighting as the paths on the rails adjacent the bridge roadway. This lighting will illuminate the edges of the bridge roadway and attempt to achieve a lighting level approaching AS/NZS1158.1.2 Category V3 lighting that is provided on the adjacent roadways. The level of lighting over the bridge roadway achieved by this lighting will need to be approved by TCCS as a non-conformance.

Streetlight control cubicles will be installed adjacent to the bridge to provide power supply and control of the bridge lighting. The bridge LED lighting will require low voltage power supplies to be installed at approximately 20 metre intervals across the bridge. The weatherproof power supply enclosures will be integrated into the bridge design by Cox Architecture.

11.4 Outstanding Items

The following table outlines the outstanding utility items at the time of the PSP submission.

Table 11.3 Outstanding items

Utility	Outstanding item description
Water	• Updated Hydraulic Master Plan required for Molonglo 3.
Sewer	• Updated sewer Master Plan required for Molonglo 3 • Potholing of sewer trunk main south of the bridge to confirm alignment with respect to Butters Bridge. • Icon Water "approval in principle" of Final PSP design proposal
Gas & Electrical	• An electrical hazard assessment will be required at the next phase for ST2. • Outcomes from Jemena's Molonglo Master Plan Review will be required at the next phase to determine if any future changes are required

12. Urban Design and Landscape Architecture

12.1 Approach

The urban design and landscape concept for JGD3C is to respond to and integrate with adjacent road development JGD2A and JGD3B whilst matching the surrounding environmental and aesthetic context. JGD3C connects road sections JGD2A and JGD3B and is required to ensure continuity and unity along John Gorton Drive and future-proof the route as a gateway to the long-term development proposals of the area.

The design will include a mixture of native and more formal deciduous tree species to respond to the surrounding rural character whilst recognising the future urban expansion that will transform the area into a fully developed and populated suburb within the ACT. To provide for the future population, a quality pedestrian/cyclist shared path which connects the proposed developments is integral to the design. The PSP will acknowledge the importance of the shared path user experience for pedestrians and cyclists and the increasing importance of active transport.

To meet the project brief requirements of matching the design standards of JGD2A and JGD3B, this design has adopted the safety clearance zone of 5.5m from the edge of the traffic lane on the verges and 2.6m into the central median.

12.2 Principles

The following principles were developed to guide the design and produce a cohesive and consistent landscape aesthetic for the scheme:

- Ensure the design and character of JGD3C is integrated with the adjoining road sections;
- Acknowledge and link to the context of the existing natural environment;
- Select tree species which match and compliment adjoining road sections;
- Provide planting to enhance the amenity of the pedestrian/cyclist shared path;
- Landscape the median to create interest and contrast to enhance driver experience;
- Use a 5.5m safety clearance zone from the edge of the traffic lane on the verges and 2.6m into the central median.

12.3 Outcomes

The urban design and landscape concept for JGD3C creates a cohesive and unified link between the adjoining road sections by:

- Continuation of the 3m width pedestrian/ cyclist shared path;
- Extension of the Platanus orientallis ‘Digitata’ formal tree avenues on either side of the road corridor;
- Continuation of the Eucalyptus rossii tree planting within the median to create visual interest and contrast to enhance driver experience;
- Use of Quercus palustris ‘Freefall’ in approaches to intersections and links into future developments.

The design references the existing natural environment and enhances the amenity of the shared path by:

- Use of Eucalyptus rossii tree planting within the median in an informal planting layout;
- Implementation of extensive, block planted drifts of native grasses within the median to create visual interest/ contrast and enhance driver experience;
- Use of tall, native grasses that will move with the wind and create visual interest for pedestrian/cyclists using the shared path;
- Use of deciduous species to provide seasonal variation;

- Use of Quercus palustris ‘Freefall’ in approaches to the bridge, intersections and links into future developments. The red hue of these trees will create visual contrast and the formality of a gateway to the future development for future residents and visitors (species approved in MIS25).

Refer to drawings IA216800-DG-LS-0101-08, IA216800-DG-LS-0201-02, IA216800-DG-LS-0301 and IA216800-DG-LS-401-02

13. Pavement Design

For Pavement Design information refer to Appendix T.

14. Planning and Environmental Approvals

14.1 Pre-DA Meeting

A Pre-DA Document was accompanied with a request for a pre-DA meeting on 17 May 2019, to inform government agencies of the project and the predicted impacts and statutory implications.

A Pre-DA meeting was held on 11 June 2019, the key outcomes of this meeting were:

- EIS is not likely required;
- An Environmental Significance Opinion (ESO) is not likely to be supported;
- A new Section 211 application should cover the entire project area rather than just the gap between the existing s211 areas;
- No additional field work should be required to confirm the presence or absence of threatened species potentially occurring in the study area (i.e. Pink-tailed worm lizard, Murray Cod, Tarengo Leek Orchid, Perunga Grasshopper);
- A separate Contamination Management Plan (CMP) is required to be prepared for the Geotechnical Investigations (GI) and approved by the EPA as part of the Construction Environmental Management Plan CEMP).

14.2 Geotechnical Investigations Contamination Management Plan

The CMP is a new requirement of the ACT EPA, requiring a separate report to be approved by the EPA prior to commencement of work within the Molonglo Valley. EPA provided comment on the draft GI CEMP and GI CMP via email on 23 July 2019.

The final Geotechnical Contamination Management Plan (GI CMP) was lodged with EPSDD on 24 July 2019.

The EPA provided endorsement of the GI CMP on 9 August 2019. No other comments on the CMP were received from other agencies.

Separate advice from David Hale (EPA) in an email on 15 August 2019, confirmed the GI CMP does not need auditor review.

14.3 Geotechnical Investigations Construction Environmental Management Plan (CEMP)

Geotechnical Construction Environmental Management Plan (GI CEMP) was lodged with EPSDD on 24 July 2019.

Comments were received from the agencies on 9 August 2019.

Issues raised included:

- Weed management;
- Compliance with Statement of Heritage Effect (SHE) approval:
  - Status of known heritage items;
  - Geological site delineation and impacts;
- EPA endorsement of the GI CEMP and GI CMP.

A geological site memo was produced by Jacobs' geotechnical engineer (dated 14 August 2019) addressing the requirements of the SHE in relation to the GI. The delineation and significance assessment has been endorsed by the Geological Society of Australia in an email from Douglas Finlayson on 15 August 2019.

The GI CEMP was updated and re-lodged with EPSDD on 19 August 2019 and approved on 27 August 2019

14.4 Section 211 EIS Exemption

An application for an Exemption for an EIS under Section 211 of the *Planning and Development Act 2007* (the P&D Act) for the entire JGD3C Project Area was lodged on 1 August 2019. An email response to the completeness check was received on 8 August 2019 which identified the following issues to be addressed before the application can be accepted for governmental review and exhibition:

- Attach copies of existing s211 exemptions
- Update the biodiversity assessment to address the entire proposed s211 exemption area.

Additional biodiversity field work and update to the biodiversity assessment was undertaken and the revised s211 re-lodged on 23 August 2019.

Post adequacy check comments were received from EPSDD on 17 February 2020. A subsequent meeting was held with representatives of EPSDD, Conservator of Flora and Fauna, TCCS and Canberra Town Planning (for Jacobs) on 12 March 2020 to discuss the issues raised and agree on the management approaches. Further confirmation of the water quality treatment criteria was received from the Conservator of Flora and Fauna on 19 May 2020.The S211 was lodged on 11 June 2020.

Agency correspondence is provided in Appendix W.

Should the Section 211 exemption not be approved, the EPSDD will provide an EIS Scoping Document and preparation will commence for the EIS to support the DA.

14.5 Development Application

JGD3C triggers impact track assessment under Section 123(a) of the *Planning and Development Act 2007*, being development of a kind mentioned in Schedule 4.

Table 14.1 Relevant EIS triggers under Schedule 4 Part 4.3, Areas and Processes

Proposal	Triggered
Involving: **a) the clearing of more than 0.5ha of native vegetation in a native vegetation area, other than on land that is designated as a future urban area…; or** **b) the clearing of more than 5.0ha of native vegetation in a native vegetation area, on land that is designated as a future urban area under the territory plan, unless the conservator of flora and fauna produces an environmental significance opinion that the clearing is not likely to have a significant adverse environmental impact**	Assuming clearing of the entire s211 area, approximately 6.86 ha of native vegetation will be cleared The total actual clearing required for construction is expected to amount to less than 5ha (approximately 1ha).
For development in a reserve, unless: **a) the conservator of flora and fauna produces an environmental significance opinion that the proposal is not likely to have a significant adverse environmental impact; or** **b) the proposal is for minor public works to be carried out by or for the Territory in accordance with a minor public works code approved by the conservator of flora and fauna under the Nature Conservation Act2014, section318A**	The project is within the River Corridor Special Purpose Reserve.

At the time of submission of this report, the DA is being prepared. The specialist studies forming part of this PSP will inform the DA.

The key issues to address in the DA are described below.

14.6 Environmental Constraints

Key environmental constraints are identified in Figure 14.1. Note this figure has been updated in accordance with design development of the permanent detention basins since the original submission of the S211 EIS exemption document. The s211 exemption application boundary has also slightly adjusted to accommodate relocation of the northern off-site work area in response to the construction timing of the adjoining urban developments. No additional native vegetation or habitats are impacted by this amendment.

14.6.1 Biodiversity

A Biodiversity Memo was prepared to inform the Pre-DA meeting (dated 19 June 2019) which included a review of the existing site information and site inspection to identify any knowledge gaps and assess the likely impacts of the proposal with regard to the triggers for an EIS.

The assessment identified gaps in the data in relation to the potential presence of threatened species: Pink-tailed worm lizard, Murray Cod, Tarengo Leek Orchid, Perunga Grasshopper.

However, the ACT Conservator Liaison Officer advised at a meeting on 17 May 2019 that there was no value in undertaking additional field survey to confirm the presence or absence of these species since the project impact would still be considered not significant.

A "Biodiversity Review s211" was prepared with additional field survey across the entire s211 exemption application area to support the s211 application. The assessment validated the existing ecological studies and confirmed the site conditions based on field survey.

This assessment concluded that JGD3C:

- is unlikely to result in a significant impact requiring an EIS;
- can be compliant with the NES plan; and
- can be adequately assessed with existing studies to justify a s211 exemption.

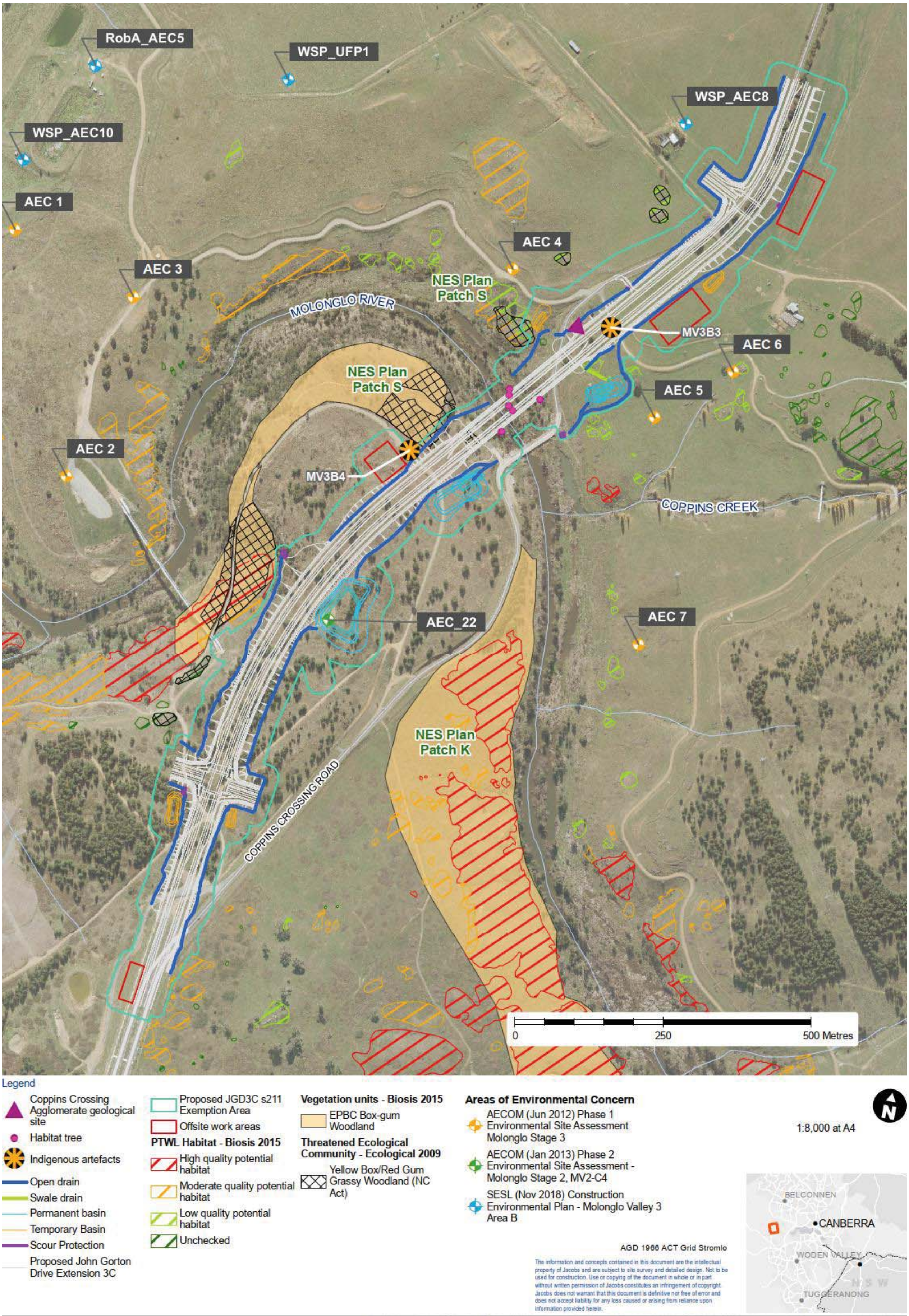


Figure 14.1 Environmental Constraints

14.6.2 Contamination

The JGD3C study area has been the subject of extensive contamination investigations and Site Audit Statements (SASs) and Site Audit Reports (SARs) as part of the Molonglo Valley Urban Developments Stage 2 & 3 (Figure 14.2). All work in the audited areas must be compliant with the relevant SAS endorsed management plans. The relevant environmental controls from these EPA endorsed assessments will be incorporated into a Contamination Management Plan (CMP) to be reviewed and approved by an EPA Accredited Auditor, and form part of the project Construction Environmental Management Plan (CEMP) prior to construction. A commitment to this will be included in the DA.

One portion of the project (north of the Molonglo River known as MV3B2) is subject of an ongoing audit and does not yet have a Site Audit Statement (SAS). This portion was assessed as part of the Phase 1 Environmental Site Investigations prepared by Jacobs 2018.

Previous studies have been undertaken for the entire project area as part of other urban development projects. The JGD3C construction footprint does not affect any mapped areas of environmental concern (AEC) (refer to Figure 14.3). Unexpected finds protocols and mitigation measures will be included in the Project CMP and CEMP to be reviewed and approved by an EPA Accredited Auditor prior to construction.

14.6.3 Aboriginal Heritage

The project will affect two know Aboriginal heritage items (MVB34 and MV3B3). A Statement of Heritage Effect Approval was issued by the ACT Heritage Council for the salvage of MV3B3 prior to construction.

A commitment to undertake this salvage will be made in the DA.

ACT Heritage Council has requested the known sites be fenced off during the GI.

14.6.4 Geological Site

Coppins Crossing Conglomerate Formation (G2) delineation as required under the SHE approval, was undertaken in a Geological Site Memo prepared by Jacobs dated 14 August 2019.

The delineation and significance assessment have been endorsed by the Geological Society of Australia in an email from Douglas Finlayson on 15 August 2019.

Ongoing liaison with the Geological Society to confirm the impacts and mitigation measures of the project prior to lodgement of the development application will be undertaken.

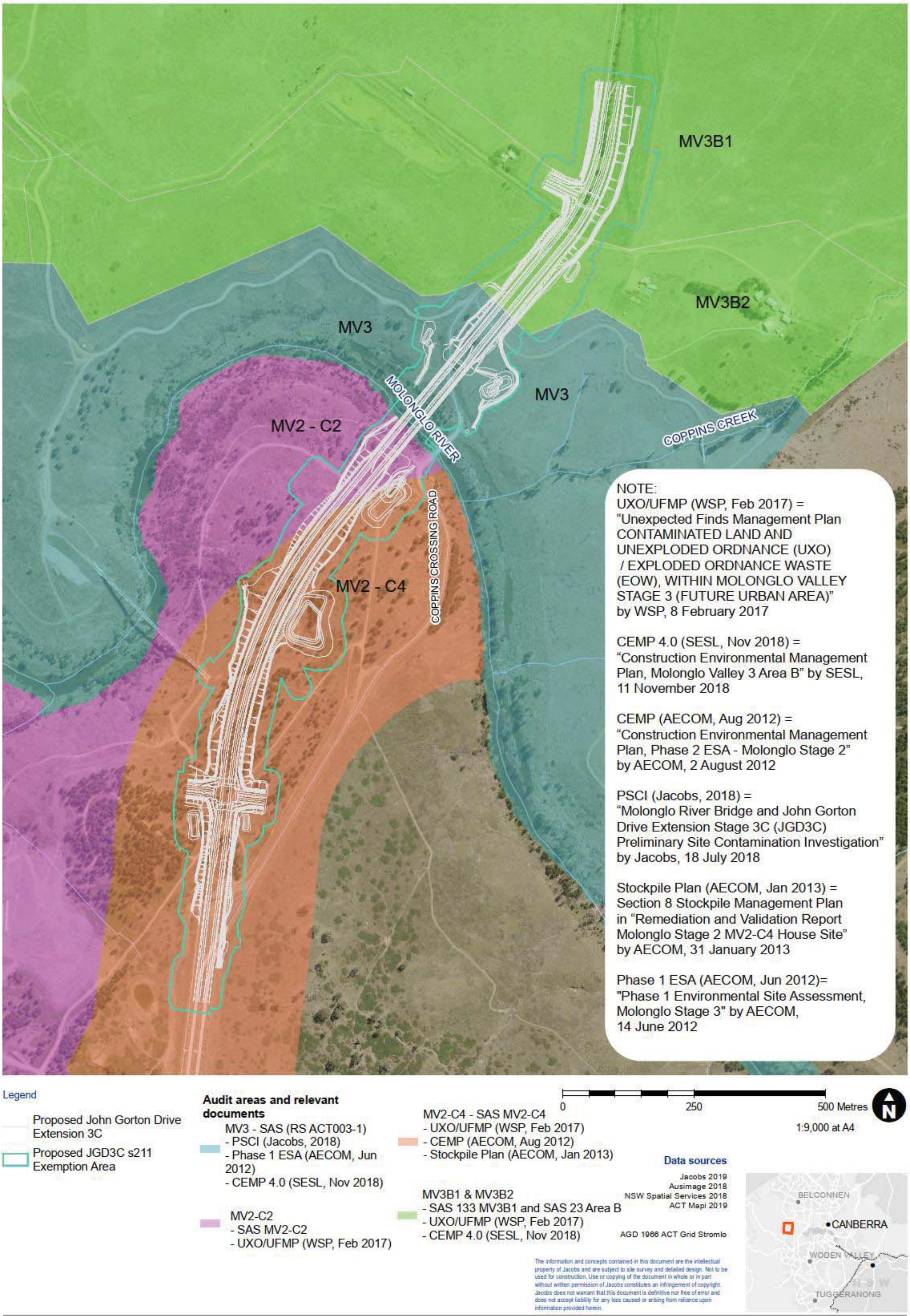


Figure 14.2 JGD3C Audit Areas and Relevant Documents

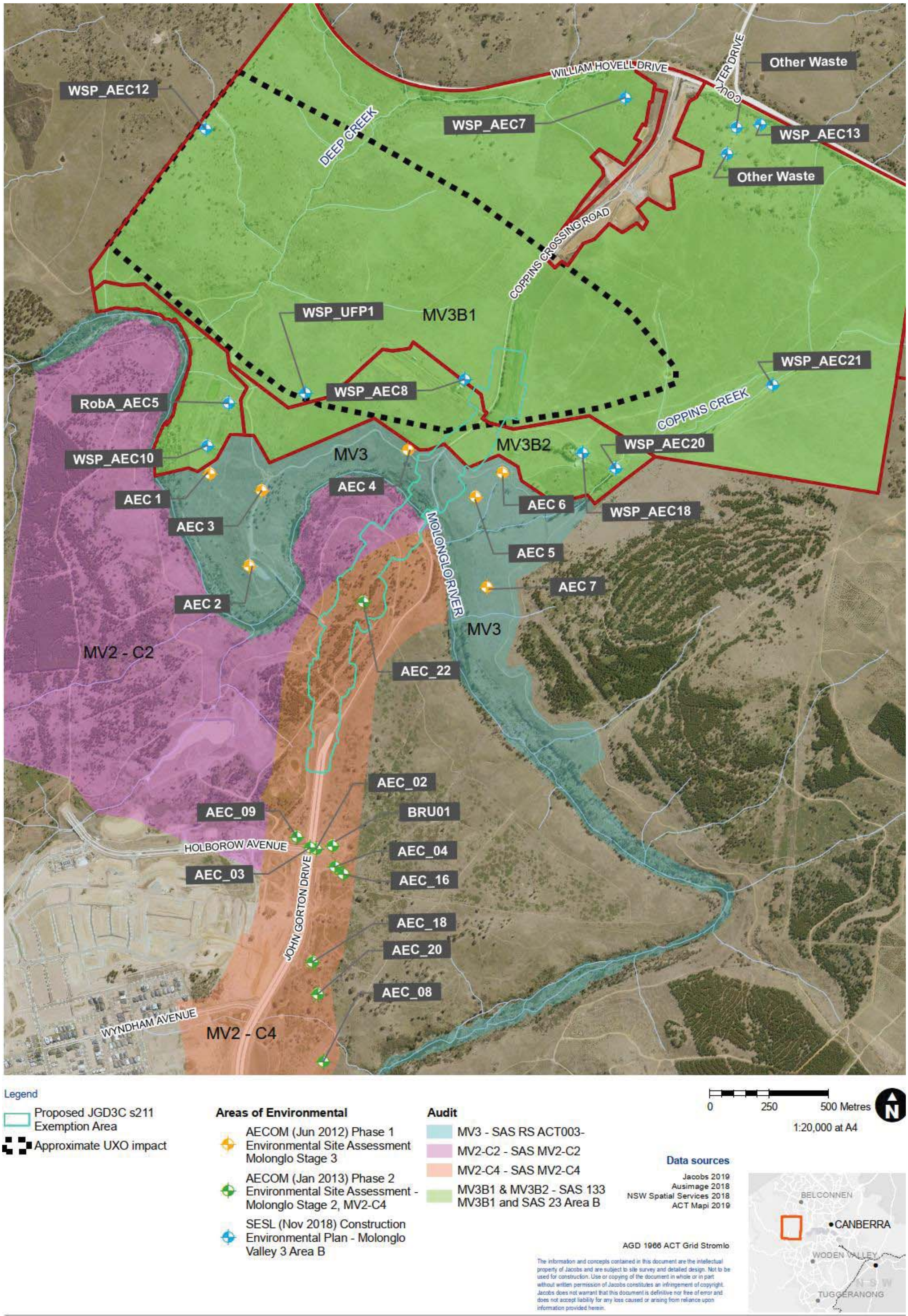


Figure 14.3 JGD3C Contamination Audit Areas & AEC

15. Flooding

15.1 Introduction

A flooding assessment is required to define existing flooding behaviour in the Molonglo River in the proximity of the project to assess potential impacts of the project on flooding in the Molonglo River and to assess structural integrity of the proposed bridge elements against scouring caused by floods up to 0.05% annual exceedance probability (AEP) event.

15.2 Review of Available Data

The available flood modelling information for the Scrivener Dam was reviewed. A detailed hydrologic model was undertaken for the Scrivener Dam using Monte-Carlo technique (*Molonglo Catchment and Scrivener Dam Flood Hydrology Review – Phase 1, Review of Extreme Flood Hydrology Report prepared by SKM in 2011*) and the hydrologic assessment is generally considered robust and fit for this assessment.

The one-dimensional MIKE11 hydraulic model utilised for a flooding assessment downstream of the Scrivener Dam was also reviewed and the model is considered too coarse for this assessment. This is due to the existing Coppins Crossing and other crossings located downstream of the Scrivener Dam not being included in the model and the MIKE11 model was developed using LiDAR data captured over Canberra CBD in July 2004 by AAMHatch (*Molonglo Catchment and Scrivener Dam Flood Hydrology Review – Phase 2, Hydraulics and Inundation Mapping Report prepared by SKM in 2011).* Hence a new hydraulic model needs to be developed to address limitations of the MIKE11 model.

A 1m resolution digital elevation model (DEM) derived from LiDAR data, captured in 2015, was available to this investigation. The DEM is the most recent topographic data available for this investigation.

15.3 Catchment hydrology

The Molonglo River has a catchment area of approximately 1920 km^2 at Coppins Crossing. It includes Lake Burley Griffin (catchment area approximately 1,870 km^2) which is impounded at the western end by Scrivener Dam and two main branches, namely the upper Molonglo River and the Queanbeyan River. The flood behaviour at Coppins Crossing is dominated by outflows from the Scrivener Dam.

15.4 Hydraulic modelling

15.4.1 Model setup

A TUFLOW combined one-dimensional (1D) and two-dimensional (2D) hydraulic model was developed for this study. TUFLOW is an industry-standard flood modelling platform, which was selected for this assessment. The model was developed and run in TUFLOW 2018-03-AE-iDP-w64, using the Classic module.

The model extent is along the Molonglo River which is bounded by the Scrivener Dam at the upstream end and 140 m downstream of the Lower Molonglo Nature Reserve to the west.

Three inflow boundaries are defined in the model. The main one is located at upstream end of the model boundary representing outflow from the Scrivener Dam. The second one includes inflow from the catchment area of Weston Creek and the third one represents local catchment runoff generated from the remaining catchment areas located between the dam and Coppins Crossing. An elevation discharge relationship was defined as the downstream model boundary for the TUFLOW model.

All the inflow hydrographs and the downstream elevation-discharge boundary condition adopted in the TUFLOW model were sourced from the available MIKE 11 model (SKM, 2011).

Three existing bridges including the Tuggeranong Parkway Bridge and Butters Bridge and two culverts at the Bicentennial National Trail and Coppins Crossing are represented in the TUFLOW model.

Manning's 'n' values which are recommended in Australian Rainfall and Runoff (ARR) were applied to represent surface roughness for various land uses within the model domain. Adopted Manning's n values in the TUFLOW model for the major land use are shown in Table 15.1.

Table 15.1 Adopted Manning's n values

Land use	Manning's n
River/Creek	0.035
Pasture	0.04
Residential	0.15
Dense vegetation	0.1

The 1% annual exceedance probability (AEP) and 0.05% AEP design events were assessed both for the existing conditions and conditions with the new bridge.

15.5 Flood behaviour

15.5.1 Existing condition

Coppins Crossing is overtopped in 1% AEP event under existing conditions. The maximum existing upstream flood level at the proposed new bridge location is 512.5m AHD and the maximum flow velocity is 4.9m/s. Peak flood level in the 0.05% AEP event upstream of the proposed new bridge location is estimated at 514.1m AHD and the estimated maximum flow velocity (depth averaged) is 6.5m/s.

15.5.2 Proposed condition

The proposed bridge was represented in the model and run for both the 1% and 0.05% AEP events.

The proposed case maximum upstream water level at the new bridge is 512.6m AHD and the maximum flow velocity (depth averaged) is estimated at 4.8m/s. The proposed case maximum upstream water level at the new bridge is estimated at 514.3m AHD and the maximum velocity is estimated at 6.6m/s.

15.5.3 Potential flood impact

Maximum impacts on flood levels in the proximity of the proposed bridge are 0.25m and 0.7m in the 1% and 0.05% AEP event respectively. However, impacts are generally limited to the channel and floodplain located between Coppins Crossing and the new bridge.

15.6 Sensitivity analysis

A sensitivity analysis was undertaken for the 0.05% AEP event with the proposed bridge for the following scenarios:

- Inflows increased by 10%.;
- 20% change in adopted Manning's n values;
- Applying 100% blockage for the low flow culverts and 50% blockage for the upper level culverts at Coppins Crossing.

The comparison between the sensitivity tests and the base case is shown in Table 15.2.

Table 15.2 Comparison of water level and velocity between the sensitivity tests and the base case with proposed bridge

Scenario	Difference in flood level between scenario and base case (m)	Difference in peak velocity between scenario and base case (m/s)
Manning's n increased by 20%	0.6	-1.9
Manning's n decreased by 20%	-0.4	2.4
Inflow increased by 10%	0.5	0.1
With blockage of culverts at Coppins Crossing	< 0.1	0.1

15.7 Conclusions and Recommendations

A new TUFLOW hydraulic model has been developed to define flood behaviour at the proposed new bridge. The flood behaviour at the proposed new bridge site is influenced by outflow from the Scrivener Dam and Coppins Crossing which is located immediately upstream of the new bridge.

Flood behaviour at the new bridge site is generally sensitive to the adopted Manning's n roughness values. Impacts of the new bridge on flooding is generally limited to the floodplain located between Coppins Crossing and the new bridge. It is recommended that scour counter measures are designed using lower Manning's n values.

The final 12D model and TUFLOW model results have been reviewed against the Final PSP design and the following observations have been made:

- The basin is located outside the 1:2000 AEP flood extent and hence the basin would have no impact on flood behaviour;
- An open channel is located below existing ground surface and hence the open channel is unlikely to have adverse impact on flooding;
- The scour protection work on the open channel is unlikely to have an adverse impact on flood behaviour.

16. Scour Assessment

16.1 Background

The proposed John Gorton Drive 3C crossing of the Molonglo River was assessed for potential scour impacts in accordance with Austroads 2018. The bridge consists of two sets of piers (each consisting of 2 no 2.5 m diameter circular columns), both located on the river's banks, and spill-through abutments on each side. These abutments are outside the modelled extent of the 0.05% AEP flood (the ultimate design limit from AS 5100.1).

16.2 References

The scour check has been completed using the following sources:

- TCCS Trunk Road Infrastructure Technical Specifications and Standard Drawings;
- Austroads Guide to Bridge Technology 2018 ('Austroads 2018') – Part 8 Hydraulic Design of Waterway Structures;
- TRITS 07 – Bridges and Related Structures, a supplement to Austroads, identifying ACT-specific exceptions and additional requirements;
- CBE 1996/04 Driven Piles – NSW Circular, recommended by TRITS 07 which includes minimum of 1m scour at bridges. TCCS design standards for bridges.

16.3 Scour depths

Scour depths have been estimated using equations given in Austroads (2018) and results from the TUFLOW model for the 0.05% AEP. Relevant scour methods include contraction, pier and abutment scour.

To inform these estimates, bed particle information has been from previous geotechnical investigations. The riverbed itself is comprised of 1m of silty sand, before bedrock is encountered. Exposed rock is seen on both sides of the river, with outcrops along the centre of the river in the area where the bridge is proposed. For the silty sand, d50 of 0.8mm has been applied.

16.3.1 Contraction Scour

Using Laursen's 1960 equation for live-bed scour, the following estimates has been obtained for both 1% and 0.05% AEP events. As an additional check, the contraction equation from the United Kingdom's Construction Industry Research and Information Association's (CIRIA) scour manual has been applied.

Table 16.1 Contraction Scour

AEP	Upstream Average Flow Depth (m)	Average Flow Velocity in Contracted Section (m/s)	Contraction Scour Depth (m) {Laursen 1960}	Contraction Scour Depth (m) {CIRIA C551 2002}
1%	4.00	4.70	0.07	0.31
0.05%	5.20	5.00	0.00	0.22

16.3.2 Pier Scour

For piers, the CSU equation recommended by Austroads 2018 has been applied to the 2D hydraulic model results, and checked against the Froehlich equation (used within HEC-RAS) producing the estimates summarised below:

Table 16.2 Pier Scour

	Pier Scour Depth (m) {CSU}		Pier Scour Depth (m) {Froehlich}	
AEP	**Pier 1**	**Pier 2**	**Pier 1**	**Pier 2**
1%	5.78	4.19	4.45	3.91
0.05%	6.19	6.14	4.75	4.48

16.3.3 Abutment Scour

Flood modelling, including the 0.05% AEP event, suggests that floodwaters do not extend to either abutment, both being located high enough along the floodplain. As such, abutment scour cannot be calculated and is not anticipated.

16.3.4 Total Scour

The combination of both contraction and pier scour gives the total predicted scour at the piers. These levels, however, are beneath the bedrock at the crossing. It is recommended that bridge protection, in terms of pier footings, are implemented to these depths or to bedrock, whichever is highest elevation.

16.3.5 Scour Protection

The 1% AEP results have been used to size riprap scour protection as per Austroads 2018. As a comparison, the rock sizing method from Queensland's DTMR Bridge Scour Manual has been applied. It is important to note Austroads 2018 does not recommend pier protection for new bridges.

Table 16.3 Pier protection

d50 rock size (mm)	Pier 1	Pier 2
Austroads	900	280
DTMR	600	190

17. Geotechnical investigations

The geotechnical investigations have been completed. Refer to Appendix Z for the geotechnical investigations report.

18. Construction Staging

18.1 Stage 1

Apart from the bridge structure, it is proposed to have the bulk of the civil works completed off-line during the first stage of construction. The description of the stage 1 works is from north to south.

Safety barriers will be installed at the northern limit of works to separate traffic travelling along the newly built JGD3B section from the JGD3C construction zone site and guided onto Coppins Crossing Road which is an existing two-lane / two-way road.

JGD3B southbound traffic will be diverted onto Coppins Crossing Road across the newly constructed temporary pavement built from CH16975 to CH16871. JGD3B northbound traffic, already on Coppins Crossing Road, can continue onto the newly built northbound JGD3B carriageway once they pass the northern limit of works. The 12m median will be constructed at a later stage from the southern end of the Sculthorpe Avenue intersection to the JGD3B interface.

Due to the requirement for traffic to continue using the existing Coppins Crossing Road during construction, only the southern bridge abutment will be built during this stage as the northern abutment would impact on the existing road and prevent traffic from using it. An off-line realignment of the existing Coppins Crossing Road is proposed for this stage to provide clearance to the northern bridge abutment during the next stage of construction. Safety barriers will be installed as required to protect traffic from this construction zone.

The proposed works will be severing an existing RFS fire track, near the proposed bridge site and MVIS alignment. The track has been realigned along the eastern side of the proposed works and connected to the existing Coppins Crossing Road as a T-intersection near the existing Coppins Crossing Road Bridge.

In addition to the road works being undertaken, it is proposed the bridge piers to be installed during this stage. Stage 1 works will terminate at the existing stub provided by the recently constructed JGD2A works.

Refer to design drawings CS-101 to CS-103.

18.2 Stage 2

The civil works to be built during this stage will be the construction of the northern bridge abutment and parts of the JGD3C northbound carriageway between the JGD3B interface and temporary realignment of Coppins Crossing Road.

Temporary pavement will be constructed from the southern end of the Sculthorpe Avenue intersection to the northbound carriageway of JGD3C across the 12m median. Northbound traffic will be directed into the western lane of the existing Coppins Crossing road whilst the eastern lane is constructed. The western lane will tie-in to the existing JGD3B temporary pavement. Southbound traffic will continue along the newly constructed JGD3C constructed southbound carriageway.

Sculthorpe Avenue and the intersection into Whitlam, except the 12m median will be constructed during this stage. Safety barriers will be installed as required to separate traffic from this construction zone site.

Once clear of the proposed construction works near the Sculthorpe Avenue intersection, both northbound and southbound traffic can be diverted onto the newly realigned Coppins Crossing Road so that the northern bridge abutment can be constructed. The connection from the newly built JGD3C main carriageway to the existing Coppins Crossing Road pavement levels will be assisted with the use of temporary pavement across the JGD3C median, eastern footway/verge as well as a small section of existing terrain.

Refer to design drawings CS-201 to CS-203.

18.3 Stage 3

Northbound traffic at the Sculthorpe Avenue intersection will be switched over from the western lane on the existing Coppins Crossing Road across to the newly constructed eastbound lane utilising the temporary pavement constructed during stage 2. This will tie-in with the existing temporary JGD3B pavement. The western northbound lane and the western verge will be constructed during this stage. and the southbound traffic will be re-directed onto the realigned Coppins Crossing Road while the bridge structure is being installed. Existing temporary pavement from the previous stage can be retained to connect Coppins Crossing Road to JGD3C.

Refer to design drawings CS-301 to CS-303.

18.4 Stage 4

The temporary pavement at the Sculthorpe Avenue intersection and the JGD3B temporary pavement will be removed to allow for the construction of the 12m median. New temporary pavement will be required during this stage allow for continued traffic flow during construction with one lane in each direction. This will allow for the new northbound and southbound carriageways to be built separately with traffic to switch over once completed. The construction of the southern tie-in to the recently built JGD2A design will also be constructed in this stage as there is a mismatch between the JGD3C median width (12m) and the JGD2A median width (7m), a transitional tie-in over approximately 150m has been proposed. These works can be completed under local traffic control or during nightworks. The final asphalt wearing course will be laid during this final stage of construction across the full length of the alignment.

Refer to design drawings CS-401 to CS-403.

18.5 Additional Comments

The following comments need to be considered during the construction phase of the project:

- Uninterrupted access to the MVIS must be available at all times;
- The siting of temporary facilities must be outside of the MVIS easement. For any blasting works, a separate approval by Icon Water will be required;
- The trade waste receiving facility is still active and in use. Therefore, 2/7 access must be maintained;
- Uninterrupted access to the MVIS ventilation shaft’s works (at location to be confirmed by Icon Water) is to be maintained.

19. Cost Estimate

19.1 Summary of the Estimate, and Estimate Risk

Jacobs have developed a detail cost plan for the project, and associated Risk Based Estimate, capturing accuracy to the base estimate, and project contingent risks.

The summary of the Estimate Risk Model Outputs are as follows:

Description	%	Probabilistic Estimate Output Results ($M)
Base Estimate, including bridgeworks, roads, civils, services, construction management, and engineering		$138.2
P50 Contingency *	9.75% *	$13.5
P90 Contingency *	5.75% *	$7.9
Total for P90 Estimate		$159.7
Escalation Allowance	7.0%	$11.2
ACT Government Procurement and Contract Management		$6.8
TEI – Total Estimated Investment		**$177.7M**

Two the key Risk Model Outputs are the P50 and P90 contingency results.

The P50 Result was equal to 9.75%, and the P90 Result is equal to a further 5.75%. Collectively, making up a contingency amount of 15.5%. This compared closely to our earlier guide P90 contingency of 20%, or in other words, our deterministic allowance of 20%.

The model outcomes indicate the following major elements which contribute to the inherent risk on the base estimate;

- Steel Bridge, supply and fabrication of steel girders
- Construction Management Costs
- Road Pavements, and sub bases
- Bulk Earthworks
- Service routes, and combined service routes, and 3rd party services scope, yet to be fully defined

The contingent risk items, with the largest contribution to the Project P90 Value are;

- Risk of contractor claims / commercial claims from the head contractor
- Market conditions / tendering
- Failure of either a key subcontractor, or the head contractor
- River / flooding risks

It is recommended that the following actions be continually revisited, and monitored during the project;

- Maintain the project Risk Register, and follow the mitigation measured
- Revisit the high risk items at least every month, and monitor the success of the mitigation measures, and update the risks (as required / as applicable)

19.2 P50/P90 Risk Workshop Purpose

The previous Cost Estimate Risk Workshop serves a number of purposes;

- It provides an overview of the estimate detail, and scope inclusion, and provide clarity of base costs, to the various stakeholders
- The base estimate is then ranged – ranges are given to the quantities, based on this stage of the design, and ranges are also applied to the costs / rates.
- The project contingent risks were reviewed, and the group assisted with adding cost implications / cost consequences, if the risk occurs, and guide probabilities of the risk event occurring.

The above are the 3 key inputs for the P50/P90 Risk adjusted Estimate Outputs;

- Base estimate
- Ranging of the base estimate, assessing in the base estimate inherent risk
- Contingent risk assessment

From this data, we have then run the risk estimate model through the excel based Monte Carlo Simulation Software / "@Risk" Software. The results are discussed below.

19.3 Project Estimate Summary

The project estimate is based on the Final PSP Drawings for the 3 Span Weathered Steel Bridge.

Key scope inclusions are;

- Bridge abutments
- Bridge piers, including piles, pile caps, and pier headstock
- Steel trough girder bridge structure, plus precast concrete deck, guard rails, asphalt surfacing
- Earthworks including cut and fill
- Other, including anti-graffiti coatings, services crossings
- New roads to tie into existing roads, approx. 1750 linear metres x 4 lanes, plus shoulders
- Signalised intersections into the Molonglo Town Centre and Whitlam Estate (Sculthorpe Avenue)
- Pavement and transverse drainage design
- Pedestrian underpass
- A water quality detention basin and multiple temporary erosion and sedimentation control basins
- Construction management
- Project indirect costs, including engineering, and client project management
- Risk and contingency allowances - the result of the risk model outputs
- Provisional allowance for escalation.

The main exclusions are;

- GST
- Land costs, land acquisition, environmental offsets, etc.

A summary of the preliminary estimate is as follows;

▪ Direct Costs – Bridge	$53.7M
▪ Direct Costs – Road and Civils	$37.6M
▪ Construction Management / Delivery	$30.1M
▪ Design	$ 8.1M
▪ Client Costs (procurement and	
▪ insurances)	$ 8.8M
▪ Contingency and Escalation	$32.6M
▪ ACT Government Procurement	$ 6.8M
Total	**$177.7M**

Refer to the full estimate summary in the appendices for a more comprehensive summary list.

The main assumptions include;

- Cut and fill quantities of circa 320,000m3
- Assumed 5,000m3 of imported fill
- No allowance for Lane Use Management Systems (LUMS), or Intelligent Transport Systems (ITS), and no allowance for associated major gantry structures
- Steel bridge girder weight of 2970T, and $8,350/t used for the supply and fabrication.

Note: steel prices are currently escalating, due to the volume of work in the Australian market.

19.4 Development of a Probabilistic Estimate Process Overview

The development of a probabilistic estimate is a four step process that quantifies the identified risks associated with the project and applies a structured approach to provide a robust and consistent outcome that may be used to assess the value of contingency applied to a project.

Step 1: Development of the base project estimate and project risk matrix: The Jacobs team have developed a project estimate in cooperation with our estimating / quantity surveying team. This also includes ranging the quantities and rates within the base estimate.

Step 2: Jacobs have since made appropriate updates to the risks that have become apparent during the PSP stage of the project

Step 3: An update to the risk model from the concept design stage. This includes inherent risk estimate ranging, and contingent risk register, with associated probability, and costs: minimum, most likely, and maximum.

Step 4: Running the risk model and undertaking a sensitivity analysis to test the robustness of the model and consistency of the outcomes. The “@Risk” Software is utilized for running the model / performing the Monte Carlo Simulation.

19.5 Probabilistic Estimation Process

19.5.1 Base Estimate Inherent Risk

Inherent risks are the uncertainties in the known project scope of works. These are developed from the base project estimate, developed by traditional means by the estimating team. First principles estimating rate build-ups have been utilised for the high cost items. Recent and current quotations are also utilised within the estimate.

For each of the estimate items, we then assessed a likely range to the quantities, and range to the rates. At first, we use a guide set of ranges, as follows;

- Low Range -5% / +10%
- Medium Range -10% / +20%
- Medium High Range -15% / +30%
- High Range -20% / +40% to +50%
- Very High Range -50% / +100%
- Extreme Range +200% in rare circumstances

The ranges are then modified slightly, to suit the variability or sensitivity of each item.

This provided the basis for the Inherent Risk Estimate.

19.5.2 Contingent Risk

The existing contingent risk register was utilised to assess the risks with cost implications / cost consequences. The risks were then quantified, with reference to the risk matrix.

- the likelihood of the risk occurring on this project expressed as a percentage;
- the most likely value that each risk item may impact on the project, given the likelihood above, expressed in Australian Dollars;
- the most likely minimum and most likely maximum value for each risk item of the impact on this project, expressed in Australian Dollars.

This 3 point cost data set (low, most likely, and high), and associated likelihood percentage, form the key inputs to the contingent risk estimate.

We then utilize the @Risk Pert-Alt (Pert Alternate) function, which caters for general engineering bias. For example, when the group assess a "Maximum Cost Impact", it may be decided that maximum impact is $2M. However, with the simulation, the $2M is set as the tail of the "bell curve", and in reality, the model rarely/never samples $2M, even though the group concluded that the event may have an impact of $2M. The Pert-Alternate function sets the $2M at the 90th percentile, so as $2M is sampled more frequently during the simulation.

19.6 Modelling

19.6.1 Model Inputs

The base estimate inherent risk data, and the contingent risk register with impact data, form the basis of the model inputs.

19.6.2 Model Running

We utilise the "@Risk" Software, to the run the estimate risk model.

We then ran the risk model through 5,000 iterations, using the Latin Hypercube Sample Type, and the Mersenne Twister Random Number Generator.

19.6.3 Model Outputs

The key model outputs are as follows, and are attached in the appendices;

- Statistics summary: P5 to P95 percentile results, including P50, and P90
- Changes in output statistics for the inherent risks, contingent risks, and combined inherent and contingent risks.

19.7 Conclusion, and further work

The risk adjusted project estimate is equal to an overall 16% P90 Contingency. This compared to our previous 20% allowance, as a deterministic risk allowance.

It is common for complex projects to attract contingencies of 20%+ and 25%, due to higher levels of contingent risk, and higher level of foreign procurement risk. However, this bridge project has a slightly higher certainty around the major quantities, and key procurement items.

19.7.1 Recommendations

The East Coast Australian infrastructure construction industry is currently seeing a high volume of projects, including many longer term major projects. This is making an impact in cost escalation, particularly in relation to market factors: tenderers have several projects coming up for pricing, and also have several projects in delivery. In turn, if there are delays in going forward with the project, into delivery mode, then the estimate should be updated.

Refer to Appendix AA, Appendix BB and Appendix CC for details.

The base date for this estimate is June 2020.

20. Water Sensitive Urban Design

20.1 Methodology

The following sections outline the process used to assess the potential water quality impacts of the project and develop impact mitigation measures for the various aspects of this report.

20.1.1 Operational Phase Mitigation Guidelines

The following design guidelines and management procedures are relevant in identifying the appropriate water quality management and mitigation measures to be implemented during the operational phase of the project:

- Municipal infrastructure Standards 08 - Stormwater, 2019 ACT Government, Transport Canberra and City Services.
- Territory Plan 2008 - Waterways: Water Sensitive Urban Design General Code, 21 February 2020.
- Austroads (2001), Road Runoff and Drainage: Environmental Impacts and Management Options, Austroads AP-R180.
- Austroads (2003), Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure, Austroads AP-R232.
- Austroads (2010), Guide to Road Design, Part 5: Drainage Design.

The objective of these documents is to provide guidance on water management practices, water quality and quantity, and water conservation issues related to the design, operation and maintenance of the roads and traffic system. This is in order to protect waterways and water quality where practicable and feasible. They provide guidance on the process of designing permanent water quality treatment in a consistent and practicable manner. The design for the project would address the sensitivity of receiving waters and local environment within and directly outside the project area.

20.1.2 Water Quality Design Criteria

The water quality objective and design criteria of the project is to meet the requirements that are outlined in the *Territory Plan 2008 - Waterways: Water Sensitive Urban Design General Code, 21 February 2020* document, in particular the requirements that are provided in Section 3.2 on *Stormwater Quality Target – Major Roads*. This rule applies to development of major roads, including the duplication of an existing major road in full or in part.

An extract of these targets is provided below.

The average annual stormwater pollutant export is reduced when compared with a road catchment of the same area with no water quality management controls for all of the following:

a) Gross Pollutants by at least 90%.

b) Total Suspended Solids by at least 60%.

c) Total Phosphorous by at least 45%.

d) Total Nitrogen by at least 40%.

The other important project objective and water quality target is to ensure that there is no downstream environmental impact. This means that proposed mitigated pollutant load conditions would need to be equal or less than the pollutant loads for existing conditions.

20.2 Assessment of Operation Impacts

20.2.1 Relevant Operational Activities

During the operational phase of the project, roads would be sealed, embankments landscaped and cuts stabilised. Typically, no exposed topsoil would be located within the project during operation. Hence, risks are no longer associated with sediment loading but are instead associated with pollutants from atmospheric deposition, vehicles and motorists.

20.2.2 General Impacts

Once the project is complete and becomes operational, the main risk to water quality is surface runoff from an increase in impervious surfaces and the concentration of runoff via drains, kerbs and pipes. This can result in the build-up of contaminants on road surfaces, median areas, rest areas and roadside corridors in dry weather, which, during rainfall events, can be transported to surrounding watercourses. The generation of additional pollutants are attributable to the increased road surface area and associated increased vehicle traffic in the future.

The most important pollutants of concern relating to road runoff include:

- Sediments from the paved surface from pavement wear and atmospheric deposition.
- Heavy metals attached to particles washed off the paved surface.
- Oil and grease and other hydrocarbon products.
- Litter from the road corridor.
- Nutrients such as nitrogen and phosphorus (organic compounds) from biological matter and from natural atmospheric deposition of fine soil particles.

The emphasis in stormwater quality management for road runoff includes managing the export of suspended solids and associated contaminants – namely heavy metals, nutrients, hydrocarbons and organic compounds (Austroads, 2001). Pollutants such as nutrients, heavy metals and hydrocarbons are usually attached to fine sediments. Trapping suspended solids is, therefore, the primary focus of the water quality management strategy for the operational phase of the project.

20.2.2.1 Spills

Though unlikely, the risk of accidental spillage of hazardous materials such as petroleum hydrocarbons is present along the road corridor. Without satisfactory means of containment, the spillage of contaminants could pass rapidly into the project drainage system and impact the Molonglo River and downstream ecosystems. Accidental spills of chemicals or petrol in road accidents can cause severe damage to the ecology of waterways and therefore environmental protection would be required. All bridge runoff including spills would be collected in a basin that includes spill capture capability. Section 20.3 outlines operational mitigation measures for the project that would manage potential operational water quality impacts.

20.2.3 Site Impacts

20.2.3.1 Impacts on Waterways

The water quality of the Molonglo River has the potential to be impacted during the operation of the project. These impacts could result in:

- Increased sediment loads reducing light penetration through the water column, impacting aquatic flora and fauna.
- Decay of organic matter and some hydrocarbons which can decrease dissolved oxygen levels affecting fish and aquatic life.
- Increased nutrients (nitrogen and phosphorus) stimulating the excessive growth of algae and aquatic plants leading to toxic conditions.

- Increased levels of heavy metals (including aluminium and iron) which are toxic to aquatic biota and fish.
- Silting of waterways and associated smothering of aquatic flora and fauna.
- Increased levels of litter, oils and grease which can form a film over water making it difficult for aquatic animals and plants to breathe and can also be toxic to plant and animals.

20.3 Mitigation measures

20.3.1 Operational Water Quality Control Design

The water quality design developed locations and sizes for operational water quality controls that include vegetated swales and basins. An outline of the design approach used is provided below.

20.3.1.1 Design Criteria

The water quality control design criteria is to meet the water quality objectives outlined in Section 20.1.2 of this report that were obtained from the *Territory Plan 2008 Waterways: Water Sensitive Urban Design General Code, 21 February 2020* document under Section 3.2 on Stormwater Quality Target – Major Roads.

Those targets were adopted as the project design criteria for the sizing of water quality treatment controls. These load-based targets are listed in Table 20.1.

Table 20.1 Operational water quality design targets

Pollutant	Minimum reduction of the annual average load
Total Suspended Solids (TSS)	60 %
Total Phosphorus (TPh)	45 %
Total Nitrogen (TN)	40 %
Gross Pollutants	90 %

20.3.1.2 Swale and Basin Locations

The locations of the proposed vegetated swales and water quality basins as shown in Figure 20.1 were identified in relation to the project alignment and drainage discharge points. Where possible, the locations of temporary sediment basins and permanent water quality basins have been consolidated so that the construction phase temporary basins can be converted into operational basins following completion of construction and stabilisation of the site. This would minimise the need to construct for the project and would minimise total drainage infrastructure.

All runoff from the proposed road and bridge will be captured and piped to the two permanent basins before discharging into the Molonglo River.

20.3.1.3 Water Quality Controls Sizing Methodology

MUSIC Modelling

MUSIC water quality modelling was carried out to identify volumes of the permanent water quality basins that comply with the project design targets given in Table 20.1. The pollutants modelled were Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TPh).

The catchment draining to an individual control measure was delineated by considering the formation of the proposed carriageway and the proposed pipe drainage network. The total catchment area was divided into two components according to the different land use characteristics of the 'impervious road catchment' area, and the batter slope or 'pervious road side' area.

Water quality models of the swales and basins were created adopting the sub-catchment areas estimated in the catchment analysis and using the vegetated swales located upstream of the proposed basins (refer Figure 20.1). The MUSIC model of the water quality controls was run to determine the minimum basin volumes required for a 1.75 metre maximum depth basin.

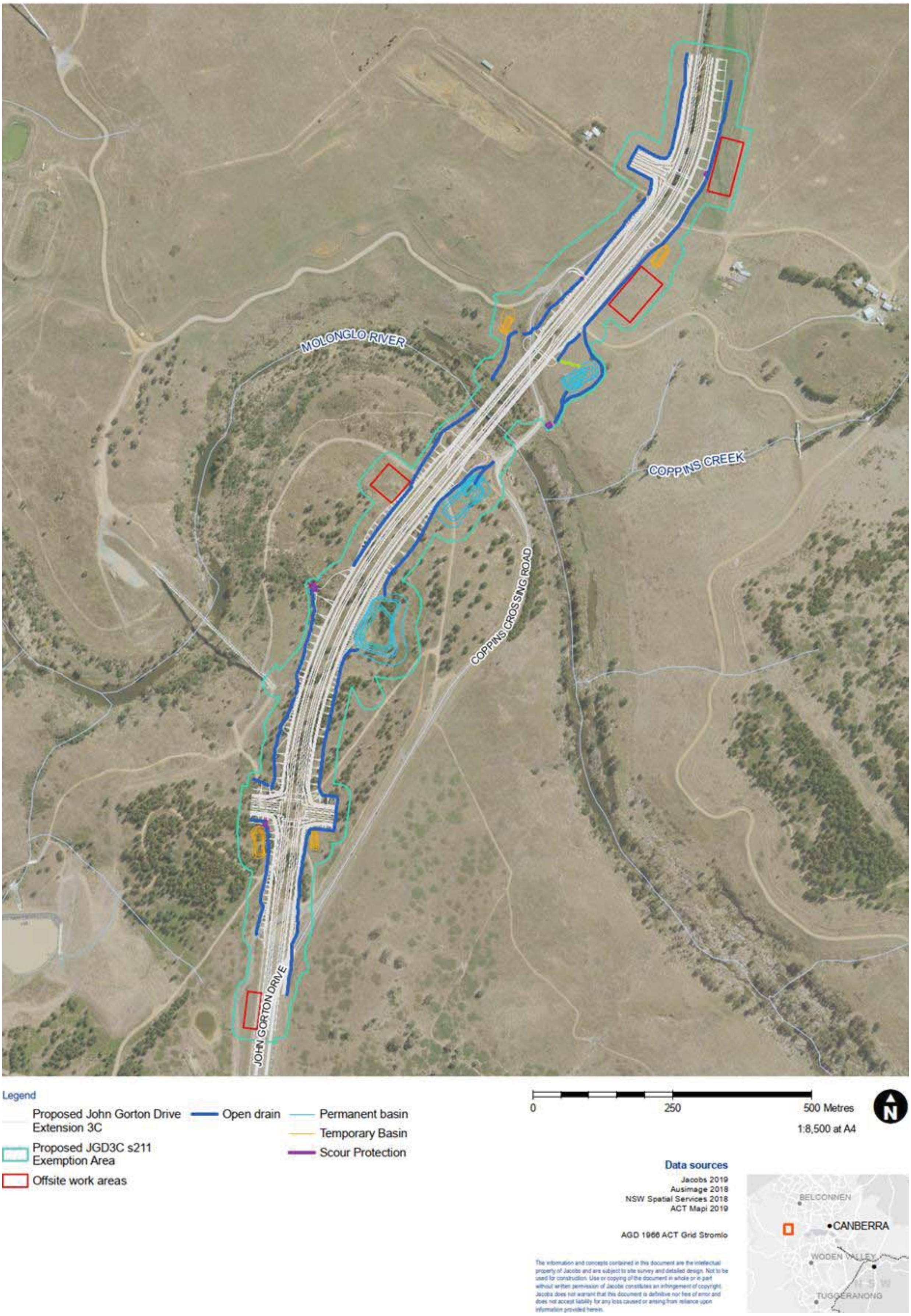


Figure 20.1 Drainage swales and water quality basins

Rainfall Inputs

The MUSIC model uses pluviograph data (half hour rainfall data) and user-defined event mean concentrations (EMCs) to estimate pollutant loads. Pluviograph data was obtained from the Bureau of Meteorology for Station 070014 called Canberra Airport which is the most appropriate pluviograph station for the project with half-hour time increments and an appropriate duration of recorded data. The data was available for a period of approximately 72 years from 27/2/1937 to 30/4/2010. The model was run at half hour time steps for the available duration.

Event Mean Concentrations

A literature review was undertaken to identify the Event Mean Concentrations (EMCs) for the proposed road pavement areas for TSS, TN and TP to use in the MUSIC model. The following references were used to assess the typical concentrations:

- RTA (2003), Procedure for Selecting Treatment Strategies to Control Road Runoff (Version 1.1).
- CRC for Catchment Hydrology (1997), Best Practice Environmental Management Guidelines for Urban Stormwater.
- CSIRO (1997), *Metals and Hydrocarbons in Stormwater Runoff from Urban Roads.*
- CRC for Catchment Hydrology (2000), *Water Sensitive Road Design, Design Options for Improving Stormwater Quality of Road Runoff*.
- CRC for Catchment Hydrology (1999), *Urban Stormwater Quality, A Statistical Overview*.
- Austroads (2001), *Road Runoff and Drainage: Environmental Impacts and Management Options*.
- CRC for Catchment Hydrology and Monash University (2004), *Stormwater Flow and Quality and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, A review and Gap Analysis*.

The MUSIC model also contains EMCs for various land uses. The EMCs found through the abovementioned literature search for road pavement surfaces, is similar to the MUSIC model EMCs for Sealed Roads. Therefore, the MUSIC model EMCs for Sealed Roads were adopted with the appropriate percent imperviousness as measured from the drainage plans. These are outlined in Table 20.2.

The EMCs adopted for existing conditions were those shown in Table 20.2 for Sealed Roads and the EMCs obtained from Table 8-14 of the *Municipal Infrastructure Standards Part 8 - Stormwater, 2019, ACT Government* document for the pervious surfaces.

The MUSIC model rainfall runoff parameters were adopted with the required modification of the MUSIC default values for the Canberra area as recommended by the MUSIC model manual. These updates were for the soil storage capacity which was modified to 40mm, and the field capacity parameters which was modified to 25mm as recommended in the Appendix A of the MUSIC model manual for the Canberra area.

As the remaining MUSIC rainfall runoff parameters were slightly different to those shown in *Table 8-12* of the *Municipal Infrastructure Standards Part 8 - Stormwater, 2019, ACT Government* document for "Urban" land use, a sensitivity test was undertaken using the MIS values in *Table 8-12* so that any differences and impacts on the results are understood. The findings of the sensitivity test are further explained in Section 5, but in summary, the MIS parameters provided an even better treatment result, which means it is a conservative result.

Table 20.2 Typical stormwater runoff concentrations for operational phase

Pollutant concentration (mg/L)	TSS		TPh		TN	
	Event (wet)	Base (dry)	Event (wet)	Base (dry)	Event (wet)	Base (dry)
Sealed Roads - Road pavement	269	15.8	0.501	0.141	2.19	1.29
Pervious areas for existing conditions. Agricultural/open space	110	25.1	0.218	0.132	2.06	1.19

Soil Permeability

The sub-soils in the project area are generally characterised by low permeability soils as described in the soil data information contained in Appendix M. For the purposes of the MUSIC model, it has been assumed that the basins are in medium to heavy clays range.

Basin Characteristics and Capture of Gross Pollutants

The water quality basins have been modelled in 12D to identify cut and fill requirements in 3D and to ensure space requirements are adequate. The modelling is based on the following characteristics:

- Compacted earth embankments with a nominal slope of 2:1 (H:V) and a minimum crest width of one metre, or up to three metres where space is available.
- An excavated storage area that allows a maximum water depth of 1.75 metres.
- One inflow point.
- A primary outlet spillway and protection to reduce erosion downstream.
- An underflow oil baffle board at the outlet of the basin to provide accidental spill containment.
- Vehicular maintenance access from the main road to water quality treatment basins would be provided for all basins, and a three metre wide access would be included on at least one side of all basin.
- Fencing of the proposed water quality basins may be required when future development occurs in the adjacent area. Signage of warning for the general public against entering the basins may need to be provided.
- The basins will contain all gross pollutants that either sink to the bottom of the basin or that float on the surface. The proposed underflow baffle arrangement for spill containment provides the capture of floating gross pollutants by default and a formal GPT is not required. The gross pollutant loads from the road is expected to be minimal and therefore maintenance requirements for gross pollutant removal are infrequent. Any floating debris would either sink or be removed once every 2 years. The debris that sinks would be removed together with the captured sediment. This maintenance may not be required once every 10 to 15 years. The percentage retention of gross pollutants is very high at approximately 95%. Any wind-blown gross pollutants that do not reach the basin and therefore bypass it and reach the river would be very small.

Catchment Areas

The road pavement catchment areas including batters are shown in Table 20.3.

Table 20.3 Catchment areas for the MUSIC model

Catchment Name	Total catchment area (ha)	Percentage of total catchment impervious (%)
South	6.88 ha	88 %
North	3.15 ha	94 %

The eWater MUSIC water quality model was used to obtain the required basin volume that can achieve and meet the design criteria requirements and the project's water quality targets listed in Section 20.2. This was an iterative process that required the basin volumes to be sufficiently large to meet the project criteria and objectives.

The proposed permanent basin locations and sizes are presented in Table 20.4 and Figure 20.1.

The vegetated swale that is located upstream of the northern basin has a longitudinal slope of 0.5% with a base width of 1m, V:H side slopes of 1:2 and a depth on 300mm.

Table 20.4 Permanent basins for the operational phase

Basin Name	Location / chainage (m)	Basin volume required for the operational phase (m^3)	Length of vegetated swale upstream of the basin (m)
Basin South (B5)	16060 m	3000	-
Basin North (B7)	16360 m	1228	40 m

20.4 MUSIC Modelling Results

The MUSIC modelling pollutant load reductions for the proposed water quality controls are summarised in Table 20.5 and compared against the design criteria.

Table 20.5 MUSIC modelling results – Pollutant loads and percentage reductions

Stormwater Pollutant	Design criteria *	Existing conditions (kg/yr)	Proposed mitigated conditions (kg/yr)	Pollutant load reductions for the proposed conditions	Meets requirements and project objectives (Y/N)
Gross Pollutants	**90 %**	**883**	**72**	**95 %**	**Y**
Total Suspended Solids	**65 %**	**2,700**	**1,830**	**87.5 %**	**Y**
Total Phosphorus	**45 %**	**5.69**	**5.16**	**79.23 %**	**Y**
Total Nitrogen	**40 %**	**54.9**	**46.6**	**53.9 %**	**Y**

* Territory Plan 2008 - Waterways: Water Sensitive Urban Design General Code, 21 February 2020

As shown in the above table, the pollutant loads reductions that have been achieved by the proposed water quality controls (basins and swale) for the combined discharges into the Molonglo River meet and exceed the required criteria listed in the of the *Territory Plan 2008-Waterways: Water Sensitive Urban Design General Code, 21 February 2020* document for *Stormwater Quality Targets for Major Roads.*

The other important objective and water quality target for the project is to ensure that there is no downstream environmental impact. This means that proposed mitigated pollutant load conditions would need to be equal or less than the pollutant loads for existing conditions. A comparison of these loads in Table 20.5 and Table 20.4 indicates that the mitigated proposed loads are smaller than the existing loads. The most critical parameter being Total Phosphorus with a reduction of 9%.

The sensitivity analysis that was mentioned in Section 0 under Event Mean Concentrations used the MIS concentrations instead of the adopted concentration to test how the results would be affected. The findings of this sensitivity assessment indicated that the results would not be affected and that they would also meet the design criteria listed in Table 20.1 and would also generate less pollutant loads than existing conditions. Therefore, the proposed basin sizes remain unaffected.

The two proposed basins that receive surface runoff from the project area will also capture any accidental spills. This would further improve the protection of the downstream environment and the Molonglo River against acute pollution from toxicants such as petroleum hydrocarbons.

20.5 References

ANZECC/ARMCANZ (2000) *National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

Austroads (2001), Road Runoff and Drainage: Environmental Impacts and Management Options, Austroads AP-R180

Austroads (2003), Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure, Austroads AP-R232

Austroads (2010), Guide to Road Design, Part 5: Drainage Design.

Municipal Infrastructure Standards Part 8 - Stormwater, 2019, ACT Government.

Territory Plan 2008 - Waterways: Water Sensitive Urban Design General Code, 21 February 2020.

21. Safety in Design

The safety in design register for the PSP can be found in Appendix GG.

22. Design Issues / Non-Conformances

A schedule of design issues and non-conformances has been populated in a register located in Appendix FF. It should be noted that the design issues can be mitigated through design development during the detailed design phase.