MARYLAND DEVELOPMENT COMPANY PTY LTD
(LENDLEASE COMMUNITIES)

LINKS ROAD EXTENSION AND UPGRADE, ST MARYS

CONCEPT DESIGN REPORT

NOVEMBER 2018

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Links Road Extension and Upgrade, St Marys
Concept Design Report

Maryland Development Company Pty Ltd
(Lendlease Communities)

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

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	NAME	DATE	SIGNATURE
Prepared by:	Andrew Clune	22/11/2018	
Reviewed by:	Alistair Kelly	22/11/2018	
Approved by:	Nuno Muralha	22/11/2018	

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ABBREVIATIONS

AGPT	Austroads Guide to Pavement Technology
AGRD	Austroads Guide to Road Design
AGTM	Austroads Guide to Traffic Management
ARI	Average Recurrence Interval
AEP	Annual Exceedance Probability
CBR	California Bearing Ratio
CDF	Cumulative Damage Factor
Ch.	Chainage
DA	Development Application
DCP	Development Control Plan
DDA	Disability Discrimination Act
ESA	Equivalent Standard Axles
HV	Heavy Vehicle
MF	Maintenance Factor
LGA	Local Government Area
NSW	New South Wales
PCC	Penrith City Council
RMS	Roads and Maritime Services
RSA	Road Safety Audit
SAR	Standard Axle Repetitions
SEE	Statement of Environmental Effects
SMZ	Selected Material Zone
SREP	Sydney Regional Environmental Plan
SID	Safety in Design
TCS	Traffic Control Signals

EXECUTIVE SUMMARY

WSP has been engaged by Maryland Development Company Pty Ltd (Lendlease Communities) to provide the lead engineering services and concept design for the Development Application of the Links Road Extension and Upgrade, St Marys to Penrith City Council; a road link between the Dunheved South Development and the existing T-Junction between Christie Street and Lee Holm Road.

The main project works include:

- Upgrade, extension and re-alignment of the Links Road over a total length of 1.5km between the gateway intersection into the South Dunheved Precinct and Christie Street. The upgrade section of road is the Links Road and the extension section of road is the Links Road Extension
- Signalisation of the existing T-Junction between Christie Street and Lee Holm Road. This section of the project is the Christie Street Intersection.

The project falls wholly within the Penrith City Council Local Government Area. The project will include access adjustments to the existing private access road into the Dunheved Golf Course, and driveways into the Sydney Water Sewer Pumping Station.

This design report will form part of the Development Application for submission to Penrith City Council as an integrated development under the Environmental and Planning Assessment Act 1979. The works under the development application include:

- Upgrade of the existing Links Road from South Dunheved Precinct to the Dunheved Golf Course
- Extension of Links Road for approximately 300m through vacant land to the existing Christie Street Intersection
- Construction of a signalised four-way intersection at Christie Street and Lee Holm Road
- Carry out utility works and drainage upgrades to support the proposed road works
- Erect supporting roadside infrastructure including streetlighting, signage and fencing.

This report documents the processes undertaken to prepare the Development Application design documentation for the Links Road Extension/ Upgrade and associated works. The report outlines how the required road infrastructure will be delivered in accordance with the St Marys Planning Agreement with Penrith City Council, the Penrith City Council Development Control Plan and relevant authority design guidelines and technical requirements.

This report appends other design reports and supporting information for further reference on the design methodologies that have informed the concept design documentation.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Lendlease Communities are proposing to construct an upgrade and extension of Links Road to connect with Christie Street within St Marys, NSW.

Links Road Extension/ Upgrade project is located approximately 5 kilometres north-east of Penrith and 45 kilometres west of Sydney CBD. The project will run from the frontage of the South Dunheved Precinct (within the St Marys Development Site), along the existing north-south section of Links Road connecting to Christie Street via a new four-leg signalised intersection with Lee Holm Road, within St Marys. This intersection is currently an unsignalised T-junction with Lee Holm Road and Christie Street. Links Road is a local industrial road that currently serves the existing Dunheved Industrial Area and is within the Penrith Local Government Area (LGA). The project will provide an additional access point to the St Marys Development Site from via Christie Street.

The intersection at South Dunheved has been agreed in kind between Lendlease Communities and Penrith City Council through the St Marys Planning Agreement. Concept Design (and associated Environmental Assessments) was complete and the Development Application was submitted to Penrith City Council in April 2018. This is a key interface project to the Links Road Extension and Upgrade project.

The St Marys Development Site covers an area of approximately 1,545 hectares and comprises five precincts including:

- Jordan Springs (formerly known as Western Precinct) and Jordan Springs East (formally known as Central Precinct) precincts, which include residential and recreational open space area
- Ropes Crossing (formerly known as Eastern Precinct and Ropes Creek Precinct)
- North Dunheved and South Dunheved precincts, which are zoned for Employment and are located immediately north of the existing Dunheved employment area.

The precincts are development areas identified under the Sydney Regional Environmental Plan No. 30 – St Marys (SREP 30) that are being developed by Lendlease Communities. As of 2018, the Ropes Crossing and Jordan Springs Precincts are substantially completed with approximately 50% of the Jordan Springs East Precinct complete. There has been no development within the Dunheved Precincts.

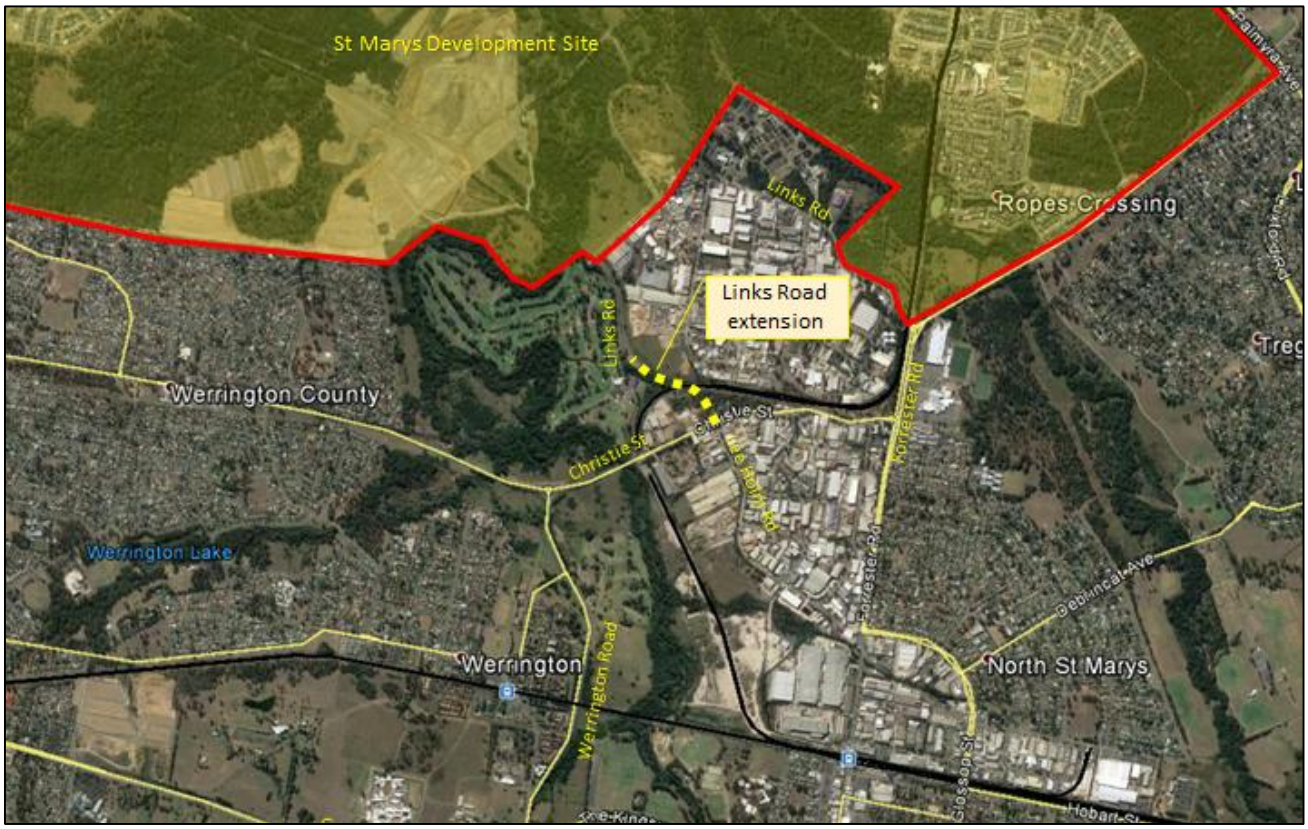


Figure 1.1 Site Location

1.2 PROJECT SCOPE

The Links Road Extension and Upgrade project aims to provide an additional access point to the St Marys development site. To facilitate this, a section of the existing Links Road will be upgraded. The existing road is proposed to be extended to join the intersection between Christie Street and Lee Holm Road.

The upgrade to the existing road begins just west of the South Dunheved Precinct gateway roundabout. The design of this roundabout is outside the Links Road Extension and Upgrade scope of works and will tie into the proposed works at Links Road. The upgrade continues along Links Road until it reaches the entrance to Dunheved Golf Club, where the existing Links Road ends. Road access adjustments will be provided to facilitate access to the golf course.

The new Links Road Extension will continue south, through a disused rail corridor, until it joins the northern side of the existing T-Junction between Christie Street and Lee Holm Road. The intersection of Christie Street, and Lee Holm Road, and the proposed Links Road Extension will become a signalised intersection.

The proposed works will include a shared path facility along the length of the upgrade.

2 DESIGN DEVELOPMENT

2.1 ROAD GEOMETRY

Refer to Road Alignment and Details Drawings (RD package).

2.1.1 DESIGN CRITERIA

The road geometry has been designed to comply with the St Marys Planning Agreement, Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments, the RMS supplements to Austroads Guide to Road Design, and Austroads Guide to Road Design. This has been conducted in consultation with Penrith City Council engineering representatives, as documented in the DA Pre-lodgement meeting and 50% Concept Design meeting minutes. In the instance of inconsistencies between the standards, the order of hierarchy for the design has been conducted as follows:

1. Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments
2. RMS Supplements to Austroads Guide to Road Design
3. Austroads Guide to Road Design.

2.1.2 DESIGN SPEED

The posted and design speeds throughout the project have been conducted in accordance with Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments in consultation with Penrith City Council engineering representatives. These are shown in Table 2.1 below.

Table 2.1 Posted Speeds and Design Speeds

ROAD	POSTED SPEED	DESIGN SPEED
Links Road/ Links Road Extension	50km/h	50km/h
Christie Street	60km/h	60km/h
Lee Holm Road	60km/h	60km/h

2.1.3 DESIGN VEHICLE

All roads on the project are listed as 25/26m B-double routes in the NSW Restricted Access Vehicles Map. All vehicle movements have been designed to cater for a 26m B-double, with the exceptions listed below. Vehicle swept paths are shown in Appendix A.

2.1.3.1 SYDNEY WATER PUMP STATION

The upgrade to the access driveways into the Sydney Water Pump Station have been designed for a left in left out configuration, assuming 12.5m SU Truck. In the absence of a formal Scope of Works and Technical Criteria document to list required design vehicles, an analysis was conducted on the existing configuration to show a 12.5m SU Truck being the largest vehicle to perform the ingress/egress movements. This informed the decision to design these driveways for a 12.5m SU Truck. Vehicle swept paths of the driveways are shown in Appendix A.

2.1.3.2 DUNHEVED GOLF COURSE

As the access into the Dunheved Golf Course is the existing Links Road, its requirements are for B-Double access as per the NSW Restricted Access Vehicles. Links Road is to be upgraded as part of the project with the access into the Dunheved Golf Course to become its own road via a new T-junction intersection to be constructed with Links Road. It

was assumed that the largest vehicular access into the Dunheved Golf Course would be a 12.5m SU Truck. The T-junction has been designed to cater for a 12.5m SU Truck for all movements. A 14.5m Long Rigid Bus can access the golf course via right in, right out movements. Vehicle swept paths for the T-junction at the Dunheved Golf Club access can be found in Appendix A.

2.1.3.3 LEFT TURN FROM CHRISTIE STREET INTO LEE HOLM ROAD

Due to a single westbound lane provided on Christie Street and a single southbound lane provided on Lee Holm Road as per the St Marys Planning Agreement, the south-eastern kerb return at Christie Street and Lee Holm Road has been designed to cater for a 19m semi-trailer. This is in line with recommendations from Penrith City Council documented in the DA Prelodgement Meeting Minutes conduced on the 27th September 2018. Access into Lee Holm Road can be gained by B-doubles via a right turn from Christie Street or the existing arrangement at Power Street. Vehicle swept paths for the signalised intersection can be found in Appendix A.

2.1.4 CROSS SECTION

The cross sections provided for Links Road, Christie Street and Lee Holm Road have been provided in accordance with the St Marys Planning Agreement, with the following exceptions:

- Shared path provided from pedestrian crossing at left slip lane at the signalised intersection through the entirety of the proposed alignment to the future roundabout at South Dunheved
- Links Road cross section has been modified through the bend for road safety and delineation purposes. This is outlined further in Section 2.1.7
- Links Road pavement width to be reduced to 13.0m between kerb faces north of the bend. This in in line with Penrith City Council Development Control Plan pavement width for Industrial Roads, and has been implemented to reduce the land impact on the Future Regional Park. This was discussed and accepted in the 50% Concept Design, and has been documented in the meeting minutes.

In addition to the following sections above, minor footpath upgrades have been provided around the signalised intersection as shown on the Pavement Design drawings. Batters have been provided as per the details in Section 2.7

2.1.5 HORIZONTAL AND VERTICAL ALIGNMENT

Horizontal and vertical alignment has been conducted in accordance with Design Speed listed in Section 2.1.2, except through the sharp bend. Description of the design criteria used through this area can be found in Section 2.1.7. Any outstanding issues with the horizontal and vertical alignment can be found in the Issues Register, contained in Appendix C.

2.1.6 INTERSECTIONS

The proposed design contains three intersections along the alignment of the proposed upgrade. Details of these are discussed below.

2.1.6.1 CHRISTIE STREET SIGNALISED INTERSECTION

The intersection at Christie Street and Lee Holm Road is currently an unsignalised T-junction at the southern end of the project extents with single lanes in each direction. The intersection is to be upgraded as part of the works to a four-way signalised intersection, with the new section of Links Road to form the fourth leg. Christie Street and Lee Holm Road are to be widened to provide additional lanes, with linemarking modifications provided to Christie Street to form an auxiliary through lane configuration. A left-hand slip lane is to be provided from Christie Street into Links Road.

2.1.6.2 GOLF COURSE ACCESS T-JUNCTION

As part of the proposed upgrade works, a new single lane T-junction will be provided for access into the Dunheved Golf Course. The intersection design has been conducted to ensure an existing box culvert can remain. Further design input for this intersection will be required during the Construction Certificate Documentation stage.

2.1.6.3 SOUTH DUNHEVED ROUNDABOUT

The intersection at South Dunheved is currently a T-junction at the northern extents of the project extents. A Development Application has been submitted to Penrith City Council (DA18/0381) which has been designed by others to upgrade this intersection to a roundabout design. The design of the roundabout is to be modified to tie in to design as part of the proposed works to Links Road.

2.1.7 GEOMETRY AROUND BEND (LINKS ROAD)

To reduce the property acquisition to the future Regional Park, compliant geometry around the bend cannot be achieved. An analysis has been conducted to determine a safe operating speed around the bend in accordance with Austroads Guide to Road Design Park 3 guidelines and principles. The geometric criteria applied around the bend is shown in Table 2.2 below.

Table 2.2 Geometry Applied Around Bend

CRITERIA	VALUE	COMMENTS
Input: Min radius at inside of curve	32.8m	Control line radius 39.0m, lane width 6.2m to facilitate B-double swept paths
Input: Friction factor, f	0.25	AGRD Part 3 Table 7.5 shows no minimum side friction below 50km/h Operating Speed. Minimum value of 0.25 has therefore been adopted
Input: Superelevation	6.0%	Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments Section 2.2.16 specifies 6.0% maximum crossfall. AGRD Part 3 Table 7.8 specifies maximum superelevation for Urban Roads of all speeds to be 5.0%. This issue is documented in Section 12.1 and outlined in further detailed in the Issues Register in Appendix C.
Output: Design Speed	**36km/h**	This the result of the inputs above and informs the recommended speed of 35km/h around the bend

In addition to the geometric criteria used through the bend to achieve a 35km/h recommended speed, further safety measures have been included in the Development Application submission, including:

- No stopping zones
- Lane widths sufficient for 26m B-double vehicles. Vehicle swept paths can be found in Appendix A
- Warning signage (and accompanied 35km/h recommended speed) prior to the bend to alert motorists of the upcoming geometry
- 1.2m median to prevent vehicles traversing into the opposing lane

Further design input will be required during Construction Certificate Documentation stage to determine any additional traffic calming safety measures to be implemented. This is to be determined in collaboration with Penrith City Council through formal review and approval processes.

2.1.8 SIGNAGE AND LINEMARKING DESIGN

No signage and linemarking design package has been conducted as part of the Development Application submission. This is to be undertaken during Construction Certificate Documentation stage. Signage and linemarking design as provided on the Concept Design plans have been shown to demonstrate the design intent for safety and/or delineation purposes.

2.1.9 ROAD FURNITURE AND FENCING

No road furniture and fencing design package has been conducted as part of the Development Application submission. This is to be undertaken during Construction Certificate Documentation stage.

2.1.10 NOISE MITIGATION

As part of the Statement of Environmental Effects document, an Operational and Construction Noise Impact Assessment has been undertaken. No noise mitigations have been recommended as part of this document, and as such, have not been included in this submission.

2.2 PAVEMENT DESIGN

Refer to Pavement Drawings (PV package).

2.2.1 DESIGN STANDARDS

The following design standards have been used in the concept pavement design for the Development Application submission:

- Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments
- Austroads Guide to Pavement Technology Part 2: Pavement Structural Design (2012)
- RMS Pavement Design Supplement to 'Part 2: Pavement Structural Design' of the Austroads Guide to Pavement Technology (22 January 2015).

2.2.2 BASIS OF DESIGN

2.2.2.1 DESIGN CRITERIA

DESIGN LIFE

Pavement design has been conducted to provide design life in accordance Penrith City Council Guidelines for Engineering Works for Subdivisions and Developments. This is shown in Table 10.1.

PROJECT RELIABILITY LEVEL

A project reliability level of 90% for Links Road been adopted for the Development Application submission.

2.2.2.2 METHODOLOGY

The design methodology adopted during the development of the concept pavement design has been as follows:

1. Extract traffic data from the St Marys Development Site Regional Traffic Modelling Traffic and Transport Assessment to determine relevant ESA, growth rates and heavy vehicle percentages
2. Determination of appropriate traffic multipliers
3. Review geotechnical investigation data conducted by JPS&G in the Environmental Site Assessment to determine presumption subgrade design CBR

4 Determination of appropriate elastic moduli

5 Pavement design calculations to be undertaken using CIRCLY.

2.2.3 GEOTECHNICAL

The pavement design proposed for the concept design is based on the Environmental Site Assessment completed by JBS&G. Due to lack of subgrade testing available, the typical presumptive subgrade design CBR was ascertained using the soil classification of the subgrade from the borehole logs and correlating them to Table 5.4 of Austroads Guide to Pavement Technology Part 2.

2.2.4 PAVEMENT DESIGN

Pavement design drawings are provided with the Development Application documentation. These drawings contain hatched areas showing extents of pavement type and pavement profiles. Design ESA has been determined to be 6.15 x 10^6.

2.2.4.1 FULL DEPTH PAVEMENT DESIGN

Table 2.3 Pavement Design Summary

PAVEMENT LAYER	DETAILS	CDF
Wearing Course	50mm AC10 DG (C320) AC Surface	Non-Structural
Prime and Seal	Prime (AMC00) and 10mm nominal size bitumen seal (C170)	-
Base	250mm DGB20 102% Standard Compaction	-
Subbase	370mm DGS40 102% Standard Compaction	-
SMZ	300mm SMZ	-
Subgrade CBR	3% Presumptive Design CBR	9.30×10^{-1}
Total Depth	**970mm**	

NOTE: 10mm construction tolerance has been added to granular subbase layer.

The pavement design output from CIRCLY outlining all the design inputs can be found in Appendix F.

2.2.4.2 LINKS ROAD OVERLAY

A pavement overlay design has been proposed for Links Road, north of the bend. The structural overlay depth has not been designed as part of the Development Application submission, due testing not yet being conducted on the existing pavement. This is to be undertaken following the submission of the Development Application, and will be used to inform the pavement overlay design during Construction Certificate Documentation stage.

2.2.4.3 CHRISTIE STREET

No pavement overlay design has been proposed for the new signalised intersection. The only modifications to the existing pavement as per agreements between Penrith City Council and Lendlease Communities, will be linemarking modifications to change the lane configurations to suit the proposed intersection layout.

2.3 STORMWATER DRAINAGE

Refer to Stormwater Drawings (SM package).

2.3.1 EXISTING CONDITION

Links Road and Christie Street fall within the South Creek catchment. South Creek is a tributary of the Hawkesbury River. The existing scenario consists of separate drainage system for Christie Street and Links Road ultimately discharging into South Creek.

Christie Street drainage system includes pits and pipes and kerb and gutter to discharge the road and property runoff from the south of the project corridor into South Creek via Dunheved Golf Course. Drainage outlet has been identified approximately 135 metres west of the Christie Street - Lee Holm Road intersection and ultimately discharges into the Golf Course via a drainage easement.

The Links Road drainage system consists of a disused railway corridor that operates as an open drain. Flows from Dunheved Business Park discharge into this open drain. Culverts under existing Links Road to convey flows from the disused railway corridor into South Creek via Dunheved Golf Course.

Along Links Road, east of the ninety-degree bend, pits and pipes and box culvert that collect flows from Dunheved Business Park and discharge into the future Dunheved industrial precinct.

2.3.2 PROPOSED SCENARIO

2.3.2.1 STORMWATER DRAINAGE SYSTEM

The stormwater drainage network has been designed to comply with:

- Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments.

Key design criteria include the following:

- Design storm events:
  - Minor system – 20 year ARI storm event (industrial)
  - Major system – 1% AEP.
- Maximum allowable flow width – 2.5 metres during the design storm event.

The minor road longitudinal drainage system along Christie Street have been designed to maintain existing drainage regime and to utilise existing drainage network wherever possible. The drainage design requires adjustment to the existing drainage pits, and adding new pits and pipes to cater for changes to the catchments due to the proposed widening.

Along Christie Street, existing pits and pipes are retained where the proposed upgrade works results in no change to the catchment area. The minor drainage system discharges into the creek located within the Golf Course via the drainage easement located approximately 135m west of Christie Street-Lee Holm Road intersection. The drainage line within the easement is proposed to be upgraded to cater to the additional flows generated by the upgrade works.

The minor drainage system along Links Road east of the ninety-degree bend has been designed to discharge at the existing culvert outlet location located near eastern limit of works. The future Dunheved Precinct drainage system is proposed to collect flows from this portion of Links Road.

2.3.2.2 FLOOD ASSESSMENT

The flood extents of the existing scenario for the various storm events have been obtained from the Updated South Creek Flood Study prepared by WorleyParsons in 2015. Flood extents have been provided for 20 year ARI, 100 year ARI, 200

year ARI and the probable maximum flood within the Updated South Creek Flood Study. It can be deduced from the flood extents that Christie Street and Links Road section between Christie Street and the ninety-degree bend do not achieve the 20 year ARI flood immunity. Properties adjacent to Links Road, however, achieve the 200 year ARI flood immunity. The design strategy has been to meet, as a minimum, the existing flood immunity for the proposed upgrade works and adjacent properties.

As part of the proposed transverse drainage design, the local catchments have been assessed. The upstream catchments do not change as the road upgrade works are undertaken on the downstream side of the catchment. The pipes and channels are proposed to be replaced on a like for like basis to ensure that the properties on the upstream catchment are not adversely impacted during events up to and including the 200 year ARI flood events i.e. the existing flood extents delineated in the Updated South Creek Flood Study are maintained. The existing overland flow path has been maintained. An assessment of the safe "escape route" for excess flows has also been carried out if the minor system fails or the capacity exceeds.

The proposed works have been summarised below:

— Existing road overtopping levels at Christie Street and Links Road east of the ninety-degree bend have maintained to allow for escape route for excess flows without impacting adjacent properties upstream.

— Existing disused railway corridor that acts as an open drain has been retained as shown in Figure 2.1 to ensure that flows do not encroach into adjacent properties. Excess flows overtop the upgraded Links Road therefore maintaining the existing flow regime.

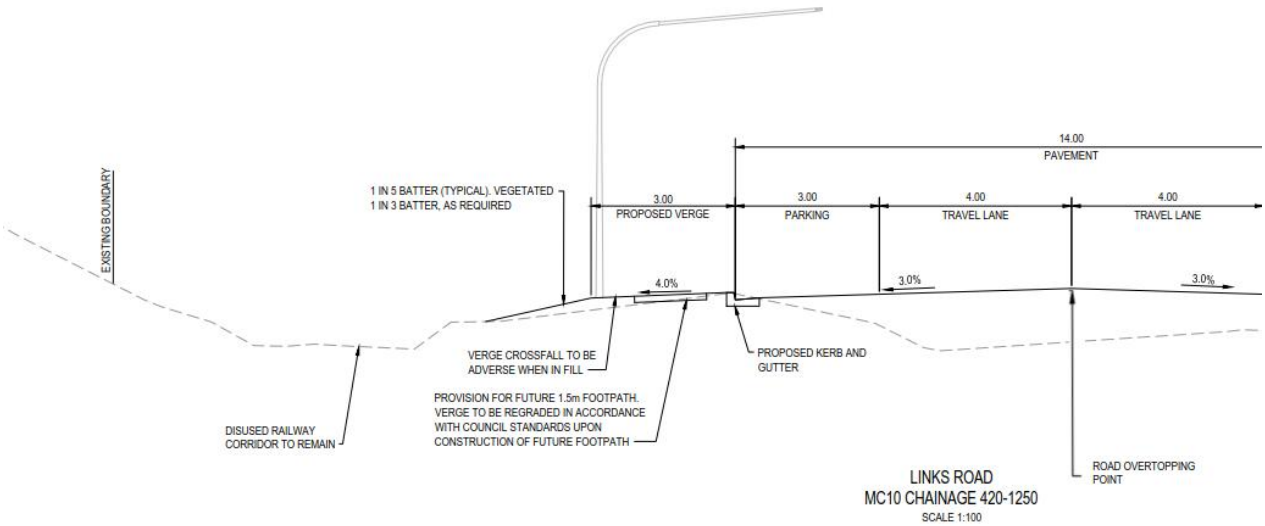


Figure 2.1 Links Road Typical Section

- New culverts have been proposed under Links Road between Christie Street and the ninety-degree bend. Existing culverts cannot be retained due to cover issues. Existing box culvert under Links Road, east of the ninety-degree end is proposed to be extended.
- A new box culvert has been provided approximately 170 metres north of the proposed Christie Street – Links Road intersection to replace an existing channel filled in by the proposed works.

An external catchment area, proposed transverse drainage and existing flow paths are shown below in Figure 2.2.

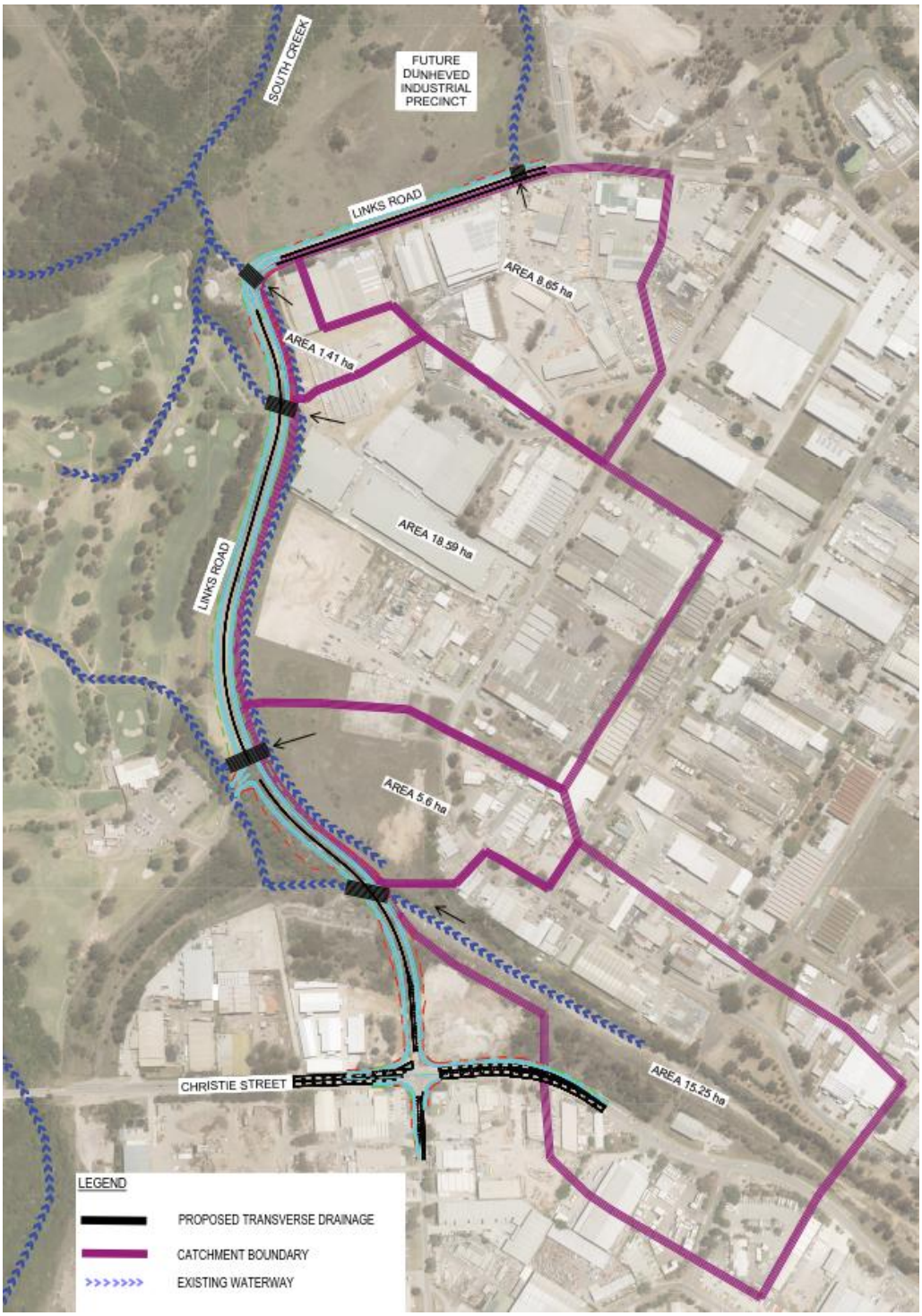


Figure 2.2 Catchment Plan

2.3.2.3 STORMWATER QUALITY

Due to the industrial nature of the site, Links Road carries high volume of heavy vehicle traffic. Proprietary water quality improvement devices have been provided at the longitudinal drainage outlets to ensure that South Creek and its tributaries are protected against spills occurring on the new pavement. It is assumed that Dunheved Business Centre have made adequate provisions for the treatment of runoff generated prior to discharge into the receiving waterways. Therefore, only the runoff generated by the new pavement has been considered. Runoff generated by the Links Road, east of the ninety-degree bend discharges into the future Dunheved industrial precinct and will therefore be treated by measures to be provided within the future precinct.

2.3.2.4 EROSION AND SEDIMENT CONTROL

Erosion and sediment control will be installed in accordance with the Council's requirement and Landcom's Managing Urban Stormwater, Soils and Construction, also known as the Blue Book. Sediment basins have not been proposed due to constrained boundary and proximity of the proposed works to existing buildings. A combination of standard erosion and sediment control measures such as sediment fences and sediment traps have been proposed while separating external flows from dirty water runoff generated by the proposed clearing works.

Refer to Erosion and Sediment Control plans (EV package).

2.4 UTILITIES

Refer to Utilities Drawings (UT package).

A utility services strategy report has been conducted as part of the Development Application. The report can be found in Appendix B.

2.5 GEOTECHNICAL

No additional geotechnical analysis has been conducted throughout the Concept Design stage. The JBS&G Environmental Site Assessment previously prepared for Links Road Extension and Upgrade in Dunheved has been used to inform the design.

Geotechnical and pavement investigation, testing and analysis will be conducted following the submission of the Development Application to inform the Construction Certificate Documentation.

2.6 TRAFFIC SIGNALS

Refer to Traffic Signal Plan (TS package).

A concept traffic control signals design has been undertaken by Transport and Urban Planning as part of the Development Application submission. An indicative traffic signal layout plan is included with this Development Application submission.

The draft concept design of the Christie Street Intersection has been issued to RMS and consultation is ongoing in regards to the intersection layout.

2.7 LANDSCAPING

No specific landscaping design package has been conducted as part of the Development Application submission. The current road geometry drawings show batters typically at 1 in 5, which are to be turfed. Batters proposed at 1 in 3 are to be vegetated in accordance with Penrith City Council Engineering Construction Specification for Civil Works.

Any trees shown within the earthworks extents are to be removed. Further analysis is required during Construction Certification Documentation stage to assess existing trees outside the limits of the earthworks with regards to clear zone requirements and Austroads Guide to Road Safety.

2.8 LIGHTING

Refer to Road Alignment Drawings (RD package) for indicative locations and types.

2.8.1 DESIGN STANDARDS

The following Standards and Guidelines have been used for the development of the indicative lighting design:

- Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments
- AS 1158 Lighting – Roads and Public Spaces
- AS 2053 Conduits and Fittings for Electrical Installations
- AS 3000 Electrical Installation
- AS 3008.1 Electrical installations – Cable Selection
- Roads and Maritime Services (RMS) QA Specification 151 – Street Lighting.

2.8.2 LIGHTING DESIGN

2.8.2.1 ROAD LIGHTING DESIGN

As part of the Development Application submission, it was assumed that all existing road light poles will be removed and new lighting infrastructure installed.

The following lighting design criteria has been followed:

- Luminance-based requirements for straight sections
- Illuminance-based requirements for the intersections, converging and diverging traffic streams
- All road lighting poles are to be located in accordance with AS 1158.1.2 and Roads and Maritime Services drawing "EM827" based on the design speeds specified in Table 2.1.
- The pole types specified in the design are to be approved Endeavour Energy standard poles with setbacks in accordance with Roads and Maritime Services design guide tables included on Roads and Maritime Services drawing number EM827.

Following a review of the geometric design and characteristics, it was determined that the Links Road design falls into lighting subcategory V3 in accordance with Table 2.2 of AS 1158.1.1. To satisfy these requirements, Sylvania Roadster luminaires with 250W and 400W HPS IP66 luminaries mounted on 11.5 m poles with 4.5 m outreach have been proposed, refer to Appendix H for technical data sheet. The lighting asset elements of the concept design are to have a design life in accordance with Table 10.1.

2.8.2.2 SHARED PATH LIGHTING

It has been determined that the shared path lighting category is P4 type, based on the following assumptions:

- Mixed vehicle and pedestrian traffic
- Moderate to high vehicle volume
- High pedestrian volume
- Moderate to low vehicle speed
- Stationary vehicles alongside the carriageway
- Through and local traffic
- Moderate traffic generation from abutting properties.

Additional footpath lighting was not required, as the street lights provide sufficient illuminance levels to comply with subcategory P4 in accordance with AS 1158.3.1 for the shared paths.

2.8.2.3 POWER SUPPLY TO LIGHTING

For concept design, the power supply design to the lighting system has not been conducted. However, we have assumed that all overhead low voltage distribution services will be underground. This is to be conducted during Construction Certificate Documentation stage.

3 PROPERTY ADJUSTMENTS

As per Penrith City Council requirements, property adjustment plans have been prepared as part of this Development Application submission to inform Penrith City Council during the property acquisition process.

Further consultation and analysis will be required during Construction Certificate Documentation stage to accommodate the outcomes of the consultation process with the land owners. The plans will be updated to reflect the outcomes of the consultation and to include fencing, driveway access, and utilities design.

Refer to Property Works Drawings (PW package).

4 STRUCTURES

No retaining structures or bridges have been proposed as part of the Development Application submission.

5 ACTIVE TRANSPORT

As a part of design development, a shared user path is included from the Christie Street Intersection, to the South Dunheved roundabout (design by others). This is additional to the typical section of Links Road contained within the in-kind St Marys Planning Agreement between Penrith City Council and Lendlease Communities.

The provision of a shared user path ensures future utility and potential of integration with the Bicycle NSW River Cities Program for the Penrith Subregional Area.

Pedestrian footpaths and cycle links will be integrated into the existing Active Transport network. Crossing points exist at the:

- Christie Street Intersection
- South Dunheved roundabout
- Sydney Water facility driveway
- Dunheved Golf Course Access.

The existing Christie Street Intersection with Lee Holm road will be upgraded to an RMS compliant, four-way signalised intersection with full pedestrian movement. Continuation of the shared user path will be possible onto the existing on-road cycling environment.

The shared-user path will transition into the South Dunheved roundabout shared-user path at the northern most extent of the Links Road.

All pedestrian and shared-user paths will be designed compliant with the Penrith City Council Development Control Plan, St Marys Voluntary Planning Agreement and Austroads Guide to Road Design 6A.

6 ENVIRONMENTAL CONSIDERATIONS

Statement of Environmental Effects (SEE) report has been prepared, and will accompany the concept design documentation with the Development Application submission. This Statement of Environmental Effects (SEE) contains all technical studies and environmental considerations required to comply to Penrith City Council environmental requirements. In summary, the SEE includes the following technical assessments:

- Biodiversity assessment report
- Traffic impact report
- Noise and vibration impact assessment report
- Aboriginal cultural heritage assessment report
- Environmental site assessment report.

7 CONSTRUCTABILITY AND MAINTENANCE

No formal construction staging package has been completed as part of Development Application submission. Constructability and maintenance have been considered with project stakeholders in the Safety in Design documentation contained in Appendix E. The project design team and Lendlease Communities held a Safety in Design Workshop during the development of the concept design documentation that considered constructability, maintenance and operation issues.

As discussed in the SEE documentation, the concept design assumes construction will start in 2019 and would take about 10 months to complete. This duration would be subject to approvals, land acquisitions, weather and coordinating with other construction activities in St Mary's. Construction would be largely carried out in accordance with standard construction working hours:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and public holidays: no work.

Consideration is to be given that to minimise disruption to daily traffic and disturbance to surrounding land owners and businesses, it may be necessary to carry out some work outside of these hours. Prior advice would be given to the community if any work is planned to be carried out outside standard construction working hours.

Further consultation, workshops and analysis will be required during Construction Certificate Documentation stage to formally document the construction staging and strategy.

8 SAFETY IN DESIGN

The aim of the Safety in Design (SiD) process is to ensure the safety of all people involved in the construction, operation, and maintenance phases of the Links Road Extension and Upgrade project. It also aims to satisfy stakeholders, contractors, operators, maintainers, and Lendlease Communities management procedures (Global Minimum Requirements) and WHS Laws and Regulations.

A Safety in Design workshop was held to inform the Concept Design documentation and submission of the Development Application. The workshop included the identification of risks and hazards during the construction, maintenance, and operation. Emphasis was placed on health and safety hazards that can be eliminated, minimised or engineered controlled in the design process.

The list of workshop attendees and outcomes of this workshop are presented in the Safety in Design Register contained in Appendix E.

9 PUBLIC TRANSPORT

There are currently limited public transport facilities in the area of proposed works. One existing bus stop is provided in each direction on Christie Street northbound and southbound respectively. Neither of these bus stops contain concrete hardstand facilities, seats, separate bus stop pole or additional lighting. The design in the Development Application submission proposes the upgrade of these facilities to provide a concrete hardstand area.

The bus stop locations have been relocated to be a minimum of 40m from the departure side of the Christie Street intersection, in accordance with Austroads requirements.

Public transport requirements to be further discussed with Penrith City Council and relevant NSW government agencies to inform the Construction Certificate Documentation.

10 DURABILITY

The Development Application submission has been developed to ensure all asset elements have sufficient durability and design life. Durability of each element is to be in accordance with Penrith City Council Engineering Construction Specification for Civil Works or the relevant jurisdictions' specifications. A summary of the design life for each element is listed below:

Table 10.1 Design Life Criteria

ELEMENT	DESIGN LIFE
Drainage pipes	100 years
New pavement construction	20 years
Pavement overlay	20 years
Sign faces	10 years
Roadside furniture	40 years
Lighting and electrical equipment	20 years

Condition assessments to be potentially undertaken on existing assets (i.e. drainage structures, utilities) that are proposed to remain. This is to be undertaken during Construction Certificate Documentation stage in consultation with Lendlease Communities and Penrith City Council in accordance with Penrith City Council Engineering Construction Specification for Civil Works.

11 ROAD SAFETY AUDIT (RSA)

A Concept Design Road Safety Audit has been completed as part of the Development Application submission. The report showing the findings and actions taken be found in Appendix D.

12 DESIGN ISSUES

An issues register has been developed an updated throughout the Concept Design stage. This register contains all details and resolutions of issues encountered throughout the design development. Full details of design issues to be addressed during Construction Certificate Documentation are contained within the register, and can be found in Appendix C.

A summary of the key issues for further resolution can be found below.

12.1 ROAD GEOMETRY

- Superelevation development length not sufficient through the bend
- 6.0% superelevation applied through bend greater than the maximum Austroads recommended value of 5.0%
- Design vehicles not confirmed for Sydney Water Pump Station or Golf Course access roads
- Coordination with other projects in the area (i.e. East West Connector Road Project) to ensure correct interface
- Confirmation and agreement from RMS on geometry and requirements (including lane widths) at the Christie Street signalised intersection, to finalise property acquisition requirements
- Existing crossfall on Links Road greater than maximum Penrith City Council allowance of 6.0%
- Penrith City Council's preferred approach to traffic calming measures for B-doubles prior to the bend
- Minimum horizontal curve lengths not achieved.

12.2 DRAINAGE

- Water quality targets unlikely to be achieved as per Penrith City Council Water Sensitive Urban Design Technical Guidelines following instruction from Council to only provide proprietary devices in Development Application submission
- Incomplete survey resulting in drainage design sizes based on assumed downstream pipe sizes
- Formal maintenance bays for GPTs have not been included in the Development Application submission.

12.3 UTILITIES

- Strategy to be determined regarding the construction of Stage 3 East West Connector roundabout utilities issues
- Confirmation of Sydney Water utilities within the proposed road alignment to be confirmed
- Location of Overhead Power Wires running adjacent to the Christie Street Intersection to be confirmed
- Confirmation of material type of communication lines in the northern section of Links Road as PVC or asbestos
- Potholing required on all critical assets (450Ø rising sewer main, 750Ø rising sewer main, 375Ø rising sewer main, 150Ø HP gas main) to confirm depth and inform the early development of Construction Certificate Documentation stage.

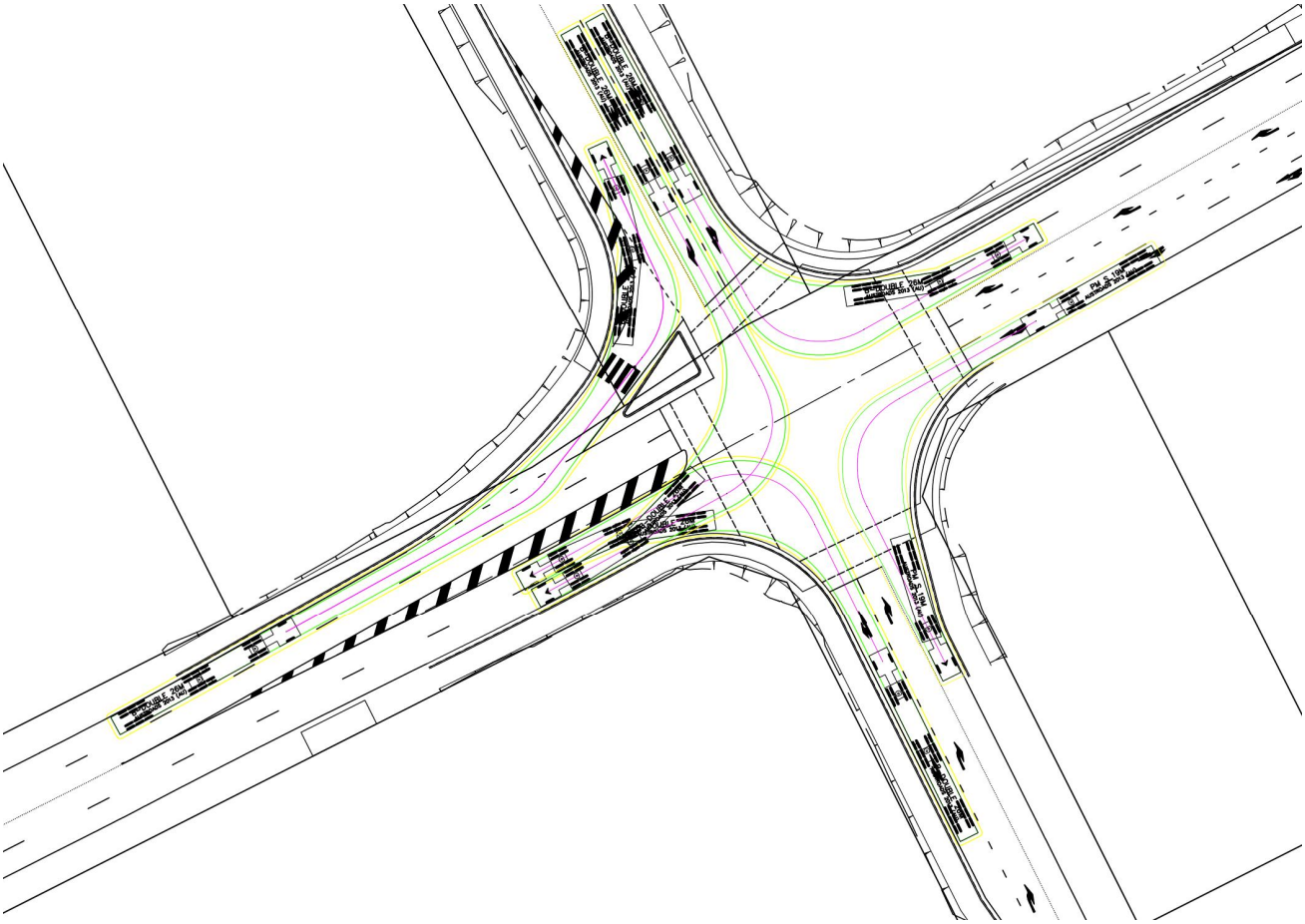
12.4 PAVEMENT

- No geotechnical testing conducted to inform the overlay design and extents.

APPENDIX A

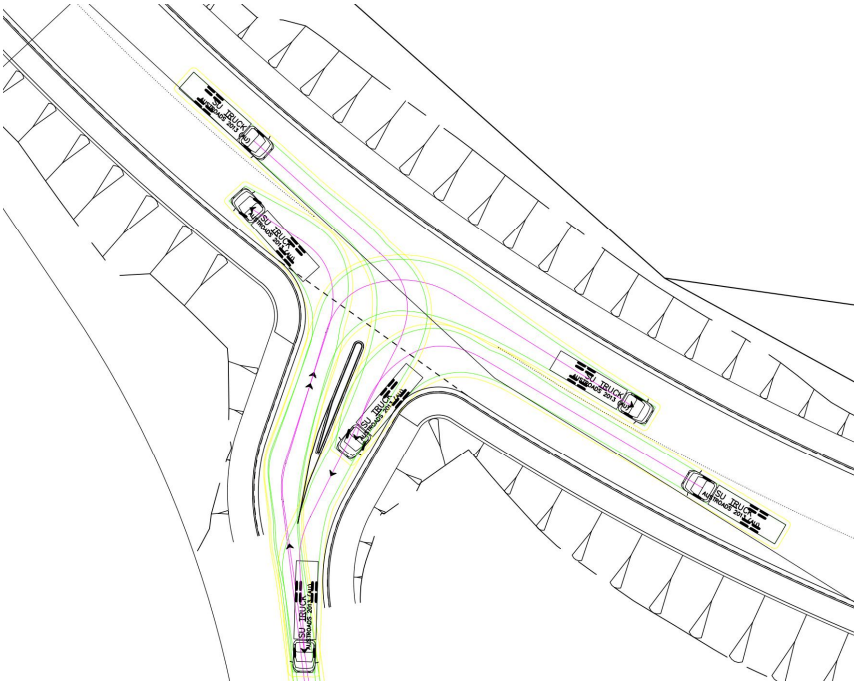
VEHICLE SWEPT PATHS

A1 CHRISTIE STREET INTERSECTION

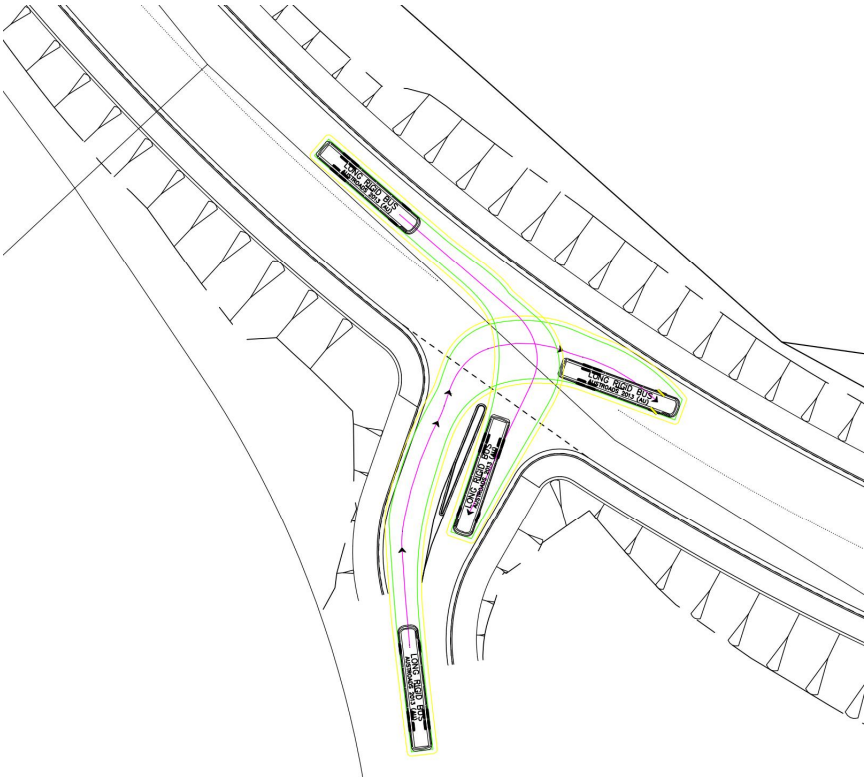


A2 GOLF COURSE ACCESS

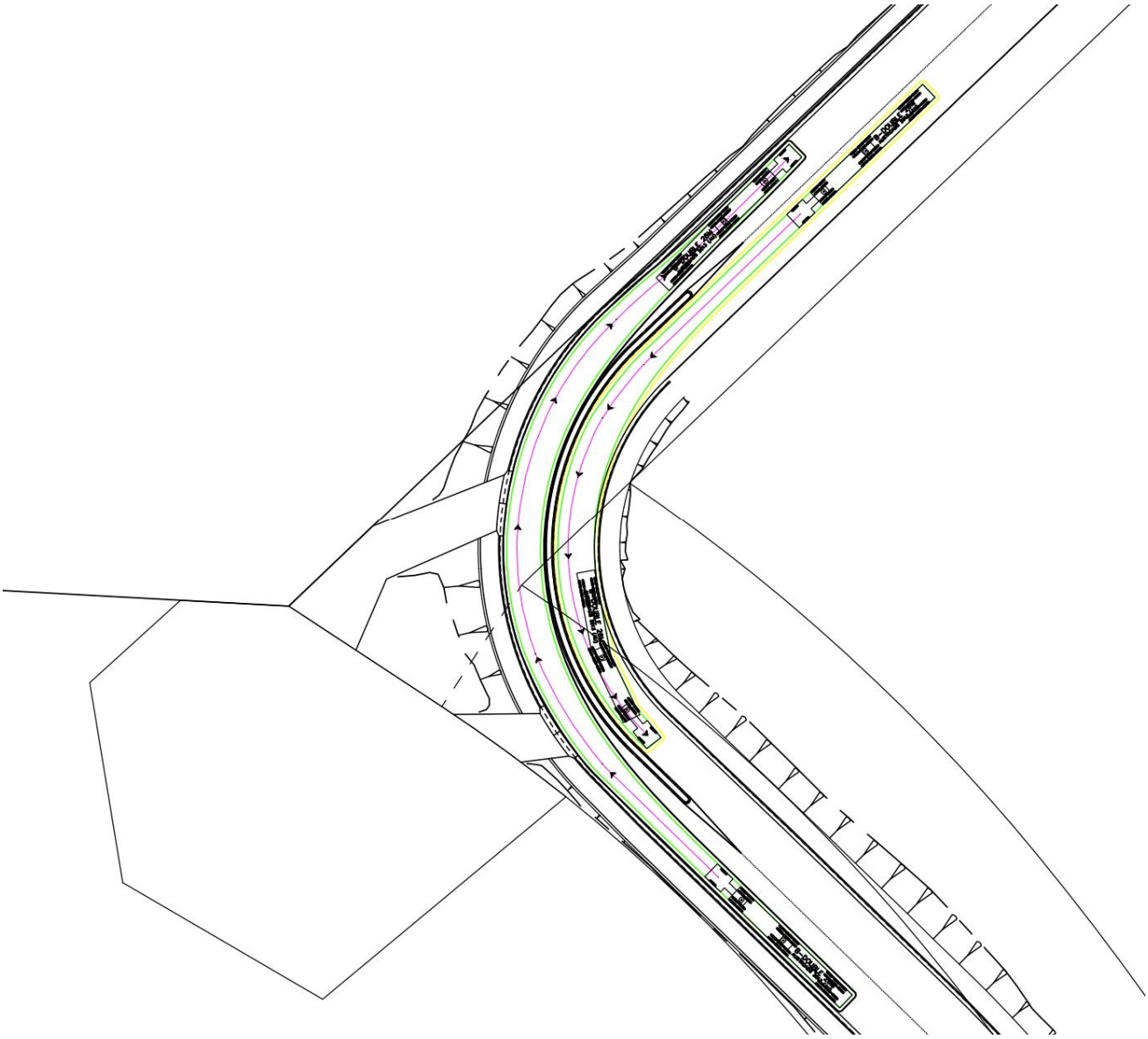
SU Truck



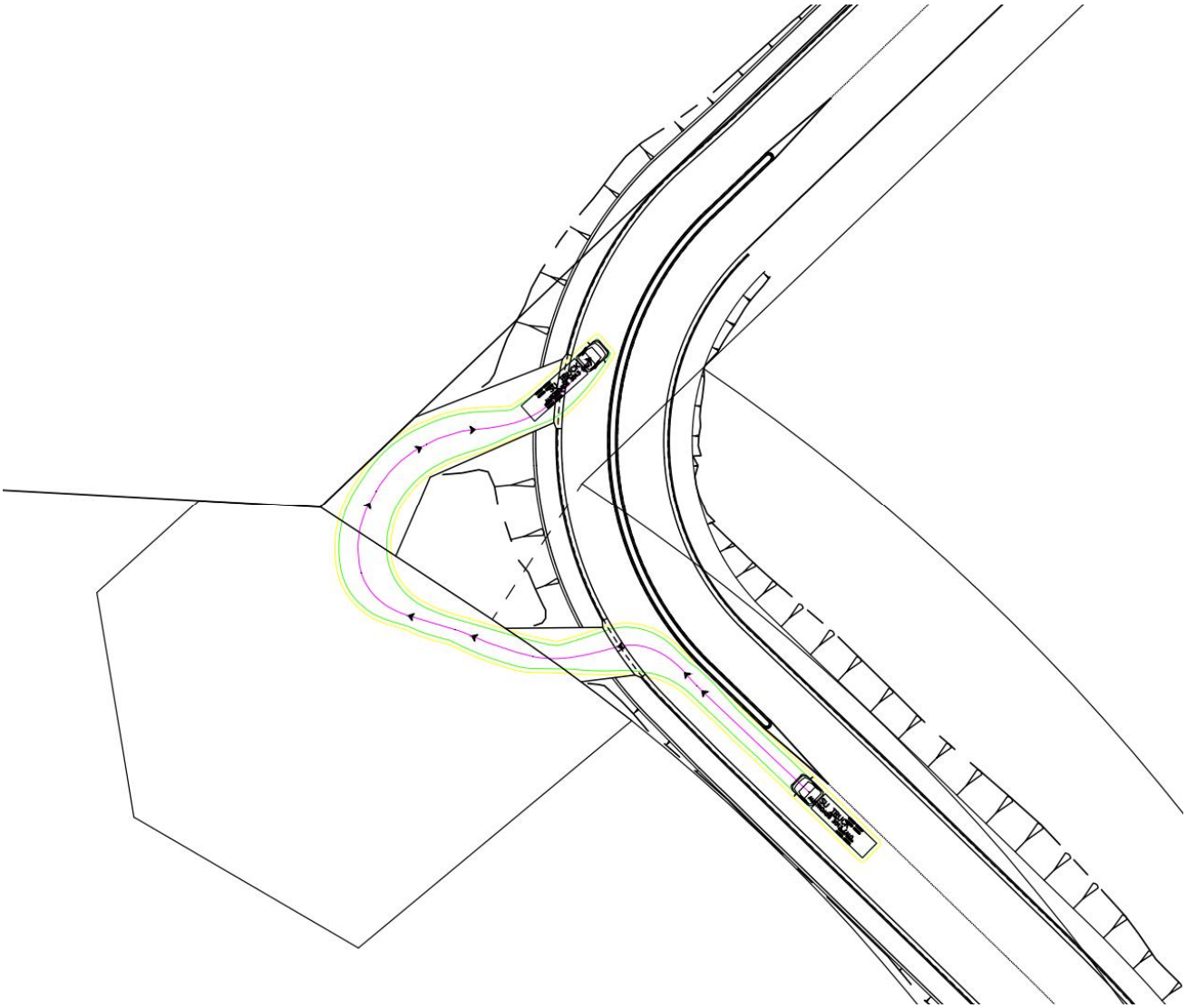
14.5m Long Rigid Bus



A3 SHARP BEND



A4 SYDNEY WATER PUMP STATION



APPENDIX B

UTILITY SERVICES STRATEGY AND REPORT

Design
for a better
future /

LEND LESAE COMMUNTIES

LINKS ROAD EXTENSION/UPGRADE, ST MARYS

PS111235-UTILITY SERVICES STRATEGY REPORT

wsp

Question today
Imagine tomorrow
Create for the future

LINKS ROAD EXTENSION/UPGRADE ST MARYS
PS111235 – UTILITY SERVICES STRATEGY REPORT

LENDLEASE COMMUNTIES

WSP
Level 27, Ernst & Young Centre
680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101 wsp.com

REV	DATE	DETAILS
2	14/11/2018	Utility Services Strategy Report

	NAME	DATE	SIGNATURE
Prepared by:	Suchit Jani	30/10/2018	
Reviewed by:	Henry Swan	14/11/2018	
Approved by:	Elias Khoury	15/11/2018	

TABLE OF CONTENTS

ABBREVIATIONS AND DEFINITIONS

DBYD	Dial Before You Dig
ITS	Intelligent Transport Systems
RMS	Road and Maritime Service
SID	Safety in Design
SP	Service provider
USS	Utility services strategy
LLC	Lendlease Communities
Project	The project tis inclusive of Links Rd Links Rd extension and the new intersection at Christie St and Lee Holm Rd
Client	Lendlease Communities
Internal stakeholder engagement	Interdisciplinary design reviews and consultation with those responsible for tasks other than review of utility impacts
Third Parties	A group or person besides other than WSP Australia or Lendlease Communities
Contractors	The party responsible for construction of the proposed infrastructure
Designers	The party responsible for design (concept and/or detail) of the proposed infrastructure
Utilities	Infrastructure providing public services of water, electricity, gas and telecommunications to citizens and organizations.
Service Provider or Utility Authority	An organization that owns and maintains the infrastructure for a public service. - Sydney Water - Jemena Gas - Telstra - Endeavor Energy

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Lendlease Communities are proposing to construct an upgrade and extension of Links Road to connect the existing Links Rd with Christie St St Mary's, NSW. Lendlease Communities is currently in the process to execute a revised Development Agreement with Penrith City Council. The agreement will include a new signalized intersection at Links road extension to Christie street/Lee holms road.

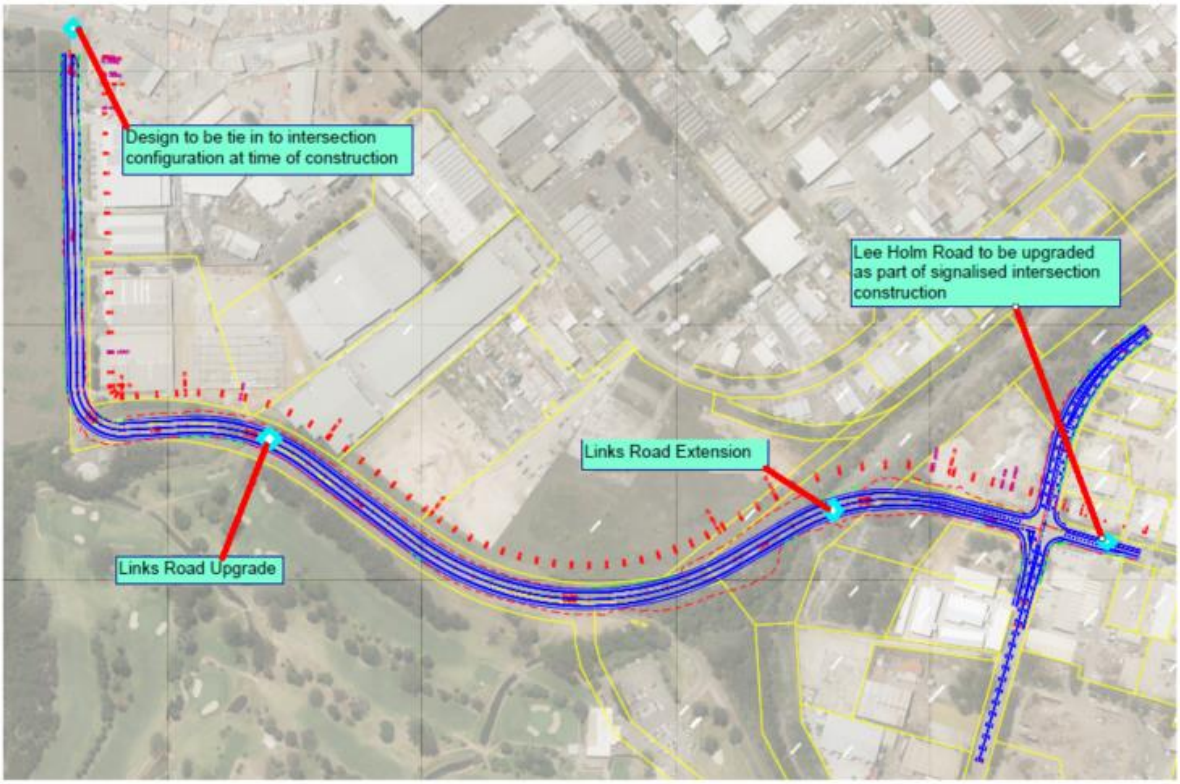
The aim of this road extension is to provide an additional access to the Jordan Springs East precinct within the St Marys Development Site.

The key components of the Proposal are:

- Upgrading the existing Links Road from Dunheved Precinct to Dunheved Golf Club;
- Extending Links Road to Christie St;
- Construction of a new four-way intersection at Christie Street and Lee Holm Road;
- Utility works and drainage upgrades; and,
- Provision of supporting roadside infrastructure including street lighting and signage.

The below image shows the location of proposed development.

Figure 1 – Location of Works



1.2 PURPOSE OF THIS REPORT

This report describes the main project objectives and design process adopted to produce the utility coordination concept design for the Link Rd upgrade, St Mary's.

In doing so, this report describes the key design considerations, methodology and regards technical standards into the various utility treatment options to meet the project objectives. It details the service providers contact details and information on the methodology undertaken for clash analysis. The report discusses design consideration, risk and recommendations for the detailed design phase of the project.

The report outlines assumptions considered when reviewing survey data, and will recommend treatment option of utilities impacts by the proposed Links Rd upgrade.

1.3 PROJECT SCOPE

Lend Lease communities have engaged WSP to develop a concept design and prepare an environmental assessment for the Project. This report details the existing utility adjustment scope and treatment strategies for the existing utilities.

By undertaking the above scope of works the following coordination tasks are also included:

- Undertake internal stakeholder engagement to manage utility requirements in line with the proposed concept road design;
- Reference to utility authority requirements and standards to identify assets requiring treatment;
- Output of combined utility drawings identifying assets requiring adjustments impacted by the Project; and,
- Identify risks and provide recommendations to LLC as the project moves into the detailed design phase.

2 METHODOLOGY AND ASSUMPTIONS

2.1 METHODOLOGY

Under the first stage of work, a comprehensive review was undertaken on all documentation provided by LLC to identify missing information and determine critical assets existing within the project area. To undertake the review and gap analysis, WSP obtained existing project data and any information made available by council and third parties . Following the review and gap analysis, all inconsistencies and missing information identified was documented in a spreadsheet and included as Appendix A of this report.

Using the survey data provided by LLC, a 3D utilities model was produced. The model has been used to undertake the below design steps:

- communicate the proposed impacts to internal and external stakeholders;
- undertake a full visual 3D analysis of the available existing utilities data and proposed road design to identify utility impacts;
- Develop a combined utility plan; and,
- Produce a Utility Strategy Report outlining the initial treatments proposed for utilities along the Links Rd development.

Based on information within the 3D model, a clash identification process was undertaken to confirm utilities affected by the road upgrade works. The clash detection was done by visually identifying conflicts between existing utilities and the concept design within the 3D model. During this clash detection, impacted utilities were reviewed for treatment options. The output of this stage of works is demonstrated in this report and in the combined utility plans (Appendix B and Appendix C)

Further actions undertaken to complete the above works are as follows:

- Completed a “Dial Before You Dig” (DBYD) search of existing underground utility services within the project boundary Review DBYD plan and models to gain understanding of existing utilities;
- Identified potential conflicts between the proposed road design and existing utility services;
- Attendance at a SID workshop to discuss safety concerns to be considered whilst developing the utility design; and,
- Refine utility models and for 100% Concept Design submission.

2.2 ASSUMPTIONS

2.2.1 GENERAL

- Conduits noted as being empty on DBYD plans will be required to be replaced during construction unless the utility authority indicates otherwise during detailed design;
- Conduits/pipes noted as being abandoned are not required to be replaced unless the utility authority indicates otherwise during detailed design;
- Potholing of some area of works is recommended during the design phase to verify the current records;
- Construction staging and temporary utility works has not been considered as part of the strategy report;
- No consultation has been made with the utility authorities. Recommendations for future proofing or upsizing of assets has not been determined at this stage;
- Where data was missing from survey or inconsistent with DBYD information, the data was interpreted into the 12D model from GIS information. Refer to the Gap Analysis spreadsheet in Appendix A for further details;
- Large portions of the sewer network along the full length of works are of Class D quality. These include several rising mains across the length of the project. Further investigation will be required at a later phase to confirm the locations of these utilities;
- It is assumed that any Telstra NSW conduit that are currently carrying other carriers will be maintained and all services will be incorporated in the relocation of Telstra NSW conduits;
- Overhead powerlines were not recorded on DBYD plans. Existing overhead powerlines have been digitised based on aerial photography and Google Street View only. This information will require further proving in future phases; and,
- All assets requiring relocation are to be designed in the detailed design phase of the project. Alignment of proposed utilities to be in accordance with the Street Opening Conference and utility authority guidelines.
- This report has been done without any consultation of the utility authorities. The utility treatments listed in this report is based on our design experience, utility authority requirements and general construction practices. Consultation with the utility authorities is to be done during the detailed design phase
- Utility impacts were reviewed against the concept road design freeze on the 9th November 2018

2.2.2 SURVEY AND DATA QUALTIY LEVELS

The data used to generate the 3D utility model used various inputs of varying levels of quality. The below table clarifies varies data quality levels for utility services survey in line with AS 5488-2013 Classification of Subsurface Utility Information (SUI). The quality level of data identifies the risk tolerance of each assets location. It is suggested during detailed design that potholing is undertaken where required to confirm the precise depth and location of utilities.

Table 1 – Survey Quality Levels

LEVEL	DESCRIPTION	INCLUDES
Level A	Potholing and surveying to give accurate horizontal and vertical position of the existing utility (includes measurement and survey of pit and maintenance structures)	• Utility owner identification • Utility type, status, material, size and configuration identification • Date of installation (if known) • Feature codes of surface features, including but not limited to pits, access chambers, poles, valves and hydrants • Location of points surveyed on surface and subsurface features measured in terms of absolute spatial positioning with a maximum horizontal tolerance of +/- 50mm
Level B	Geophysical locating and survey using cable location equipment or ground penetrating radar to generate an approximate horizontal and vertical position.	• Utility owner identification • Utility type identification • Date of installation (if known) • Location of surface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of +/- 300mm • Location of surface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of +/- 300mm and maximum vertical tolerance of +/- 500mm
Level C	Undertake field ground survey of existing asset features as a surface feature correlation of approximate location	• Utility owner identification • Utility type identification • Date of installation (if known) • Interpolation of the location and direction of the subsurface utility surface features as a point of reference • Feature codes of surface features, including but not limited to pits, access chambers, poles, valves and hydrants • Location of surface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of +/- 300mm
Level D	Use of ‘dial before you dig’ hotline and consult Utility Services Authorities GIS database location information.	• Existing records • Cursory site inspection • Anecdotal evidence

3 UTILITY IMPACTS

3.1 KEY INTERFACES

During the review process, all relevant discrete design elements have been considered to provide a well-coordinated, integrated, economic, safe and solution to impacted assets. **Error! Reference source not found.** Table 3 identifies the design interfaces that have influenced the proposed treatment options of the utilities.

Table 2 Design Interface Coordination

DISCIPLINE	INTERFACE	RESULTING DESIGN OUTCOME
Geotechnical	Earthworks batter slopes	Proposed utility alignment will need to consider the embankment slope stability in the next phase of design and where batters will be constructed
Pavements	Pavements and sub-surface drainage	Depth of utilities relative to pavement depths will be confirmed in the next phase of design. The current design assumes any existing utilities less than 1.0m below proposed pavement level clash and will require relocation or protection
Constructability	Construction Impacts	Constructability reviews have been undertaken during the concept design development. Impacts considered temporary reduced cover over assets and impact from plant loading.
Surrounding Projects	East West Connector (EWC3) Road Project	The design elements included within the EWC3 are outside of the WSP scope of works and have not been reviewed to assess associated utility impacts.

3.2 SUMMARY OF EXISTING UTILITIES

There are several public utility assets currently underground and overheard at Links Rd, Christie St and Lee Holms Rd. As part of the Links Rd extensions concept design, WSP has reviewed the assets along the extent of the proposed works.

The following utility authority owners have been identifying as having assets within the vicinity of the proposed road upgrade:

Table 3 – Service Providers

SERVICE PROVIDER	DESIGNATED CONTACT NUMBER
Endeavour Energy	02 9853 4161
Jemena Gas West	1300 880 906
Sydney Water	13 20 92
Telstra	1800 653 935
Optus	1800 505 777

An asset register has been included in Appendix B to identify those which are impacted by the Links Rd upgrade. The register identifies asset numbers, owner, size impact and suggested treatment option. The below treatment options are relevant to the concept design review:

- **Leave in Situ**

The utility is not directly impacted by a clash with the proposed design and can remain in place. Further supervision is required during planned works near asset and additional approvals may be required to construct over or adjacent to the asset (i.e. Sydney Water approval for Building Over and/or Adjacent to Pipe Assets).

- **Protection**

Conflict is identified between utility and road design in the form of reduced clearance. The utilities identified can remain in situ but require mechanical protection in form of concrete encasement or a bridging structure.

- **Relocation**

A direct conflict is identified between utility and road design. In this case the existing utility needs to be disused and a new asset reconstructed with the same functionality of existing asset.

Listed below are the critical utilities for each utility type that were assessed. Critical assets are those which are considered and integral part of the service provider network, or have features including age and condition that deem them a higher risk to the project. Refer to Appendix B for the full utility adjustment schedule which also allocated each utility with the below risk rating:

Table 4 – Utility Risk Ratings

Utility Risk	Asset Impact	Treatment
Red	Critical	Relocate or Protect or Design Review
Yellow	Affected	Relocate or Protect
Green	Low Risk	Protect or Leave in Situ

3.2.1 SYDNEY WATER ASSET

RISING SEWER MAINS – LINKS RD

There are three rising sewer mains that run adjacent to each other along the Links Rd from SPS (Sewer Pumping Station) 0366, to the sewer treatment plant at the intersection of Links Rd and Triggs St. The details of these mains are below:

- 375mm ductile iron main – Constructed in 2009 (Project Asset Tag – W04)
- 450mm ductile iron main – Constructed in 1982 (Project Asset Tag – W05)
- 750mm ductile iron main – Constructed in 1993 (Project Asset Tag – W06)

There are inconsistencies in depth of these assets along their length where they seem shallower than expected in some locations. The sewer mains are assumed to be at standard depth (1.2m) beneath the road. It is recommended potholing takes place in multiple locations along the length of the assets to confirm their depths.

It is proposed to leave these mains in situ and seek approval to construct of the assets from Sydney Water. The following inputs will be required to the included in the application to build over the sewer:

- Details of the proposed works including design plans and pavement depths;
- The construction methodology and sequence of construction above mains;
- Depth to mains during and post construction;
- The details of heavy construction equipment to be used in construction above the mains. The allowable loading on Sydney Water services during construction is outlined below;
  - Depth to asset <450mm. No Loading
  - Depth to asset >450 and <750mm. Allowable loading is 5 tonnes
  - Depth to asset <750 and <1200mm. Allowable loading is 10 tonnes
  - Depth to asset >1200mm. Allowable axle load is not to exceed 160kN
- Details of construction impacts on the asset;
  - Temporary loads
  - Reduced cover, etc.
- A Service Protection Report (Surveyed location of asset identified on plan with Level A depths reported)
- Existing condition of the asset. Depending on the depth of the asset and the construction loading proposed, Sydney Water may require a condition assessment be undertaken on the assets. The assessment would identify structural and durability conditions of the asset. This may include sampling and destructive testing of sewer assets.
- An appraisal of the impact of the proposed permanent and temporary works on the pipe asset
- Incident response plan in the event of damage to the assets

Consultation with Sydney Water is required early in the design process to understand any current operational restrictions associated with the assets.

SEWER PUMPING STATION (SPS0366)

The sewer pumping station is located at concept design CH360. The project works will impact on accessibility to the pumping station. Consultation will be required with Sydney Water to understand the following:

- Current access requirements and frequency of access;
- Current emergency access requirements and procedures; and,
- Confirm what machinery and vehicle size are required to access the pumping station site; and.

The above information is required to finalize the entry design into the pumping station and confirm temporary access arrangements during construction of the road upgrade.

3.2.2 ENDEAVOUR ENGERY

OVERHEAD 11KV DISTRIBUTION

Existing 11kV electrical distribution supply is currently overhead along Links Rd and Christie St. The over-head supply is behind the existing kerb on the Southern side of Links Rd and does not clash with the proposed road design until CH360. From CH360 throughout the remaining road concept alignment, it is proposed disuse the existing overhead electrical and install it underground beneath the shared user path.

The route of the proposed electrical has not been confirmed, but is proposed to be aligned with the proposed street lighting on the Western side of the Link Rd alignment. The detailed design of the Christie St intersection will need to be coordinated with the proposed water main, gas and telecommunications adjustments.

The transfer of property connections and temporary power supply to the sewer pumping station will need to be considered in detailed design and construction.

3.2.3 TELSTRA

OPTICAL FIBRE – LINKS RD AND CHRISTIE ST

Telstra have numerous optical fibre routes and adjoining pits that are clashing with the proposed concept alignment.

The service along Links Rd (Project Asset Tag – T01) provides communications to the Sydney Water pumping station and relocation of this asset will need to consider temporary communication service to this facility. The asset within Links Rd is also situated within an existing asbestos conduit. Standard safety practices for handling asbestos material will need to be implemented during construction

Another optical fibre cable is also present along Christie St, and runs through the future intersection of Christie St and Lee Holms Rd. It is proposed to relocated this asset due to a clash with an existing pit and proposed kerb alignment on Christ St.

Refer to the combined utility plans (Appendix C) for location of the above identified assets.

3.2.4 JEMENA GAS

150MM – 1050KPA SECONDARY GAS MAIN (SECONDARY GAS MAIN)

There is an existing 150mm high pressure (1050kPa) gas main that runs the length of Links Rd. The main crosses beneath the concept road alignment at Ch380 (outside the SWC pumping station) and Ch900 (near the golf course entry), and runs beneath the Western batter of the Link Rd concept between CH380 – CH900.

It is noted that the survey level of this gas main in some locations is inconsistent with the surface level, that is that in some location the gas main is quite shallow or above ground level. It has been assumed there are some inconsistencies in the survey model and it is recommended that this asset is re-surveyed and potholed to confirm its depth.

It is proposed to relocate this gas main at the locations where it crosses the proposed alignment for the following reasons:

- Risk of striking during construction;
- Risk of failure due to additional loading during construction;
- Gas main crosses beneath the road will be re-installed to me the design life of the road; and,
- Gas main will be located outside of the road alignment where possible to increase accessibility during maintenance.

Level A data from potholing this gas main will confirm its depth, which may then negate a required relocation and instead fall back on the option to leave in situ and protect during construction.

For the length of the main that is situated beneath the batter between CH380 and CH900, it is proposed to be left in situ. The main will not be subject to post construction trafficable loading. Protection measures for this gas main will be confirmed after potholing takes place, and may include limiting plant size and loading above the asset or placing temporary steel plates over the main where heavy plant will be traversing it.

Confirmation on the scope of this asset will be confirmed by Jemena, and there may be reason to re-lay the main on the outside of the batter upon consultation.

200MM – 1050KPA SECONDARY GAS MAIN (SECONDARY GAS MAIN)

An additional 200mm, 1050kPa gas main is also present at the intersection of Christie St and Lee Holm Rd. This gas main is currently laid within the existing road alignment, and has many fittings within the existing intersection. It is proposed to relocate this main or the following reasons:

- Main to be designed with fittings behind the proposed kerb line. As the intersection at Christie St is being developed to service additional traffic, the fittings are proposed to be re-located being kerb in a non-trafficable area to ease future access; and,
- Relocating the gas main prior to construction will eliminate the risk of damage to the gas main by plant striking the surface fittings.

It is noted that Jemena may have conditions of the relocation of the high-pressure gas main at the locations nominated. As the service provides provision to a wider network, there may be seasonal demand that restrict the time of year when the main can't be shut down for adjustment.

The above stated impacts to the high-pressure gas main network are to be discussed with Jemena to confirm system requirements and final scope.

3.3 UTILITY STANDARDS AND GUIDLINES

The utility strategy report has been undertaken in accordance with varies utility authorities' standards and guidelines, RMS Standards and Technical Guidelines, and relevant Australian Standards.

The following engineering standards and utility authorities have been incorporated into the assessment and must be considered during detailed design and construction of the project:

- Water Supply Code of Australia WSA 03-2011-3.1. Sydney Water Edition 2014
- Sewerage Code of Australia WSA 02-2002-2.2. Sydney Water Edition Version 3
- Guides to Code and Practices for Street Opening. Seventh Edition 2009
- Telstra Lead-in Trenching Requirements. Issue 3, 22 June 2009
- Sydney Water Technical Guidelines for Building over and Adjacent to Pipe Assets. October 2015
- Jemena Network Operator Rules. November 2011
- AS 5488.1:2018 Classification of Subsurface Utility Information (SUI)
- Endeavour Energy Underground Distribution Construction Standards Manual
- RMS Technical Specifications

3.4 SAFETY IN DESIGN

The Safety in Design (SiD) process must satisfy WHS Laws and Regulations and ensure the safety of people during construction, operation and maintenance phases is maximized by developing all elements of the design with safety in mind.

To satisfy these requirements design development must incorporate SiD principles to identify health and safety hazards and as far as is reasonably practicable, eliminate them. Where it is not reasonable or practicable to eliminate a hazard, the objective is to minimize the risk it presents to health and safety by the application of other controls selected in order of the hierarchy of control.

A safety in design workshop was conducted during the concept design stage on the 13th November 2018, and reference to this workshop can be found in the main project design report.

4 REVIEW CONSIDERATIONS AND RECOMMENDATIONS

4.1 FURTHER DESIGN DEVELOPMENT ACTIONS

The following summarize the steps/information required in the Detailed Design Phase:

1. Locating will be required to confirm utilities which are currently Level D quality, as well as to identify any additional utilities that may have been installed since the current utility survey was undertaken. Additionally, an updated DBYD request will be submitted;
2. Potholing is required of critical assets that are proposed to stay in place. This is to ensure adequate cover during construction and identify any additional relocations. Proposed pot holing scope will be identified prior to detailed design;
3. Assess in greater detail the coordination of the East West Connector (EWC3) Rd project and it's impact on the Links Rd Upgrade project;
4. Review impacted utilities and confirm treatment scope;
5. Confirm with Service Providers (SP):
    a. that abandoned assets can be removed;
    b. the suitability of proposed treatment options; and,
    c. future proofing provisions.
6. Identify any possible early works, assessing the value and practicality of such works;
7. Co-ordinating with the contractor and utility authorities to determine if any temporary utility connections may be required, and if so, the most effective way to undertake these works;
8. A Water Services Coordinator will be required to be engaged to liaise with Sydney Water and facility the approval to build over or relocate Sydney Water assets; and,
9. An accredited ASP3 consultant will be required to be engaged to liaise with Endeavor Energy and facilitate the certification of relocated electrical assets.

APPENDIX A
GAP ANALYSIS REGISTER

Document / Date Review and Gap Analysis

REVISION 1 DATE: 11/19/2018

Links road Upgrade - Design Review and Gap Analysis

REVIEWER	DESIGN DISCIPLINE	DOCUMENT REVIEWED	DOCUMENT REFERENCE	ISSUE IDENTIFIED	IDENTIFY WHO IS RESPONSIBLE FOR RESOLVING	RISK / OPPORTUNITY / NONE	CURRENT PROJECT SCOPE IMPACT	ACTION COMMENT	CLOSURE COMMENT	STATUS (Open/Close/Pending)
Enter your Full Name as a PBA Reviewer	Nominate your Design Discipline for which your comment is relevant	Enter the review document which is the MC Works Brief Rev 0.4	Describe in detail the Document Reference by TITLE, CLAUSE AND PAGE NUMBER OR SPECIFIC DRAWING NUMBER	Describe in detail the issue or comment or gap or discrepancy which is of concern	Select the route for best resolving the issue or comment either by RFI to one of the consortium, client or through internal PBA discussion from the pull down menu below	Nominate if there is a PROJECT RISK or OPPORTUNITY associated with the issue or comment	Does the Issue or Comment have an impact on the Design Scope during Tender or Detailed Design MAJOR / MINOR / NONE	Descrive outstanding action to address gap		
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	Three rising main pipes in northen section of Links rd were reflected as water main pipe in data provided by surveyor, DBYD confirms that this detected pipes are rising mains, - 450mm pipe - 750mm Pipe - 375mm Pipe Above pipes are digitised in water sewer combined model.	Internal WSP	RISK	MINOR	Check against Sydney Water GIS and DBYD	Mains confirmed as rising sewer mains	CLOSED
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	900mm Sewer was not detected during the survey , data from DBYD confrims that this sewer pipe gets close concept road design. This pipe is digitised in water sewer combined model.	Internal WSP	RISK	MINOR	Confirm the exact location of the sewer pipe	Level D locatoin from Sydney Water GIS was used to input the 900 sewer main into the utilities model. Main shown outside of project boundary in park adjacent to Links Rd	CLOSED
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	225mm Recycled water main was not detected during the survey , data from DBYD confirms that this pipe is within the road design. This pipe is digitised in water sewer combined model.	Client	RISK	MINOR	Confirm the exact location of the recylcled pipe for survey	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	Overhead line towards southern in the intersection of the project in Lee holm rd and Christie st were not detected during survey, this Overhead lines are reflected as degistised electrical lines in electrical combined model, quality data D	Client	RISK	MINOR	Confirm the exact location of the overhead lines and poles	Location of OH wires to be confirmed via survey prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	Material for conduits around the communication (Telstra) lines in northen section of links rd has been idetified as PVC but the DBYD reflects material as Asbestos. This has been corrected in attributes for each affected strings.	Other	RISK	MINOR	Update the material of the conduits to match DBYD	Material to be confirmed with service provide during detailed design	CLOSED
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	225mm sewer pipe and Manhole at the Links rd extension (between the exisitng Link Rd end, and the Christie St interesection) sections were not detected during survey, data from GIS and DBYD confirmed that this sewer pipe and manhole are within concept road deisgn, Assets are digitised in water sewer Combined model.	Client	RISK	MINOR	Confirm the location of Sewer pipe and Manhole	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	150mm Water main was not detected during Survey at the Links rd and extension sections, data from GIS confirmed this water pipe clashes with concept design, Pipe is digitised in water sewer combined model	Client	RISK	MINOR	Confirm the exact location of Water pipe.	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	225mm sewer pipe runs within Proposed intersection from property 61-63 was not detected during Survey , data from GIS confirmed this sewer pipe clashes with concept design, Pipe is digitised in sewer combined model	Client	RISK	MINOR	Confirm the location of Sewer pipe.	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	150mm sewer pipe towards property 69-73 was not detected during Survey at the Christie st, data from GIS confirmed this sewer pipe clashes with concept design, Pipe is digitised in water sewer combined model	Client	RISK	MINOR	Confirm the location of Sewer pipe.	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	225mm sewer pipe towards propery 61-63 was not detected during Survey at the Christie st, data from GIS confirmed this sewer pipe clashes with concept design, Pipe is digitised in water sewer combined model	Client	RISK	MINOR	Confirm the location of Sewer pipe.	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	225mm sewer pipe towards property 72-74 was not detected during Survey at the Lee Holm rdt, data from GIS confirmed this sewer pipe clashes with concept design, Pipe is digitised in water sewer combined model	Client	RISK	MINOR	Confirm the location of Sewer pipe.	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed design	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	225mm sewer pipe towards property 137 was not detected during Survey at the Christie st, data from GIS confirmed this sewer pipe clashes with concept design, Pipe is digitised in water sewer combined model	Client	RISK	MINOR	Confirm the location of Sewer pipe.	Main was digitised in the model using Level D Sydney Water GIS data. Survey to be requested prior to detailed	OPEN
Suchit Jani	Utilities	Survey	ACAD-PR138258-DET-002a	Multiple Assets along the route had survey depths which are shallower than expected. At some locations the assets are seen to be at or above ground existing level. Some critical assets inlcude: - 450mm rising sewer main Links Road - 750mm rising sewer main Links Road - 375mm rising sewer main Links Road - 1050kPA gas main. The entire length throughout the project	Client	RISK	MAJOR	Potholing required on all critical assets to confirm depth. Level of assets may impact the treatment options and construction mehtodology around the assets	To be completed prior to detailed design	OPEN

APPENDIX B
ASSET REGISTER

REVISION	1	DATE:	11/19/2018												
	DESIGN FREEZE DATE		9/11/2018												
ID	Data Class (AS 5488)	Utility	Owner	HLFC	LLFC	Size	Material	Capacity	Chainage section start	Chainage section end	Existing Location Description	Design Element Clash	Risk	Action	Treatment Advice
Communication															
T01	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Polyvinylchloride	NA	300	380	crosses Links Rd at design CH360 to provide communication connection to the SWC pump station	concept road design	Red	Relocate	Clash with concept design and 30 Pair cable within P100 conduit. Proposed road allignment and kerb also clashes with 5 and 6 pit at the bend. These will also require relocation along with comms line back to the Pit at CH300 at least
T02	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	35mm	Polyvinylchloride	NA	380	910	Runs within the Links Rd design between design CH380 to CH910 to provide communication to office along Links Rd	concept road design	Red	Relocate	Clash with concept design and 30 Pair cbale within P35 conduit. Proposed road allignment and kerb also clashes with a single type 3 and five type C pits along the proposed route. This will required relocation
T03	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Asbestos Cement	NA	235	310	Run from proposed island at new signalised intersetion of Christie st and Lee Holm Rd from design CH235 to CH310	concept road design	Red	Relocate	Clash with concept design and 10 Pair cable within A100 conduit (asbestos). Proposed road allignment and kerb also clashes with two type 8 pits. This will required relocation
T04	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Asbestos Cement	NA	160	240	crosses concept design at the proposed intersection at Christrie st and Lee Holm Rd, from design CH160 to CH240	concept road design	Red	Relocate	Clash with concept road design and proposed island with 2x30 pair cable, 1x10 pair cable within A100 conduit (asbestos) and two type 8 pits as mentioned under T03. Proposed design also clashes with a single type 5 pit outisde 61-63 Christie St. This assets requires relocation.
T05	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Polyvinylchloride	NA	190	270	crosses concept design at the proposed intersection at Christrie St and Lee Holm Rd, from design CH190 to CH270	concept road design	Red	Relocate	Concept road design and proposed island clashes with 2x30 pair cable, 2x10 pair cable within A100 conduit. This assets requires relocation due to clash with pit type 9 and proposed kerb oustide of 53-59 Christie St.
T06	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Asbestos Cement	NA	0	30	crosses concept design at the proposed intersection at Christrie St and Lee Holm Rd. Runs along from section of Links Rd extension to Lee Holm Rd between design CH00 to CH30	concept road design	Red	Relocate	Concept road design and proposed island clashes with 2x30 pair cable, 2x10 pair cable within A100 conduit. This assets requires relocation in conjuction with pit relocation mentioned under asset T03
T07	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Asbestos Cement	NA	30	30	crosses proposed road design at Lee Holm Rd , at the design CH30	concept road design	Red	Relocate	Clash with concept road design and 1x100 pair cable, 1x10 pair cable within P100 conduit as it crosses Lee Hold Rd. This assets requires relocation.
Electrical															
E01	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	0	340	Overhead line runs paralled to proposed Links Rd between CH0 to CH340	concept road design	Yellow	Leave in-situ	Overhead electrical line runs parallel to the proposed road design. Proposed road design on Links Rd is tieing into the existing kerb. This assets is proposed to be left in-situ.

ID	Data Class (AS 5488)	Utility	Owner	HLFC	LLFC	Size	Material	Capacity	Chainage section start	Chainage section end	Existing Location Description	Design Element Clash	Risk	Action	Treatment Advice
E02	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	340	960	crosses Links Rd near the band of the road at pump station. Design CH340 to CH960	concept road design	Yellow	Relocate	Clash with concept design. Two existing electrical disctribution poles are located within the concept design footway at the bend near the SWC pump station. An additional seven poles are also clashing with the concept design route after the pump station as Links Rd goes toward Christie St. There is also an overhead transformer located at CH340 . The over head lines are proposed to be reinstated underground along the concept allignment.
E03	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	1000	1380	Electrical pole located within the designed footway of proposed Links Rd extension towards the souther side between design CH1000 to CH1380	concept road design	Yellow	Relocate	Earthworks is clashing with three existing pole locations. The asset requires relocation and is an extension of E02. The over head lines are proposed to be reinstated underground along the concept allignment.
E04	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	140	230	Runs in designed footway and crosses kerb of concept design between design CH140 to CH230	concept road design	Yellow	Relocate	Clash with concept design, Existing Electrical disctribution 4x poles are located within the concept design footway at CH140 and at CH230 . This asset require relocation.
E05	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	230	240	In the proposed intersection of Lee Holm Rd and Christies st at design Ch230 to Ch240	concept road design	Yellow	Relocate	Clash with concept design,1 X Electrical pole between designated design location. Asser required relocation.
E06	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	240	340	Runs in designed footway and crosses kerb of concept design between design CH240 to CH340	concept road design	Yellow	Relocate	Clash with concept design allignment and three existing 11kV distribution poles located within the concept design roadway at CH240 and in the proposed footway from CH260 to CH340. These assets require relocation and are proposed to be installed undeground. Note there is a property connection to number 53-59 Christie St that will also require relocation
E07	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	20	50	Runs in designed road between design CH20 to CH50	concept road design	Yellow	Relocate	Two existing poles are located behind the kerb allignhment which I clashing with the proposed concept designCH20 and at CH50 on Lee Holms Rd. These assets require relocation and electrical supply proposed to be re-installed underground
Gas															
G01	B	Gas	Jemena Gas West	High Pressure	Pipe or Conduit	150mm	Steel	1050kpa	360	380	Crosses Links Rd at the corner near pump station at design CH360 to CH380	concept road design	Red	Relocate	Clash with concept design, High pressure 150mm gas pipeline crosses concept design at designated location. Action for this asset is required to be relocated.
G02	B	Gas	Jemena Gas West	High Pressure	Pipe or Conduit	150mm	Steel	1050kpa	900	960	Crosses Links Rd and runs within design road between design CH900 to CH960 near the golf course entrance	concept road design	Red	Relocate	Existing bends are located beneath the concept road allignment. High pressure 150mm gas pipeline crosses concept design at designated location. Action for this asset is required to be relocated.
G03	B	Gas	Jemena Gas West	High Pressure	Pipe or Conduit	200mm	Steel	1050kpa	160	260	Within Christie St from design CH160 to CH260, and then turn South on Lee Hold Rd and continue to CH 60	concept road design	Red	Relocate	Clash with concept design. High pressure 200mm gas pipeline crosses concept design at designated location and has numerous fitttings located within the furture intersection. Action for this asset is required to be relocated with fittings installed behind the kerb allignment
Water															
W01	D	Potable Water	Sydney Water	Potable Water	Pipe or Conduit	150mm	Ductile Iron Cement (mortar) Lined	NA	0	380	Within Links Rd from Start of the Proposed Road to Pump station within Links Rd between CH0 to CH380	concept road design	Yellow	Relocate	Water main 150mm is within the linked road concept design allignement. Water main was previoulsy in the berm on the Northern side of the road, and would now be beneath the new road allignemnt. Proposal it to relocate the main outside of the road alignment.
W02	D	Recycled Water	Sydney Water	Recycled Water	Pipe or Conduit	225mm	Polypropylene	NA	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	concept road design	Yellow	Relocate	Recylced water main 225mm is within the linked road concept design allignement. Recylced water main was previoulsy in the berm on the Northern side of the road, and would now be beneath the new road allignemnt. Proposal it to relocate the main outside of the road alignment.

ID	Data Class (AS 5488)	Utility	Owner	HLFC	LLFC	Size	Material	Capacity	Chainage section start	Chainage section end	Existing Location Description	Design Element Clash	Risk	Action	Treatment Advice
W03	D	Recycled Water	Sydney Water	Recycled Water	Pipe or Conduit	600mm	Ductile Iron Cement (mortar) Lined	NA	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	concept road design	Red	Leave in-situ	The 600mm recycled water main is within the Links Rd concept design allignment. Action for this asset is leave in situ and protect during construction. The asset it currently within the road way and it proposed to remain beneath the future road. Potholing data required to confirm this assets depth. SWC approval required to build over this main (BOA assessment)
W04	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	375mm	Ductile Iron Cement (mortar) Lined	NA	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	concept road design	Yellow	Leave in-situ	The 375 sewer rising main is within the Links Rd concept design allignment. Action for this asset is leave in situ and protect during construction. The asset it currently within the road way and it proposed to remain beneath the future road. Potholing data required to confirm this assets depth. SWC approval required to build over this main (BOA assessment)
W05	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	450mm	Ductile Iron Cement (mortar) Lined	NA	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	concept road design	Red	Leave in-situ	The 450 sewer rising main is within the Links Rd concept design allignment. Action for this asset is leave in situ and protect during construction. The asset it currently within the road way and it proposed to remain beneath the future road. Potholing data required to confirm this assets depth. SWC approval required to build over this main (BOA assessment)
W06	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	750mm	Ductile Iron Cement (mortar) Lined	NA	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	concept road design	Red	Leave in-situ	The 750 sewer rising main is within the Links Rd concept design allignment. Action for this asset is leave in situ and protect during construction. The asset it currently within the road way and it proposed to remain beneath the future road. Potholing data required to confirm this assets depth. SWC approval required to build over this main (BOA assessment)
W07	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	900mm	Concrete	NA	0	900	Runs parellel to Links Rd concept design,between CH0 to CH900	concept road design	Yellow	Leave in-situ	Sewer main 900mm pipe is runs parallel to the Links Rd concept design. Action for this asset is leave in situ
W08	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	375mm	Vitrified Clay	NA	920	940	Crosses proposed concept road design in extension section, between design CH920 to CH940	concept road design	Yellow	Relocate	375mm sewer main pipe crosses the Links Rd concept design. Action for this asset is leave in situ, with Sydney Water approval to build over (i.e. BOA assessment)
W09	B	Potable Water	Sydney Water	Potable Water	Pipe or Conduit	375/150mm	Ductile Iron Cement (mortar) Lined	NA	1370	20	Within proposed intesection, between CH1370 to CH20. Water main tapers down in size on the Northern side of Christie St	concept road design	Yellow	Relocate	Configuration of trunk main and adjoining connections are currently behind kerb. Proposed concept alignment will extened surface fittings into the new road cooridor and therefore must be relocated
W10	B	Potable Water	Sydney Water	Potable Water	Pipe or Conduit	150mm	Ductile Iron Cement (mortar) Lined	NA	160	230	In the souther side of the Christie st between CH160 to CH230	concept road design	Yellow	Leave in-situ	Existing water main is located behind the kerb allignment and will remain. Proposed to be left in situ
W11	B	Potable Water	Sydney Water	Potable Water	Pipe or Conduit	150mm	Ductile Iron Cement (mortar) Lined	NA	230	360	In the souther side of the Christie st and run within the proposed intersection between CH160 to CH360	concept road design	Yellow	Relocate	Existing water main is located behind the kerb allignment and will remain. Proposed to be left in situ along Christie St, but relocated within the intersection along with W09
W12	B	Potable Water	Sydney Water	Potable Water	Pipe or Conduit	100mm	Cast Iron Cement Lined	NA	0	60	Southern Side of intersection Run within proposed footway between design CH0 to CH60	concept road design	Yellow	Relocate	Existing water main is located behind the kerb allignment which is pushing back. Main will need to be relocated behind the ker and fittings located behind the future kerb
W13	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	225	Vitrified Clay	NA	160	270	Run within proposed intersection between design CH160 to CH270	concept road design	Yellow	Relocate	Sewer maiin pro+E36:V36vide point of connection for property 53-59 Christie St. Clash with concept design would place this in the middle of the new intersection. Relocate to provide frontage to property
W14	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	225	Reinforced Concrete	NA	1050	1050	Crosses proposed extension of Links Rd between design CH1050 to CH1050	concept road design	Yellow	Relocate	Sewer is alligned beneath proposed road and cutting. Replace sewer with new man holes to be designed to proposed surface levels
W15	D	Waste Water	Sydney Water	Potable Water	Pipe or Conduit	150	Cast Iron Cement Lined	NA	1310	1330	Croses proposed extension of Links Rd between design CH1310 to CH1330	concept road design	Yellow	Relocate	150mm water main crosses concept road allignment. Proposal it to relocate asset and install as maintenance free (concrete encased)

ID	Data Class (AS 5488)	Utility	Owner	HLFC	LLFC	Size	Material	Capacity	Chainage section start	Chainage section end	Existing Location Description	Design Element Clash	Risk	Action	Treatment Advice
W16	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	150	Vitrified Clay	NA	160	160	Crosses Christie St at design at CH160	concept road design	Yellow	Leave in-situ	Sewer main crosses perpendicular beneath the road. Proposed to be left in situ
W17	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	225	Reinforced Concrete	NA	180	180	Crosses Christie St at design at CH180	concept road design	Yellow	Leave in-situ	Sewer main crosses perpendicular beneath the road. Proposed to be left in situ
W18	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	225	Vitrified Clay	NA	80	80	Crosses Lee Holm Rd at design at CH80	concept road design	Yellow	Leave in-situ	Sewer main crosses perpendicular beneath the road. Proposed to be left in situ
W19	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	225	Vitrified Clay	NA	420	440	Crosses Christie St at design CH420 to CH440	concept road design	Yellow	Leave in-situ	Sewer main crosses perpendicular beneath the road. Proposed to be left in situ

APPENDIX C
COMBINED UTILITY DRAWINGS

Refer to UT package design drawings.

APPENDIX C

DESIGN ISSUES REGISTER

Links Road Extension - Issues Register	
Proj No.	PS111235
Client	Lendlease Communities
Date	21/11/2018

Item	Subject and Description	Location	Date	Action	Comments	Status	Further Responses
2	Lane Widths Christie Street through lanes. 3.5m kerbside travel lanes and 3.0m general lane below minimum requirement for general traffic lanes, bus lanes and lanes with high truck volumes. This is in accordance with AGRD Part 3, RMS Supplements	Project wide	4/09/2018	To be documented as part of DA submission	Lane widths (as per the St Marys Planning Agreement) have been documented on the Design Drawings (GA plans).	Issue Outstanding	Await Council/RMS recommendation following submission of DA
14	Project Boundary Existing property on the north-western side of the signalised intersection has a DA for a service station to be constructed. A "future boundary" has been proposed as part of this DA, with no survey data provided	Christie Street intersection	10/10/2018	Show boundary for previous DA on Property Adjustment Plan	Include proposed future boundary line from Service Station DA on Property Adjustment drawing. Council to confirm new cadastral boundary during DA Approval process.	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit and Design drawings
19	Road Design - Christie Street Intersection Unclear what design to implement through approach to Christie Street intersection. St Marys Planning Agreement contained several non-conformances in the design.	Christie Street intersection	18/10/2018	Engage with RMS to determine intersection design. Document individual non-conformances in Issues Register for DA submission	Concept TCS plan conducted as part of DA submission. No formal RMS review undertaken on signal intersection design. Engagement with RMS has begun as part of Community Consultation work, to be undertaken throughout design progression through to Construction Certification documentation	Issue Outstanding	Signal design to progress upon review by RMS
23	Signalised Intersection Geometry Stop lines offset more than 10m from adjacent through traffic lane	Christie Street intersection	12/11/2018	To be documented as part of DA submission	Documented in Design Report for Council review as part of DA submission. RMS engagement has been initiated as part of project development. Intersection geometry and issues to be flagged to RMS for comment	Issue Outstanding	To be resolved during Construction Design
24	Signalised Intersection Geometry Footpaths not offset 1.0m from kerb line to allow for signal posts, as per RMS requirements	Christie Street intersection	12/11/2018	To be documented as part of DA submission	Documented in Design Report for Council review as part of DA submission. RMS engagement has been initiated as part of project development. Intersection geometry and issues to be flagged to RMS for comment	Issue Outstanding	To be resolved during Construction Design
25	Signalised Intersection Geometry Traffic island has insufficient size to cater for a mast arm in the standard location, as per RMS requirements	Christie Street intersection	12/11/2018	To be documented as part of DA submission	Documented in Design Report for Council review as part of DA submission. RMS engagement has been initiated as part of project development. Intersection geometry and issues to be flagged to RMS for comment	Issue Outstanding	To be resolved during Construction Design
26	Signalised Intersection Geometry Departure lane on Links Road has insufficient width. RMS requires 5.m for a single lane.	Christie Street intersection	12/11/2018	To be documented as part of DA submission	Documented in Design Report for Council review as part of DA submission. RMS engagement has been initiated as part of project development. Intersection geometry and issues to be flagged to RMS for comment	Issue Outstanding	To be resolved during Construction Design
27	Design vehicles Unconfirmed design vehicle into golf course, sewer pump station	Project wide	12/11/2018	To be documented as part of DA submission	Assumed design vehicles: • Sydney Water Pump Station - 12.5m SU Truck • Golf Course Access Road - 12.5m SU Truck These have been documented in Design Report and Swept Paths provided as Appendix A	Issue Outstanding	To be resolved during Construction Design
29	Existing crossfall along Links Road Design extends existing crossfall on the southbound lane heading towards the bend. The existing crossfall is greater than maximum allowed with Council (6.0%) in areas	Links Road	12/11/2018	To be documented as part of DA submission	Documented in Design Report for Council review as part of DA submission.	Issue Outstanding	To be resolved during Construction Design

Links Road Extension - Issues Register	
Proj No.	PS111235
Client	Lendlease Communities
Date	21/11/2018

Item	Subject and Description	Location	Date	Action	Comments	Status	Further Responses
43	Road Design - Minimum Curve Length Minimum curve length for R350m of MC10 alignment has not been provided, as per Table 7.7 of Austroads Guide to Road Design Part 3	Links Road	14/11/2018	To be documented as part of DA submission	Minimum curve length criteria is not considered absolute minimums (AGRD Part 3 Cl. 7.6.2), so not deemed a non-conformance. Reviewer comment is noted, however, and will be highlighted as issue to be resolved during Construction Design	Issue Outstanding	To be resolved during Construction Design
44	Road Design - Minimum Curve Length Minimum curve length for R39m of MC10 alignment has not been provided, as per Table 7.7 of Austroads Guide to Road Design Part 3	Links Road	14/11/2018	To be documented as part of DA submission	Minimum curve length criteria is not considered absolute minimums (AGRD Part 3 Cl. 7.6.2), so not deemed a non-conformance. Reviewer comment is noted, however, and will be highlighted as issue to be resolved during Construction Design	Issue Outstanding	To be resolved during Construction Design
45	Road Design - Minimum Curve Length Minimum curve length for R500m of MC20 alignment has not been provided, as per Table 7.7 of Austroads Guide to Road Design Part 3	Links Road	14/11/2018	To be documented as part of DA submission	Minimum curve length criteria is not considered absolute minimums (AGRD Part 3 Cl. 7.6.2), so not deemed a non-conformance. Reviewer comment is noted, however, and will be highlighted as issue to be resolved during Construction Design	Issue Outstanding	To be resolved during Construction Design
68	Road Furniture - Traffic Calming Devices The road alignment comprises a 90-degree curve. Warning signs such as hazard markers are not provided to indicate the curve. This could result in drivers not recognising the road alignment ahead, particularly in dark or wet conditions. Apart from the 35 km/hr advisory speed signs, no other signs or traffic calming treatments are provided prior or at the bend. Vehicles in particular heavy vehicles travelling in excessive speed through this bend may have the potential to lose control and HVs to tilt over. Given the content of HVs in the traffic stream consideration should be given to employing “Tilting Truck” signs (W1-8B), in both directions, supporting the 35 Km/hr advisory speed signs, displayed in correct orientation.	Links Road	16/11/2018	To be documented as part of DA submission	Design has been conducted to achieve a 35km/h design speed for heavy vehicles around the bend. This uses 6.0% superelevation, which is in excess of Austroads recommendations. This is outlined in detail in the Design Report. To be undertaken during Construction Design and incorporate Council engagement, review and approvals process. This issue (supply of W1-8B) has been documented and escalated for resolution in next design phase.	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit
71	Road Design - Access Driveways Two existing driveways are located at the outer corner of the 90-degree bend which provide access to the Sydney Water pump station. These gaps would not protect an errant vehicle from leaving the road. The batter slopes at this location are unknown. An errant vehicle onto the batter of steep slopes is exposed to non-recovery risks.	Links Road	16/11/2018	To be documented as part of DA submission	Maximum height of batters approximately 1.2m. Road Furniture package not required for Concept Design phase. Has been highlighted in the Design Report for Council consideration for DA Approval. Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council during Construction Design. Consultation process during DA determination to confirm access arrangements for this property. Unlikely that guardrail can be implemented, as the site constraints of the Sydney Water Sewer Pumping Station preclude closure of one of the driveways, enforcing a left in (southern driveway), left out (northern driveway) access arrangement. This is documented in the Design Report as an outstanding issue for resolution in next design phase.	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit

Links Road Extension - Issues Register	
Proj No.	PS111235
Client	Lendlease Communities
Date	21/11/2018

Item	Subject and Description	Location	Date	Action	Comments	Status	Further Responses
76	Road Design - 90 Degree Bend - "Run Off Road" Crashes It is noted the design of the 90-degree bend in the road alignment proposes a 39m radius. Concern is expressed that given the approach alignment of the road the stated radius may induce "run off road" type crashes. Minimum radii for horizontal curves accommodating heavy vehicles needs to be checked against Austroads Guide to Road Design.	Links Road	17/11/2018	To be documented as part of DA submission	Agreed about the geometry is poor and does not meet minimum Austroads requirements. However, an analysis has been conducted, and 36km/h for trucks can be achieved around that bend as per side friction demand equation, assuming 6.0% superelevation. This is outlined in the DA Design Report for Council review. Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council during Construction Design. Run off type crash has been documented.	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit
60	Road Geometry - Design Speed The design brief requires a design speed and signposted speed of 50 km/hr for Links Road, with all other (connecting) roads at 60 km/hr. Concern is expressed that "design" would not be compatible for a 50 km/hr regulated speed road environment given the proposed road alignment and lack of land use interaction. The speed environment must be appropriate to the terrain and type of road for drivers to comply with the signposted speed. It is considered there is a high potential for non-compliance to the signposted speed of the road and future road users to travel in excess of the posted speed limit. Core to the Safe System approach to road safety is management of vehicle speeds to ensure that crashes are survivable without serious injury. On this basis consideration should be given to increasing design speed whilst maintaining intended regulated speed of the road at 50 km/hr.	Project wide	16/11/2018	To be documented as part of DA submission	DA submission will proceed under the basis of Design Speed is to match Posted Speed for Council roads. Clearly documented in DA Submission. Will await comment from Council following DA lodgement Verbally confirmed at DA Prelodgement meeting with Council on 27/09/18 that a 50km/h speed limit will be enforced. In accordance with Penrith City Council Design Guidelines for Engineering Works For Subdivisions and Developments Cl. 2.3.7, this therefore results in a Design Speed of 50km/h. If Council request modification to 60km/h Design Speed, it is expected that this is achievable with superelevation modifications. AGTM principles still required at the bend.	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit and Design drawings
63	Road Geometry - Swept Path The design indicates that the westbound left turn into Lee Holm Road would only allow access for vehicles up to 19-metre semi-trailer. It is noted that the approved B-double routes in the surrounding road network include Christie Street, Links Road and Lee Holm Road. B-double vehicles that require to perform this movement would either utilise the middle lane in Christie Street or otherwise have the risk of overturning into Lee Holm Road onto the opposing traffic.	Christie Street intersection	16/11/2018	To be documented as part of DA submission	B-double access to Lee Holm Road currently provided via Power Street. Documented in DA Pre-lodgement meeting with Council that the left turn into Lee Holm Road could restrict certain heavy vehicle movements, if required. As noted on Road Design drawing, signage to be provided during next design phase to prevent B-doubles turning left into Lee Holm Road. This is documented in the Design Report as an outstanding issue for resolution in next design phase.	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit and Design drawings
79	Road Design - Crossfall Development The horizontal alignment of the road between CH 340 and CH 580 employs a 39m radius LH curve followed by a 185m radius RH curve with a separation of 60m between tangent points of the curves. Concern is expressed that standards may need to be compromised to accommodate the road crossfall transition between the two curves.	Links Road	17/11/2018	To be documented as part of DA submission	Agreed. This has been raised during internal geometric QA processes. This is documented in the Design Report as an outstanding issue for resolution in next design phase.	Issue Outstanding	To be resolved during Construction Design

Links Road Extension - Issues Register	
Proj No.	PS111235
Client	Lendlease Communities
Date	21/11/2018

Item	Subject and Description	Location	Date	Action	Comments	Status	Further Responses
70	Road Geometry - Auxiliary Lanes The eastbound merging lane terminates at a road bend. This is a location where driver's sight lines appear restricted. Shoulder is not provided on the northern side of Christie Street at the end of merging taper to allow transition. Late merging traffic may push vehicles in the adjacent lane over onto the opposing traffic.	Christie Street	16/11/2018	To be documented as part of DA submission	No pavement works to be undertaken on Christie Street (only linemarking modifications), in accordance with St Marys Planning Agreement between Council and Lendlease. Noted that design kerb does not tie in to existing kerb at this location. Modification of kerb design will increase shoulder to 3.7m. No stopping zones to be enforced east of kerb time in point to ensure safe vehicle runout. This is documented in the Design Report as an outstanding issue for resolution in next design phase.	Issue Outstanding	To be resolved during Construction Design
72	Drainage - Water Quality Targets Penrith City Council Water Sensitive Urban Design Technical Guidelines requires the following pollutant retention: • TSS - 85% • TP - 60% • TN - 45% Water quality treatment measure have not been designed to the above mentioned pollutant retention targets as it has been agreed with Council to provide proprietary devices such as GPT which doesn't meet the abovementioned retention targets.	Project wide	16/11/2018	To be documented as part of DA submission	Documented as part of Design Report for DA submission for Council consideration. Confirmed from Council during 50% Concept Design that no water quality swale to be provided, due to maintenance concerns. Only proprietary devices to be included at outlets as part of DA submission	Issue Outstanding	Await Council recommendation following submission of DA
75	Drainage - Water Quality Runoff generated by Links Road east of the ninety degree bend to be treated by future Dunheved Industrial Precinct.	Links Road	16/11/2018	To be documented as part of DA submission	Documented in the Design Report in Issues Outstanding section	Issue Outstanding	Await Council recommendation following submission of DA with this issue highlighted in the Road Safety Audit

APPENDIX D

ROAD SAFETY AUDIT

DESKTOP ROAD SAFETY AUDIT

STAGE 2 (PRELIMINARY DESIGN)

PENRITH CITY COUNCIL
(LENDLEASE)

LINKS ROAD EXTENSION
Dunheved Precinct to Christie Street
ST. MARYS

For
WSP International Australia

November 2018

Prepared by

Winning Traffic Solutions Pty Ltd
PO Box 4106 Denistone East NSW 2112
Tel: 61 2 9807 9962
Email: terry@winningtraffic.com.au
ABN: 74 091 818 021

Desktop Road Safety Audit Summary
Penrith City Council
Links Road Extension, St Marys
Dunheved Precinct to Christie Street, St Marys

Report No.	WTS – LR1
Audit For	WSP International Australia for Lendlease
Address	Level 27 680 George Street Sydney NSW NSW 2000
Telephone	02 9325 5642
Project Manager	James Wallace (WSP)
Audit Team	Terry Winning (WTS –Team Leader) Qian Liu (WSP – Team Member)
Audit Type	Stage 2 – Preliminary Design (50% Completion)
Commencement Meeting	Wednesday 14 November 2018
Audit Date	Friday 16 November 2018
Completion Meeting	Wednesday 21 November 2018
Previous Audit No.	NIL

Summary of Audit

This report presents summary findings of a Stage 2 – Preliminary Design Stage (50% Completion), Road Safety Audit of the proposed improvements and upgrade of Links Road, from Dunheved Precinct to Dunheved Golf Club and new road from Golf Club to Christie Street linking with Lee Holm Road under traffic signal control within the Penrith City Council administrative boundaries.

WSP in collaboration with Maryland Development Company (Lendlease) are proposing to install traffic signal management (at Christie street) and associated road infrastructure enhancements with the objective of improving road user safety, increase road capacity and public amenity.

A Road Safety Audit is a series of formal checks of road and traffic works, both existing and future, in relation to their accident potential and safety performance based on the National Road Safety Strategy of a Safe Systems approach.

It is considered this issue is an influencing factor in assessing road user safety of the road infrastructure improvements presented for Audit.

Other road user safety issues that have been identified are recorded in the following report and listed in the Road User Risk Assessment Log attached at Appendix 2.

Of greatest concern arising from the audit is:

- The Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments requires a design speed and signposted speed of 50 km/hr for Links Road, with all other (connecting) roads at 60 km/hr.

Concern is expressed that “design” would not be compatible for a 50 km/hr regulated speed road environment given the proposed road alignment and lack of land use interaction. The speed environment must be appropriate to the terrain and type of road for drivers to comply with the signposted speed. It is considered there is a high potential for non-compliance to the signposted speed of the road and future road users to travel in excess of the posted speed limit.

- It is noted that street lighting is only to be provided on one side of Links Road.

  Consideration is required to intensify lighting at the 90-degree bend and the future roundabout at Links Road/Dunheved Link Road

- At Approx. CH 380 (RD-00102) It is noted the design of the 90-degree bend in the road alignment proposes a 39m radius.

  Concern is expressed that given the approach alignment of the road the stated radius may induce “run off road” type crashes.

  Minimum radii for horizontal curves accommodating heavy vehicles needs to be checked against Austroads Guide to Road Design.

  Consideration may need to be given to employing central median crash barrier.

- At Approx. CH 380 (RD-00102) At the same location it is noted that two driveway accesses are provided to Sydney Water pump station.

  It is considered there are two issues that need to be addressed with this configuration:

  1. The need for guardrail protection for through traffic (Safe System Approach) given the batter slope on the outside of the curve and curve radius
  2. The design indicates, by notation provision for a 12.5m HRV but does not show the detail for the extent of works to accommodate this vehicle (i.e. widening at the throat of the westernmost driveway).

  Should guardrail need to be employed consideration might need to be given to the relocation of these driveways or combining driveways into one and relocating.

- At Approx. CH 380 (RD-00102) Two existing driveways are located at the outer alignment of the 90-degree bend which provide access to the Sydney Water pump station.

  These gaps would not protect an errant vehicle from leaving the road. The batter slopes at this location are unknown. An errant vehicle onto the batter of steep slopes is exposed to non-recovery risks.

- At Approx. CH 380 (RD-00102) It is understood maximum superelevation, of 6% is to be applied to the 39m radius curve and that a 1.2m wide central median and downhill grade (to the east) of 1.5%.

  The tabled Stormwater management plans do not indicate central median collection of water run-off that would occur across the pavement of the EB carriageway at the eastern end of median.

  Consideration should be given to collecting water run-off at the end of median to eliminate the potential of aquaplaning.

- At Approx. CH 380 (RD-00102) The road alignment comprises a 90-degree curve. Warning signs such as hazard markers are not provided to indicate the curve. This could result in drivers not recognising the road alignment ahead, particularly in dark or wet conditions.

  Apart from the 35 km/hr advisory speed signs, no other signs or traffic calming treatments are provided prior or at the bend.

  Vehicles in particular heavy vehicles travelling in excessive speed through this bend may have the potential to lose control and HVs to tilt over.

Given the content of HVs in the traffic stream consideration should be given to employing “Tilting Truck” signs (W1-8B), in both directions, supporting the 35 Km/hr advisory speed signs, displayed in correct orientation.

- At Approx. CH 1200 (SM 00105) The design indicates a substantial drainage structure crossing Links Road.

  Consideration might need to be given to employing guardrail protection for this culvert.

- NW Corner (RD-00106) It is understood that a development consent has been granted by Penrith City Council for the construction of a service station at the south-eastern corner of the intersection of Christie Street/Links Road/Lee Holm Road. The future vehicle access at the service station has not been indicated on the design.

  The approved service station vehicle access may require specific road treatment (e.g. central median, Conditioned by RMS).

  This will need to be reviewed and any RMS requirements of the development incorporated into the final design.

- Bus Stops in Christie Street (RD-00106) Other than by notation, details on two existing bus stops on Christie Street are not provided. The overall road user safety at the bus stops remain unknown.

  Consideration is required to incorporate relevant RMS technical guidelines at a later design stage.

CONTENTS

Attachment

DESKTOP ROAD SAFETY AUDIT REPORT
STAGE 2 (PRELIMINARY DESIGN)

Desktop Road Safety Audit Summary
Penrith City Council
Links Road Extension
Dunheved Precinct to Christie Street, St Marys

1. *Introduction*

WSP International Australia has engaged Winning Traffic Solutions Pty. Ltd. (WTS) to undertake an independent Desktop Road Safety Audit of the Preliminary Design (for Lendlease at 50% Completion) for the proposed improvements and upgrade of Links Road, from Dunheved Precinct to Dunheved Golf Club and new road from Golf Club to Christie Street linking with Lee Holm Road under traffic signal control within the Penrith City Council administrative boundaries (refer Figure 1).

The site is located in St Marys, in an industrial precinct between the future Jordon Springs Development and the Dunheved Business Area

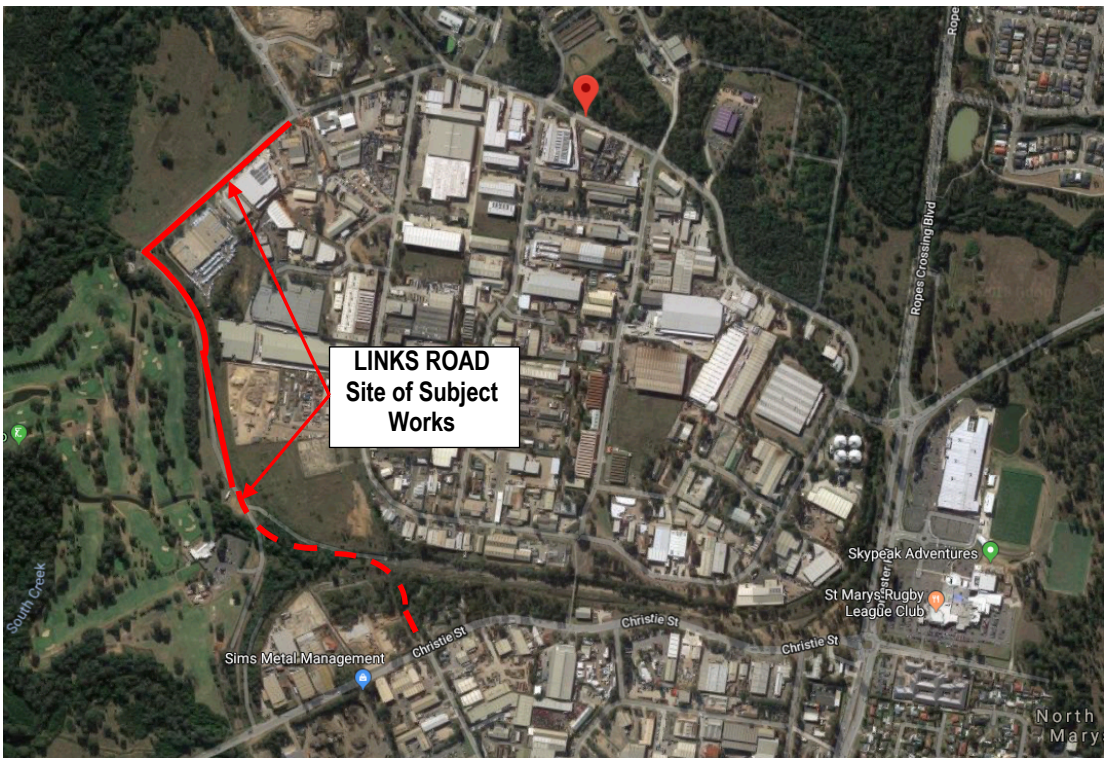


Figure 1

The project is a concept design Preliminary Design (for Lendlease at 50% Completion) for a DA submission to Penrith City Council.

Links Road and extension to Christie Street and the connecting road network are administered by Council who have directed that the design speed is to be the same as the posted speed limit (50 km/hr) in Links Road and all connecting roads at 60 km/hr , in accordance with Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments.

WSP in collaboration with Lendlease are proposing to install traffic signal management (at Christie street) and associated road infrastructure enhancements with the objective of improving road user safety, increase road capacity and public amenity.

SIDRA intersection modelling has been carried out for the intersection of Links Road/Christie Street/ Lee Holm Road to determine capacity requirements and predicted queuing at the intersection.

The aim of an audit at the Preliminary Design stage (50% completion) is to identify road user safety considerations prior to final design commencing. Other objectives are to:

- Check what standards have been used and what departures there have been from standards;
- Check the signing, linemarking and landscape plans;
- Check that all likely users have been considered;
- Check the interaction of the detailed elements;
- Check connectivity to the existing road network and assess effects in transition areas.

2. ***Project Description***

The tabled design (refer Appendix 1 Extracts), incorporating traffic signal controls at the southern end of the works at the intersection of Links Road/Christie Street/ Lee Holm Road and proposes to retain the general layout of the existing road network as generally two-lane two way traffic flow addressing the following site issues:

- Sharp bend (approximately 90 degrees) along Links Road;
- Existing access into the Dunheved Golf Course to be upgraded;
- Signalised intersection reconstruction at Christie Street/Lee Holm Road;
- Shared pedestrian/Bicycle path on one side of the road only (basically southern side;
- Overhead street lighting (basically on southern side only)
- Tie in to future roundabout to the north (Dunheved Link Road), being designed by others (Cardno);
- Heavy industrial area – all roads to be designed to accommodate B-double vehicles

In addition the design proposes to:

- maintain urban design features of the existing road reserve. These features include grassed verges, concrete footpaths and medians where applicable:
- provide Regulatory and advisory signage shown on the drawings (subject to approval by RMS) and existing regulatory signposting affected by the works is to be re-instated;
- Relocation/upgrade of existing light/power poles required as part of the proposed work.

Penrith City Council is undertaking the project with the objective of improving road user safety, increase road capacity and public amenity with the strategic aims as listed above.

A Road Safety Audit is a series of formal checks of road and traffic works, both existing and future, in relation to their accident potential and safety performance based on the National Road Safety Strategy of a Safe Systems approach.

This involves a holistic view of the road transport system and the interactions among roads and roadsides, travel speeds, vehicles and road users. It is an inclusive approach that caters for all groups using the road system, including drivers, motorcyclists, passengers, pedestrians, cyclists, and commercial and heavy vehicle drivers. Consistent with the long-term road safety vision, it recognises that people will always make mistakes and may have road crashes—but the system should be forgiving and those crashes should not result in death or serious injury.

A Road Safety Audit is conducted by a team independent to the Project who can provide an objective road user safety assessment. The purpose of the audit process is to pro-actively manage road safety by identifying and addressing risks associated with identified road safety deficiencies.

The aim of an audit at the Preliminary Design stage is to identify road user safety considerations prior to final design commencing.

3. Supporting Information

The following documents were provided by the client prior to the commencement meeting:

- A brief description of Penrith City Council's objectives for the Project
- SIDRA Analysis and associated traffic volume counts.
- WSP International Preliminary Civil Design (50% completion) indicating proposed kerb arrangements, pedestrian improvements, parking arrangements and landscaping provisions (refer Appendix 1)

The following materials were not provided to support this Audit:

- Preliminary Traffic Signal Design;
- Current pedestrian/bicycle Counts; and
- Accident data

4. Checklist and Reference Material

The audit has been carried out following the procedures set out in the Austroads/Standards Australia publication Guide To Road Safety Audit (Part 6: Road Safety Audit 2009), using "Checklist 2 – Preliminary Design Stage Audit", the RMS publication Guidelines for Road Safety Audit Practices – Part 1 Road Safety Audit (2012), AS 2890.5 Parking Facilities Part 5: On-street parking, the RMS (RTA) publication NSW bicycle guidelines, Section 12 Safety audits as guides and compliance also compared against the following documents:

- RTA QA Specification G24 Occupational Health & Safety (Non-Construction) Works and Services
- RMS "Traffic Signal Design" (and RTA Technical Direction 98/4 Bus Lanterns At Signalised Intersections)
- Austroads Guide To Road Design;
- RMS Supplements to Austroads Guide To Road Design
- RMS Delineation Guidelines;
- Austroads Guide to Traffic Engineering Practice
- AS 1742.11 -1989 "Manual of uniform traffic control devices Part 11: Parking controls"
- RTA "Changes to NSW Road Rules"

5. Auditors and Audit Process

The audit was carried out by:

Terry Winning (WTS) - Team Leader

Qian Liu (WPS) - Team Member

The audit included a commencement meeting with the Design Manager for the project, Mr. Alistair Kelly (WSP), at WSP Offices on Wednesday 14 November 2018. The tabled design was discussed with the Mr Kelly as well as the audit process and information exchanged on the project development, Council's direction (re design speed) and abutting land uses.

A desktop audit by the Audit Team was undertaken on the same day.

Following the Audit, a review of gathered data was undertaken and applied to the tabled design in detail prior to formulating the audit findings.

The audit addresses the physical features of the works that may affect road user safety and operations of the intersection and is sought to identify potential safety hazards.

A completion meeting was conducted on Wednesday 21 November with the Project Design Manager (WSP), Alistair Kelly, where the audit findings were tabled and discussed.

6. ***Road Safety Audit findings***

This audit addresses the physical features of the project that may impact road user safety and is sought to identify potential safety hazards. However, the auditors point out that no guarantee is made that every deficiency has been identified. Further, if all the unsafe issues identified in this report were to be acted upon, this would not confirm that the submitted design is "safe" rather, remedial action should improve the level of safety of the proposed facility.

The focus to this Road Safety Audit Stage 2 – Preliminary Design (50% Completion) is to identify road user safety issues prior to commissioning Final Design. Other objectives are to:

- Check what standards have been used and what departures there have been from standards (if at all);
- Check the signing, linemarking and landscape plans against Standards and Guidelines;
- Check that all likely users have been considered;
- Check the interaction of the detailed elements;
- Check connectivity to the existing road network and assess effects in transition areas; and
- To alert designers to areas where attention will be needed at a detailed design stage.

The tabled design (refer Appendix 1 Extracts), incorporating traffic signal controls at the southern end of the works at the intersection of Links Road/Christie Street/ Lee Holm Road and proposes to retain the general layout of the existing road network as generally two-lane two way traffic flow addressing the following site issues:

- Sharp bend (approximately 90 degrees) along Links Road;
- Existing access into the Dunheved Golf Course to be upgraded;
- Signalised intersection reconstruction at Christie Street/Lee Holm Road;
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- Tie in to future roundabout to the north (Dunheved Link Road), being designed by others (Cardno);
- Heavy industrial area – all roads to be designed to accommodate B-double vehicles

In addition the design proposes to:

- maintain urban design features of the existing road reserve. These features include grassed verges, concrete footpaths and medians where applicable:
- provide Regulatory and advisory signage shown on the drawings (subject to approval by RMS) and existing regulatory signposting affected by the works is to be re-instated;
- Relocation/upgrade of existing light/power poles required as part of the proposed work.

A Road User Risk Assessment Log (RURAL) of identified road user safety risks (refer Appendix 3) has been prepared that provides a site reference, indicates the direction of travel, and provides a "Preliminary Risk Rating" based on how often the problem is likely to lead to a crash (Frequent, Probable, Occasional, Improbable) and the likely severity of the resulting accident type (Catastrophic, Serious, Minor, Limited), Refer Austroads – Road Safety Audit: Part 6 – Section 4, Tables 4.1, 4.2, 4.3.

The RURAL lists the concerns identified by the Audit Team that are raised to ensure that road user safety issues are considered in the final design phase. There are some road user safety issues that need to be considered by the Project Manager that are identified in the Log (Appendix 2).

The identified road user safety issues, when viewed individually appear innocuous however, in some instances when combined raise the level of road user risk associated with the proposed works.

It has been recognised that the operation of this facility will generate not only increased pedestrian movement, but there is potential of increased road activity particularly in the heavy vehicle movement (B-Double) along the route and concern is expressed for the "directed" design speed of the road at 50 km/hr being the same as the signposted speed.

This issue has been listed in the RURAL for priority to ensure it is considered in development of the final design.

It is also considered this issue is an influencing factor in assessing road user safety of the road infrastructure improvements presented for Audit.

Of greatest concern arising from the audit is:

- The design brief requires a design speed and signposted speed of 50 km/hr for Links Road, with all other (connecting) roads at 60 km/hr.

  Concern is expressed that "design" would not be compatible for a 50 km/hr regulated speed road environment given the proposed road alignment and lack of land use interaction. The speed environment must be appropriate to the terrain and type of road for drivers to comply with the signposted speed. It is considered there is a high potential for non-compliance to the signposted speed of the road and future road users to travel in excess of the posted speed limit.

- It is noted that street lighting is only to be provided on one side of Links Road.

  Consideration is required to intensify lighting at the 90-degree bend and the future roundabout at Links Road/Dunheved Link Road

- At Approx. CH 380 (RD-00102) It is noted the design of the 90-degree bend in the road alignment proposes a 39m radius.

  Concern is expressed that given the approach alignment of the road the stated radius may induce "run off road" type crashes.

  Minimum radii for horizontal curves accommodating heavy vehicles needs to be checked against Austroads Guide to Road Design.

  Consideration may need to be given to employing central median crash barrier.

- At Approx. CH 380 (RD-00102) At the same location it is noted that two driveway accesses are provided to Sydney Water pump station.

  It is considered there are two issues that need to be addressed with this configuration:

  1. The need for guardrail protection for through traffic (Safe System Approach) given the batter slope on the outside of the curve and curve radius
  2. The design indicates, by notation provision for a 12.5m HRV but does not show the detail for the extent of works to accommodate this vehicle (i.e. widening at the throat of the westernmost driveway).

  Should guardrail need to be employed consideration might need to be given to the relocation of these driveways or combining driveways into one and relocating.

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  These gaps would not protect an errant vehicle from leaving the road. The batter slopes at this location are unknown. An errant vehicle onto the batter of steep slopes is exposed to non-recovery risks.

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  The tabled Stormwater management plans do not indicate central median collection of water run-off that would occur across the pavement of the EB carriageway at the eastern end of median.

  Consideration should be given to collecting water run-off at the end of median to eliminate the potential of aquaplaning.

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  Apart from the 35 km/hr advisory speed signs, no other signs or traffic calming treatments are provided prior or at the bend.

  Vehicles in particular heavy vehicles travelling in excessive speed through this bend may have the potential to lose control and HVs to tilt over.

  Given the content of HVs in the traffic stream consideration should be given to employing “Tilting Truck” signs (W1-8B), in both directions, supporting the 35 Km/hr advisory speed signs, displayed in correct orientation.

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  Consideration might need to be given to employing guardrail protection for this culvert.

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  The approved service station vehicle access may require specific road treatment (e.g. central median, Conditioned by RMS).

  This will need to be reviewed and any RMS requirements of the development incorporated into the final design.

- Bus Stops in Christie Street (RD-00106) Other than by notation, details on two existing bus stops on Christie Street are not provided. The overall road user safety at the bus stops remain unknown.

  Consideration is required to incorporate relevant RMS technical guidelines at a later design stage.

7. Responding to this Audit Report

As set out in the road safety audit guidelines, responsibility for implementing and or accepting/rejecting the audit findings, always rests with the Project Manager (or equivalent), and not with the auditors.

A Project Manager is under no obligation to accept all the audit findings and comments. Also, it is not the role of the Audit Team to accept or approve of the Project Manager's response to the audit. Rather, the audit provides the opportunity to highlight potential problems and risks and to have them formerly considered by the Project Manager in developing the final design, in conjunction with all other road management considerations.

8. Concluding Statement

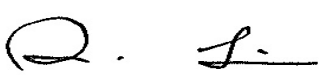
We, the undersigned, declare that we have reviewed the material and data listed in this report and identified what are considered road user safety and operational risks presented in the tabled Preliminary Civil Design Plan (50% completion - refer Appendix 1 Extracts).

It should be noted the while every effort has been made to identify potential safety hazards, no guarantee can be made that every deficiency has been identified.

Concern is expressed by the Audit Team that the Council "directed" design speed of the road at 50 km/hr being the same as the signposted speed may impact Safe Systems approach to this road design. This issue has been raised to ensure it is considered by the Project Manager in developing the final design.

We recommend that points of concern be investigated, a review of the design proposal be undertaken, and corrective actions implemented as soon as practicable.

It should be noted in the RURAL (refer Appendix 2) are road user safety issues that are raised for consideration and have been considered by the Project Manager and the intended action(s) listed accordingly.



…….. ……..

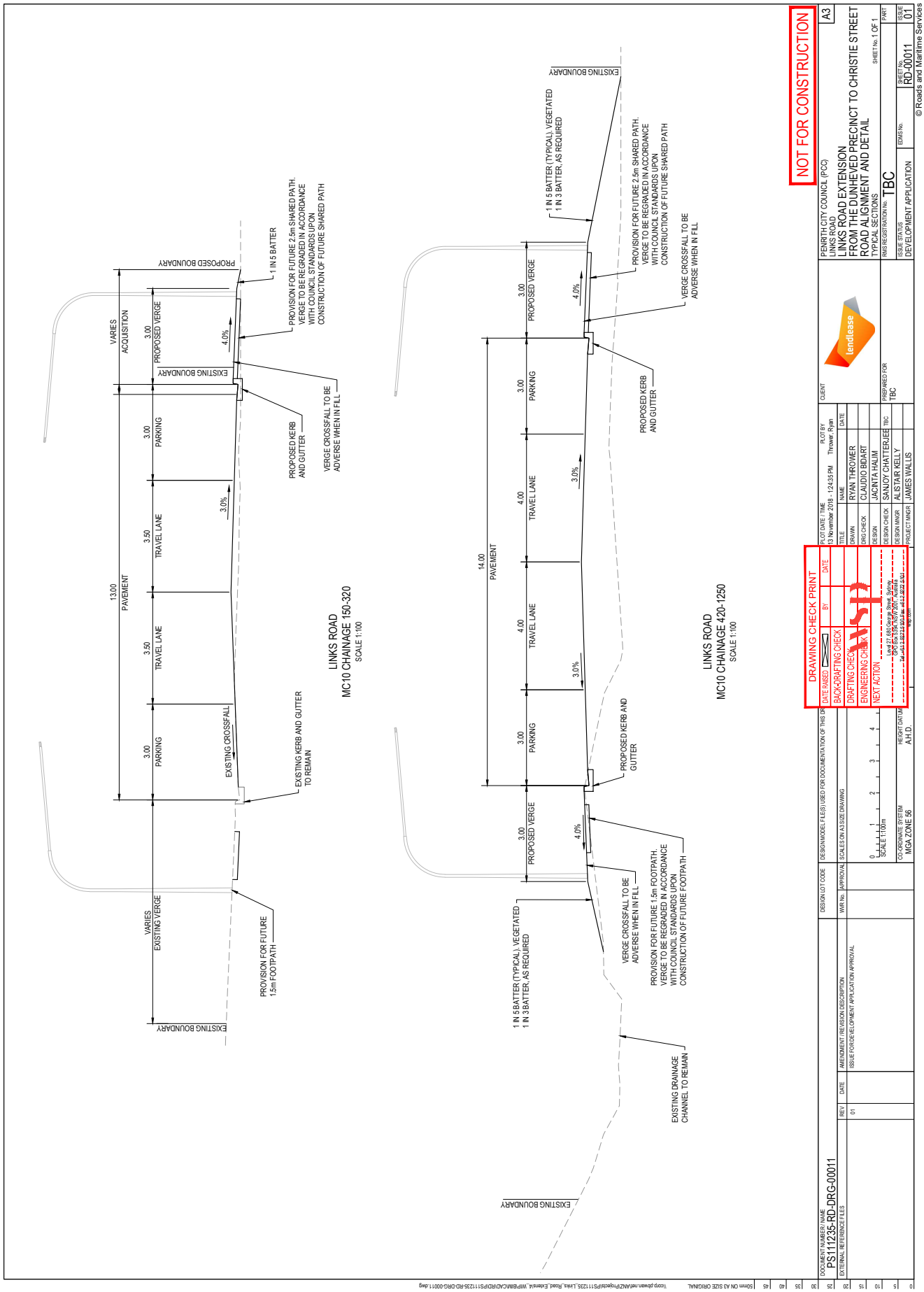
Terry Winning (Team Leader)
Winning Traffic Solutions Pty. Ltd.
Level 3 RSA.02.0063

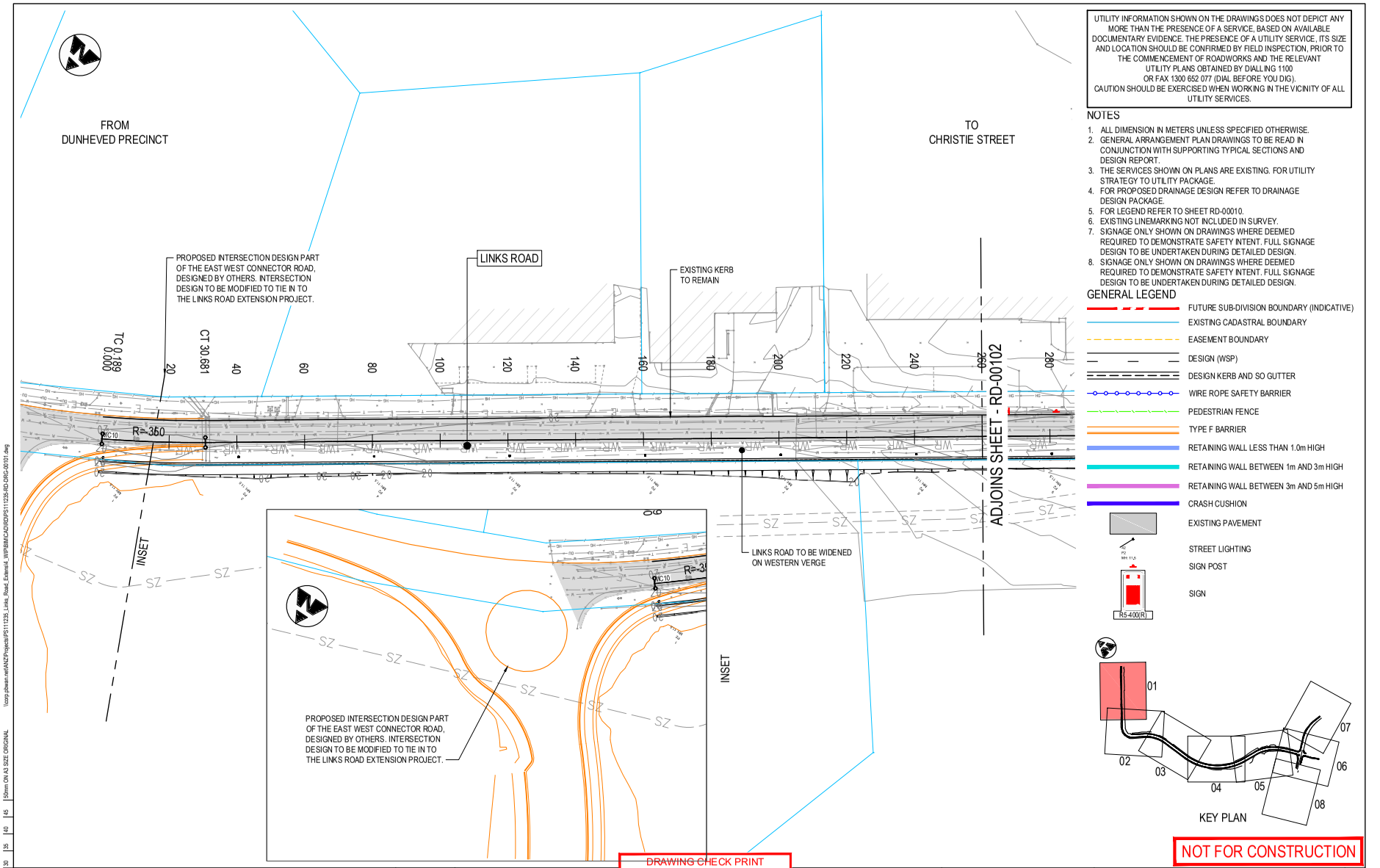
Qian Liu (Team Member)
WSP International Pty. Ltd.
Level 2 RSA.02.1291

DATE: 21 November 2018

APPENDIX 1

Preliminary Civil Design Plan Extracts





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- EXISTING PAVEMENT
- STREET LIGHTING
- SIGN POST
- SIGN (R5-400(R))

KEY PLAN

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PLOT DATE / TIME	PLOT BY
13 November 2018 - 1:25:12 PM	Thrower, Ryan

TITLE	NAME	DATE
DRAWN	RYAN THROWER	27.06.18
DRG CHECK	CLAUDIO BIDART	27.06.18
DESIGN	JACINTA HALIM	27.06.18
DESIGN CHECK	SANJOY CHATTERJEE	TBC
DESIGN MNGR	ALISTAIR KELLY	27.06.18
PROJECT MNGR	JAMES WALLIS	27.06.18

CLIENT: lendlease

PREPARED FOR: TBC

DOCUMENT NUMBER / NAME: PS111235-RD-DRG-00101

DESIGN LOT CODE:

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DR

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SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56

HEIGHT DATUM: A.H.D.

PENRITH CITY COUNCIL (PCC)
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LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN

A3

SHEET No. 1 OF 8

RMS REGISTRATION No.: TBC

PART:

ISSUE STATUS: DEVELOPMENT APPLICATION

EDMS No.:

SHEET No.: RD-00101

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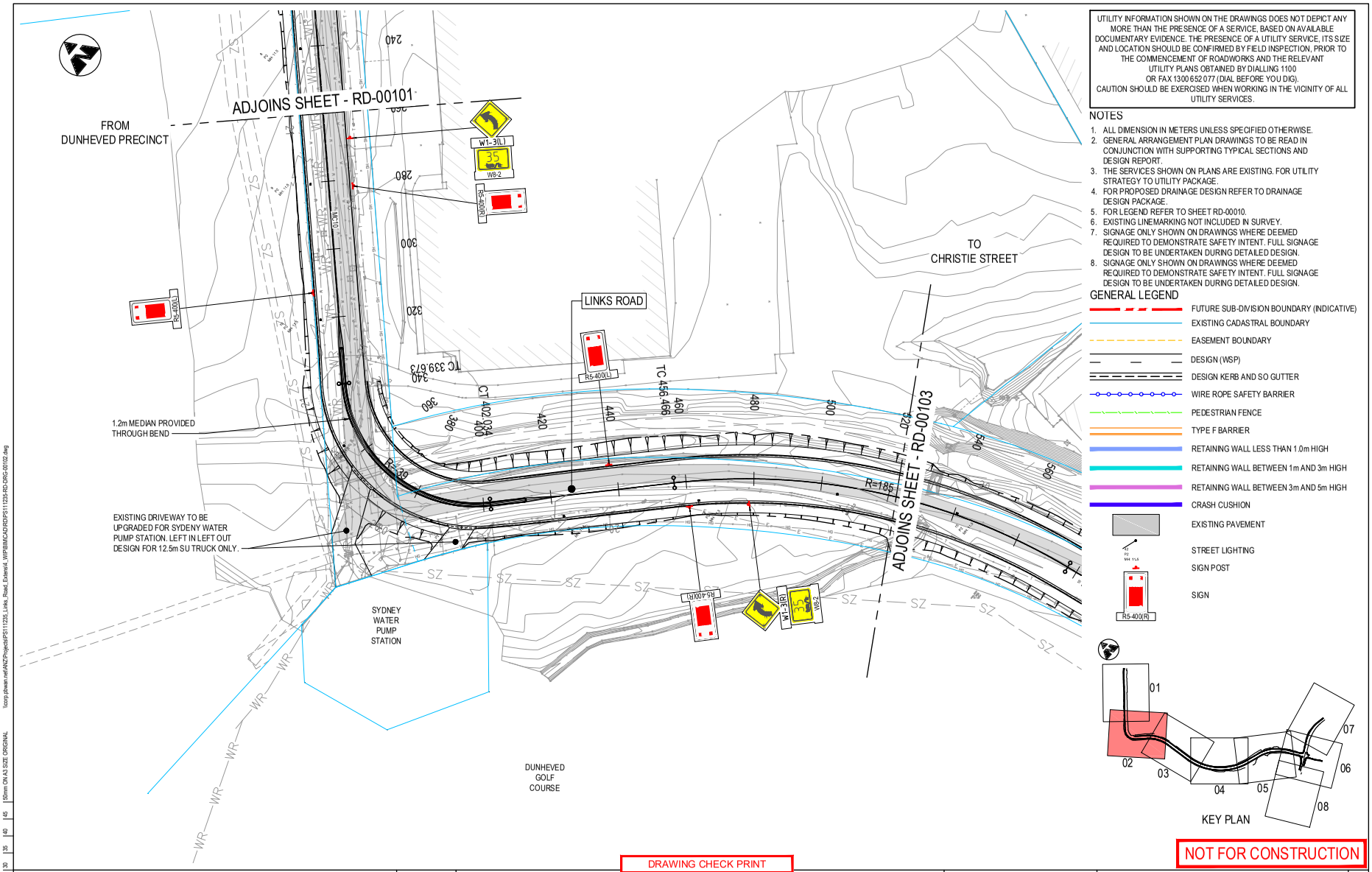

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- STREET LIGHTING
- SIGN POST
- SIGN

KEY PLAN

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HEIGHT DATUM: A.H.D.

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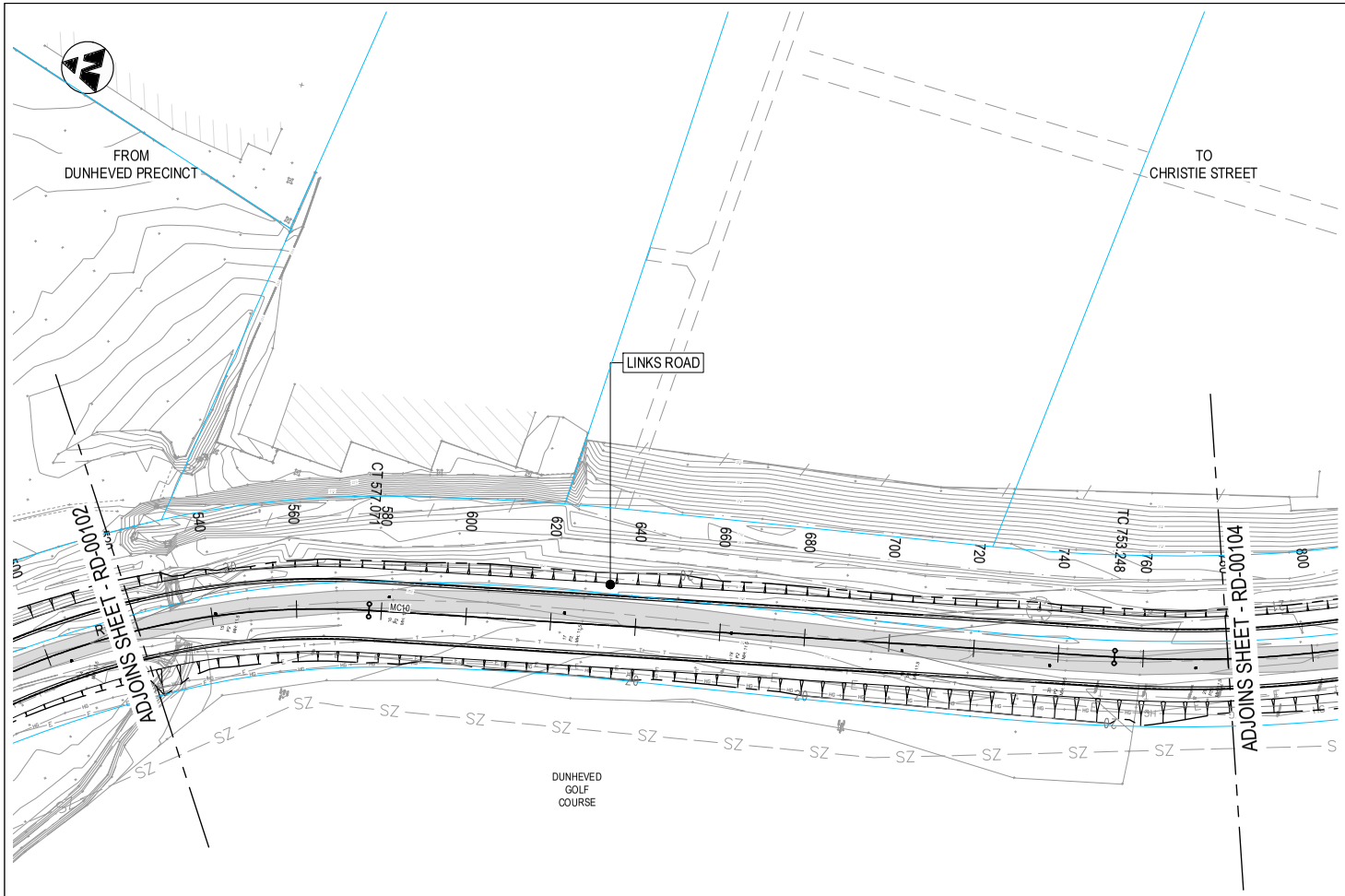
PLOT BY: Thrower, Ryan

TITLE	NAME	DATE
DRAWN	RYAN THROWER	27.06.18
DRG CHECK	CLAUDIO BIDART	27.06.18
DESIGN	JACINTA HALIM	27.06.18
DESIGN CHECK	SANJOY CHATTERJEE	TBC
DESIGN MNGR	ALISTAIR KELLY	27.06.18
PROJECT MNGR	JAMES WALLIS	27.06.18

CLIENT: lendlease
PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC) — A3
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN — SHEET No. 2 OF 8

RMS REGISTRATION No. TBC — PART
ISSUE STATUS: DEVELOPMENT APPLICATION — EDMS No. — SHEET No. RD-00102 — ISSUE 01



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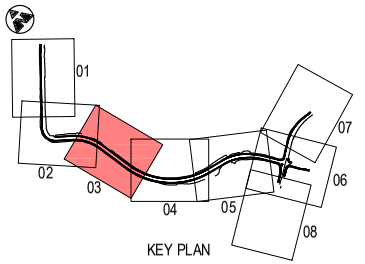

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HEIGHT DATUM	A.H.D.

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
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DESIGN	JACINTA HALIM	27.06.18
DESIGN CHECK	SANJOY CHATTERJEE	TBC
DESIGN MNGR	ALISTAIR KELLY	27.06.18
PROJECT MNGR	JAMES WALLIS	27.06.18

CLIENT: lendlease

PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC) — A3
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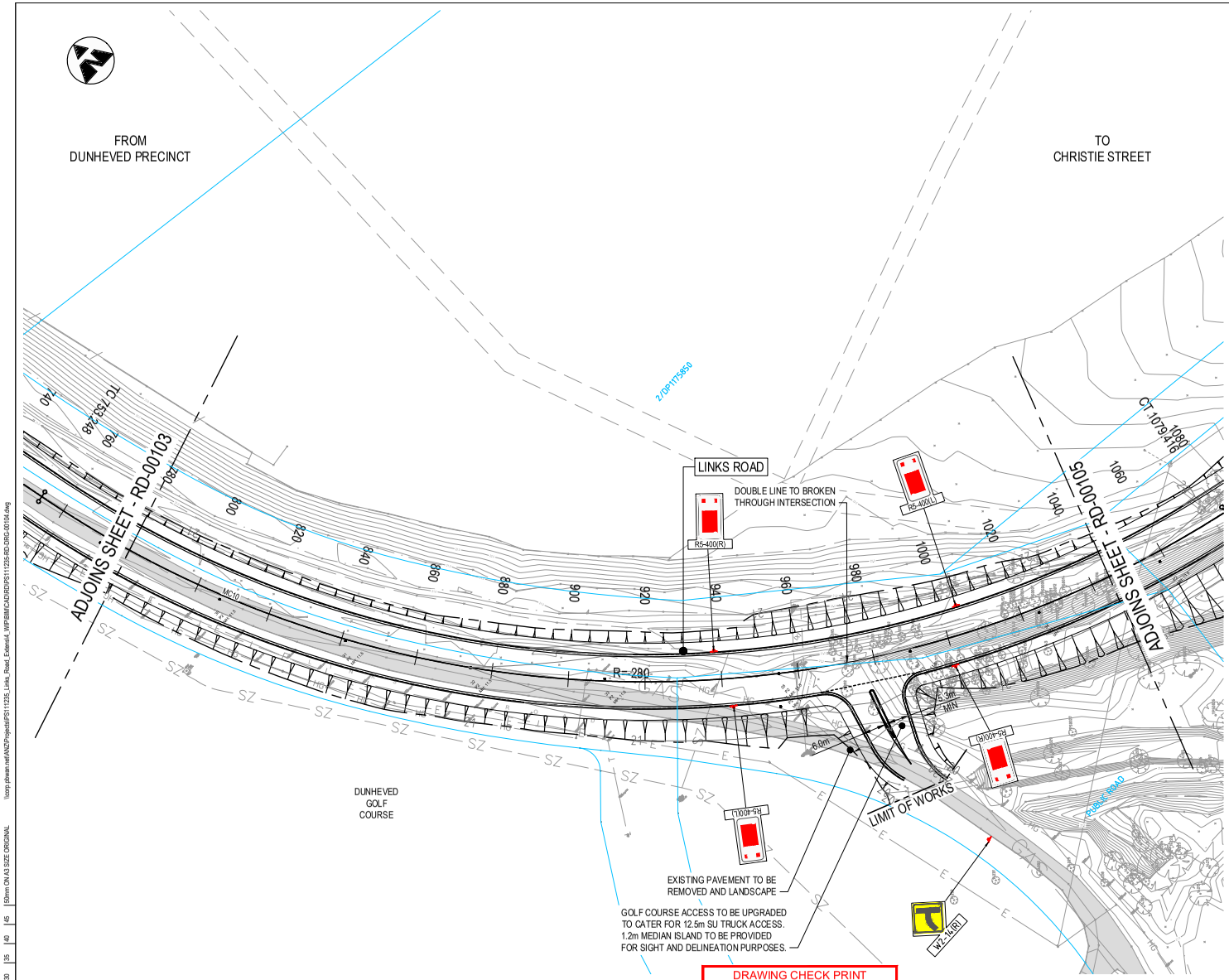
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN — SHEET No 3 OF 8

RMS REGISTRATION No.	PART
TBC	

ISSUE STATUS	EDMS No.	SHEET No.	ISSUE
DEVELOPMENT APPLICATION		RD-00103	01



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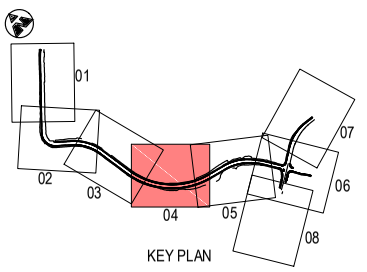

KEY PLAN

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DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DR	
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CO-ORDINATE SYSTEM	MGA ZONE 56
HEIGHT DATUM	A.H.D.

REV	DATE	AMENDMENT / REVISION DESCRIPTION
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TITLE	NAME	DATE
DRAWN	RYAN THROWER	27.06.18
DRG CHECK	CLAUDIO BIDART	27.06.18
DESIGN	JACINTA HALIM	27.06.18
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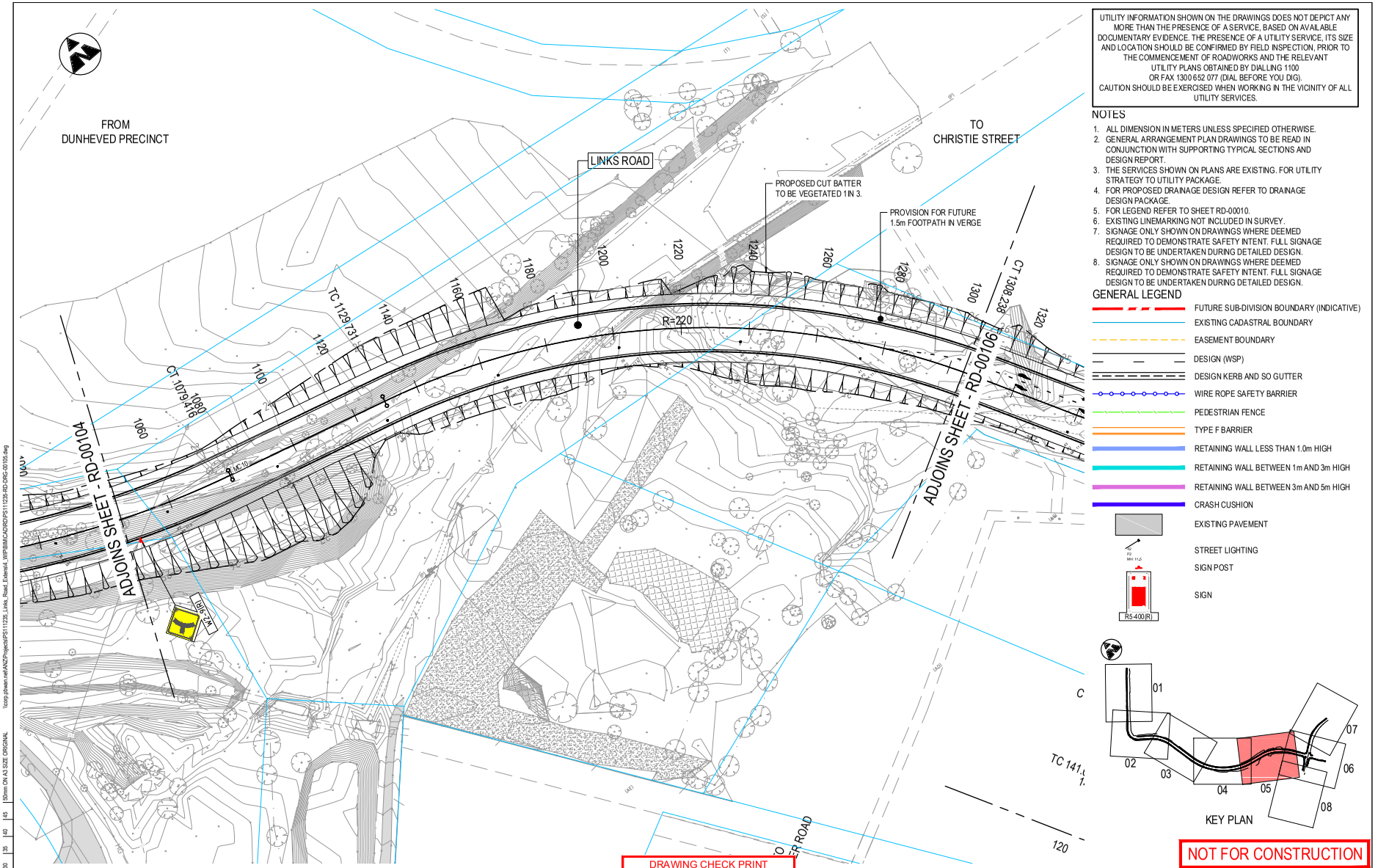
CLIENT: lendlease

PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN
SHEET No. 4 OF 8

A3

RMS REGISTRATION No. TBC			PART
ISSUE STATUS: DEVELOPMENT APPLICATION	EDMS No.	SHEET No. RD-00104	ISSUE 01



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TITLE	NAME	DATE
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PROJECT MNGR	JAMES WALLIS	27.06.18

CLIENT: lendlease

PREPARED FOR: TBC

DOCUMENT NUMBER / NAME: PS111235-RD-DRG-00105

EXTERNAL REFERENCE FILES

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01		ISSUE FOR 60% CONCEPT DESIGN

DESIGN LOT CODE | WRR No. | APPROVAL

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DR

SCALES ON A3 SIZE DRAWING

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SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: A.H.D.

PENRITH CITY COUNCIL (PCC) — A3

LINKS ROAD

LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN — SHEET No. 5 OF 8

RMS REGISTRATION No. TBC — PART

ISSUE STATUS	EDMS No.	SHEET No.	ISSUE
DEVELOPMENT APPLICATION		RD-00105	01

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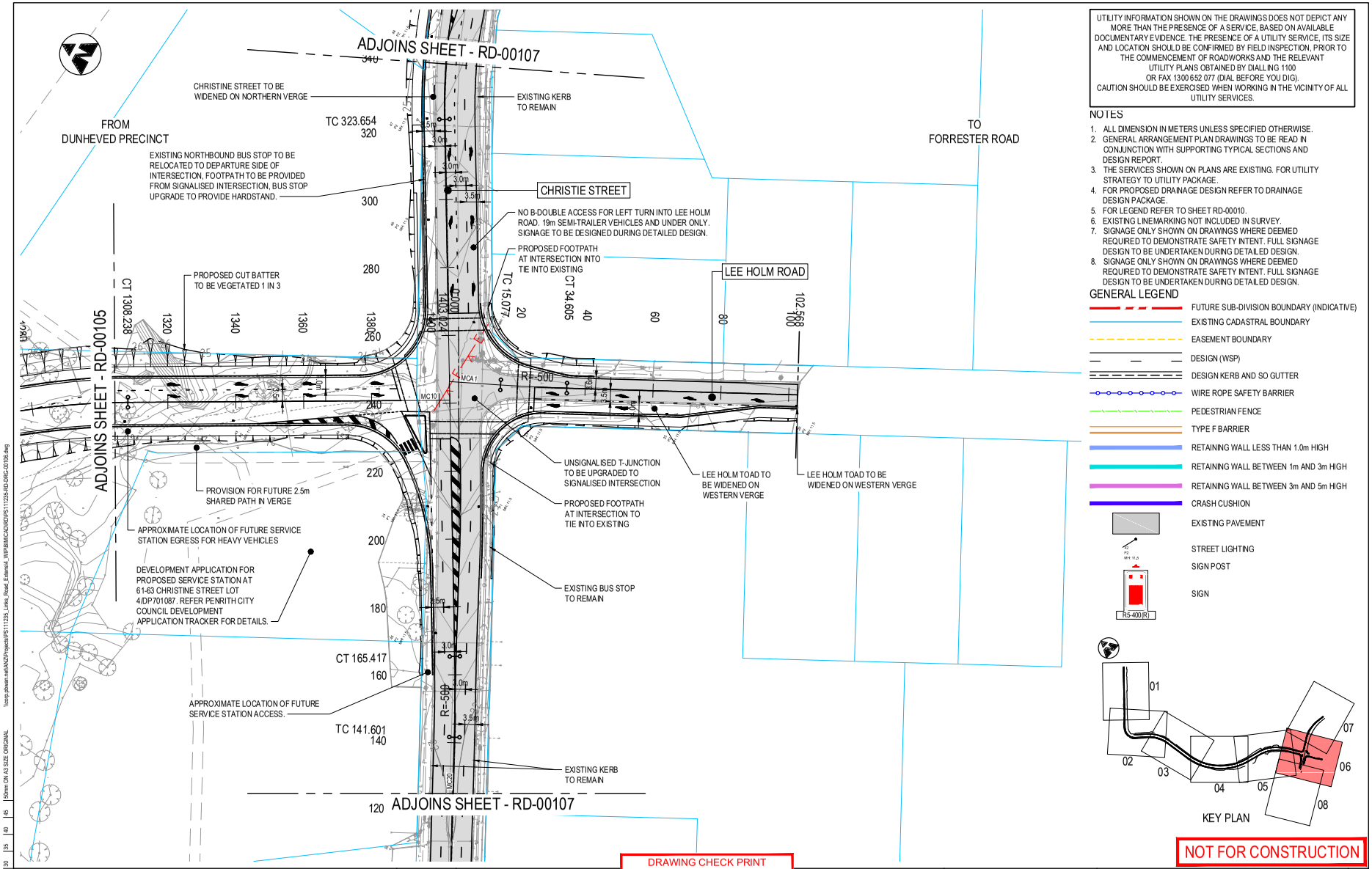

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KEY PLAN

NOT FOR CONSTRUCTION

DRAWING CHECK PRINT

	BY	DATE
DATE RAISED		
BACK-DRAFTING CHECK		
DRAFTING CHECK		
ENGINEERING CHECK		
NEXT ACTION		

wsp
Level 27, 680 George Street, Sydney
GPO Box 5394 NSW 2001, Australia
Tel +61 2 9272 5100 Fax +61 2 9272 5101
wsp.com

PLOT DATE / TIME	13 November 2018 - 1:26:40 PM	PLOT BY Thrower, Ryan
TITLE	NAME	DATE
DRAWN	RYAN THROWER	27.06.18
DRG CHECK	CLAUDIO BIDART	27.06.18
DESIGN	JACINTA HALIM	27.06.18
DESIGN CHECK	SANJOY CHATTERJEE	TBC
DESIGN MNGR	ALISTAIR KELLY	27.06.18
PROJECT MNGR	JAMES WALLIS	27.06.18

CLIENT: lendlease

PREPARED FOR: TBC

DOCUMENT NUMBER / NAME: PS111235-RD-DRG-00106

EXTERNAL REFERENCE FILES

REV	DATE	AMENDMENT / REVISION DESCRIPTION
01		ISSUE FOR 50% CONCEPT DESIGN

DESIGN LOT CODE | WVR No. | APPROVAL

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DR

SCALES ON A3 SIZE DRAWING

0 10 20 30 40
SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

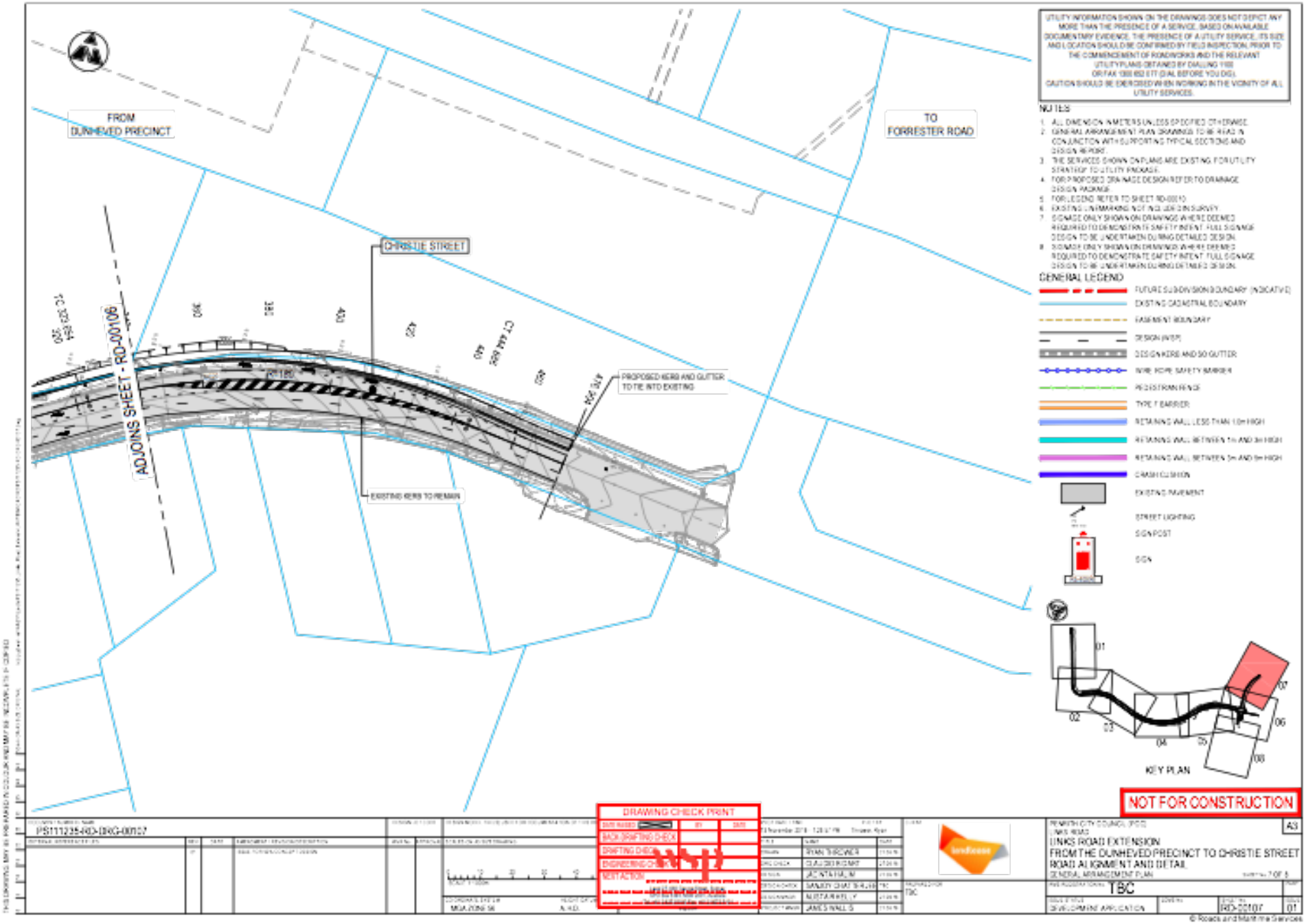
PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN
SHEET No. 6 OF 8

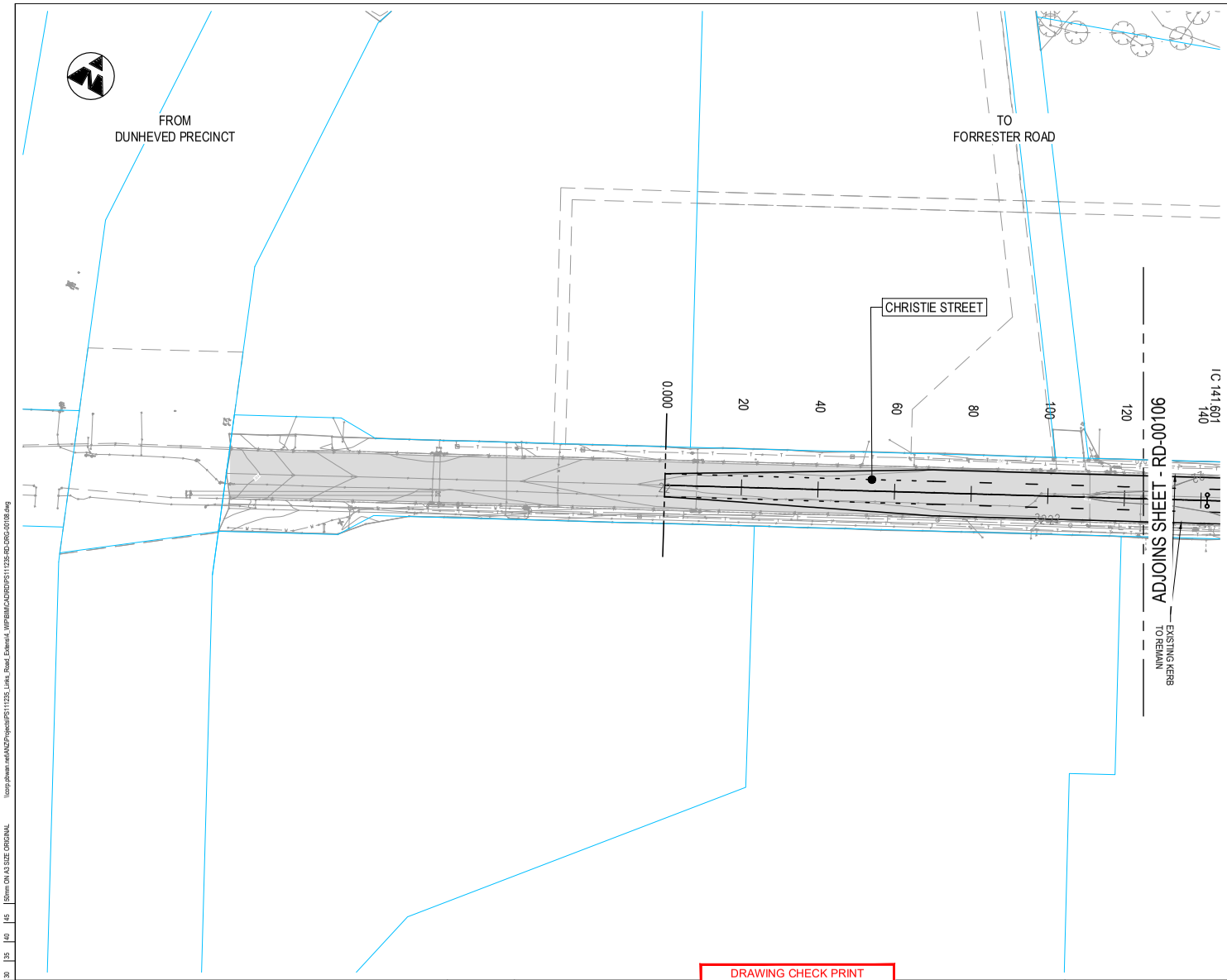
A3

RMS REGISTRATION No.: TBC
PART

ISSUE STATUS: DEVELOPMENT APPLICATION
EDMS No.
SHEET No.: RD-00106
ISSUE: 01

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED
I:\corp\phase\ref\AND\Projects\PS111235_Links_Road_Extend\4_WIP\BIM\CAD\RDPS111235-RD-DRG-00105.dwg
50mm ON A3 SIZE ORIGINAL





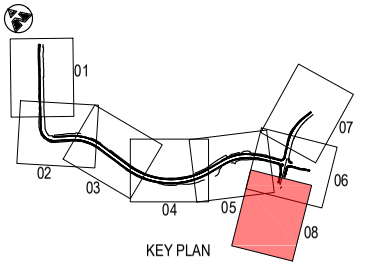
UTILITY INFORMATION SHOWN ON THE DRAWINGS DOES NOT DEPICT ANY MORE THAN THE PRESENCE OF A SERVICE, BASED ON AVAILABLE DOCUMENTARY EVIDENCE. THE PRESENCE OF A UTILITY SERVICE, ITS SIZE AND LOCATION SHOULD BE CONFIRMED BY FIELD INSPECTION, PRIOR TO THE COMMENCEMENT OF ROADWORKS AND THE RELEVANT UTILITY PLANS OBTAINED BY DIALLING 1100 OR FAX 1300 652 077 (DIAL BEFORE YOU DIG). CAUTION SHOULD BE EXERCISED WHEN WORKING IN THE VICINITY OF ALL UTILITY SERVICES.

NOTES

1. ALL DIMENSION IN METERS UNLESS SPECIFIED OTHERWISE.
2. GENERAL ARRANGEMENT PLAN DRAWINGS TO BE READ IN CONJUNCTION WITH SUPPORTING TYPICAL SECTIONS AND DESIGN REPORT.
3. THE SERVICES SHOWN ON PLANS ARE EXISTING. FOR UTILITY STRATEGY TO UTILITY PACKAGE.
4. FOR PROPOSED DRAINAGE DESIGN REFER TO DRAINAGE DESIGN PACKAGE.
5. FOR LEGEND REFER TO SHEET RD-00010.
6. EXISTING LINEMARKING NOT INCLUDED IN SURVEY.
7. SIGNAGE ONLY SHOWN ON DRAWINGS WHERE DEEMED REQUIRED TO DEMONSTRATE SAFETY INTENT. FULL SIGNAGE DESIGN TO BE UNDERTAKEN DURING DETAILED DESIGN.
8. SIGNAGE ONLY SHOWN ON DRAWINGS WHERE DEEMED REQUIRED TO DEMONSTRATE SAFETY INTENT. FULL SIGNAGE DESIGN TO BE UNDERTAKEN DURING DETAILED DESIGN.

GENERAL LEGEND

- FUTURE SUB-DIVISION BOUNDARY (INDICATIVE)
- EXISTING CADASTRAL BOUNDARY
- EASEMENT BOUNDARY
- DESIGN (WSP)
- DESIGN KERB AND SO GUTTER
- WIRE ROPE SAFETY BARRIER
- PEDESTRIAN FENCE
- TYPE F BARRIER
- RETAINING WALL LESS THAN 1.0m HIGH
- RETAINING WALL BETWEEN 1m AND 3m HIGH
- RETAINING WALL BETWEEN 3m AND 5m HIGH
- CRASH CUSHION
- EXISTING PAVEMENT
- STREET LIGHTING
- SIGN POST
- SIGN (R5-400(R))



KEY PLAN

NOT FOR CONSTRUCTION

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\\corp.pbwan.net\ANZ\Projects\PS111235_Links_Road_Extend\4_WIP\BIM\CAD\RD\PS111235-RD-DRG-00108.dwg
50mm ON A3 SIZE ORIGINAL

DOCUMENT NUMBER / NAME	DESIGN LOT CODE	DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DR
PS111235-RD-DRG-00108		

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
	01		ISSUE FOR 50% CONCEPT DESIGN		

SCALES ON A3 SIZE DRAWING
0 10 20 30 40
SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: A.H.D.

DRAWING CHECK PRINT

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wsp.com

PLOT DATE / TIME: 13 November 2018 - 1:27:14 PM
PLOT BY: Thrower, Ryan

TITLE	NAME	DATE
DRAWN	RYAN THROWER	27.06.18
DRG CHECK	CLAUDIO BIDART	27.06.18
DESIGN	JACINTA HALIM	27.06.18
DESIGN CHECK	SANJOY CHATTERJEE	TBC
DESIGN MNGR	ALISTAIR KELLY	27.06.18
PROJECT MNGR	JAMES WALLIS	27.06.18

CLIENT: lendlease
PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
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GENERAL ARRANGEMENT PLAN
SHEET No. 8 OF 8

A3

RMS REGISTRATION No.: TBC
PART:

ISSUE STATUS: DEVELOPMENT APPLICATION
EDMS No.:
SHEET No.: RD-00108
ISSUE: 01

APPENDIX 2

ROAD USER RISK ASSESSMENT LOG

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG
PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET
STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)
NOVEMBER 2018

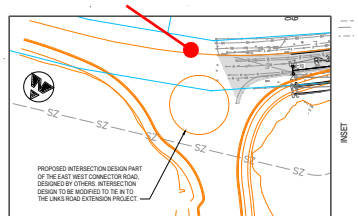
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
GENERAL						
1	Design Speed	The design brief requires a design speed and signposted speed of 50 km/hr for Links Road, with all other (connecting) roads at 60 km/hr. Concern is expressed that "design" would not be compatible for a 50 km/hr regulated speed road environment given the proposed road alignment and lack of land use interaction. The speed environment must be appropriate to the terrain and type of road for drivers to comply with the signposted speed. It is considered there is a high potential for non-compliance to the signposted speed of the road and future road users to travel in excess of the posted speed limit. Core to the Safe System approach to road safety is management of vehicle speeds to ensure that crashes are survivable without serious injury. On this basis consideration should be given to increasing design speed whilst maintaining intended regulated speed of the road at 50 km/hr.		H	A	DA submission will proceed under the basis of Design Speed is to match Posted Speed for Council roads. Clearly documented in DA Submission. Will await comment from Council following DA lodgement Verbally confirmed at DA Prelodgement meeting with Council on 27/09/18 that a 50km/h speed limit will be enforced. In accordance with Penrith City Council Design Guidelines for Engineering Works For Subdivisions and Developments Cl. 2.3.7, this therefore results in a Design Speed of 50km/h. If Council request modification to 60km/h Design Speed, it is expected that this is achievable with superelevation modifications. AGTM principles still required at the bend.
2	Guidance & Delineation	Whilst it is accepted the design is at a "preliminary" stage consideration will need to be given to linemarking and delineation at critical locations, specifically those areas of curved alignment and at intersections.		M	A	Not required as part of DA submission. Will be undertaken during Detailed Design, as this is a requirement of Council's review and verification process. Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council.

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG

PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

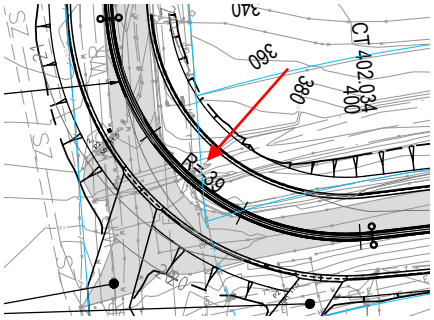
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
3	Road Alignment & Cross Sections	Typical cross section for cut earthworks (batter slope) are not shown on the design drawings. It is unclear if the batter slope is suitable to allow maintenance vehicle access. The warrant for guardrail adjacent 1 in 3 fill batter needs to be considered.		L	R	Additional Typical Cross Sections to be provided during Detailed Design, in addition to standard cross section sheets. No location in the design has any fill batters shown at 1 in 3. There is only one location that has 1 in 3 batters on the Concept Design, and this is noted up on the GA drawing. Maintenance vehicles to use parking lane. Confirmed by Council at 50% Concept Design stage that 1 in 5 batters to be turfed and maintained by mowing. 1 in 3 batters are to be vegetated in accordance with Council specifications.
4	Lighting	It is noted that street lighting is only to be provided on one side of Links Road. Consideration is required to intensify lighting at the 90-degree bend and the future roundabout at Links Road/Dunheved Link Road		H	A	To be undertaken during Detailed Design. Only Concept needed for DA submission of Lighting Design. Has been noted as issues to be escalated and analysed further in Detailed Design.
LINKS ROAD						
5	Links Road & Dunheved Link Road RD – 00101 CH 00	It is understood that future projects may incorporate a roundabout at the intersection of Links Road/Dunheved Link Road that is to be designed by others and to link with the Links Road Extension design. It is noted (Google Maps) that this road is under construction and the design has not indicated/recognised the existing driveway (4th leg) access of the roundabout.		NOTE ONLY		Not part of the Links Road Extension project, and has been assessed as part of the East West Connector Road Development Application to Penrith City Council.

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG

PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

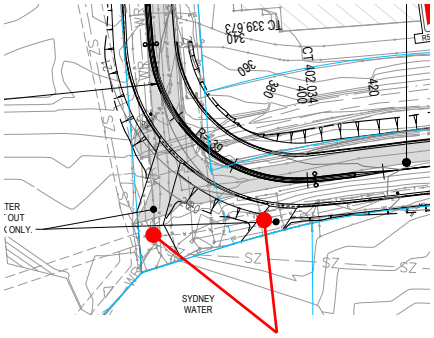
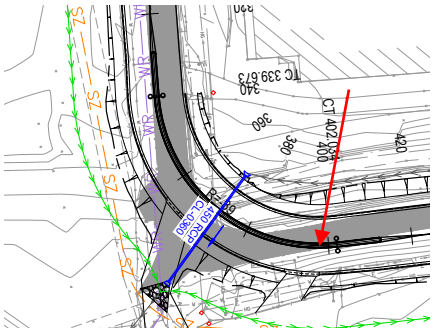
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
6	At Approx. CH 380 RD-00102	It is noted the design of the 90-degree bend in the road alignment proposes a 39m radius. Concern is expressed that given the approach alignment of the road the stated radius may induce “run off road” type crashes. Minimum radii for horizontal curves accommodating heavy vehicles needs to be checked against Austroads Guide to Road Design. Consideration may need to be given to employing central median crash barrier.		H	A	Agreed about the geometry is poor and does not meet minimum Austroads requirements. However, an analysis has been conducted, and 36km/h for trucks can be achieved around that bend as per side friction demand equation, assuming 6.0% superelevation. This is outlined in the DA Design Report for Council review. Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council during Detailed Design. Run off type crash has been documented.
7	At Approx. CH 380 RD-00102	At the same location it is noted that two driveway accesses are provided to Sydney Water pump station. It is considered there are two issues that need to be addressed with this configuration: 1. The need for guardrail protection for through traffic (Safe System Approach) given the batter slope on the outside of the curve and curve radius 2. The design indicates, by notation provision for a 12.5m HRV but does not show the detail for the extent of works to accommodate this vehicle (i.e. widening at the throat of the westernmost driveway). Should guardrail need to be employed consideration might need to be given to the relocation of these driveways or combining driveways into one and relocating.		H	A	Road Furniture package not required for Concept Design phase. Has been highlighted in the Design Report for Council consideration for DA Approval. Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council during Detailed Design. Swept paths have been conducted for the upgraded driveways, assuming 12.5m SU Truck. This is documented in the DA design report. Consultation process during DA determination to confirm access arrangements for this property. Unlikely that guardrail can be implemented, as the site constraints of the Sydney Water Sewer Pumping Station preclude closure of one of the driveways, enforcing a left in (southern driveway), left out (northern driveway) access arrangement. This is documented in the Design Report as an outstanding issue for resolution in next design phase.

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG

PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

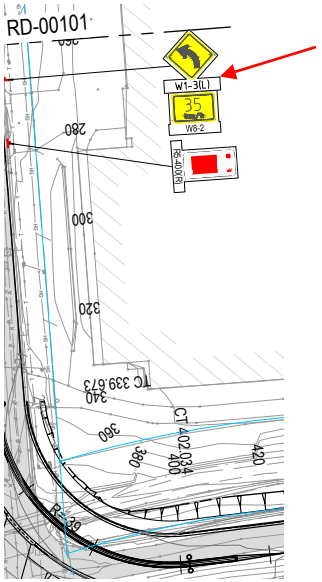
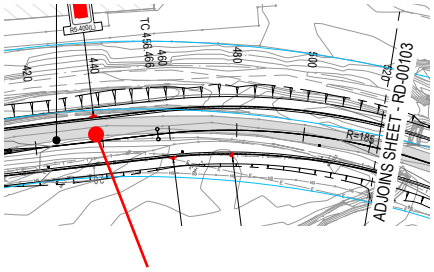
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
8	At Approx. CH 380 RD-00102	Two existing driveways are located at the outer alignment of the 90-degree bend which provide access to the Sydney Water pump station. These gaps would not protect an errant vehicle from leaving the road. The batter slopes at this location are unknown. An errant vehicle onto the batter of steep slopes is exposed to non-recovery risks.		H	A	Maximum height of batters approximately 1.2m. Road Furniture package not required for Concept Design phase. Has been highlighted in the Design Report for Council consideration for DA Approval. Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council during Detailed Design. Consultation process during DA determination to confirm access arrangements for this property. Unlikely that guardrail can be implemented, as the site constraints of the Sydney Water Sewer Pumping Station preclude closure of one of the driveways, enforcing a left in (southern driveway), left out (northern driveway) access arrangement. This is documented in the Design Report as an outstanding issue for resolution in next design phase.
9	At Approx. CH 380 RD-00102	It is understood maximum superelevation, of 6% is to be applied to the 39m radius curve and that a 1.2m high crash barrier employed in the central median and downhill grade (to the east) of 1.5%. The tabled Stormwater management plans do not indicate central median collection of water run-off that would occur across the pavement of the EB carriageway at the eastern end of median. Consideration should be given to collecting water run-off at the end of median to eliminate the potential of aquaplaning.		H	A	Design does not currently contain concrete barrier design, as Collaborative approach to deal with sharp bend (linemarking, traffic calming measures etc.) to be confirmed and approved by Council during Detailed Design in line with Council review and approval processes. Longitudinal drainage design has been conducted but not shown on drawings available for RSA. Central median drainage to be confirmed during detailed design. This issue has been documented and escalated for resolution in next design phase.

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG

PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

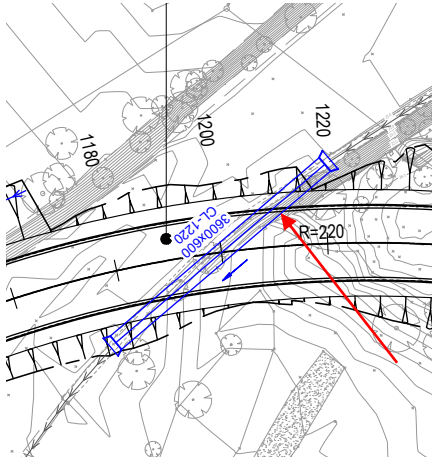
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
10	At Approx. CH 380 RD-00102	The road alignment comprises a 90-degree curve. Warning signs such as hazard markers are not provided to indicate the curve. This could result in drivers not recognising the road alignment ahead, particularly in dark or wet conditions. Apart from the 35 km/hr advisory speed signs, no other signs or traffic calming treatments are provided prior or at the bend. Vehicles in particular heavy vehicles travelling in excessive speed through this bend may have the potential to lose control and HVs to tilt over. Given the content of HVs in the traffic stream consideration should be given to employing "Tilting Truck" signs (W1-8B), in both directions, supporting the 35 Km/hr advisory speed signs, displayed in correct orientation.		H	A	Design has been conducted to achieve a 35km/h design speed for heavy vehicles around the bend. This uses 6.0% superelevation, which is in excess of Austroads recommendations. This is outlined in detail in the Design Report. To be undertaken during Detailed Design and incorporate Council engagement, review and approvals process. This issue (supply of W1-8B) has been documented and escalated for resolution in next design phase.
11	At Approx. CH 460 RD-00102 & RD-00103	The horizontal alignment of the road between CH 340 and CH 580 employs a 39m radius LH curve followed by a 185m radius RH curve with a separation of 60m between tangent points of the curves. Concern is expressed that standards may need to be compromised to accommodate the road crossfall transition between the two curves.		M	A	Agreed. This has been raised during internal geometric QA processes. This is documented in the Design Report as an outstanding issue for resolution in next design phase.

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG

PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

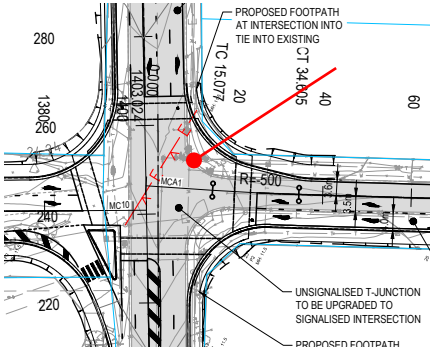
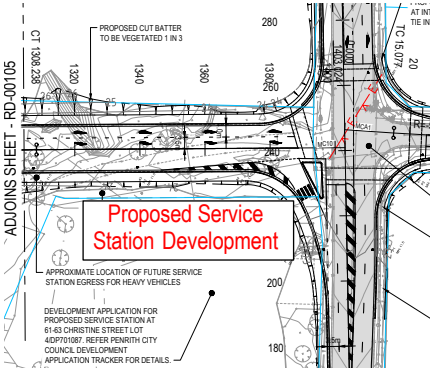
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
12	At Golf Course Access CH 980 RD-00104	At the Golf Course access a central median and kerb have been employed in the access road. Kerb return radii to Links Road has not been shown. It is assumed that large vehicles will be required to service the Golf Club and on this basis appropriate radii serving an HRV should be considered.		M	A	Kerb returns have been determined using swept paths for 12.5m SU Truck for all movements, and are shown in the Design Report. Design can also cater for all a 14.5m Long Rigid Bus, excluding the left in movement. Consultation process during DA determination to confirm access arrangements for the golf course.
13	At Golf Course Access CH 980	The design includes a new T-intersection at the Golf Course. The Golf Course likely attracts a high volume of visitors who may not be familiar with the area and may not recognise the priority at the T-intersection due to the lack of signposting. Review of appropriate advance warning signs (lacking in the EB direction) and directional signposting should be considered for the final design.		M	A	Agreed. Signs and Linemarking design not undertaken as part of DA submission. This is documented in the Design Report as an outstanding issue for resolution in next design phase.
14	At Approx. CH 1200 SM 00105	The design indicates a substantial drainage structure crossing Links Road. Consideration might need to be given to employing guardrail protection for this culvert		H	A	Agreed. Road Furniture design not conducted as part of Concept Design DA submission. This is documented in the Design Report as an outstanding issue for resolution in next design phase.

DESKTOP ROAD SAFETY AUDIT – ROAD USER RISK ASSESSMENT LOG

PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
AT CHRISTIE STREET/LEE HOLM ROAD						
15	LT from Christie Street RD-00106	The design indicates that the westbound left turn into Lee Holm Road would only allow access for vehicles up to 19-metre semi-trailer. It is noted that the approved B-double routes in the surrounding road network include Christie Street, Links Road and Lee Holm Road. B-double vehicles. Concern is expressed that B-double vehicles that are required to perform this LT movement would either utilise the middle lane in Christie Street or otherwise have the risk of encroaching into Lee Holm Road into the opposing traffic.		M	R	B-double access to Lee Holm Road currently provided via Power Street. Documented in DA Pre-lodgement meeting with Council that the left turn into Lee Holm Road could restrict certain heavy vehicle movements, if required. As noted on Road Design drawing, signage to be provided during next design phase to prevent B-doubles turning left into Lee Holm Road. This is documented in the Design Report as an outstanding issue for resolution in next design phase.
16	NW Corner RD-00106	It is understood that a development consent has been granted by Penrith City Council for the construction of a service station at the south-eastern corner of the intersection of Christie Street/Links Road/Lee Holm Road. The future vehicle access at the service station has not been indicated on the design. The approved service station vehicle access may require specific road treatment (e.g. central median, Conditioned by RMS). This will need to be reviewed and any RMS requirements of the development incorporated into the final design.		H	A	Note has been added on GA drawings regarding future service station. Future property boundary from plan by J.Wyndham Prince has been shown on Property Adjustment Plan.
17	Bicycles RD-00106	There is no transition provided to allow cyclists to safely leave the shared path and ride on-road which may result in increased risk of cyclists/vehicle collisions. Consideration will need to be given in the final design on appropriately signposting this activity.		M	A	Agreed. To be undertaken during Detailed Design. Kerb ramps have not been considered as part of DA submission. Signs and Linemarking not conducted as part of DA submission. To be undertaken during next design phase.

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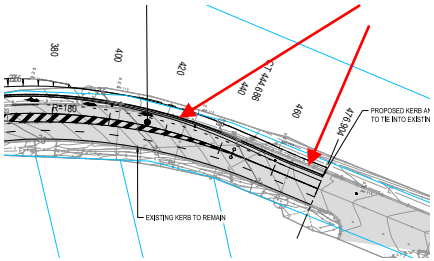
PENRITH CITY COUNCIL – LINKS ROAD EXTENSION – DUNHEVED PRECINCT TO CHRISTIE STREET

STAGE 2 PRELIMINARY DESIGN AUDIT (50% COMPLETION)

NOVEMBER 2018

Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
18	Bus Stops in Christie Street RD-00106	Other than by notation, details on two existing bus stops on Christie Street are not provided. The overall road user safety at the bus stops remain unknown. Consideration is required to incorporate relevant RMS technical guidelines at a later design stage.		H	A	Quality of existing bus stops extremely poor. Bus stops shown on departure side of intersection for safety purposes at this stage. Confirmed from Council during 50% Concept Design that existing bus stops to be upgraded to provide concrete hardstand, as currently shown. Noted in the Design Report that Public transport requirements to be designed further during Detailed Design under the instruction of Penrith City Council and the relevant NSW government agencies.
19	Christie Street EB Merge	The eastbound merging lane terminates at a road bend and does not appear to align with existing kerb. This is a location where driver's sight lines appear restricted. Concern is expressed that a shoulder is not provided on the northern side of Christie Street at the end of merging taper to allow passage of a vehicle should the merge not take place. Late merging traffic may push vehicles in the adjacent lane over into the opposing traffic.		M	A	No pavement works to be undertaken on Christie Street (only linemarking modifications), in accordance with St Marys Planning Agreement between Council and Lendlease. Noted that design kerb does not tie in to existing kerb at this location. Modification of kerb design will increase shoulder to 3.7m. No stopping zones to be enforced east of kerb time in point to ensure safe vehicle runout. This is documented in the Design Report as an outstanding issue for resolution in next design phase.

APPENDIX E

SAFETY IN DESIGN REGISTER

Safety-in-design workshop attendance

Project: PS111235 - Links Road Extension, St Marys – Concept Design

Workshop Location: WSP Offices, World Square

Date: 13 November 2108

Time: 1.30pm

Safety-in-design workshop attendance register

Name	Title/role/ expertise	Company	Signature	Experience					
				Design	Construction	Operation	Maintenance	Demolition	Disposal
Nuno Muralha	Project Director/ Facilitator	WSP		☑	☑	☑	☑	☐	☐
Sean Porter	Development Manager	Lendlease		☑	☐	☑	☐	☐	☐
Ahmad Ali	Snr Development Manager	Lendlease		☐	☑	☑	☑	☐	☐
Kelly Alistair	Design Manager	WSP		☑	☐	☐	☐	☐	☐
Annabella Dao	Drainage Designer	WSP		☑	☐	☐	☐	☐	☐
Vince Urbano	Senior Principal Engineer	WSP		☑	☑	☑	☑	☐	☐
Andy Clune	Graduate Engineer	WSP		☑	☐	☐	☐	☐	☐
Henry Swan	Utilities Reviewer	WSP		☑	☐	☐	☐	☐	☐
Jacinta Halim	Road Engineer/ Designer	WSP		☑	☐	☐	☐	☐	☐
Richelle Boston	Road Designer	WSP		☑	☐	☐	☐	☐	☐
Manisha Dhungel	Drainage Reviewer	WSP		☑	☑	☐	☑	☐	☐
Suchit Jani	Utilities Engineer	WSP		☑	☐	☐	☐	☐	☐
Zoe McLaughlin	Environmental Engineer	WSP		☐	☐	☐	☐	☐	☐
				☐	☐	☐	☐	☐	☐
				☐	☐	☐	☐	☐	☐
				☐	☐	☐	☐	☐	☐
				☐	☐	☐	☐	☐	☐

Project Safety In Design Risk Register
Links Road - St Marys

Highlighted cells are revised

Prepared by:	Andy Clune	21/11/2018
Reviewed by:	Nuno Muralha	21/11/2018

ID	Life Cycle Phase	Guideword	GMR	Description	Area/ Owner	Consequence	Likelihood	Inherent Risk	Design Controls Identified	High risk, novel or complex?	Design Actions and Outcomes (Design Verification)	Residual Risk Controls (other than design) to be investigated (O&M and / or Constructor Related Controls)	Consequence	Likelihood	Residual Risk Level	Status	Status Rationale /SFAIRP Argument (consider hierarchy of control)
1	Construction	3. Utilities / Services:	4.8 Excavation and stockpile collapse	*Trench collapse when excavating parallel and adjacent to existing utility assets. Potential engulfment and asset damage*	*Geotech*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.8.1 Ground conditions 4.8.2 Excavation management*	*YES*	*Further geotechnical investigation required at detailed design stage to ensure excavation can be completed safely*	*Ensure results of geotechnical investigation informs excavation*	***4 Serious***	***1 Rarely***	*4 Class 3 / L*	*Under Review*	*Awaiting results of geotechnical investigation*
2	Construction	3. Utilities / Services:	4.20 Essential service failure	*Damage to existing assets Working near bare OH conductors*	*Utility*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*4.20.1 Identification and testing*	*YES*	*Assets to be identified and measures to be implemented to prevent inadvertent contact and damage*	*Ensure operational activity does not inadvertently contact overhead wiring*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*SFAIRP For Design*	
3	Construction	4. Egress / Access:	4.14 Vehicle and plant incident (public areas)	*Work in verge and live traffic lanes risk of traffic accident and/or injury to workers by vehicles.*	*Traffic*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*4.14.1 Traffic planning 4.14.2 Pedestrian and vehicle segregation*	*YES*	*Traffic Management Plan to be developed as part of detailed design.*	*Ensure Traffic management plans are adhered to, and exclusion zones are provided.*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*SFAIRP For Design*	*Staging and traffic management will be considered to provide a safe worksite*
4	Construction	4. Egress / Access:	4.14 Vehicle and plant incident (public areas)	*Work in footpath and verge areas and risk of injuring pedestrians and cyclists.*	*Traffic*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*4.14.1 Traffic planning 4.14.2 Pedestrian and vehicle segregation*	*YES*	*Traffic Management Plan to be developed as part of detailed design. Create exclusion zones to prevent pedestrians / cyclists entering unsafe work areas.*	*Ensure Traffic management plans are adhered to, and exclusion zones are provided.*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*SFAIRP For Design*	*Staging and traffic management will be considered to provide a safe worksite*
5	Construction	9. Heights / Depths:	4.2 Fall of material / object	*Excavation near trees. Potential for injury by tree fall or equipment failure due to tree roots*	*Environment*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.2.5 Exclusions zones*	*YES*	*Nil*	*Assess tree condition on site, and ensure adequate exclusion zones are implemented*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*Transferred*	*Contractor to assess tree condition and set up exclusions zones*
6	Construction	4. Egress / Access:	4.8 Excavation and stockpile collapse	*Construction / trenching below water table. Risks of engulfment and flooding of occupied trench.*	*Geotech*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.8.1 Ground conditions*	*YES*	*Further geotechnical investigation required at detailed design stage to identify water table*	*Ensure results of geotechnical investigation informs excavation*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*Under Review*	*Awaiting results of geotechnical investigation*
7	Construction	4. Egress / Access:	4.8 Excavation and stockpile collapse	*Deep Excavations. Excavations up to 4m deep if open trench methodology is used, possibility of collapse or fall into trench*	*Geotech*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.8.1 Ground conditions 4.8.2 Excavation management*	*YES*	*Further geotechnical investigation required at detailed design stage to ensure excavation can be completed safely*	*Ensure results of geotechnical investigation informs excavation*	***4 Serious***	***1 Rarely***	*4 Class 3 / L*	*Under Review*	*Awaiting results of geotechnical investigation*
8	Operation	5. Position / Location:	4.14 Vehicle and plant incident (public areas)	*Inconsistent geometry through the intersection means vehicles lane discipline could be affected and side swap accidents may result*	*Road design*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*4.14.3 parking and traffic routes*	*YES*	*Intersection geometry to be revised in detailed design*	*Nil*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*Under Review*	*Geometry to be further investigated in detailed design*
9	Construction	3. Utilities / Services:	4.4 Uncontrolled release of electrical energy	*Damage to existing assets and electrocution if assets are damaged. Working near OHW*	*Utility*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.4.1 Identification and schematics 4.4.2 appropriate electrical equipment 4.4.4 isolation 4.4.5 live work 4.4.7 overhead conductors*	*YES*	*Consult with utility authority regarding protection of asset. To be further investigated in detailed design phase*	*Ensure operational activity does not inadvertently contact overhead wiring*	***4 Serious***	***1 Rarely***	*4 Class 3 / L*	*SFAIRP For Design*	
10	Construction	3. Utilities / Services:	4.4 Uncontrolled release of electrical energy	*Damage to existing assets and electrocution if assets are damaged. Working near underground electrical assets*	*Utility*	***4 Serious***	***3 Likely***	*12 Class 2 / M*	*4.4.1 Identification and schematics 4.4.2 appropriate electrical equipment 4.4.4 isolation 4.4.5 live work 4.4.8 underground services*	*YES*	*Consult with utility authority regarding protection of asset. Potholing survey recommended to physically locate service*	*Ensure all utilities on ground before starting any construction activity which could likely impact the existing utilities*	***4 Serious***	***1 Rarely***	*4 Class 3 / L*	*Under Review*	*Awaiting confirmation of potholing and subsequent results*
11	O&M	1. General Planning of the Project as a Whole:	4.3 Vehicle and plant incident (work sites)	*Unsafe turning locations for heavy vehicles (at all intersections) during construction and operation*	*Road design*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*4.3.1 Traffic management 4.3.2 Pedestrian and vehicle segregation 4.3.8 High Visibility clothing*	*YES*	*Swept path analysis completed for final design to ensure design vehicle can safely travel through intersections*	*Nil*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*Under Review*	*Risk eliminated for final design, needs to be considered for construction*
12	Construction	1. General Planning of the Project as a Whole:	4.3 Vehicle and plant incident (work sites)	*Works at intersection of Christie St and Lee Holm Drive, while still in use by live traffic, may result in vehicle colliding with workers.*	*Traffic*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*4.3.1 Traffic management 4.3.2 Pedestrian and vehicle segregation 4.3.8 High Visibility clothing*	*YES*	*Traffic Management Plan to be developed as part of detailed design*	*Ensure Traffic management plans are adhered to, and exclusion zones are provided.*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*SFAIRP For Design*	*Staging and traffic management will be considered to provide a safe worksite*
13	Construction	3. Utilities / Services:	4.15 Uncontrolled release of stored energy (non-electrical)	*Excavation over live underground gas lines - potential for asset damage and failure causing explosion*	*Utility*	***5 Catastrophic***	***2 Unlikely***	*10 Class 2 / M*	*4.15.1 isolation 4.15.5 Underground services (Non-electrical)*	*YES*	*Potholing survey recommended to physically locate service, allowing construction to avoid impacts.*	*Ensure all utilities on ground before starting any construction activity which could likely impact the existing utilities*	***5 Catastrophic***	***1 Rarely***	*5 Class 3 / L*	*Under Review*	*Awaiting confirmation of potholing and subsequent results*
14	Construction	3. Utilities / Services:	4.20 Essential service failure	*Excavation over critical assets. Potential for striking or failure of assets, causing network failure*	*Utility*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*4.20.1 Identification and testing*	*YES*	*Potholing survey recommended to physically locate service, allowing construction to avoid impacts.*	*Ensure all utilities on ground before starting any construction activity which could likely impact the existing utilities*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Under Review*	*Awaiting confirmation of potholing and subsequent results*
15	Construction	3. Utilities / Services:	4.20 Essential service failure	*Relocation of water mains may impact residents and businesses supply*	*Utility*	***2 Minor***	***3 Likely***	*6 Class 2 / M*	*4.20.1 Identification and testing*	*NO*	*Co-ordination with Sydney Water, will be considered in detailed design stage*	*Nil*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Under Review*	*Coordination with Sydney Water to be considered at a later stage*
16	Construction	12. Toxicity / Safety:	4.10 Occupational health exposure	*Disturbance of materials containing asbestos fibres. Potential for asbestosis if workers are exposed to inhale airborne fibre.*	*Environment*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.10.1 Hazardous substance and hazardous materials identification 4.10.3 Asbestos register and maintenance plan*	*YES*	*Further geotechnical investigation required at detailed design stage*	*Residual risk dependant on contamination testing results. If positive protective measures can be implemented*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Under Review*	*Awaiting results of geotechnical investigation*
17	Construction	12. Toxicity / Safety:	4.11 Public health exposure	*Disturbance of contaminated materials. Particular at the existing mound in the disused rail corridor - as this may have been used to dump waste soil/spoil from original construction*	*Environment*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*4.10.1 Hazardous substance and hazardous materials identification*	*YES*	*Further geotechnical investigation required at detailed design stage*	*Residual risk dependant on contamination testing results. If positive protective measures can be implemented*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Under Review*	*Awaiting results of geotechnical investigation*

Project Safety In Design Risk Register
Links Road - St Marys

Highlighted cells are revised

Prepared by:	Andy Clune	21/11/2018
Reviewed by:	Nuno Muralha	21/11/2018

ID	Life Cycle Phase	Guideword	GMR	Description	Area/ Owner	Consequence	Likelihood	Inherent Risk	Design Controls Identified	High risk, novel or complex?	Design Actions and Outcomes (Design Verification)	Residual Risk Controls (other than design) to be investigated (O&M and / or Constructor Related Controls)	Consequence	Likelihood	Residual Risk Level	Status	Status Rationale /SFAIRP Argument (consider hierarchy of control)
18	Operation	14. Environmental:	4.13 Degradation and pollution of the environment	*Links Road borders on zoned future regional park which is the natural habitat of kangaroos and emus. They can be seriously or fatally injured if they interact with road*	*Environment*	***2 Minor***	***4 Very Likely***	*8 Class 2 / M*	*4.13.4 Biodiversity and Natural Habitats*	*NO*	*Review fencing design to ensure it is adequate. To be completed in detailed design stage*	*If adequate fencing is provided residual risk is nil*	***1 Insignificant***	***1 Rarely***	*1 Class 3 / L*	*Eliminated*	*Risk will be eliminated with fence*
19	Operation	14. Environmental:	4.14 Vehicle and plant incident (public areas)	*Links Road borders on zoned future regional park which is the natural habitat of kangaroos and emus. They can be seriously or fatally injured if they interact with road*	*Environment*	***3 Moderate***	***4 Very Likely***	*12 Class 2 / M*	*4.14.2 Pedestrian and vehicle segregation*	*YES*	*Review fencing design to ensure it is adequate. To be completed in detailed design stage*	*If adequate fencing is provided residual risk is nil*	***1 Insignificant***	***1 Rarely***	*1 Class 3 / L*	*Eliminated*	*Risk will be eliminated with fence*
20	Construction	14. Environmental:	4.11 Public health exposure	*If access routes are blocked emergency services will be unable to service area in event of emergency. May also prevent evacuation*	*Constructability*	***4 Serious***	***3 Likely***	*12 Class 2 / M*		*YES*	*Nil*	*Ensure emergency access / evacuation routes are maintained during construction*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Under Review*	*Will be considered in construction staging, which is to be completed in detailed design stage*
21	Construction	14. Environmental:	4.13 Degradation and pollution of the environment	*No temporary drainage during construction, pollutants can damage waterway*	*Drainage and Hydrology*	***3 Moderate***	***5 Extreme Likely***	*15 Class 1 / H*	*4.13.1 Stormwater, sediment, and erosion controls*	*YES*	*Propose temporary drainage following construction staging development*	*Ensure temporary drainage structures are installed and maintained*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*SFAIRP For Design*	*Providing to standard temporary drainage represents current good practice*
22	Operation	14. Environmental:	4.11 Public health exposure	*Larger emergency vehicles will be unable to perform U-turn, preventing access/evacuation from area.*	*Constructability*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*		*YES*	*Won't be an issue as design vehicle is B-double.*	*Nil*	***1 Insignificant***	***1 Rarely***	*1 Class 3 / L*	*Eliminated*	*Risk Eliminated*
23	Operation	1. General Planning of the Project as a Whole:	4.14 Vehicle and plant incident (public areas)	*Along Links Road no dedicated pedestrian crossing is provided.*	*Pedestrian and Cyclists*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.14.1 Traffic planning 4.14.2 Pedestrian and vehicle segregation*	*YES*	*Safe crossing is provided at signalised intersection of Christie St and Lee Holm Rd. To be further investigated in detailed design*	*Nil*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*Under Review*	*To be reviewed during detailed design*
24	Construction	2. Interfaces External to the Project:	4.20 Essential service failure	*Sydney Water pumping station requires access. If access is blocked while service requires repair the network could fail.*	*Road design*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*4.20.3 System of work*	*NO*	*Consult with Sydney Water to confirm access requirements*	*Consult with Sydney Water during construction*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*SFAIRP For Design*	*Consultation with Sydney Water regarding access requirements will reduce risk to practical level*
25	Operation	1. General Planning of the Project as a Whole:	4.14 Vehicle and plant incident (public areas)	*Driver disregard of speed limit / other road rules, particularly at bend. Potential vehicle crash*	*Road design*	***4 Serious***	***3 Likely***	*12 Class 2 / M*	*4.14.1 Traffic planning 4.14.3 Parking and traffic routes*	*YES*	*Road safety considered throughout design. I.e.. At bend, features include: median, warning signage, appropriate line marking, etc. See design report for full details.*	*Nil*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*Under Review*	*Road geometry will continue to be reviewed during detailed design*
26	Operation	2. Interfaces External to the Project:	4.14 Vehicle and plant incident (public areas)	*Driver crash into Sydney Water Pumping Station, causing system failure*	*Road design*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*4.14.1 Traffic planning 4.14.3 Parking and traffic routes*	*YES*	*Road safety considered throughout design. I.e.. At bend, features include: median, warning signage, appropriate line marking, etc. See design report for full details.*	*Nil*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*Under Review*	*Road furniture will continue to be reviewed during detailed design*
27	Maintenance	3. Utilities / Services:	4.14 Vehicle and plant incident (public areas)	*Maintenance / repair / access to utility services often requires workers to be on road, where there is a risk of vehicle strike*	*Utility*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*4.14.1 Traffic planning*	*YES*	*Where possible move access points away from traffic.*	*Maintenance company to ensure traffic management controls are in place when necessary*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*SFAIRP For Design*	*If access points can be moved off road risk is eliminated. If not then traffic management will reduce risk so far as reasonable practical*

APPENDIX F

PAVEMENT DESIGN CIRCLY OUTPUT

CIRCLY Version 5.0u (8 April 2013)

Job Title: PS111235 Links Road - Full Depth Reconstruction

Damage Factor Calculation

Assumed number of damage pulses per movement:
One pulse per axle (i.e. use NROWS)

Traffic Spectrum Details:

ID: PS111235-1 Title: PS111235 Links Road - Full Depth Reconstruction

Load No.	Load ID	Movements
1	ESA75-Full	6.15E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA75-Full	SA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA75-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA75-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA75-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA75-Full	1	1965.0	0.0	1.00E+00	0.00

Layout of result points on horizontal plane:
Xmin: -165 Xmax: 1965 Xdel: 165
Y: 0

Details of Layered System:

ID: PS111235-1 Title: PS111235 Links Road - Full Depth Reconstruction

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	Gran_350	Aniso.	3.50E+02	0.35	2.60E+02	1.75E+02	0.35
2	rough	Gran_250	Aniso.	2.50E+02	0.35	1.85E+02	1.25E+02	0.35
3	rough	Sub_CBR3	Aniso.	3.00E+01	0.45	2.07E+01	1.50E+01	0.45

Performance Relationships:

Layer No.	Location	Performance ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
3	top	Sub_2004	EZZ	0.009300	7.000	1.600

Reliability Factors: Not Used.

Details of Layers to be sublayered:
Layer no. 1: Austroads (2004) sublayering
Layer no. 2: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	250.00	Gran_350		n/a	n/a
2	360.00	Gran_250		n/a	n/a
3	0.00	Sub_CBR3	ESA75-Full	9.23E-04	9.30E-01

APPENDIX G

LIGHTING DESIGN CALCULATIONS

Luminaire Schedule

Symbol	Qty	Label	LLF	Description	Total Watts	Total Lamp Lumens	Arm	Lum. Watts
	4	98376-4	0.700	SLA Roadster, HPS 250W WITH AEROSCREEN	1000	28000	4.5	250
	51	Roadster S40	0.700	SLA Roadster S400C, 400W WITH AROSCREEN	20400	48000	4.5	400

Luminaire Location Summary

LumNo	Label	X	Y	MH	Orient	Tilt	Switched	Tag (Qty)
1	Roadster S400C - 98382 - PR44-4m	292922.55	6264636.58	11.5	312.165	0	On	P2 (1)
2	Roadster S400C - 98382 - PR44-4m	292664.99	6264385.82	11.5	337.685	0	On	P2 (1)
3	Roadster S400C - 98382 - PR44-4m	292893.542	6264609.04	11.5	312.165	0	On	P2 (1)
4	Roadster S400C - 98382 - PR44-4m	292864.534	6264581.49	11.5	312.165	0	On	P2 (1)
5	Roadster S400C - 98382 - PR44-4m	292835.526	6264553.95	11.5	312.165	0	On	P2 (1)
6	Roadster S400C - 98382 - PR44-4m	292806.518	6264526.41	11.5	312.165	0	On	P2 (1)
7	Roadster S400C - 98382 - PR44-4m	292777.51	6264498.87	11.5	312.165	0	On	P2 (1)
8	Roadster S400C - 98382 - PR44-4m	292748.502	6264471.33	11.5	312.165	0	On	P2 (1)
9	Roadster S400C - 98382 - PR44-4m	292719.494	6264443.79	11.5	312.165	0	On	P2 (1)
10	Roadster S400C - 98382 - PR44-4m	292690.486	6264416.25	11.5	312.165	0	On	P2 (1)
11	Roadster S400C - 98382 - PR44-4m	292664.691	6264347.62	11.5	35.689	0	On	P2 (1)
12	Roadster S400C - 98382 - PR44-4m	292691.068	6264317.55	11.5	47.793	0	On	P2 (1)
13	Roadster S400C - 98382 - PR44-4m	292719.763	6264289.68	11.5	47.793	0	On	P2 (1)
14	Roadster S400C - 98382 - PR44-4m	292746.455	6264259.89	11.5	37.517	0	On	P2 (1)
15	Roadster S400C - 98382 - PR44-4m	292763.992	6264229.62	11.5	27.867	0	On	P2 (1)
16	Roadster S400C - 98382 - PR44-4m	292775.965	6264191.82	11.5	8.353	0	On	P2 (1)
17	Roadster S400C - 98382 - PR44-4m	292780.835	6264150.98	11.5	3.71	0	On	P2 (1)
18	Roadster S400C - 98382 - PR44-4m	292784.38	6264111.54	11.5	3.71	0	On	P2 (1)
19	Roadster S400C - 98382 - PR44-4m	292788.69	6264071.27	11.5	3.71	0	On	P2 (1)
20	Roadster S400C - 98382 - PR44-4m	292792.656	6264036.14	11.5	8.379	0	On	P2 (1)
21	Roadster S400C - 98382 - PR44-4m	292895.09	6263846.56	11.5	46.18	0	On	P2 (1)
22	Roadster S400C - 98382 - PR44-4m	292923.238	6263824.75	11.5	58.432	0	On	P2 (1)
23	Roadster S400C - 98382 - PR44-4m	293244.107	6263565.74	11.5	27.02	0	On	P2 (1)
24	98376-4	293206.047	6263584.77	11.5	297.574	0	On	P1 (1)
25	Roadster S400C - 98382 - PR44-4m	293261.622	6263529.40	11.5	30.608	0	On	P2 (1)
26	Roadster S400C - 98382 - PR44-4m	293281.736	6263497.21	11.5	26.733	0	On	P2 (1)
27	98376-4	293254.059	6263609.45	11.5	301.711	0	On	P1 (1)
28	Roadster S400C - 98382 - PR44-4m	292895.36	6263846.83	11.5	224.941	0	On	P2 (1)
29	Roadster S400C - 98382 - PR44-4m	292799.442	6264001.63	11.5	17.015	0	On	P2 (1)
30	Roadster S400C - 98382 - PR44-4m	292809.8	6263968.34	11.5	22.995	0	On	P2 (1)
31	Roadster S400C - 98382 - PR44-4m	292824.241	6263936.45	11.5	29.165	0	On	P2 (1)
32	Roadster S400C - 98382 - PR44-4m	292841.567	6263907.04	11.5	40.199	0	On	P2 (1)
33	Roadster S400C - 98382 - PR44-4m	292863.088	6263879.35	11.5	40.199	0	On	P2 (1)
34	Roadster S400C - 98382 - PR44-4m	292953.393	6263806.9	11.5	58.432	0	On	P2 (1)
35	Roadster S400C - 98382 - PR44-4m	292985.2	6263792.29	11.5	69.678	0	On	P2 (1)
36	Roadster S400C - 98382 - PR44-4m	293018.49	6263781.48	11.5	70.499	0	On	P2 (1)
37	Roadster S400C - 98382 - PR44-4m	293051.836	6263770.84	11.5	70.499	0	On	P2 (1)
38	Roadster S400C - 98382 - PR44-4m	293085.182	6263759.88	11.5	70.499	0	On	P2 (1)
39	Roadster S400C - 98382 - PR44-4m	293116.234	6263743.73	11.5	52.755	0	On	P2 (1)
40	Roadster S400C - 98382 - PR44-4m	293144.021	6263722.37	11.5	44.572	0	On	P2 (1)
41	Roadster S400C - 98382 - PR44-4m	293167.245	6263696.29	11.5	36.976	0	On	P2 (1)
42	Roadster S400C - 98382 - PR44-4m	293183.918	6263668.73	11.5	31.983	0	On	P2 (1)
43	Roadster S400C - 98382 - PR44-4m	293199.341	6263640.79	11.5	31.983	0	On	P2 (1)
44	Roadster S400C - 98382 - PR44-4m	293213.53	6263614.46	11.5	31.983	0	On	P2 (1)
45	Roadster S400C - 98382 - PR44-4m	293174.165	6263564.85	11.5	299.819	0	On	P2 (1)
46	Roadster S400C - 98382 - PR44-4m	293280.166	6263624.51	11.5	301.711	0	On	P2 (1)
47	Roadster S400C - 98382 - PR44-4m	293306.334	6263639.12	11.5	299.446	0	On	P2 (1)
48	Roadster S400C - 98382 - PR44-4m	293328.855	6263649.68	11.5	290.801	0	On	P2 (1)
49	Roadster S400C - 98382 - PR44-4m	293354.107	6263658.07	11.5	280.129	0	On	P2 (1)
50	Roadster S400C - 98382 - PR44-4m	293382.916	6263662.41	11.5	270.178	0	On	P2 (1)
51	Roadster S400C - 98382 - PR44-4m	293413.477	6263662.02	11.5	260.528	0	On	P2 (1)
52	Roadster S400C - 98382 - PR44-4m	293443.477	6263657.06	11.5	260.528	0	On	P2 (1)
53	98376-4	293217.26	6263563.53	11.5	117.815	0	On	P1 (1)
54	98376-4	293264.822	6263590.82	11.5	123.779	0	On	P1 (1)
55	Roadster S400C - 98382 - PR44-4m	293473.776	6263652.53	11.5	260.528	0	On	P2 (1)

LIGHTING DESIGN DISCLAIMER:

1. WSP LIGHTING CALCULATIONS AND ASSESSMENT HAVE BEEN PRODUCED USING AGI32. WHILE WE USE MOST SOPHISTICATED SOFTWARE, THE PROGRAMS OPERATE WITHIN THE LIMITATIONS OF THE PHOTOMETRIC DATA SUPPLIED BY MANUFACTURER, CALCULATION ALGORITHMS AND ASSUMPTIONS OF THE MODEL. THE RESULTS GIVE AN EXCELLENT INDICATION OF THE RELATIVITY AND MAGNITUDE OF ILLUMINANCE, HOWEVER, IT MUST BE EMPHASISED THAT THE FIGURES ARE DERIVED FROM A MODEL AND THE LEVELS MAY NOT EXACTLY CORRESPOND WITH ACTUAL MEASUREMENTS. THE CALCULATIONS ASSUME SURFACE FINISHES AND MAY NOT ALLOW FOR ACTUAL REFLECTANCE AND AMBIENT LIGHT, OR FOR SHADING OR OTHER BLOCKING OBJECTS.
2. THE ROAD IS DESIGNED TO COMPLY WITH AS 1158 1.1 TYPE V3, PATH WAY TYPE P4

PROJECT	DRAWING	REVISION	DATE	PAGE		
FORESHORE HSSV	**FORESHORE ROAD EASTBOUND LIGHTING LAYOUT**	**A**	**10/31/2018**	**Page 1 of 7**		**WSP AUSTRALIA PTY LIMITED** **LEVEL 27, 680 GEORGE STREET SYDNEY NSW 2001 AUSTRALIA** **TELEPHONE +61 2 9272 5100 FACSIMILE +61 2 9272 5101**

Luminaire Schedule								
Symbol	Qty	Label	LLF	Description	Total Watts	Total Lamp Lumens	Arm	Lum. Watts
	4	98376-4	0.700	SLA Roadster, HPS 250W WITH AEROSCREEN	1000	28000	4.5	250
	51	Roadster S40	0.700	SLA Roadster S400C, 400W WITH AROSCREEN	20400	48000	4.5	400

Numeric Summary						
Project: Cal 1						
Label	Units	Avg	Max	Min	Min/Avg	Max/Avg
Link Road - P1_Illum	Lux	20.33	42.0	7.9	0.39	2.07
Link Road - P1_Long_Unif	Cd/Sq.m	0.93	1.0	0.8	0.86	1.08
Link Road - P1_Luminance	Cd/Sq.m	2.03	3.6	0.7	0.34	1.77
Link Road - P1_Surr_Illum_Off-	Lux	8.19	11.8	5.7	0.70	1.44
Link Road - P1_Surr_Illum_Off-	Lux	26.44	39.8	15.1	0.57	1.51
Link Road - P1_Surr_Illum_On-L	Lux	12.27	17.7	7.9	0.64	1.44
Link Road - P1_Surr_Illum_On-R	Lux	27.64	42.0	15.8	0.57	1.52
Link Road - P1_Veil_Lum	Cd/Sq.m	0.36	0.5	0.2	0.56	1.39
Link Road - Pathway 1_Illum	Lux	26.26	38.3	15.1	0.58	1.46
Link Road - Pathway 1_Vert_Ill	Lux	16.89	30.2	5.6	0.33	1.79
Link road _P10_Illum	Lux	22.50	43.9	8.4	0.37	1.95
Link road _P10_Long_Unif	Cd/Sq.m	0.82	0.9	0.7	0.85	1.10
Link road _P10_Luminance	Cd/Sq.m	1.92	3.7	0.6	0.31	1.93
Link road _P10_Surr_Illum_Off-	Lux	7.27	10.6	5.4	0.74	1.46
Link road _P10_Surr_Illum_Off-	Lux	30.75	43.6	20.4	0.66	1.42
Link road _P10_Surr_Illum_On-L	Lux	10.92	16.1	7.4	0.68	1.47
Link road _P10_Surr_Illum_On-R	Lux	31.50	43.9	21.1	0.67	1.39
Link road _P10_Veil_Lum	Cd/Sq.m	0.58	0.7	0.3	0.52	1.21
Link road _P2_Illum	Lux	21.78	41.3	8.8	0.40	1.90
Link road _P2_Long_Unif	Cd/Sq.m	0.74	0.8	0.7	0.95	1.08
Link road _P2_Luminance	Cd/Sq.m	1.18	2.3	0.7	0.59	1.95
Link road _P2_Surr_Illum_Off-L	Lux	10.80	17.3	5.9	0.55	1.60
Link road _P2_Surr_Illum_Off-R	Lux	25.03	35.8	15.1	0.60	1.43
Link road _P2_Surr_Illum_On-L	Lux	14.85	21.1	8.1	0.55	1.42
Link road _P2_Surr_Illum_On-R	Lux	28.25	41.5	17.3	0.61	1.47
Link road _P2_Veil_Lum	Cd/Sq.m	0.36	0.4	0.2	0.56	1.11
Link road _P3_Illum	Lux	19.66	41.9	7.6	0.39	2.13
Link road _P3_Long_Unif	Cd/Sq.m	2.35	2.8	1.2	0.51	1.19
Link road _P3_Luminance	Cd/Sq.m	1.56	3.6	0.5	0.32	2.31
Link road _P3_Surr_Illum_Off-L	Lux	25.27	40.1	13.4	0.53	1.59
Link road _P3_Surr_Illum_Off-R	Lux	6.63	23.3	4.1	0.62	3.51
Link road _P3_Surr_Illum_On-L	Lux	27.28	41.9	15.6	0.57	1.54
Link road _P3_Surr_Illum_On-R	Lux	9.10	22.9	5.5	0.60	2.52
Link road _P3_Veil_Lum	Cd/Sq.m	0.26	0.4	0.1	0.38	1.54
Link road _P4_Illum	Lux	21.86	42.4	8.1	0.37	1.94
Link road _P4_Long_Unif	Cd/Sq.m	2.30	3.4	1.0	0.43	1.48
Link road _P4_Luminance	Cd/Sq.m	1.34	3.6	0.5	0.37	2.69
Link road _P4_Surr_Illum_Off-L	Lux	26.08	37.7	15.6	0.60	1.45
Link road _P4_Surr_Illum_Off-R	Lux	7.09	10.1	4.7	0.66	1.42
Link road _P4_Surr_Illum_On-L	Lux	30.34	42.5	18.1	0.60	1.40
Link road _P4_Surr_Illum_On-R	Lux	10.74	15.6	6.9	0.64	1.45
Link road _P4_Veil_Lum	Cd/Sq.m	0.23	0.4	0.1	0.43	1.74
Link road _P5_Illum	Lux	19.91	41.8	7.7	0.39	2.10
Link road _P5_Long_Unif	Cd/Sq.m	2.64	3.4	1.2	0.45	1.29
Link road _P5_Luminance	Cd/Sq.m	1.45	3.4	0.4	0.28	2.34
Link road _P5_Surr_Illum_Off-L	Lux	22.22	36.4	12.1	0.54	1.64
Link road _P5_Surr_Illum_Off-R	Lux	7.10	11.7	4.2	0.59	1.65
Link road _P5_Surr_Illum_On-L	Lux	25.85	41.6	13.9	0.54	1.61
Link road _P5_Surr_Illum_On-R	Lux	10.56	17.6	5.7	0.54	1.67
Link road _P5_Veil_Lum	Cd/Sq.m	0.40	0.6	0.2	0.50	1.50

Calculation Summary						
Project: Cal 2						
Label	Units	Avg	Max	Min	Min/Avg	Min/Max
Link road _P11_Illum	Lux	22.58	43.7	9.6	0.43	0.22
Link road _P11_Long_Unif	Cd/Sq.m	0.96	1.2	0.6	0.63	0.50
Link road _P11_Luminance	Cd/Sq.m	1.63	3.8	0.5	0.31	0.13
Link road _P11_Surr_Illum_Off-	Lux	8.10	13.5	3.7	0.46	0.27
Link road _P11_Surr_Illum_Off-	Lux	26.63	43.1	16.5	0.62	0.38
Link road _P11_Surr_Illum_On-L	Lux	11.98	19.7	5.1	0.43	0.26
Link road _P11_Surr_Illum_On-R	Lux	29.81	43.7	18.5	0.62	0.42
Link road _P11_Veil_Lum	Cd/Sq.m	0.16	0.2	0.1	0.63	0.50
Link road _P12_Illum	Lux	25.65	45.6	9.4	0.37	0.21
Link road _P12_Long_Unif	Cd/Sq.m	1.26	1.8	0.7	0.56	0.39
Link road _P12_Luminance	Cd/Sq.m	2.01	4.4	0.6	0.30	0.14
Link road _P12_Surr_Illum_Off-	Lux	10.77	17.0	6.4	0.59	0.38
Link road _P12_Surr_Illum_Off-	Lux	24.63	37.1	15.2	0.62	0.41
Link road _P12_Surr_Illum_On-L	Lux	15.74	23.9	9.2	0.58	0.38
Link road _P12_Surr_Illum_On-R	Lux	30.18	43.5	20.0	0.66	0.46
Link road _P12_Veil_Lum	Cd/Sq.m	0.29	0.4	0.2	0.69	0.50
Link road _P13_Illum	Lux	20.62	42.3	10.8	0.52	0.26
Link road _P13_Long_Unif	Cd/Sq.m	0.87	0.9	0.8	0.92	0.89
Link road _P13_Luminance	Cd/Sq.m	1.42	3.3	0.7	0.49	0.21
Link road _P13_Surr_Illum_Off-	Lux	18.05	41.8	2.7	0.15	0.06
Link road _P13_Surr_Illum_Off-	Lux	14.46	28.2	3.5	0.24	0.12
Link road _P13_Surr_Illum_On-L	Lux	17.45	39.6	3.4	0.19	0.09
Link road _P13_Surr_Illum_On-R	Lux	12.92	21.3	4.5	0.35	0.21
Link road _P13_Veil_Lum	Cd/Sq.m	0.15	0.2	0.1	0.67	0.50
Link road _P14_Illum	Lux	28.19	48.8	9.2	0.33	0.19
Link road _P14_Long_Unif	Cd/Sq.m	3.08	3.6	2.5	0.81	0.69
Link road _P14_Luminance	Cd/Sq.m	2.21	4.6	0.7	0.32	0.15
Link road _P14_Surr_Illum_Off-	Lux	34.14	47.2	13.9	0.41	0.29
Link road _P14_Surr_Illum_Off-	Lux	13.08	31.0	6.0	0.46	0.19
Link road _P14_Surr_Illum_On-L	Lux	36.79	48.5	19.2	0.52	0.40
Link road _P14_Surr_Illum_On-R	Lux	18.01	38.2	8.5	0.47	0.22
Link road _P14_Veil_Lum	Cd/Sq.m	0.23	0.3	0.2	0.87	0.67
Link road _P6_Illum	Lux	21.59	43.5	7.5	0.35	0.17
Link road _P6_Long_Unif	Cd/Sq.m	0.92	1.8	0.7	0.76	0.39
Link road _P6_Luminance	Cd/Sq.m	1.94	3.5	0.6	0.31	0.17
Link road _P6_Surr_Illum_Off-L	Lux	6.47	13.1	4.6	0.71	0.35
Link road _P6_Surr_Illum_Off-R	Lux	29.23	43.6	15.0	0.51	0.34
Link road _P6_Surr_Illum_On-L	Lux	9.62	18.8	6.3	0.65	0.34
Link road _P6_Surr_Illum_On-R	Lux	29.71	43.7	16.0	0.54	0.37
Link road _P6_Veil_Lum	Cd/Sq.m	0.42	0.5	0.2	0.48	0.40
Link road _P7_Illum	Lux	22.80	44.0	9.2	0.40	0.21
Link road _P7_Long_Unif	Cd/Sq.m	0.94	1.5	0.6	0.64	0.40
Link road _P7_Luminance	Cd/Sq.m	1.92	3.4	0.6	0.31	0.18
Link road _P7_Surr_Illum_Off-L	Lux	4.58	7.4	3.2	0.70	0.43
Link road _P7_Surr_Illum_Off-R	Lux	28.84	41.7	15.4	0.53	0.37
Link road _P7_Surr_Illum_On-L	Lux	6.60	11.0	4.6	0.70	0.42
Link road _P7_Surr_Illum_On-R	Lux	31.80	44.2	19.5	0.61	0.44
Link road _P7_Veil_Lum	Cd/Sq.m	0.59	0.7	0.4	0.68	0.57

LIGHTING DESIGN DISCLAIMER:

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2. THE ROAD IS DESIGNED TO COMPLY WITH AS 1158 1.1 TYPE V3, PATH WAY TYPE P4

PROJECT	DRAWING	REVISION	DATE	PAGE		
LINK ROAD	**LINK ROAD** **LIGHTING LAYOUT**	**A**	**10/31/2018**	**Page 2 of 7**		**WSP AUSTRALIA PTY LIMITED** **LEVEL 27, 680 GEORGE STREET SYDNEY NSW 2001 AUSTRALIA** **TELEPHONE +61 2 9272 5100 FACSIMILE +61 2 9272 5101**

Luminaire Schedule								
Symbol	**Qty**	**Label**	**LLF**	**Description**	**Total Watts**	**Total Lamp Lumens**	**Arm**	**Lum. Watts**
	4	98376-4	0.700	SLA Roadster, HPS 250W WITH AEROSCREEN	1000	28000	4.5	250
	51	Roadster S40	0.700	SLA Roadster S400C, 400W WITH AROSCREEN	20400	48000	4.5	400

Numeric Summary						
Project: Cal 3						
Label	**Units**	**Avg**	**Max**	**Min**	**Min/Avg**	**Max/Avg**
Link road _P15_Illum	Lux	26.26	48.0	9.7	0.37	1.83
Link road _P15_Long_Unif	Cd/Sq.m	2.84	3.8	1.8	0.63	1.34
Link road _P15_Luminance	Cd/Sq.m	2.02	4.3	0.6	0.30	2.13
Link road _P15_Surr_Illum_Off-	Lux	33.45	42.1	19.3	0.58	1.26
Link road _P15_Surr_Illum_Off-	Lux	6.79	10.6	5.0	0.74	1.56
Link road _P15_Surr_Illum_On-L	Lux	38.30	47.8	25.8	0.67	1.25
Link road _P15_Surr_Illum_On-R	Lux	9.94	15.3	7.1	0.71	1.54
Link road _P15_Veil_Lum	Cd/Sq.m	0.53	0.6	0.3	0.57	1.13
Link road _P16_Illum	Lux	28.17	46.3	13.0	0.46	1.64
Link road _P16_Long_Unif	Cd/Sq.m	3.61	4.2	2.8	0.78	1.16
Link road _P16_Luminance	Cd/Sq.m	2.29	4.4	0.6	0.26	1.92
Link road _P16_Surr_Illum_Off-	Lux	33.13	43.3	24.4	0.74	1.31
Link road _P16_Surr_Illum_Off-	Lux	9.52	12.5	7.4	0.78	1.31
Link road _P16_Surr_Illum_On-L	Lux	36.33	46.2	28.7	0.79	1.27
Link road _P16_Surr_Illum_On-R	Lux	14.34	18.7	11.0	0.77	1.30
Link road _P16_Veil_Lum	Cd/Sq.m	0.52	0.6	0.3	0.58	1.15
Link road _P17_Illum	Lux	25.11	39.3	9.9	0.39	1.57
Link road _P17_Long_Unif	Cd/Sq.m	0.70	1.4	0.2	0.29	2.00
Link road _P17_Luminance	Cd/Sq.m	1.53	3.0	0.5	0.33	1.96
Link road _P17_Surr_Illum_Off-	Lux	11.73	30.8	2.3	0.20	2.63
Link road _P17_Surr_Illum_Off-	Lux	19.55	27.7	7.7	0.39	1.42
Link road _P17_Surr_Illum_On-L	Lux	14.61	35.3	3.1	0.21	2.42
Link road _P17_Surr_Illum_On-R	Lux	24.12	36.4	9.1	0.38	1.51
Link road _P17_Veil_Lum	Cd/Sq.m	0.10	0.1	0.1	1.00	1.00
Link road _P18_Illum	Lux	22.43	41.6	10.4	0.46	1.85
Link road _P18_Long_Unif	Cd/Sq.m	1.45	1.8	1.0	0.69	1.24
Link road _P18_Luminance	Cd/Sq.m	1.92	3.0	0.8	0.42	1.56
Link road _P18_Surr_Illum_Off-	Lux	12.91	22.0	7.8	0.60	1.70
Link road _P18_Surr_Illum_Off-	Lux	25.83	42.2	16.0	0.62	1.63
Link road _P18_Surr_Illum_On-L	Lux	17.80	31.1	10.3	0.58	1.75
Link road _P18_Surr_Illum_On-R	Lux	26.22	41.8	15.5	0.59	1.59
Link road _P18_Veil_Lum	Cd/Sq.m	0.36	0.4	0.3	0.83	1.11
Link road _P8_Illum	Lux	24.16	60.7	8.3	0.34	2.51
Link road _P8_Long_Unif	Cd/Sq.m	2.15	2.6	1.7	0.79	1.21
Link road _P8_Luminance	Cd/Sq.m	2.04	3.4	0.7	0.34	1.67
Link road _P8_Surr_Illum_Off-L	Lux	9.34	17.7	5.7	0.61	1.90
Link road _P8_Surr_Illum_Off-R	Lux	8.08	15.8	4.2	0.52	1.96
Link road _P8_Surr_Illum_On-L	Lux	13.80	25.6	7.6	0.55	1.86
Link road _P8_Surr_Illum_On-R	Lux	11.87	23.6	5.8	0.49	1.99
Link road _P8_Veil_Lum	Cd/Sq.m	0.41	0.6	0.2	0.49	1.46
Link road _P9_Illum	Lux	23.59	51.4	9.8	0.42	2.18
Link road _P9_Long_Unif	Cd/Sq.m	1.20	2.0	0.8	0.67	1.67
Link road _P9_Luminance	Cd/Sq.m	1.99	3.4	0.6	0.30	1.71
Link road _P9_Surr_Illum_Off-L	Lux	7.67	15.0	5.4	0.70	1.96
Link road _P9_Surr_Illum_Off-R	Lux	31.65	52.4	18.2	0.58	1.66
Link road _P9_Surr_Illum_On-L	Lux	11.36	21.2	7.6	0.67	1.87
Link road _P9_Surr_Illum_On-R	Lux	32.54	52.0	21.6	0.66	1.60
Link road _P9_Veil_Lum	Cd/Sq.m	0.45	0.6	0.3	0.67	1.33

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2. THE ROAD IS DESIGNED TO COMPLY WITH AS 1158 1.1 TYPE V3, PATH WAY TYPE P4

WSP AUSTRALIA PTY LIMITED
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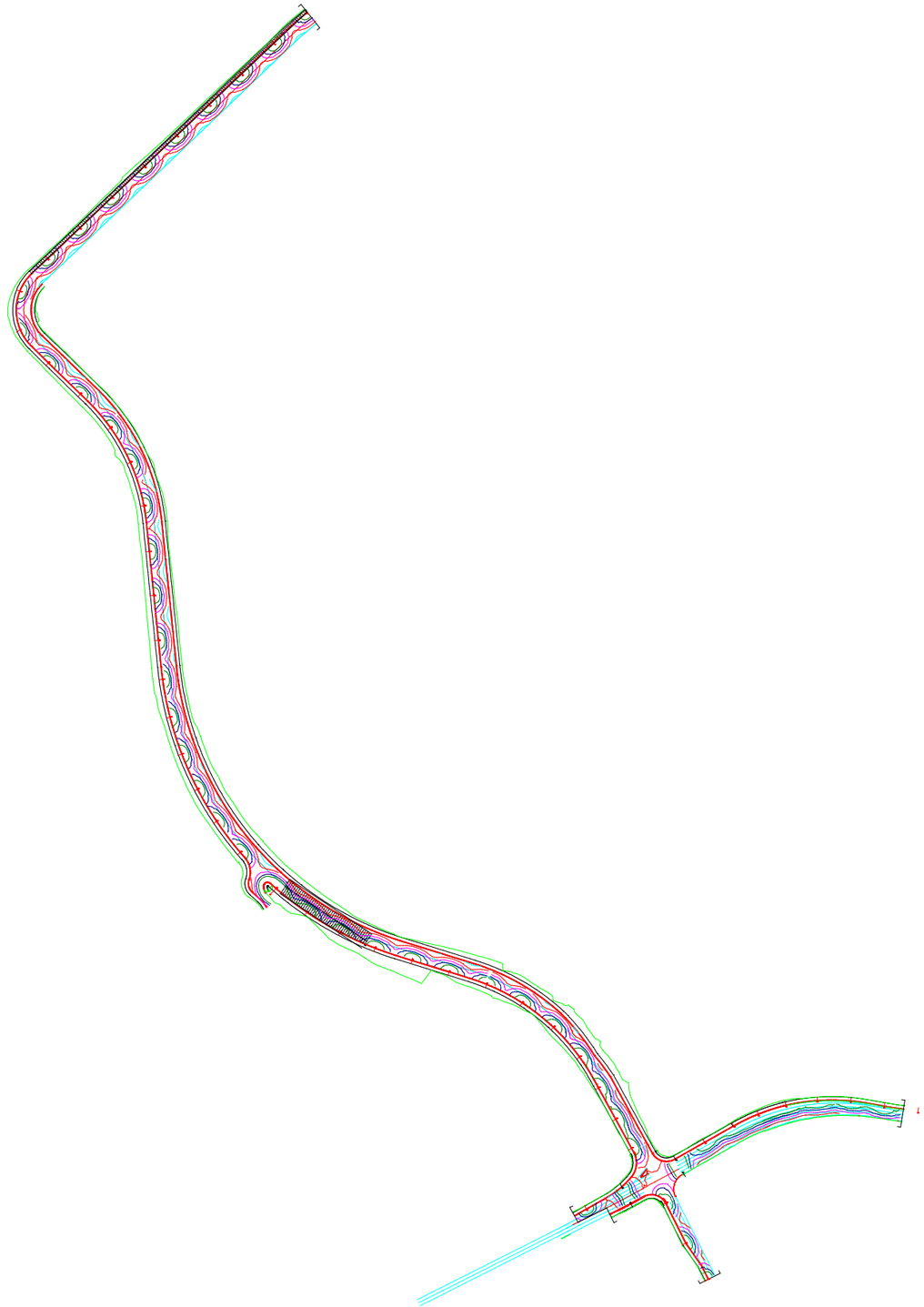
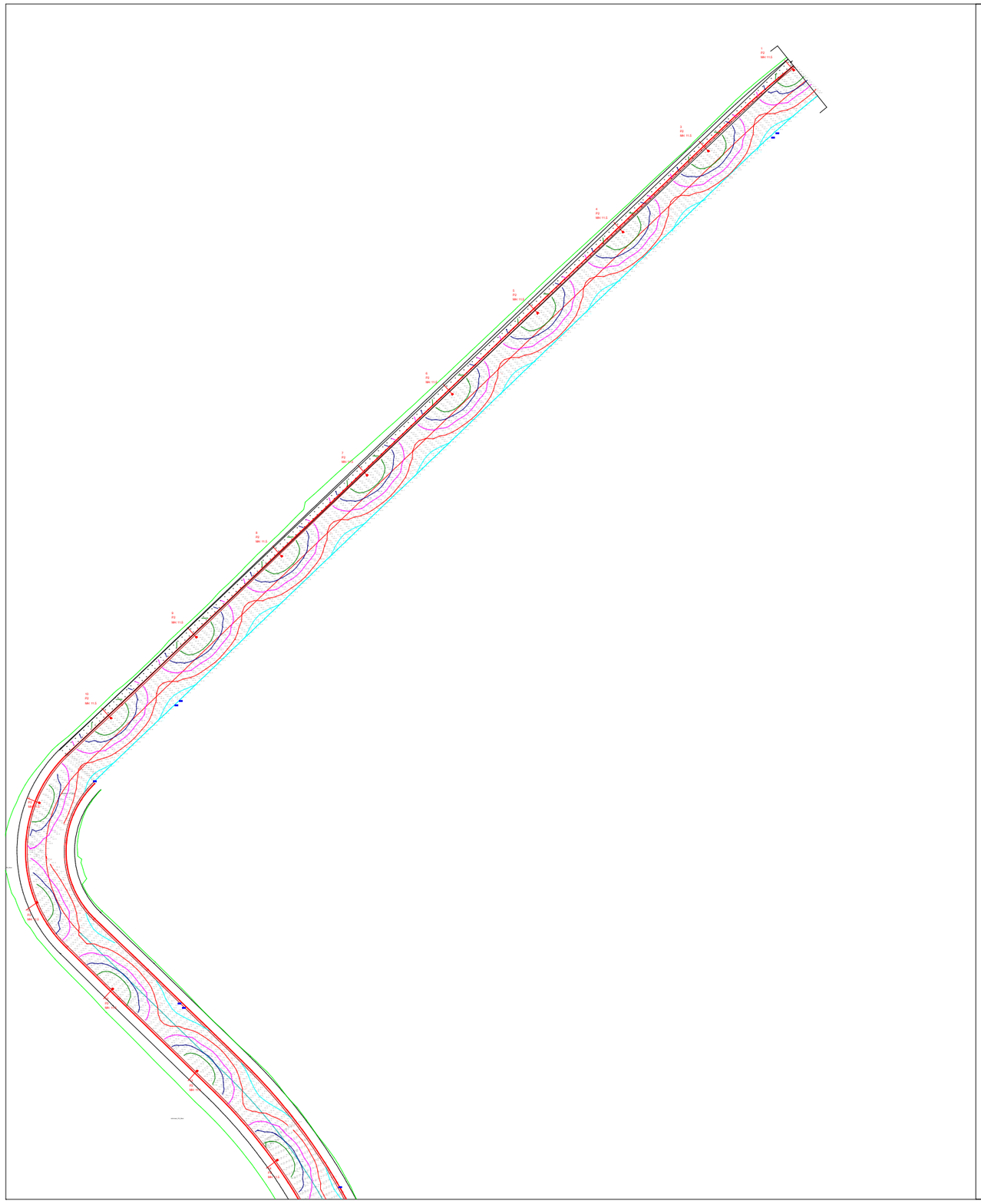
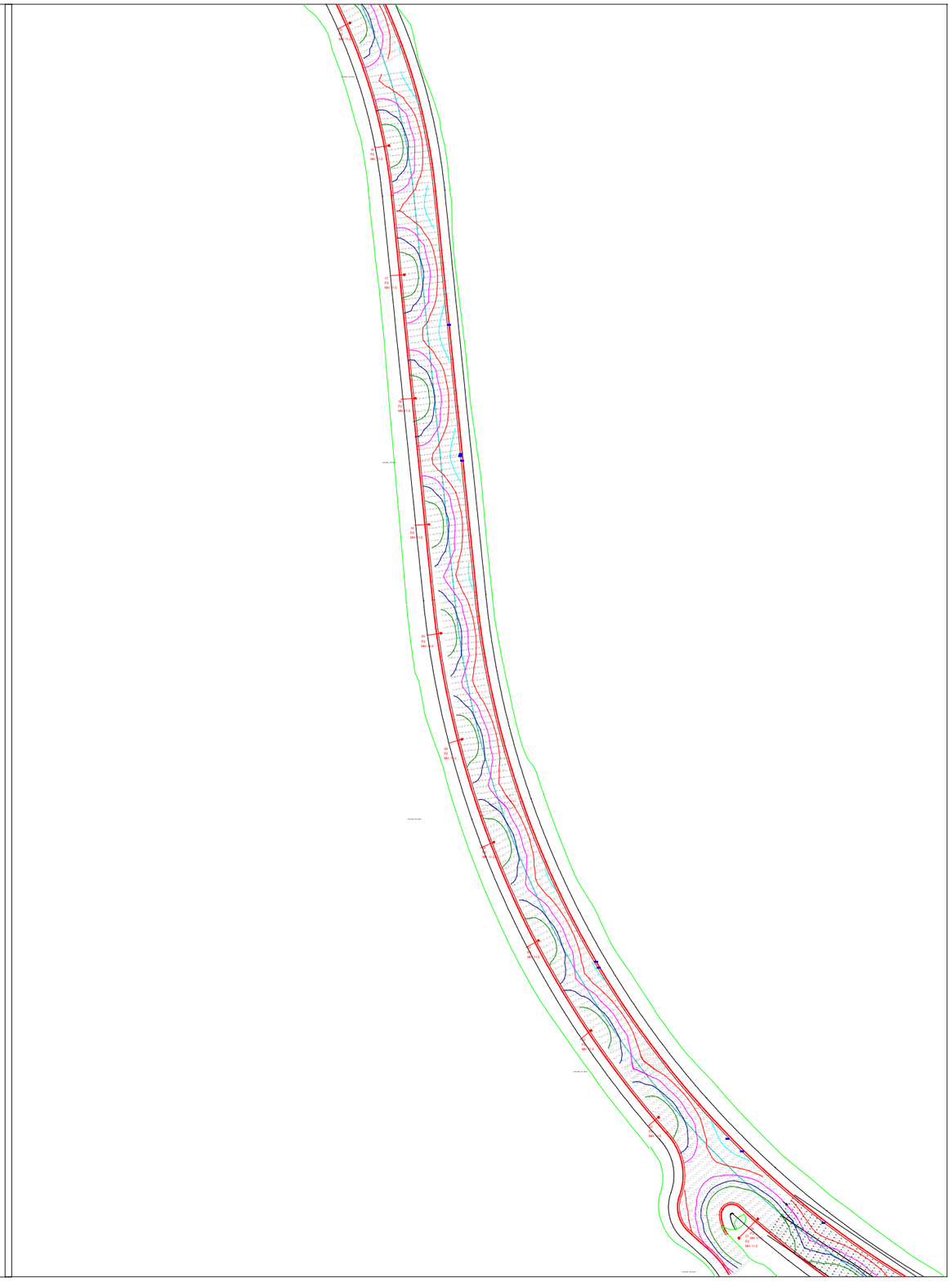
TELEPHONE +61 2 9272 5100 FACSIMILE +61 2 9272 5101



PROJECT	DRAWING	REVISION	DATE	PAGE		
LINK ROAD	**LINK ROAD LIGHTING LAYOUT**	**A**	**10/31/2018**	**Page 4 of 7**		**WSP AUSTRALIA PTY LIMITED LEVEL 27, 680 GEORGE STREET SYDNEY NSW 2001 AUSTRALIA TELEPHONE +61 2 9272 5100 FACSIMILE +61 2 9272 5101**





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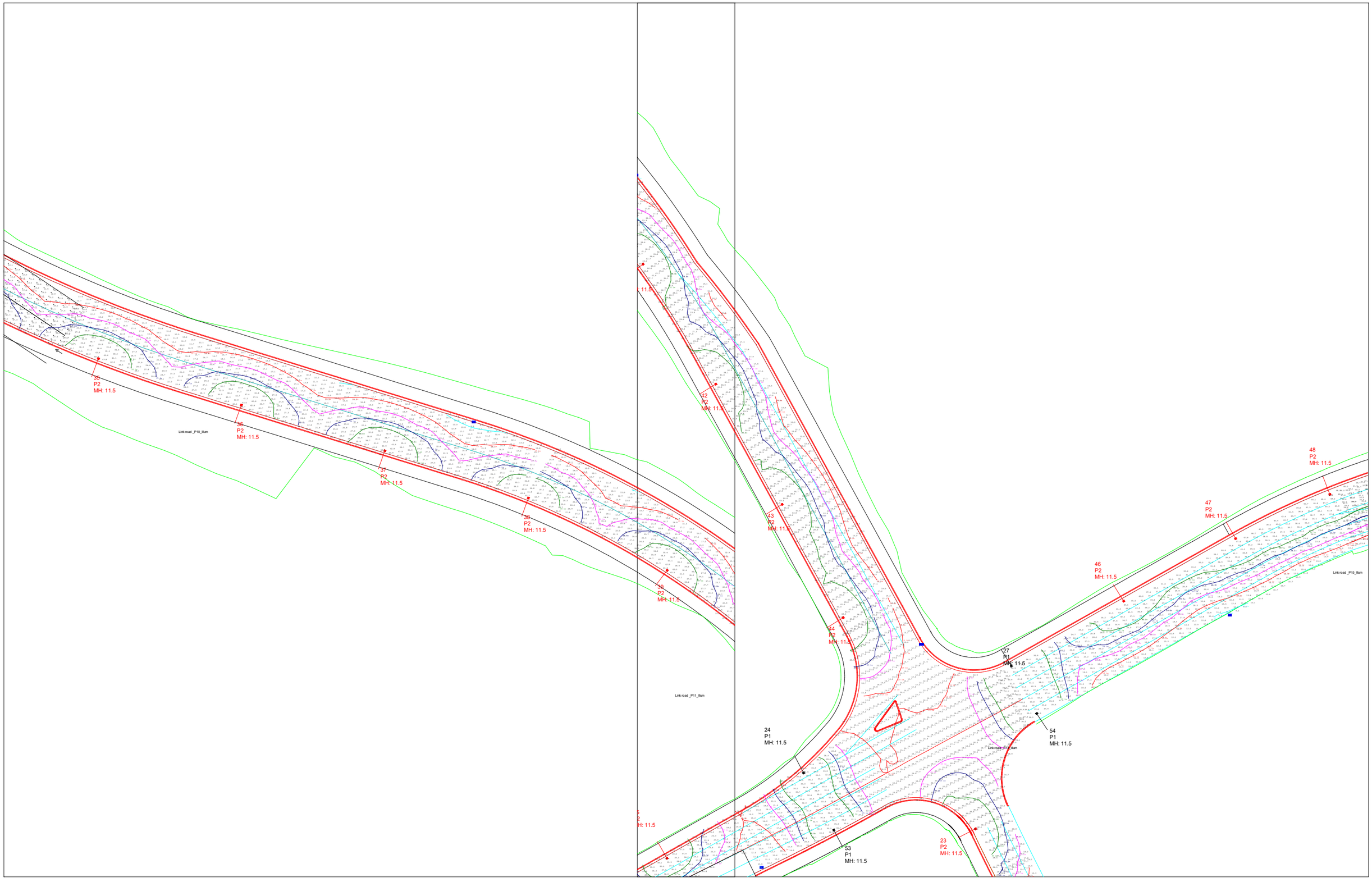

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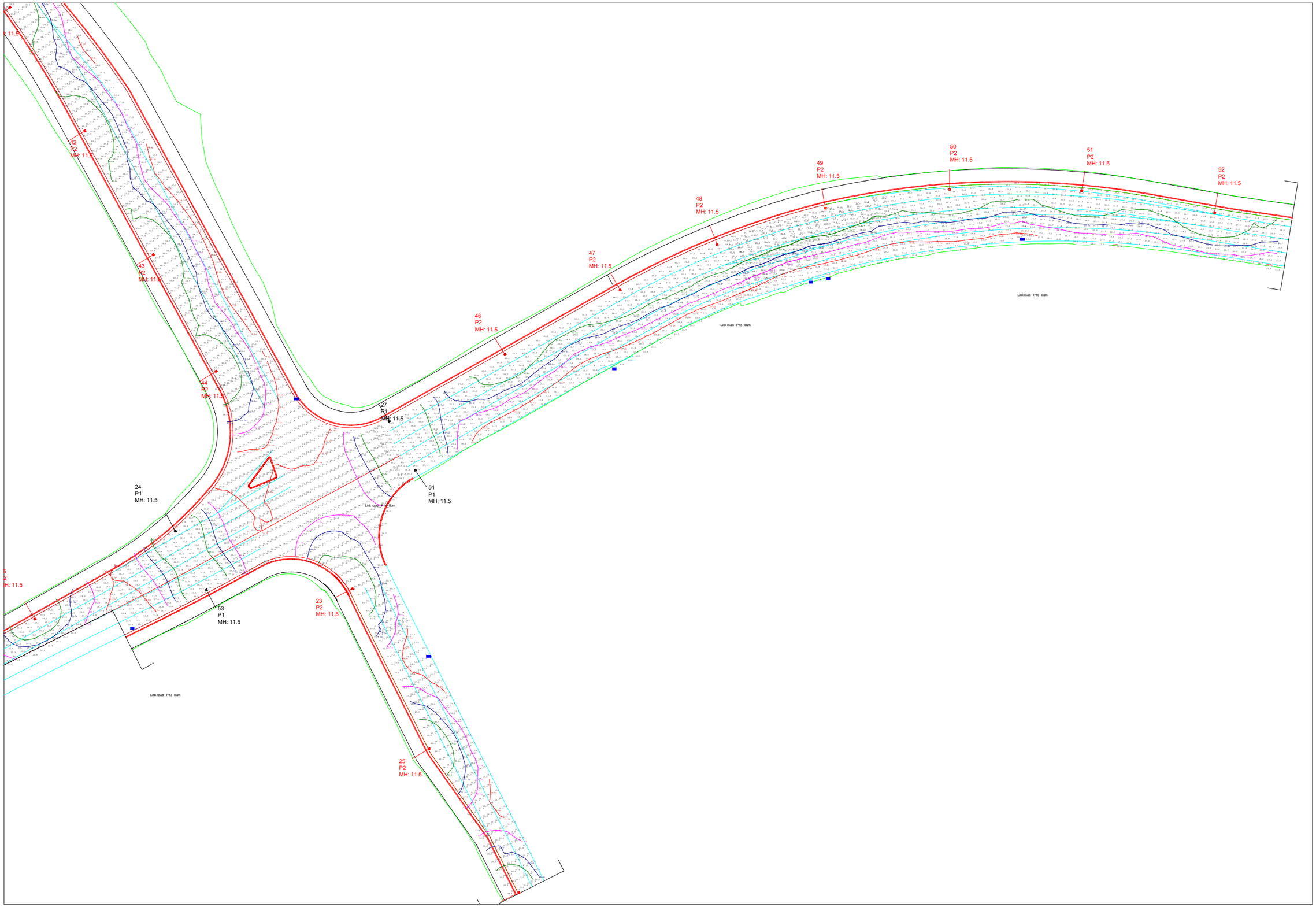

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APPENDIX H

SYLVANIA ROADSTER TECHNICAL DATA

SYLVANIA
ROADSTER SERIES

FUNCTIONAL (CATEGORY V)

FEATURES

- 100, 150, 250 & 400W HID lamps
- Integral 250V HPF control gear tray
- Complies to AS1158-1 Category V and AS1158.6

KEY APPLICATIONS

- Roadway (V)
- Amenity
- Security

The Roadster series is high performance utilitarian luminaire specifically designed for the Australian/New Zealand major road lighting requirements. The standard semi cutoff optical system with 100,150, 250 or 400 watt clear sodium lamps is optimised to provide the maximum spacing complying with AS1158-1 Category V. Combined with an IP66 lamp chamber and self cleaning visor minimises light loss, due to dirt accumulation, reducing the maintenance factor resulting in a highly energy efficient luminaire.

Metal Halide 100/150/250 watt clear and coated lamps combined with standard IR control gear.

An aeroscreen flat glass visor is available as optional for areas requiring additional control of upward light.

The Roadster series body is a single piece pressure die-cast aluminium providing for side entry mounting. Control gear is integral, which is serviced via the rear cover assembly and complies with AS1158.6 major road requirements.

LUMINAIRE CONSTRUCTION

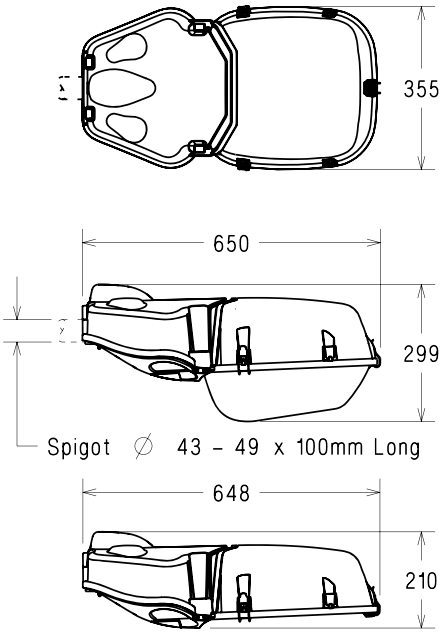
- Pressure die-cast one piece aluminium body
- IP66 optical chamber with semi cut off acrylic visor
- IP24 control chamber with High density polyethylene cover with captive quick release clips
- Side entry mounting 43 to 48mm O.D. pipe
- Stainless steel toggle latches and fasteners
- Natural finish

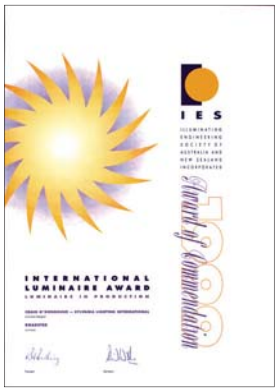
OPTIONS AVAILABLE

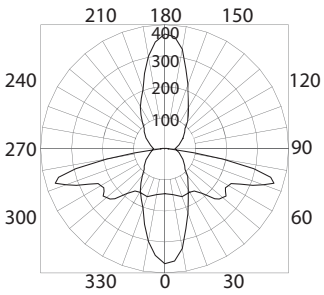
- 240V control gear
- Environ control gear (Integral 150W & 250W, HPS & MH, 400 HPS only)
- Aeroscreen flat glass visor
- NEMA Photoelectric control switch
- 60mm (50NB) mounting kit
- Polyester powdercoat finish

Description	Lamp	Base	Weight (kg)	Order Code
Roadster 100W HPS	SHPT100	E39/E40	10.00	PR47100L
Roadster 150W HPS	SHPT150	E39/E40	10.00	PR42103L
Roadster 250W HPS	SHPT250	E39/E40	10.50	PR43100L
Roadster 400W HPS	SHPT400	E39/E40	12.00	PR44100L
Roadster 150W MH	MP150/CO/U	E27	10.00	PR26100L
Roadster 250W MH	HSITHX250	E39/E40	10.50	PR21100L

Note: The above codes are for standard products only. Please refer to your local representative for more options.







Roadster 250W HPS
- - - - Vertical Plane Through Horizontal Angles (10-190)
—— Horizontal Cone Through Vertical Angle (62.5)
cd/klm