Civil Engineering & Infrastructure Report

East West Connector Road & Dunheved Link Road

89914020

Prepared for
Lend Lease

2 March 2018

Cardno
Shaping the Future

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Executive Summary

Cardno has been engaged by Maryland Development Company to provide lead engineering services for close to three kilometres of roads which will link the Jordan Springs East development to Ropes Crossing and Dunheved South.

Two sections of road will be designed as part of the project, which include:

- Approximately two kilometres of road joining the Jordan Springs East development and the suburb of Ropes Crossing. This section of road is referred to as the East West Connector (EWC) Road.
- Approximately 900 metres of road joining the proposed East West Connector Road to Links Road in the Dunheved precinct. This section of road is variously referred to as the Dunheved Link Road (DL) or North-South Link Road (NSLR).

The project traverses both Penrith City Council (PCC) and Blacktown City Council (BCC) Local Government Areas (LGA). The EWC Road will involve the upgrade of an existing private access road, part of which is being used for haulage purposes, while the DL Road will involve the formalisation and upgrade of a road currently used for construction of the JSE development.

The project has been separated into three development applications, reflecting the varying approving authorities and current anticipated construction sequencing. These stages are as follows:

- Stage one covers the section of the EWC east of the DL Road intersection through to Ropes Crossing. This will involve the replacement of an existing bridge structure across Ropes Creek as well as the replacement of a number of culvert structures that are located at existing flow paths and low points. Stage one is contained wholly within the Blacktown LGA.
- Stage two covers the remainder of the EWC to the JSE site boundary, includes the proposed intersection with the DL Road and replacement of the South Creek Bridge crossing. It also covers approximately 850 metres of the DL Road south from the EWC, which includes a multi-cell pipe culvert structure which will is necessary for the hydraulic performance of the South Creek floodplain. Separately, Stage 2 also documents the bulk earthworks required to provide an appropriate level of flood immunity to future sporting fields located within the future Regional Open Space (ROS) and also includes a temporary bund across the Dunheved South precinct which will be constructed in advance of filling of this precinct.
- Stage three includes the proposed intersection of the DL Road with the existing Links Road and an adjoining short section of the DL Road.

This report documents the processes undertaken to prepare Development Application design documentation for EWC and DL roads and associated works. The report aims to outline how the required infrastructure will be delivered in accordance with the Central Precinct Precinct Plan, Dunheved Precinct Plan, State Regional Environmental Plan 30 (SREP 30), the future requirements of the Central Precinct and relevant authority design guidelines and technical requirements.

Where required, this report also identifies, references and appends relevant background studies that have assisted in the development of the designs.

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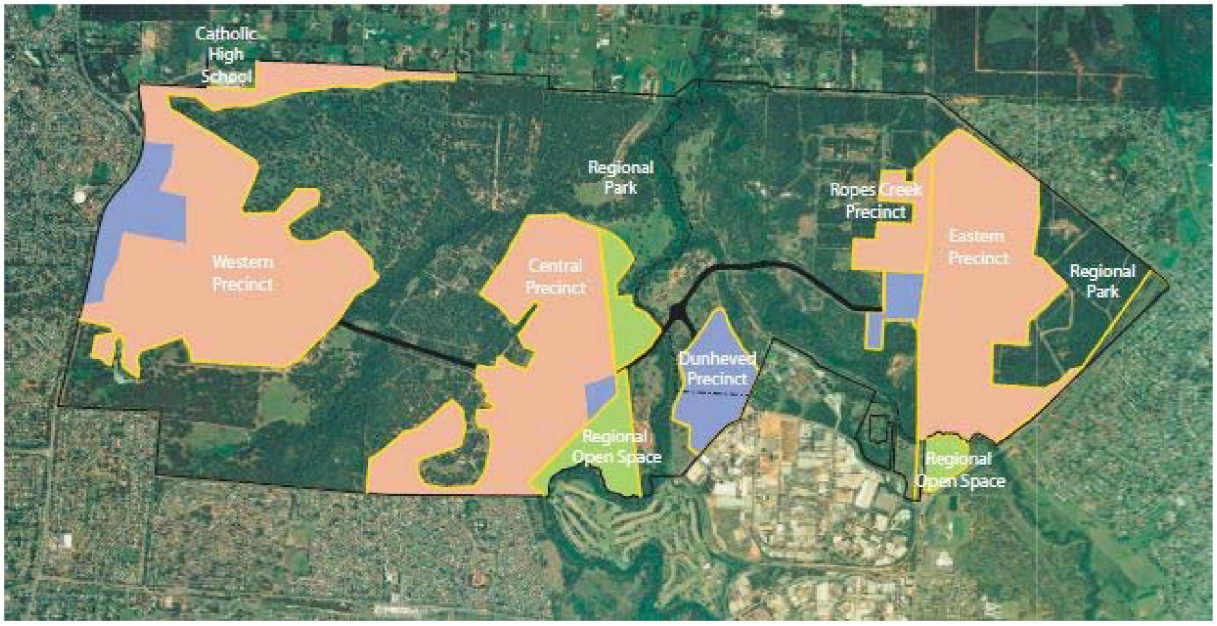
1 Introduction

Cardno has been engaged by Maryland Development Corporation to prepare documentation in support of Development Applications (DA) for the East West Connector (EWC) Road and Dunheved Link (DL) Road of the St Marys Development Site. These roads are located within the Penrith City Council (PCC) and Blacktown City Council (BCC) Local Government Areas (LGA).

1.1 St Marys Development Overview

The St Marys development site comprises four main developments, referred to as the Ropes Crossing, Jordan Springs, Jordan Springs East (JSE) (previously Central Precinct) and Dunheved Precinct. The site will also include a large area of Regional Park as well as open space to provide playing fields and recreational facilities. The site is traversed by two main watercourses, referred to as Ropes Creek and South Creek. A site locality plan for the St Marys Development site is included as **Figure 1-1**.

Figure 1-1 St Marys Development Site Locality Plan



Development within the Ropes Crossing and Jordan Springs precincts is largely complete. Development of JSE is progressing with approximately 750 lots subdivided and settled and construction currently ongoing for another 200 lots. Development of the Dunheved Precinct is yet to commence.

1.2 Overview of Proposed East West Connector and Dunheved Link Road works

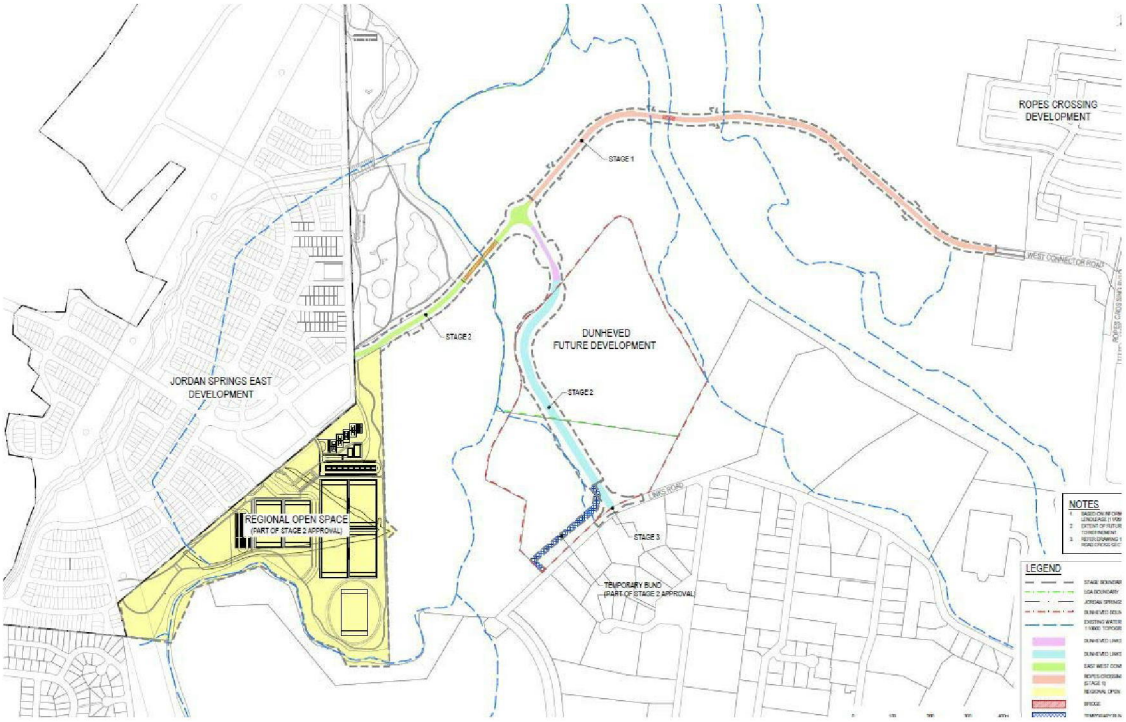
The proposed road network will provide linkage between the Ropes Crossing precinct, JSE, the existing Dunheved South development and the future Dunheved Precinct. The works will include the following:

- Construction of approximately two kilometres of road network, including two bridge crossings and numerous culvert crossings between Jordan Springs East and Ropes Crossing. This section of road is referred to as the East West Connector Road
- Construction of close to one kilometre of road joining the EWC to the existing Links Road, via the proposed Dunheved development. This section of road is referred to as either the Dunheved Link Road or the North South Connector Road.

The extent of the proposed road network is presented in **Figure 1-2**.

- The bulk earthworks of part of the regional open space to facilitate an appropriate level of flood immunity for future playing fields. The levels and immunity of these playing fields have been agreed to in consultation between Lendlease and PCC.

Figure 1-2 Extent of Proposed Road Network



Summarised in the sections below is a description of the works associated with each of these components.

1.2.1 East West Connector

Construction works to which this report relates are defined by the following:

- Bulk Earthworks
  - Forming Road Embankments.
  - Landscape shaping.
  - Boundary interfaces.
- Roads
  - Construction of the East West Connector Road between Ropes Crossing and Jordan Springs East.
  - Two bridge crossings replacing the existing bridges on Ropes Creek and South Creek (to be demolished).
  - Construction of a roundabout at the intersection with Dunheved Link Road.
- Drainage
  - Construction of a piped drainage network as required to drain the road corridor.
  - A flood relief structure comprising 6 x 4.2 x 2.7 Reinforced Concrete Box Culverts (RCBC).
  - Replacement of five existing culvert crossings located along the roadway.
- Stormwater Quality

- Oil/Water separators in pits.

- Utility Infrastructure
  - Provision of street lighting and a future HV electrical lead in between Links Road and Jordan Springs East.

1.2.2 Dunheved Link Road

Construction works to which this report relates are defined by the following:

- Bulk Earthworks
  - Forming Road Embankments
  - Landscape shaping
  - Boundary interfaces
- Roads
  - Construction of the Dunheved Link Road between the intersection of the East West Connector Road and Links Road.
  - Construction of a new roundabout at the intersection with Links Road.
- Drainage
  - Construction of a piped drainage network as required to drain the road corridor
  - A flood relief structure comprised 20 x diameter 1.8 m Pipes.
  - Temporary tailout drains in advance of the future permanent drainage works for the Dunheved precinct.
- Stormwater Quality
  - None – quality to be managed via the future Dunheved development.
- Utility Infrastructure
  - Provision of street lighting and a future HV electrical lead in between Links Road and Jordan Springs East.

1.2.3 Bulk Earthworks Fill Works

Construction works to which this report relates are defined by the following:

- Bulk Earthworks
  - Creation of a series of fill platforms to facilitate adequate flood immunity for future sporting fields located within the Regional Open Space
  - Construction of a temporary bund, within the footprint of the future Dunheved fill platform.

1.3 Staging of Works

The construction of the EWC and DL roads will be staged. A proposed staging plan for the delivery of civil works and lots is included on Drawing Number CV-CARDNO-EWC1-1041 (refer **Appendix A**). The staging is as follows:

Stage 1: Construction of the East West Connector road and associated works, east of the Dunheved Link Road intersection. Drawings documenting this stage of works are included in **Appendix A**.

Stage 2: Construction of the remainder of the East West Connector between the future Dunheved Link Road intersection and the JSE boundary, construction of the majority of the Dunheved Link Road, bulk earthworks within the Regional Open Space and construction of a temporary bund within the Dunheved South development. Drawings documenting this stage of works are included in **Appendix B**.

Stage 3: Construction of the Links Road intersection. Drawings documenting this stage of works are included in **Appendix C**.

1.4 Construction Program

Key dates associated with the delivery of the East West program are provided in **Table 1-1**.

Table 1-1 Central Precinct Construction Program Key Dates

Description	Anticipated Start Date	Anticipated End Date
Stage 1 EWC	September 2018	December 2019
Stage 2 EWC	September 2018	December 2019
Stage 3 EWC	September 2019	May 2020
Regional Open Space Filling	September 2018	December 2019

2 Existing Site Conditions

2.1 Pre-development Conditions

The project area of the EWC and DL roads covers an area of approximately 9 hectares. The existing topography at the site is noticeably flat. Elevations vary between approximately 18 – 30 mAHD. The road corridor traverses a number of watercourses, most significantly South Creek and Ropes Creek.

The road will connect the Jordan Springs East development to the Ropes Crossing development, the future Dunheved development and the existing Dunheved industrial development.

Previous studies undertaken for the St Marys Development site indicate that two soil units are located within the site, namely the Luddenham and South Creek soil landscapes.

Previous geotechnical investigations undertaken at the Central Precinct identified a shallow and deep aquifer system. The outcomes of this assessment are documented within *St Marys Central Precinct Water Soils and Infrastructure Report*, SKM, May 2009.

The road corridor is traversed by two major creek crossings, namely South Creek and Ropes Creek. A number of minor tributaries also traverse the road corridor. Existing bridge structures are located across South and Ropes Creek. Five culverts in total convey run-off from other watercourses, which include overflow channels of Ropes Creek. A structural assessment of the design life of the bridges and culverts was undertaken which determined that the structures did not have adequate remaining life to be guaranteed for a 100 year design life.

Part of the proposed road corridor coincides with an existing private access track while the remainder coincides with an existing haul road. Clearing of the land zoned as road and road widening is proposed. The extent of existing trees is documented within the drawing sets *Central Precinct East West Connector Stages 1, 2 and 3*, Cardno, February 2018 (refer **Appendix A to C**).

The road corridor itself is generally free of any live services, although a number of redundant private services exist within the area zoned for road and road widening. These will be removed as part of this project.

At the Links Road roundabout intersection, there are a number of live services, with major services including:

- 600 mm Werrington Carrier sewer main owned and operated by Sydney Water
- 600 mm recycled water main owned and operated by Sydney Water
- 450 mm sewer main owned and operated by Sydney Water.

The location of existing utility infrastructure within the proposed extent of works is included in the drawing set *East West Connector Road (various stages) Civil Works Development Application*, Cardno, February 2018 (refer **Appendix A to C**).

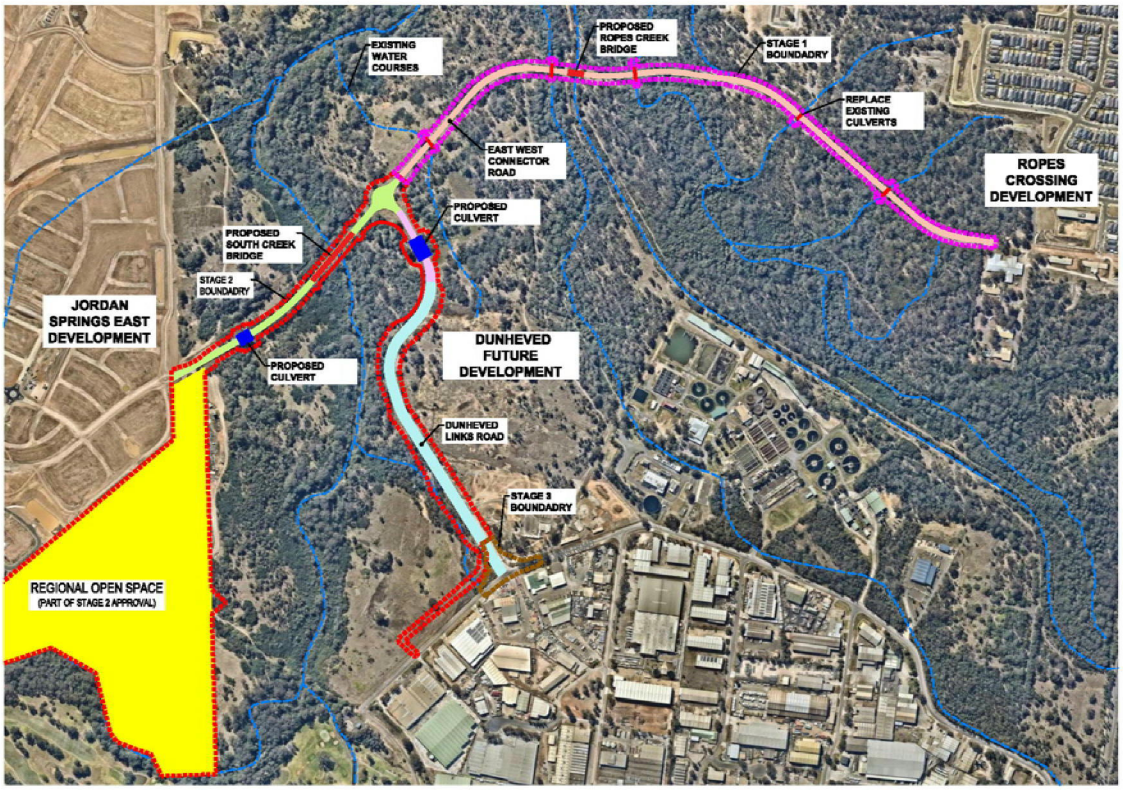
3 External Catchments

The East West connector road and Dunheved Link Road of the St Marys Development will need to incorporate suitable flood and drainage strategies to accommodate the passage of floodwaters and stormwater runoff generated external to the St Marys Site. External catchments can be defined as one of four types:

1. Major (e.g. order 3 or higher) watercourses, namely South Creek and Ropes Creek as well as a number of other first and second order streams.
2. Existing urban development, in the form of Ropes Crossing
3. Regional Park
4. Future urban development, in the form of the Dunheved Site

The location of the nominated external catchments are illustrated in **Figure 3-1** and described under the relevant sub-headings below.

Figure 3-1 Stage 1 External Catchments



3.1 Major Watercourses

The proposed road corridor will intersect South Creek and its tributary, Ropes Creek. South Creek is a major sub-catchment within the Hawkesbury Nepean system. The total catchment area of South Creek is 628 km^2.

Under existing conditions there is an existing plank bridge, approximately 90 metres long, which crosses the South Creek channel and a 25 metre long plank bridge which crosses the main Ropes Creek channel. Two overflow channels located approximately 50 metres away on either side of Ropes Creek are conveyed beneath the existing road embankment via dia. 1800 mm pipes. Flood modelling carried out by Jacobs indicates that the existing Ropes Creek deck will be overtopped while minimal freeboard is retained to the South Creek bridge deck.

A structural assessment has been carried out for both bridge structures which has concluded that the bridges are not considered to retain a 100 year design life. Accordingly, both bridges will be replaced as part of the project.

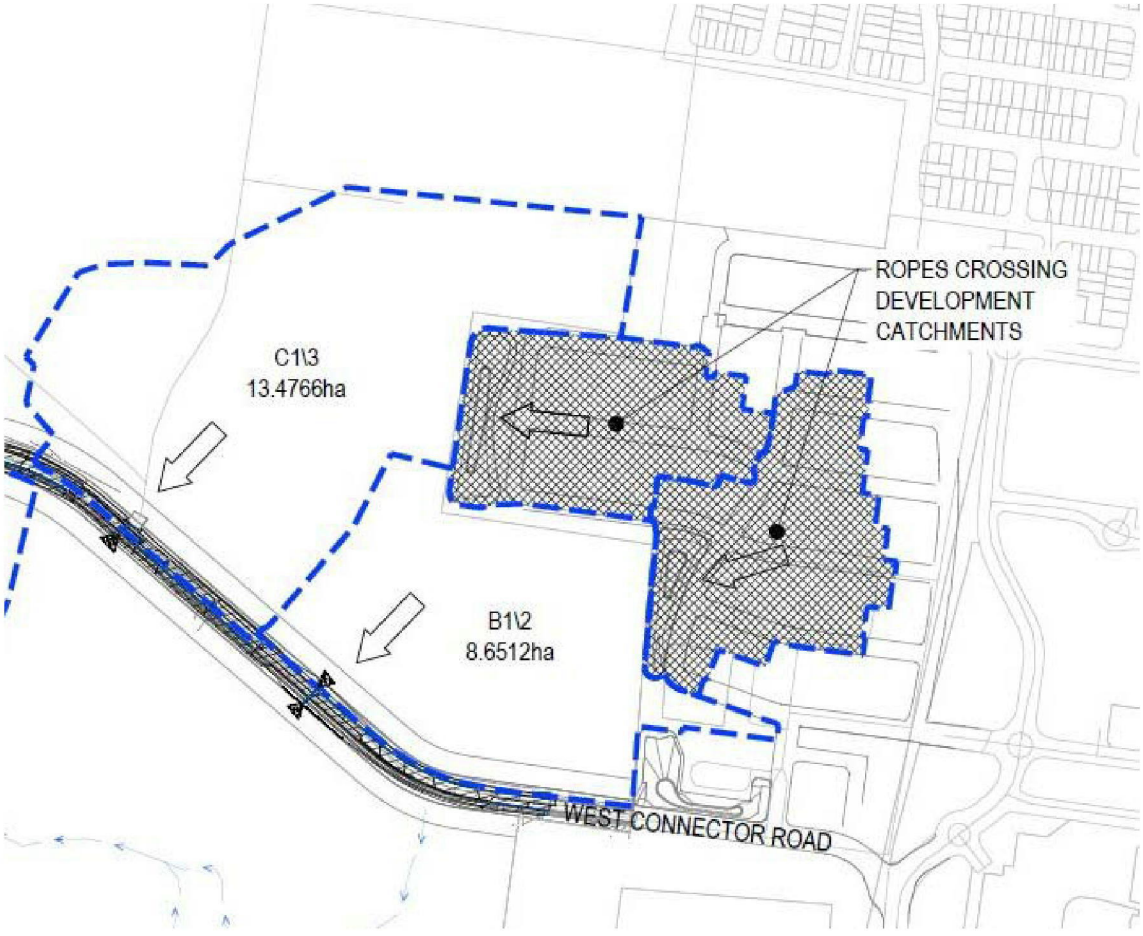
Culverts positioned at the location of the Ropes Creek overflow channels as well as the three first order streams which cross the road crossing will be replaced as part of the project.

3.2 Existing Urban Development

Towards the eastern end of the proposed EWC Road, a portion of the Ropes Crossing development will drain beneath the road via culverts that are proposed to be replaced. In total approximately 20 hectares of run-off generated from the Ropes Crossing development will drain via these culverts, together with part of the future regional open space.

Under existing conditions, these catchments drain towards the south west via existing pipe culvert crossings of the road. As part of the proposed design, the pipes are proposed to be replaced on a like for like basis. An assessment of the potential ponding of local run-off generated from these local catchments has confirmed that adequate freeboard is maintained between the ponded level upstream of the road and the roadway during events up to and including the 1% AEP flood event.

Figure 3-2 Stage 1 External Catchments



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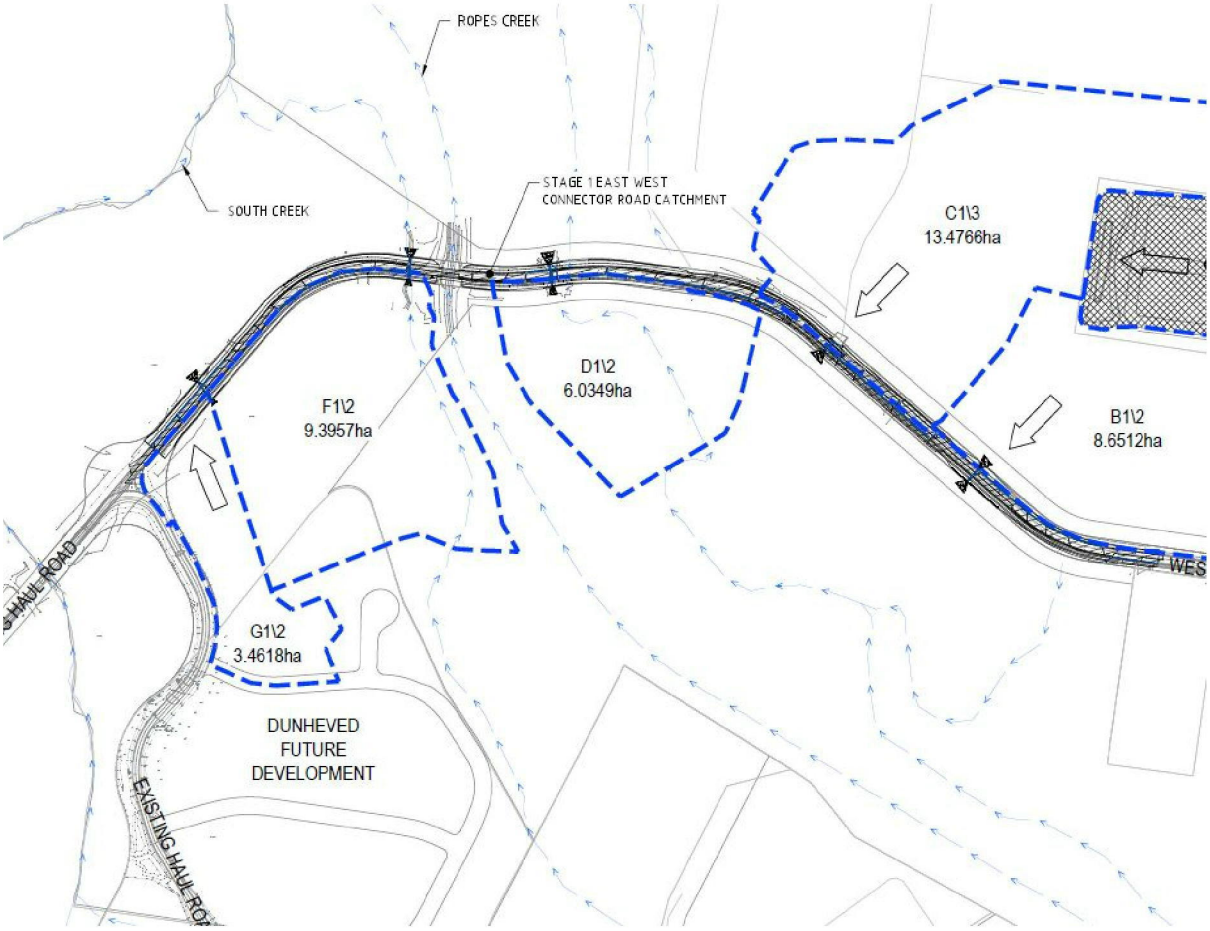
3.3 Regional Park

Sections of the proposed regional park adjoin the boundary of the road corridor. By virtue of the existing road embankment there is no fundamental change to the drainage regime of the regional park. Existing culverts, positioned at lot points, are proposed to be replaced on a like for like basis to facilitate drainage of the regional park.

The drainage strategy for accommodating this external catchment is illustrated within **Figure 3-3**.

Figure 3-3 Regional Park Drainage Strategy

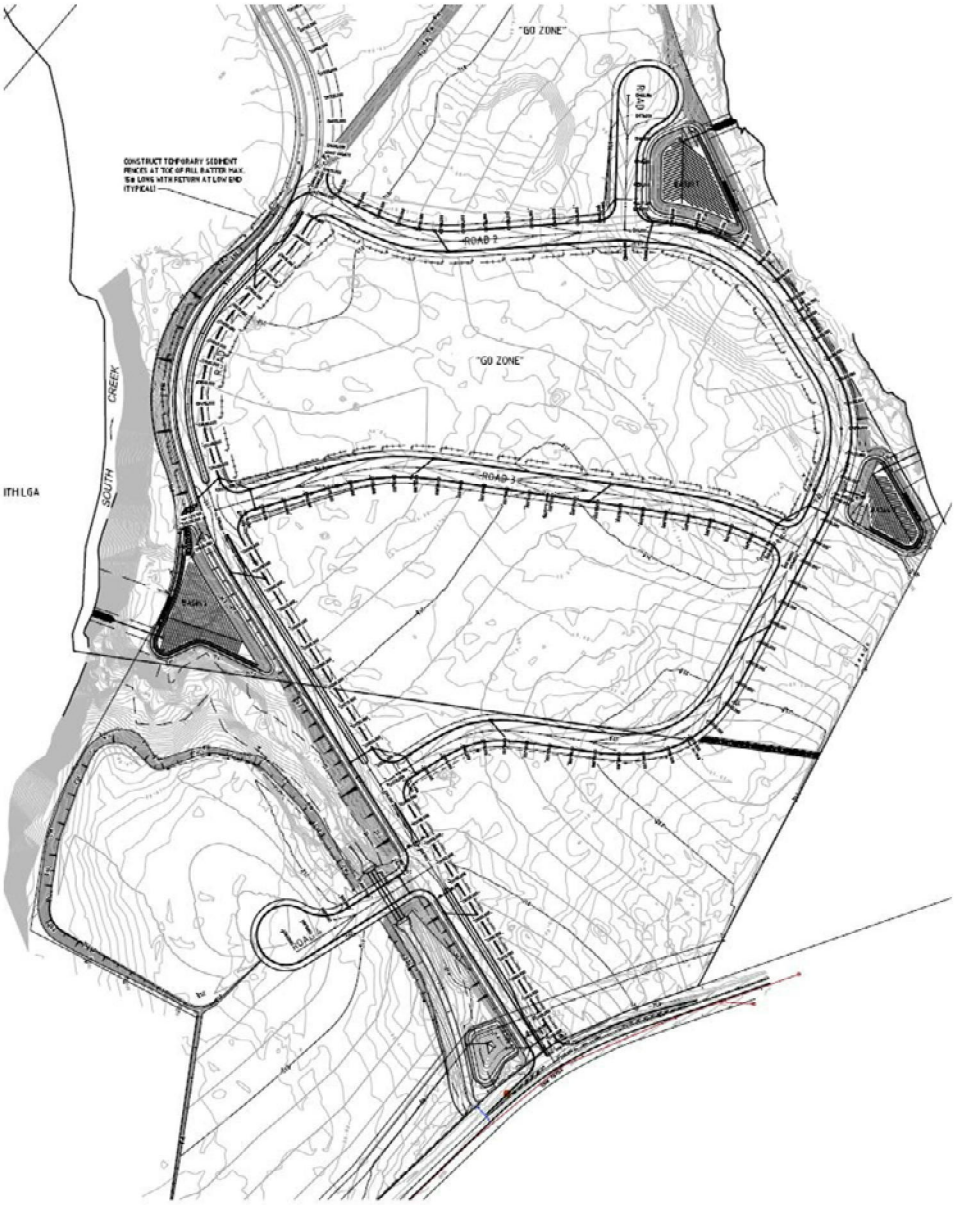


3.4 Future Urban Development

The future Dunheved development will also drain beneath the proposed road network. Approval has previously been granted for the arrangement of the stormwater drainage network at Dunheved. The Dunheved North development will discharge into an overflow channel of Ropes Creek while the Dunehved South Development will discharge into South Creek.

The drainage strategy for accommodating this external catchment is described under the relevant sub-headings below and is illustrated within **Figure 3-4**.

Figure 3-4 Future Dunheved Drainage Strategy



4 Flooding

4.1 Regional Flood Impact Assessment

The proposed road network traverses the floodplain of South Creek and its tributaries. Under existing conditions it is subject to periodic inundation from rising water levels associated with South Creek. Jacobs (previously SKM) has been responsible for undertaking appropriate studies to predict the flood behaviour of South Creek to inform the design constraints associated with the impact of the road and associated development.

The most recent 1% AEP peak water surface level estimates calculated by Jacobs are documented within the *Central Precinct of St Mary's Project Development East West Connector Flood Assessment Report Final*, Jacobs, February 2018. The 1% AEP water surface profile varies between approximately 19.6 and 19.9 mAHD along the East West Connector Road and is at around 20.0 mAHD adjacent to the proposed flood overflow structure on the Dunheved Link Road. Near the southern boundary of the Dunheved South fill platform adjoining Links Road the 1% AEP flood level is approximately 20.5m AHD.

As part of the Bulk Earthworks DA (DA14/1228) approval has been sought for the elevation of the existing surface within the Central Precinct such that future lot levels are a minimum of 500 mm above the predicted 1% AEP South Creek water surface profile.

The modelling undertaken in support of the East West Connector Road has incorporated the central precinct fill platform, the Dunheved fill platform and undertaken a detailed assessment of the size required for the flood relief structures along the proposed road network such that the impacts of the road are maintained consistent with those previously reported.

The regional flood impact assessment identified the size and location of a number of structures that would be required. These are as follows:

1. Replacement of the existing South Creek bridge with a new bridge, approximately 120 metres long and a deck level that varies between 1.2 and 2.4 metres above the 1% AEP flood event. This bridge has been designed by Northrop and is documented in its drawings NL172056 S12.01 - 02
2. Replacement of the existing Ropes Creek bridge with a new bridge, approximately 25 metres long, with a deck level approximately 1.0 metres above the 1% AEP flood event. This bridge has been designed by Northrop is documented in its drawings NL172056 S02.01 - 02
3. Installation of a 6 x 4.2 x 2.7 Reinforced Concrete Box Culvert Structure located towards the western end of the EWC. This structure will provide additional flood relief to mitigate the impact of the proposed road. The location of this structure is shown on drawing CV –CARDNO-EWC2-1301 (refer **Appendix B**).
4. Installation of 20 x 1.8 metre pipe culverts beneath the Dunheved Link Road to facilitate flood conveyance between the South Creek floodplain and Ropes Creek floodplain. The location of this structure is shown on drawing CV-CARDNO-EWC2-1302.
5. Replacement of two 1.8 metre pipe culverts, located on overflow channels either side of Ropes Creek on a like for like basis.

4.2 Local Flooding

During the preparation of DA design documentation suitable consideration has been given to extreme weather events within the local catchments. Local catchments are those that drain to the culvert crossings, generally restricted to the section of the East West Connector Road located east of the Dunheved Link Road intersection. In assessing local flooding within Stage 1 of the Central Precinct the 1% AEP peak flows have been considered.

The assessment has determined that the proposed culvert crossings retain adequate freeboard between the predicted peak water surface level generated from the local catchment run-off event and the proposed road level for events up to and including the 1% AEP event.

A stormwater drainage network has been prepared for the 20% AEP peak flows. For flow rates in excess of the 20% AEP peak flows runoff will be conveyed via the road itself.

In preparing the DA design documentation, overland flow paths have been assessed to determine peak velocities and depths to estimate the flood hazard associated with each overland flow path. Flood hazard has been defined in accordance with the guidance provided in the *Floodplain Development Manual*, April 2005, NSW Department of Infrastructure, Planning and Natural Resources.

It can be confirmed that in the occasions where the road network will be used as an overland flow path for events greater than the 20% AEP, that flows will be contained safely within the road reserve for all events up to the 1% AEP. This will need to be confirmed during detailed design.

5 Earthworks & Grading

5.1 Bulk Earthworks Design

The site grading has largely been dictated by the requirement to elevate the site above the regional 1% AEP peak water surface level. All roads along creeks, drainage channels and basins have been set above the estimated 1% AEP peak water surface profile.

5.2 Earthworks Quantities

The following outlines the cut and fill requirements for the construction of the EWC and the DLR.

- 13,420 m^3 of cut
- 118,080 m^3 of fill
- 104,660 m^3 balance (import).

The following outlines the cut and fill requirements for the construction of the Regional Open Space.

- 6,800 m^3 of cut
- 46,400 m^3 of fill
- 39,600 m^3 balance (import).

5.3 Retaining Walls

The EWC and DLR design will result in a number of retaining walls needing to be constructed. The nature and extent of all retaining walls will be subject to confirmation during detailed design.

All retaining walls be subject to detailed design by a suitably qualified structural engineer.

Table 5-1 gives an overview of the length and height of retaining walls.

Table 5-1 Retaining Wall Properties

Stage	Length (m)	Maximum Height (m)	Average Height (m)	Surface Area (m^2)
Stage 1	450	5	1.6	720
Stage 2	819	5	2.0	1640
Stage 3	0	0	0	0

5.4 Soil Salinity and Aggressivity Results

A geotechnical testing program was undertaken, the results of which are documented in a report prepared by Cardno titled, *Geotechnical Factual report – East West Connector Road* (*November 2017*). The results of this investigation are summarised below:

- In terms of classification of the soils encountered at the site the exposure classification in accordance with AS 3600 was determined to be A1. This is defined as the least aggressive exposure classification. Soil aggressivity tests which were used to determine the exposure classification were based on analysis for pH, total and soluble sulphate, chloride and conductivity.
- In total, 24 samples were tested for salinity across 14 different boreholes and test pits. Salinity was classified according to the Department of Land and Water Conservation's class assessment criteria for soil in urban environments (2002). The vast majority (19) were reported to be non-saline. Two results categorised as slightly saline were encountered, one result of moderately saline was encountered and two isolated instances of very saline occurred.

6 Roads

The design layout of the project has gone through a number of amendments due to external reviews and requests by external stakeholders. The proposed East West Connector (EWC) road design integrates with West Collector road to the east at Ropes Crossing, the proposed Jordan Springs East Collector road to the west. The proposed Dunheved Link road intersects with the existing Links Road to the south via a proposed roundabout.

The following items describe the current design.

6.1 Design Vehicles

The proposed roads are designed to accommodate the following design vehicles.

- 14.5 m long rigid bus
- 19m semi-trailer
- B – double (Links Road/Dunheved Link Road intersection).

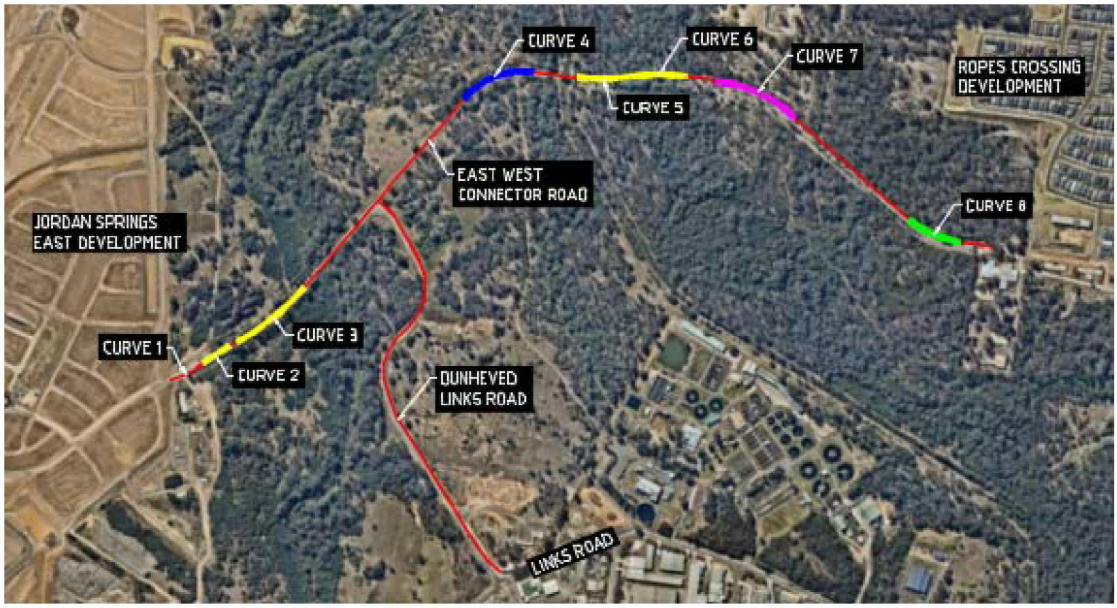
Parameters for the design vehicles were adopted from Guide to Road Design, Austroads, 2016.

Design turning paths were used to determine where local increases in pavement width were required to ensure that the design vehicle could satisfactorily negotiate turns and bends without striking or mounting the kerb. Where necessary, 'No Stopping' signs will be provided to ensure that required turning areas are free of parked vehicles.

6.2 Design Speed

All roads have been designed for a speed of 70km/h with a sign posted speed limit of 60km/h. At horizontal curves 4, 7 and 8 (refer **Figure 6-1**), warning signs with a recommended reduced speed of 55 km/h to increase safety for all road users. The short adjoining the Jordan Springs East project boundary is proposed to be retained as a 50 km/h speed limit. Proposed signage for speed is documented in drawings 1701 – 1705 (**Appendix A**), 1701 – 1705 (**Appendix B**) and 1701 (**Appendix C**) for details.

Figure 6-1 East West Connector Road Curves Locations



6.3 Horizontal Geometry

The horizontal alignments of EWC road and DL road generally follows the existing alignment of a private access road and an existing haul road. At the very western end of the EWC, the westbound road verge deviates to the south slightly outside of the existing road corridor and within the regional open space.

The horizontal alignment of the roads has been designed to comply the design requirements as prescribed in Austroads. The horizontal radii along the EWC road meet Austroads requirements as outlined in **Table 6-1** below. The location of the curves referenced is shown in **Figure 6-1**.

Table 6-1 Horizontal Curve Locations

Horizontal Curves	Adopted Horizontal Radius	Design Speed	Posted Speed	Austroads Minimum Horizontal Radius	Comments
CURVE 1	350	60	50	220	Adverse crossfall table 7.12
CURVE 2	500	70	60	400	Adverse crossfall table 7.12
CURVE 3	500	70	60	400	Adverse crossfall table 7.12
CURVE 4	161	70	60	161	Superelevation table 7.6
CURVE 5	400	70	60	400	Adverse crossfall table 7.12
CURVE 6	400	70	60	400	Adverse crossfall table 7.12
CURVE 7	290	70	60	161	Superelevation table 7.6
CURVE 8	200	70	60	161	Superelevation table 7.6

At curves 4, 7 and 8 where minimum horizontal radius exceeds minimum required adverse crossfall radii, super elevation has been applied at these curves which comply with the super elevation and widening requirements prescribed in Austorads. Although, the horizontal radius at curves 7 and 8 the minimum radius requirements outlined in *Guide to Road Design Guide Part 3: Table 3.2, Austroads 2016* for the roads on which vehicle speeds are unaffected by the horizontal alignment, the warning signs has been proposed to reduce the speed for the safety of the road users.

The horizontal geometry of the Dunheved Link Road has been designed to maintain the consistency with the design which was already been approved for the Dunheved subdivision.

6.4 Vertical Geometry

Roads have generally been graded to ensure that parameters as presented within *Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments*, Penrith City Council, November 2013 and *Engineering Guide for Development, Blacktown City Council 2005* are met. **Table 6-2** presents minimum, maximum and typical road grades proposed. All roads have generally been designed with 3% cross fall, except where superelevation is required.

Table 6-2 Summary of Minimum, Maximum and Typical Road Grades

Road Type	Minimum Road Grade	Maximum Road Grade	Typical Road Grade Range
All roads	0.7%	2.0%	0.7% to 1.0%

6.5 Sight Distance

Roads have been designed to comply with minimum sight distance requirements as prescribed in Guide to Road Design, Austroads 2016.

6.6 Road Cross Sections

There are four proposed road cross sections adopted for the proposed roads design. All road cross sections have been adopted in accordance with the approval of

Details of the road cross sections are summarised in **Table 6-3**. The proposed street cross sections are generally consistent with the works undertaken as part of the Jordan Springs East Development, Ropes Crossing Development Dunheved Development.

Table 6-3 Road Cross Sections

Road Type	Road Reserve Width (m)	Pavement Width (m)
Central Precinct Collector Road (Modified)	20.00	12.00
Blacktown Collector Road (Modified)	19.90	11.00
Dunheved Industrial Road (with Median)	26.3	17.50
Dunheved Industrial Road (Modified)	22.30	13.50

The following kerb types will generally be provided:

- Central Precinct Collector Road (Modified) — Kerb and gutter both sides
- Blacktown Collector Road (Modified) — Kerb and gutter both sides; Kerb and toe where superelevation applied
- Dunheved Employment Street (with median) — Kerb and gutter both sides
- Dunheved Employment Street (Modified for bridge) — Kerb and gutter both sides

Typical road cross sections are presented on:

- sheet 89914020-EWC1-1051 of the drawing set entitled *East West Connector Road - Stage 1 Development Application, Cardno, February 2018;*
- sheet 89914020-EWC2-1051 of the drawing set entitled *East West Connector Road and Dunheved Links Road - Stage 2 Development Application, Cardno, February 2018;* and,
- 89914020-EWC3-1051 of the drawing set entitled *Dunheved Links Road - Stage 3 Development Application, Cardno, February 2018.*

These drawings are contained in **Appendix A** to **C**.

6.7 Road Pavement

Preliminary flexible road pavement designs have been prepared and presented on sheet 89914020-ST01-1051 of the drawing set entitled *East West Connector Road Stage 1 Development Application*, Cardno,

February 2018. It should be noted that the preliminary road pavement designs are subject to detailed design pending additional geotechnical investigations and confirmation of sub-grade properties during construction.

Table 6-4 presents a summary of design criteria and overall pavement thicknesses nominated throughout the proposed roads.

Table 6-4 Pavement Design Summary

	Collector Roads	Collector Roads
Applicable road cross sections	Roundabout	Collector Road with Possible Bus Route Industrial Collector Road Industrial Collector Road with Median
Assumed CBR	3%	3%
ESA	2×10^6	5×10^5
Asphaltic Concrete	75 mm	50 mm
Base	200 mm	150 mm
Sub-base	175 mm	200 mm
Total Pavement Thickness	450 mm	400 mm

6.8 Intersections

There are two roundabouts proposed within the design, one located at the intersection of EWC road and DL road and the other located at the intersection of proposed DL Road and existing Links Road. The roundabouts have been designed to comply with the requirements in accordance with Guide to Road Design Part 4, Austroads 2016.

Assessment of the future operation of these roundabouts were undertaken with results indicating that they will operate satisfactorily during both AM and PM peak traffic periods relating to the 2016 and 2026 modelling scenarios. Details of the calculations are presented in traffic modelling undertaken by WSP (2018).

The intersection with existing Links Road involves the incorporation of a driveway which is located at 84 Links Road. The design, as documented for Stage 3 (refer drawing CV-CARDNO-EWC3-1301) proposed to incorporate the driveway as the fourth leg of the roundabout. Turn paths are provided in the set demonstrating the viability of the vehicle entering the driveway from Links Road. During the preparation of the development application, Lendlease consulted with the owner of the site, Gulf Western, regarding the suitability of the proposed arrangement.

6.9 Cycleway

There is a proposed cycleway along the right side of the EWC road and Dunheved Link road. On the eastbound side of the EWC road where there is footpath along the right side of the existing connector road stub at Ropes Crossing which will be discontinued beyond the cycleway crossing and pedestrians will continue to use the shared path.

Concrete shared paths will contain a maximum of 2.5% cross fall consistent with road verge for all EWC roads and a maximum of 2% cross fall for all DL road and a maximum width of 2.5m for all roads.

6.10 Embankment Design and Consideration of Clear Zones

Due to the constrained nature of the area zoned for road and road widening it is necessary to incorporate within the design embankment slopes steeper than the preferred minimum of 1V: 4H, with embankment slopes up to 1V:2H proposed. As part of the development application, an assessment has been carried out to verify that the minimum clear zone required by Austroads is maintained between the travel lane and the top of the embankment. In general, there is the minimum width required between the travel lane and the edge of the obstruction (i.e. the top of the embankment). Where this does not exist, e.g. immediately adjoining the proposed bridge structures, a barrier in the form of either wire rope or W beam will be documented as part of the detail design.

7 Stormwater Drainage

7.1 Drainage Standards

The stormwater drainage networks has been designed to comply with:

- Within the Penrith LGA: *Design Guidelines for Engineering Works for Subdivisions and Developments*, November 2013, Penrith City Council;
- Within the Blacktown LGA: *Engineering Guideline For Development*, 2005, Blacktown city Council; and,
- *Australian Rainfall and Runoff, Volume 1*, 1987, Institution of Engineers, across the project more generally.

The proposed drainage network has been designed to safely convey major and minor flows to outlets that coincide with existing water courses along the road network. Design rainfall intensities have been adopted as follows:

- Minor System
    - Urban residential 20% AEP
    - Local/Collector Road Crossings 10% AEP
- Major System 1% AEP.

Stormwater pits have been positioned to suit the proposed road geometry and generally maintain a maximum flow width of 2.5 metres from the face of kerb during the design storm event.

Where practical, overland flow paths have been subject to preliminary design to accommodate the 1% AEP storm event by maintaining a velocity-depth product of 0.4 or less and a maximum flow depth equal to or less than 300 millimetres. In instances where these parameters are exceeded, appropriate risk management strategies will need to be developed through the preparation of detailed design documentation.

7.2 Catchment Areas

Catchments that have been accommodated within the drainage network are documented on a series of drawings within the respective drawing sets prepared for each stage. These drawings are as follows (refer **Appendix A** to **C**):

- CV-Cardno-EWC1-2301 – 2302
- CV-Cardno-EWC2-2301 – 2302
- CV-Cardno-EWC3-2301

7.3 Hydrology Calculations

Detailed catchment modelling was conducted to calculate flows generated by the site within the DRAINS software package. This software package uses the industry standard hydrology calculation ISLAX. The following parameters were used in the model:

- Bureau of Meteorology IFD coefficients (refer **Table 7-1**) based on the geographical location of the Central Precinct
- Depression storage:
    - 1 mm for paved (i.e., impervious) areas
    - 5 mm for grassed (i.e., pervious) areas
- Antecedent moisture condition 3
- Catchments, including roads have been assumed to be 90% impervious

- Times of Concentration have been calculated based on catchment size, catchment slope and roughness. Minimum Times of Concentration of 1 minute and 3 minutes for impervious and pervious areas have been adopted respectively.

Table 7-1 Adopted IFD Coefficients

	2 Year (mm/h)	50 Year (mm/h)
1 hour rainfall intensity	29.4	59.8
12 hour rainfall intensity	6.6	12.8
72 hour rainfall intensity	1.9	4.3
Geographical Coefficients	Adopted Value	
G	0.02	
F2	4.3	
F50	15.8	

7.4 Hydraulic Calculations

The hydraulic calculation was conducted using the dynamic drainage component within the 12D software package and has been validated through comparison against results derived using the DRAINS software package.

The model represents all catchments collected via a pit and pipe network designed to cater for the minor flows with consideration of major design storms. All areas are gravity drainage with overland flows in excess of pipe capacity safely directed to bio-filtration basins, open spaces, the drainage corridor or existing watercourses.

Hydraulic calculations are preliminary only and have been used principally to assess the ability to drain the site given the relatively minor road grades proposed throughout the site and to identify overland flow paths within which flow will need to be managed.

7.5 Results

Preliminary pipe sizes are nominated within the three drawing sets prepared for each of the stages (February, 2018, refer **Appendix A**).

Drainage long-sections and hydraulic grade lines will be documented as part of the construction certificate package.

8 On Site Detention

8.1 Background

The proposed road network is located within close proximity to South Creek. No existing development is located between the Central Precinct and receiving watercourses.

The provision of on-site detention within the Central Precinct has been subject to a technical assessment by SKM (Jacobs) which was presented to Council representatives during a meeting held in Council offices (14 November 2014). The key outcomes of the Jacobs assessment include:

- The Central Precinct represents less than 1% of the South Creek catchment area upstream of the site
- The development of the Central Precinct has negligible impact on flood behaviour within South Creek
- On-site detention (OSD) is not considered necessary to mitigate against an increase in peak flow rates from the development
- Recommendation for Council representatives to undertake a merit based approach assessment for the removal of detention basins within the Central Precinct.

A complete copy of the *Hydrologic Assessment of St Mary's Central Precinct*, 12 November 2014, Jacobs is included as **Appendix F**.

It is suggested that due to the proximity of the proposed road relative to South Creek and the smaller footprint of the road that the same reasoning applies.

8.2 Current Approach to OSD

Consideration of the strength of the merit based assessment have resulted in the design adopting a position where OSD along the EWC is not required. Notwithstanding, this approach will require written confirmation from Council representatives prior to the commencement of detailed design documentation.

9 Stormwater Quality

9.1 Objectives

The stormwater management strategy for the East West Connector Road cannot be considered in isolation. Rather, the strategy needs to take into account the regional objectives outlined within SREP30 for the Eastern, Central and Western Precincts. The regional objectives seek to preserve the condition of the receiving waters by matching existing stormwater pollutant concentrations at key locations along South Creek.

The regional stormwater management strategy has been prepared by SKM (Jacobs) and incorporates a number of strategically located basins within the Regional Park. In determining the required performance characteristics of the regional basins, the design of each of the subdivisions (i.e. Eastern, Central and Western precincts) has proceeded assuming the following reductions in post-development pollutant loads, viz:

- Gross Pollutants 90%
- Total Suspended Solids 85%
- Total Phosphorus 60% (65% in Blacktown LGA)
- Total Nitrogen 45%.

9.2 St Marys Stormwater Quality Management Strategy

Water Quality controls have been included in each of the Eastern, Western, Central and Dunheved precincts of the St Marys Developments. These water quality treatment devices have been designed based on the respective (i.e. Blacktown/Penrith) Council guidelines, and to achieve the post development pollutant loads typically associated with subdivision development. The treatment devices include, but is not limited to:

- Gross Pollutant Traps;
- Bio-retention basins;
- Riparian Channels;
- Wetlands; and,
- Swales.

9.3 Application of Water Quality Modelling and Water Treatment Devices to East West Connector Road and Dunheved Link Road

The East West Connector Road will be constructed adjoining the regional park, with the western end of the road adjoining the future regional open space. The road catchment and the pollutants anticipated to be generated are not typical of the type generated within a subdivision development, for which water quality modelling software, (e.g., MUSIC) were created. A qualitative assessment of the pollutants expected to be generated is considered to be predominantly limited to oil and grease that will be generated from traffic utilising the road. Therefore, it is proposed that treatment devices within the road corridor be limited to the placement of oil/water separators within pits immediately upstream of a discharge point.

Any residual increase in the pollutant load generated as result of the development is expected to be managed via consideration with respect to the regional stormwater strategy in achieving the outcomes of SREP 30 with respect to water quality.

For the section of the DL Road with the Dunheved Precinct, water quantity and quality is being managed via controls included as part of the future subdivision development approved previously.

During the development of the design, the approach described above was advised to Blacktown City Council via email for comment.

10 Sediment & Erosion Control

Erosion and sediment control will be installed and maintained in accordance with Council's requirements and Landcom's Managing Urban Stormwater, Soils and Construction (i.e., the Blue Book).

At this stage, sediment basins are not proposed along the east west connector road. Due to the restricted nature of the corridor, there is insufficient space to install sediment basins within the area zoned for road and road widening. In lieu of sediment basins it is proposed that turbidity barriers be installed across all water courses, together with other standard erosion and sediment controls.

Construction stockpile areas will be located near areas of minimal cut and fill. Stockpiles will be protected above by local diversion drains and below by sediment fences.

The full sedimentation and erosion control strategy is presented within the Cardno drawing sets contained in **Appendix A** to **C**.

11 Utility Servicing Strategy

Utility servicing is limited to provision of street lighting along the EWC and the DL roads. Provision has been made within the verge of the road should future services be required to be installed. However, these services are not currently required and do not form part of this project. Where deemed appropriate, conduits may be installed at nominated road crossings to provide for future services.

12 Conclusion

A preliminary civil design for the East West Connector and Dunheved Link Road has been undertaken. The civil design has been developed in accordance with the relevant Council and authority guidelines as well as the requirements of SREP30.

The key outcomes documented within this report include:

- A road design has been developed, in accordance with Austroads requirements and provision of a minimum flood immunity equivalent to the 1%AEP event.
- As part of the road construction, two bridges will be replaced, two additional flood conveyance structures will be incorporated within the road network
- Other minor culvert structures are proposed to be replaced to retain flow paths at existing water courses and low points.
- The road construction requires approximately 120,000 m^3 of fill. Retaining walls will be required along the length of road to retain the fill platform within the area zoned for road and road widening.
- The road will be located above the 1% AEP peak water surface level estimated for South Creek and Ropes Creek
- Roads have been designed generally in accordance with:
    - *Guide to Road Design*, Austroads, 2006
    - *Central Precinct Precinct Plan*, JBA, 2009
    - *Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments*, Penrith City Council, November 2013
    - *Engineering Guide for Development, prepared by Blacktown City Council (2005).*
- Design vehicles used to assess the proposed road network included a B double, semi trailer and 14.5 m bus.
- The minimum longitudinal road grades within the road network is 0.7%
- A preliminary drainage network has been designed in accordance with *Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments*, Penrith City Council, November 2013 and *Blacktown City Councils Engineering Guide for Development*.
- A merit based assessment has been outlined as to why OSD is not required.
- A stormwater quality management assessment has been outlined as to why it is not appropriate to include water quality treatment structures along the road corridor.
- Sediment and erosion control measures have been included as required to protect downstream receiving waters from sediment laden runoff during construction activities.
- Utilities are not required, with the exception of street lighting. Provision for any future utility requirements is included in the road network.

13 References

- *St Marys Central Precinct Water Soils and Infrastructure Report*, SKM, May 2009
- *Central Precinct Bulk Earthworks Development Application*, Cardno, July 2014
- *Central Precinct of St Mary's Project Development Flood Assessment Report Final,* Jacobs, February 2015
- *Floodplain Development Manual,* NSW Department of Infrastructure, Planning & Natural Resources, April 2005
- *Central Precinct Precinct Plan*, JBA 2009
- *Guide to Road Design*, Austroads, 2006
- *Penrith City Council Design Guidelines for Engineering Works for Subdivision and Developments*, Penrith City Council, November 2013
- *Central Precinct Stage 1 Traffic Impact Assessment*, Cardno, December 2014
- *Central Precinct Landscape Master Plan*, JMD Design, February 2015
- *Guidelines for Riparian Corridors on Waterfront Land*, NSW Department of Primary Industries Office of Water, July 2012
- *Bushfire Emergency Evacuation Plan, Central Precinct, St Marys ADI Development*, Molino Stewart, September 2014
- *Australian Rainfall and Runoff, Volume 1*, Institution of Engineers, 1987
- *Hydrologic Assessment of St Mary's Central Precinct*, Jacobs, 12 November 2014
- *Water Sensitive Urban Design (WSUD) Policy*, Penrith City Council, December 2013
- *Managing Urban Stormwater – Soils and Construction*, NSW Department of Housing, March 2004
- *Guide to Codes and Practices for Streets Opening,* NSW Streets Opening Conference, 2009

East West Connector & Dunheved
Link Road Development Application

APPENDIX

A

EAST WEST CONNECTOR ROAD STAGE 1
CIVIL WORKS DEVELOPMENT APPLICATION

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Link Road Development Application

APPENDIX

B

EAST WEST CONNECTOR ROAD AND
DUNHEVED LINKS ROAD - STAGE 2

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Link Road Development Application

APPENDIX

C

EAST WEST CONNECTOR ROAD STAGE 3
CIVIL WORKS DEVELOPMENT APPLICATION

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