MARYLAND DEVELOPMENT COMPANY PTY LTD
(LENDLEASE COMMUNITIES)

PORTION ONE - LINKS ROAD EXTENSION AND UPGRADE, ST MARYS

DESIGN REPORT

PORTION 1 (CH 0 – CH1020)

NOVEMBER 19

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Portion One - Links Road Extension and Upgrade, St Marys
Design Report

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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
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 lead engineering services for 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.

The concept design and **S**tatement of Environmental Effects has been completed by WSP and formed the Development Application to Penrith City Council submitted on November 2018. 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.

Since the submission of the DA, the project has been divided into two portions, Portion 1 (CH0 – CH1020) and Portion 2 (CH1020 – CH1500) and Lendlease Communities has engaged WSP to commence the detailed design of Portion 1 to expedite the Construction Certification design phase. This report details the design development of Portion 1.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Links Road Extension/ Upgrade project is located approximately 5 kilometres north-east of Penrith and 45 kilometres west of Sydney CBD. The full extent of 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 existing T-Junction is intended to be upgraded to a 4-way signalised intersection.

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 SEE was prepared by WSP to form the Development Application 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.

The project has been divided into two portions, Portion 1 (CH0 – CH1020) and Portion 2 (CH1020 – CH1500) to expedite the Construction Certification phase of Portion 1. This report details the design development of Portion 1, see Figure 1.2 for the location of Portion 1 and Portion 2 areas.

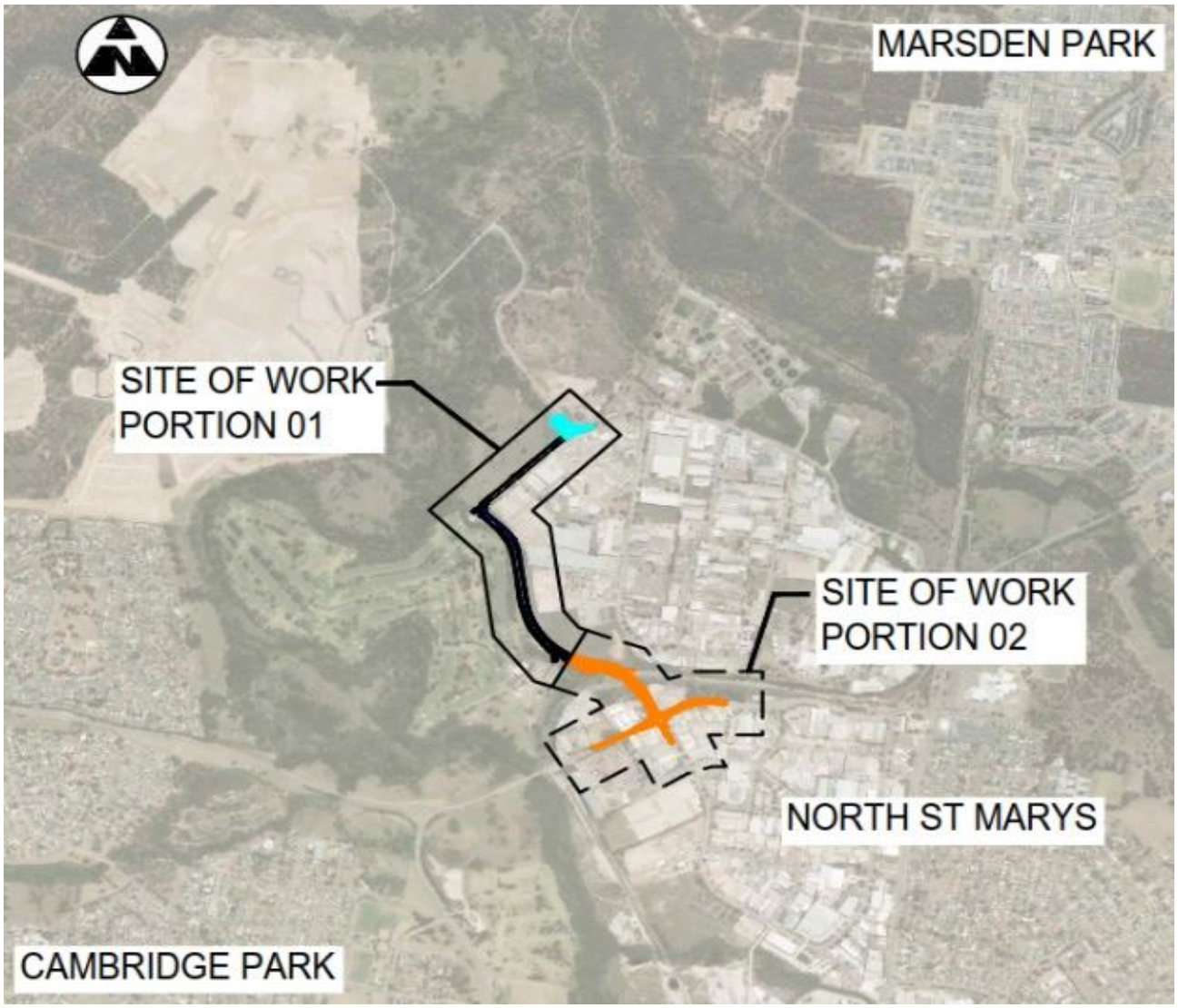

Figure 1.2 Portion 1 and Portion 2 extent of work

2 DESIGN DEVELOPMENT

This design report supports the application for the development of the Portion One upgrade works for Links Road. Subsequent to the original DA submission in November 2018, several meetings and queries have been raised and enabled a significant development of the current design. Copies of the RFIs received from Council and their response have been included in this report and can be found in Appendix A

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, where practicable, with the St Marys Planning Agreement, Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments, Penrith City Council Engineering Constructions Specification for Civil Works, Austroads Guide to Road Design and the RMS supplements to 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, as well as in response to the subsequent DA RFIs to Penrith City Council and a design review meeting held on 25th June 2019. 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 speed criteria were developed in accordance with Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments and in consultation with Penrith City Council engineering representatives. The project has adopted the design and posted speeds listed in Table 1 below. In accordance with Section 2.2.13 of the Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments, *"the design speed to be used for a particular road shall be the legal road speed limit of that road*", the design and posted speed adopted are equal.

We note that as per the Austroads Guidelines and general practice the design speed is 10 km/h higher than the posted speed in urban areas however the project has given precedence and used the Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments standard as inconsistencies have been identified between the Penrith City Council and Austroads Guidelines about the design speed criteria.

These are shown in Table 1 below.

Table 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 POSTED SPEED

Feedback from Council after the design review meeting on 25th June 2019 when discussing the geometrically constrained site noted that the design speed for Links Road, "*...in places this is not achievable, sufficient justification for the reduction of the design speed shall be provided to Council for review and acceptance.*" As such the following section provides this justification.

The existing Links Road is posted at 60km/h and assumes that the design speed matches this speed limit. The Links Road Extension project has tried to match the existing design speed of 60 km/h however this is not achievable along the full length of Links Road due to the road corridor constraints and property impacts. See Figure 1 for the achievable speeds within Portion 1 of the current detailed design. Although there are sections within the proposed design that meets 60km/h design speed there are sections where 60km/h is unachievable.

At approximately CH320, there is a 90degree bend in the road alignment and the design speed can only achieve 35 km/h due to the sharp radius (R39m) and truck turning criteria. The road geometry continuing south of this sharp bend can only achieve 50km/h speed limit due to superelevation and development length requirements.

To conform to a 60km/h speed limit, a significant land intake would be required on the private land owned by Sydney Water and the Dunheved Golf Club which is an undesirable outcome and does not align with the project objectives.

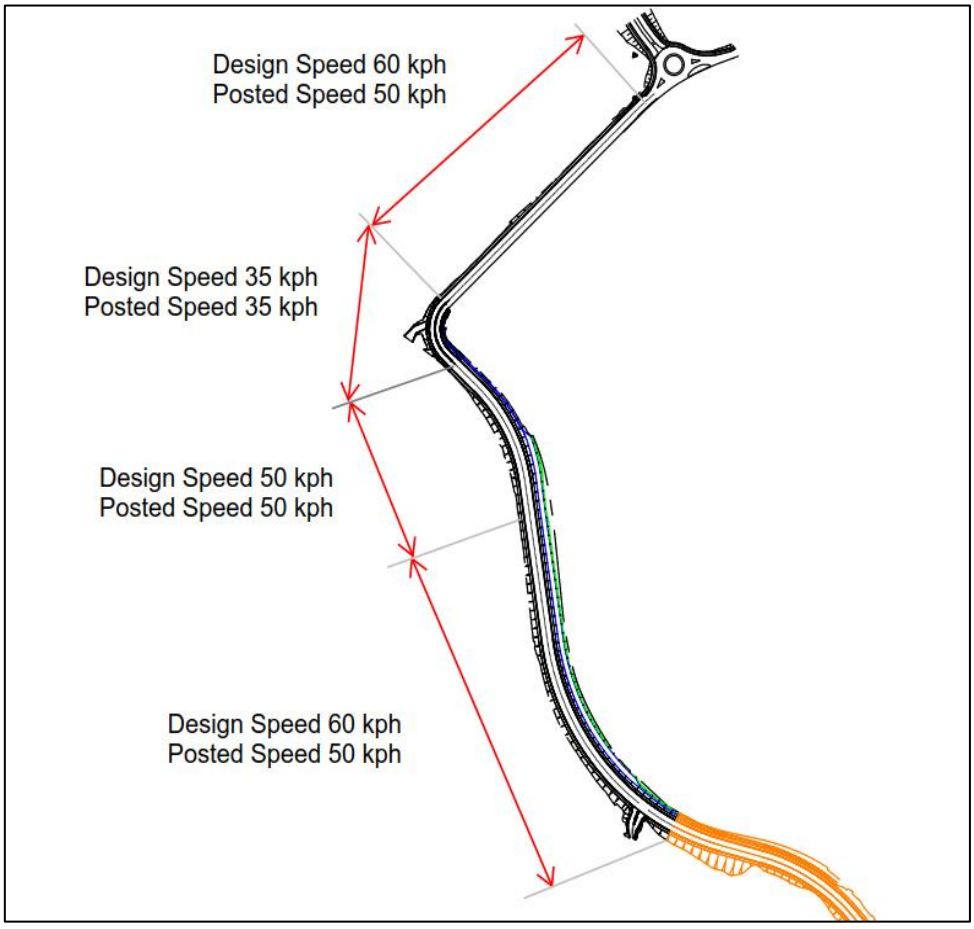

Figure 2.1 Portion 1 achievable design speed

As such, along proposed upgrade sections of the Links Road, the project team propose to adopt a uniform 50km/hr design and posted speed except at the sharp bend where 35km/h is proposed, in order to prevent regular changes to the posted speed limit and to provide safer road conditions along Links Road.

2.1.4 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 B.

2.1.4.1 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 and based on 12.5m SU Truck. This design vehicle for the Sydney Water Pump Station has been clarified through and email correspondence from Sydney Water (Cheng Chee) 12/06/19.

Vehicle swept paths of the driveways are shown in Appendix B.

2.1.4.2 DUNHEVED GOLF COURSE

As the access into the Dunheved Golf Course is via 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 receive its own access road via a new T-junction intersection to be constructed with Links Road. The intersection design has been conducted to ensure an existing box culvert can remain however due to lack of detailed survey for this culvert, this details shall be verified on site by the construction contractor.

In accordance with the DA RFI feedback from PCC, the design vehicle has been allowed for a 12.5m SU Truck. The T-junction has been designed to cater for a 12.5m SU Truck for all movements. Vehicle swept paths for the T-junction at the Dunheved Golf Club access can be found in Appendix B.

2.1.5 CROSS SECTION

The cross sections provided for Links 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 2.1.9
- 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.
- Links Road (MC10 Chainage 0.000m to 340.000m) existing crossfall gradients exceed 6%. As the Design is an extension of these crossfalls it therefore adopts the same gradients (as documented in RD Package). This is outlined further in Section 2.1.8

2.1.6 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 at CH340 of MC10 control line. Description of the design criteria used through this area can be found in Section 2.1.9. Outstanding design issues with the horizontal and vertical alignment is listed in the Issues Register, see Appendix D.

The upgraded links road has been raised, such there is 1 in 20 year flood resilience, this is in accordance with the RFIs received from Council after the original DA submission in November 2018. Appendix A has copies of these responses.

2.1.7 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.

2.1.8 EXISTING LINKS ROAD (MC10 CH. 0 TO CH. 340)

This section of existing road will maintain its current horizontal and vertical alignment whereby the Proposed Road Design will simply be an extension or interpolation of the existing geometry. This item was discussed with PCC at the design detailed design review meeting and accepted in principle. A list of non-conformance items are noted in the Non-Conformance Register (NCR).

2.1.9 GEOMETRY AROUND BEND (LINKS ROAD CH340 OF MC10)

To mitigate against property acquisition and to minimise impact on the golf course and Sydney Water pump station, a compliant geometry around this 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 below.

Table 2 Geometry Applied Around Bend (Ch340)

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 was discussed with PCC at the detailed design review meeting and accepted. It's absolute design limit is documented in Section 10.1 and outlined in further detailed in the Issues Register in Appendix D.
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 incorporated, including:

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

2.1.10 SIGNAGE AND LINEMARKING DESIGN

Refer to the Road Furniture drawings (RF package)

2.1.10.1 SIGNAGE DESIGN

Signage design must be developed to alert road users of various road conditions that may be present on or around the road alignment, such as the following;

- Notifies speed zone changes or reaffirms to motorist the current speed environment through repeater signs;
- Warns of potential hazards that may be present due to the road alignment or outside factors;
- Indicates permissible stopping and parking areas;
- Directs road users to location and destinations; and
- Assists in traffic through intersection manoeuvres.

All sign face layouts and posts have been designed in accordance with AS1742. All sign posts are classed as frangible with all sign posts having a nominal bore of 90mm as the design speed is lower than 60 km/hr.

PROPOSED SIGNAGE

The alignment through Portion 1 of Links Road Extension and Upgrade contains a 90-degree bend, between chainage 320 to 430, which has a smaller radius than the design speed limit will allow. This is implemented to mitigate against property acquisition from neighbouring lots. The sharp bend is a hazard to road users and as such motorists are advised through advisory speed warning signs and chevrons how to safely navigate this hazard.

Sydney Water pump station is located on the outside lot along the 90-degree curve. To reduce the risk to traffic the driveways servicing this lot with be a left in, left out approach to reduce the crossover of traffic on the bend. Additionally, road users will be alerted to these driveways through warning signage, as vehicles will be entering the road from the Sydney Pumping station on the tight curve.

No directional signage is proposed for the project.

EXISTING SIGNAGE

Existing signage along the road is minimal with only a few warning and regulatory signs, with a proportion of sign faces detailed to be removed as they have become redundant. All other signage is to be retained in its existing location or to be relocated subject to durability assessment on the condition of the sign face.

Sydney Water “recycled water site” and “vegetation regeneration site” signage is to be relocated or retained outside the road batter extents.

2.1.10.2 LINEMARKING DESIGN

The design has been per Roads and Maritime delineation guidelines and standards. These standards dictate the frequency and colour of associated reflective raised pavement markers (RRPM), as well as line spacing and thicknesses. The line marking design will guide and assist road users achieve;

- Lane changing and passing;
- Intersection manoeuvres; and
- Definition of carriageway, particularly during unfavourable weather conditions.

A Double-sided barrier line has been used as the dividing line between carriageways. This is except for the median island between chainage 3400 and 420, where edge line markings will be positioned along the edge of the raised median. A section of the centre line marking has also been excluded at the golf course entry road to allow for turning movements to be easily identified.

The golf course access road shall be delineated to show a give way line, and allow vehicles to enter Links road without stopping when not required. The dividing line along the access road will also be show as double-barrier until the limit of works shown. No official pedestrian crossing is shown at the intersection; however, a pedestrian refugee island has been included.

PAVEMENT MARKINGS

No pavement marking and arrows are required as part of the upgrade and extension works for Links Road.

However, chevron marking area has been proposed at the approaches to the sharp bend to further alert road users.

2.1.11 ROAD FURNITURE AND FENCING

No existing road furniture is present along this portion of the upgrade.

2.1.11.1 ROAD FURNITURE

No new barriers or other road furniture is required along this portion of the upgrade.

2.1.11.2 FENCING

New fence lines and fence line adjustments are covered in the project works packages.

2.1.12 NOISE MITIGATION

As part of the Statement of Environmental Effects document, an Operational and Construction Noise Impact Assessment has been undertaken. For all noise mitigations measures and recommendations, refer to the project SEE and accompanying reports.

2.2 PAVEMENT DESIGN

Refer to Pavement Drawings (PV package).

2.2.1 DESIGN STANDARDS

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

- Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments (as amended 20 November 2013)
- 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 5.

PROJECT RELIABILITY LEVEL

A project reliability level of 90% for Links Road been adopted.

2.2.2.2 METHODOLOGY

The design methodology adopted during the development of the 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 AADT, growth rates and heavy vehicle percentages.
2. Determination of appropriate traffic multipliers from the presumptive urban traffic load distribution as per Table F1 of Austroads Guide to Pavement Technology Part 2.
3. Derive the design traffic and resulting Equivalent Standard Axles of traffic loading (DESA) utilizing equation 14 and 17 of Austroads Guide to Pavement Technology Part 2
4. Review geotechnical investigation data conducted by JPS&G in the Environmental Site Assessment to determine presumptive subgrade design CBR
5. Determination of elastic moduli of appropriate pavement materials
6. Pavement design calculations to be undertaken using CIRCLY.

2.2.3 GEOTECHNICAL

The pavement design proposed for the 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.

The design ESA based upon the traffic data available was determined to be 6.15×10^6.

Penrith City Council Guidelines for Engineering Works for Subdivisions and Developments Table 2 specifies a minimum ESA of 1.0×10^7 for heavy industrial areas. Therefore, a design ESA of 1.0×10^7 will be adopted for the pavement design of Links Road.

2.2.4.1 FULL DEPTH PAVEMENT DESIGN

Table 3 Pavement Design Summary

PAVEMENT LAYER	DETAILS	CDF
Wearing Course	50mm AC14 DG (C320) AC Surface	Non-Structural
Prime and Seal	Prime (AMC00) and 7mm nominal size bitumen seal (C170)	-
Base	250mm DGB20 102% Standard Compaction	-
Subbase	390mm DGS40 102% Standard Compaction	-
Subgrade CBR	3% Presumptive Design CBR	9.40×10^{-1}
Total Depth	**690mm**	

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 G.

2.2.4.2 LINKS ROAD MILL & RESHEET WITH LEVEL CORRECTION

Mill and Re-sheet for the existing portion of road to be retained is proposed for Links Road, north of the bend. Any level correction required to make up the finished surface level, at the interface between the new road construction and the existing portion of road to be retained, is to be achieved by DGB20 correction course. Refer to details in the Pavement Drawings (PV package).

2.2.4.3 SHARED PATH & MAINTENANCE VEHICLE ACCESS CONCRETE PAVEMENTS

Concrete thickness of 125mm for the shared path was adopted from Penrith City Council Specification Section 7.5. Penrith City Council Specification Section 7.5 specifies that the bedding for the subbase can be either 30mm compacted sand or granular subbase. A 100mm granular subbase was selected based on recommendations in Table 7.1 of T51 Guide to Residential Streets and Paths by the Cement & Concrete Association of Australia.

Concrete thickness of 150mm for the maintenance vehicle access was adopted from Penrith City Council Specification Section 7.4. Penrith City Council Specification Section 7.4 specifies that the bedding for the subbase can be either 30mm compacted sand or granular subbase. A 125mm granular subbase was selected based on recommendations in Table 7.1 of T51 Guide to Residential Streets and Paths by the Cement & Concrete Association of Australia.

Whilst it is acknowledged that the granular subbase option could be a more expensive option as opposed to a sand bedding. Advice from T51 Guide to Residential Streets and Paths by the Cement & Concrete Association of Australia for poor to medium strength subgrade soils is to provide an adequate construction platform. The Geotech assessment has identified subgrade CBRs in the range of 3% to 5% and therefore granular subbase have been adopted instead of a sand bedding layer.

2.3 STORMWATER DRAINAGE

Refer to Stormwater Management and Details Drawings (SM package).

2.3.1 DESIGN STANDARDS

The design criteria for stormwater and drainage design for this project have been adopted based on relevant reference material and industry standard reference documents as listed below:

- Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments (PCC, Engineering Guidelines)
- Penrith City Council WSUD Technical Guidelines
- St Marys Planning Agreement
- Roads and Maritime publications
- Austroads publications
- Australian Rainfall & Runoff (AR&R1987)

2.3.2 KEY DESIGN CRITERIA

With reference to the design standards, a summary of the performance criteria adopted for the Pavement drainage as part of the detailed design is described below.

2.3.2.1 DRAINAGE INFRASTRUCTURE

They key design criteria associated with drainage infrastructure is described below:

- Design storm events:

    - Minor system – 20-year ARI storm event (industrial)
    - Major system – 100-year ARI storm event
- Maximum allowable flow width – 2.5 metres during the design storm event
- Maximum allowable pit spacing – 75 metres
- Minimum freeboard = 150 mm
- Minimum pipe diameter in roadways = 375 mm
- Friction coefficients
    - Mannings, n = 0.012 for concrete pipes; n = 0.035 for grassed line channels
    - Colebrook-white, k = 0.6 for concrete pipes
- Flows in excess of the minor system design ARI to have a safe "escape route" when capacity of minor system is exceeded.

2.3.2.2 HYDROLOGIC PARAMETERS

A local catchment assessment was undertaken to determine the flows generated from the carriageway and the required pipe size at discharge points. The rational method and the kinematic wave equation was used to estimate the time of concentration of external upstream flows from the adjacent industrial areas east of Links Road. Appropriate percentages of impervious areas were adopted for external flows by delineation of the aerial.

2.3.2.3 DESIGN LIFE

The design life of inaccessible and accessible drainage elements shall be 100yrs and 40yrs respectively.

2.3.2.4 DURABILITY

The exposure classification of precast concrete pits and pipes shall comply with the criteria outlined in AS/NZS 4058:2007, AS/NZS 5100 and RMS Specification B80.

2.3.3 DESIGN DESCRIPTION

The road drainage design comprises of drainage pits, pipes and open channels to convey stormwater runoff away from the road and discharged to appropriate outlets. The open channel will act as a bio-retention swale allowing runoff to infiltrate into the biofiltration media below to treat upstream flows. Transverse drainage culverts are also provided similar to the existing condition to allow connectivity from the external upstream industrial catchments to the South Creek tributary.

The detailed design for the road drainage included a review of the available data and the existing drainage system.

A flood assessment for the existing case for South Creek has been undertaken by Jacobs in 2015 and encompasses the project site extents.

2.3.3.1 AVAILABLE DATA

The available data available during the detailed design stage include the following:

- Limited ground survey and existing drainage pit and pipe data
- Dial Before You Dig data and limited utilities data
- Digital aerial raster
- LiDAR contours

- Update South Creek Flood Study, 2015

2.3.3.2 INTENSITY FREQUENCY DURATION (IFD)

The design IFD data and storm temporal patterns were obtained from the Australian Bureau of Meteorology (BOM) website and the corresponding design rainfall events were used in the hydrological analysis of the drainage design.

Table 4 Links Road IFD data

	2 year (mm/hr)	50 year (mm/hr)
1-hour rainfall intensity	29.64	59.14
12-hour rainfall intensity	6.58	12.93
72-hour rainfall intensity	1.88	4.39

F2 = 4.3; F50 = 15.8; skew (G) = 0.02; Latitude -33.741588, Longitude 150.762975

Source: Australian Bureau of Meteorology (BOM) website

2.3.3.3 DESIGN METHODOLOGY

The design methodology adopted during the development of the stormwater design are as follows:

1. Review of the existing drainage system and flow regime with catchment delineation of the existing road and upstream external industrial areas
2. Analysis of existing transverse drainage systems and flows in DRAINS
3. Review of proposed road design and determination of appropriate discharge locations
4. Design of proposed pit and pipe network, channels and cross-drainage culverts using the rational method analysis in 12d and DRAINS
5. Review safety in design and constructability elements

2.3.4 DESIGN ASSUMPTIONS AND LIMITATIONS

The drainage assessment is based on the available data – a combination of survey data, aerial imagery and LiDAR. Where any required data and detailed survey is missing, the relevant assumptions have been made on elements such as the size, location, alignment and depth of existing drainage infrastructure.

2.3.5 REVIEW OF DRAINAGE SYSTEM

2.3.5.1 EXISTING DRAINAGE SYSTEM

Links Road falls within the South Creek catchment. South Creek is a tributary of the Hawkesbury River. The existing scenario collects runoff from the local Links Road catchment and the industrial areas, Dunheved Business Park, between Links Road and Dunheved Circuit, ultimately discharging into South Creek.

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. Existing cross-drainage culverts under Links Road at Ch. 370 (no downstream information), 540 and 960 convey flows from the disused railway corridor into South Creek via Dunheved Golf Course. Along Links Road, at Ch. 30, pits, pipes and box culverts collect flow from Dunheved Business Park and discharge into the natural ground of the future Dunheved Industrial Precinct.

Apart from the above drainage elements, no formalised pit and pipe networks were identified in the existing condition.

2.3.5.2 PROPOSED DRAINAGE SYSTEM

The proposed drainage was designed to a 20-year ARI storm event and is described below.

CHAINAGE 0 TO 360

Based on advice from LendLease Communities and their commitments to the EPA, the existing twin 600Hx900W cross drainage box culverts at Ch. 30 have been intercepted by a new special pit and incorporated into the longitudinal drainage between Ch. 0 to 360. This drainage line has been designed against the longitudinal slope of the road, resulting in deep pits and pipes. These pits of up to 5.3m in depth from surface level to invert level have been specially designed by structural engineers – refer to Stormwater Management drawings for details. This drainage line discharges to the natural watercourse at Ch. 360 in the proposed case, however, environmental, flooding and impacts assessment have not been undertaken.

The northbound carriageway is to be retained as per the existing condition where minimal drainage infrastructure has been identified consisting of 2 inlet pits. From the 12d rational method analysis, it is found that the northbound carriageway between Ch. 0 to 270 has non-compliant flow widths exceeding 2.5m for a 20-year storm event.

CHAINAGE 360 TO 1020

The minor road longitudinal drainage system along Links Road from Ch 360 to 1020 has generally been designed to maintain existing drainage regime and to utilise existing drainage alignments and discharge points where possible. A formalised drainage pit and pipe network has been proposed for the kerbed road design as opposed to the existing over-batter sheet flow arrangement.

Due to road design constraints of access to the Sydney Water Pumping Station at the bend of Links Rd and boundary constraints, Ch. 360-540, pipes are required to have 0.3% grade to allow for positive discharge at Ch. 540. This also results in reduced cover with a minimum of 0.55m and potential non-conformances in self-cleansing velocities which will be clarified at the next design stage.

2.3.5.3 TAILWATER LEVEL

The provided Updated South Creek Flood Study did not include a study for the 2yr ARI, and as such, the current pipe design adopts the worst-case scenario tailwater level between:

1. pipe obvert for pipes with free discharge; or
2. top of bank assumed for pipes discharging into receiving waterways

as per section 3.10.2 Tailwater levels of PCC's Engineering Guidelines.

2.3.5.4 PIPE CLASS CHECK

A pipe class check was undertaken using PipeClass software developed by the Concrete Pipe Association of Australasia (CPAA) for critical pipes with minimum and maximum cover. Pipes are to be either Class 2 or Class 3 as per the pit and pipe schedule as shown in the Stormwater Management drawings.

2.3.5.5 SCOUR PROTECTION

Scour protection will be provided in all areas susceptible to scouring. For the current stage of design, rip rap will be provided at the Ch. 360, 540 and 960 headwall outlets for energy dissipation. The rip rap provided at the outlets of cross-drainage structures of Ch. 540 and 960 will also cater for the longitudinal drainage lines which discharge at the same location and have been designed for the worst-case scenario with considerations to velocity and pipe diameter. Refer to Stormwater Management drawings for details on rip rap.

2.3.5.6 REDISTRIBUTION OF CATCHMENTS

Two locations of catchment redistribution have been identified:

1. Existing cross-drainage at Ch. 30 discharges at Ch. 360 in the proposed case
2. Existing cross-drainage at Ch. 370 discharges at Ch. 540 in the proposed case

Environmental, flooding and impacts assessments have not been undertaken and has potential to cause adverse impacts to the environment and surrounds.

2.3.5.7 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 Jacobs 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 properties adjacent to Links Road 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 channels are proposed to be replaced on a like for like basis as a minimum 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, however, the cross-drainage culverts have been upgraded to allow for the raised road to have a 20-year flood immunity. 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 has been summarised below:

- Existing road overtopping levels at 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 generally been retained or improved with a larger cross-sectional area to ensure that flows do not encroach into adjacent properties. Excess flows overtop the upgraded Links Road therefore maintaining the existing flow regime.

New transverse drainage culverts have been provided at approximately Ch. 530 and 960 to replace the existing culverts. Channels adjacent to the southbound lane have been realigned to suit the new road widening and tie into the proposed culverts and discharge eastwards towards Dunheved Golf Club.

External catchment areas, proposed transverse drainage culverts and existing flow paths are shown below in Figure 2.2 below.

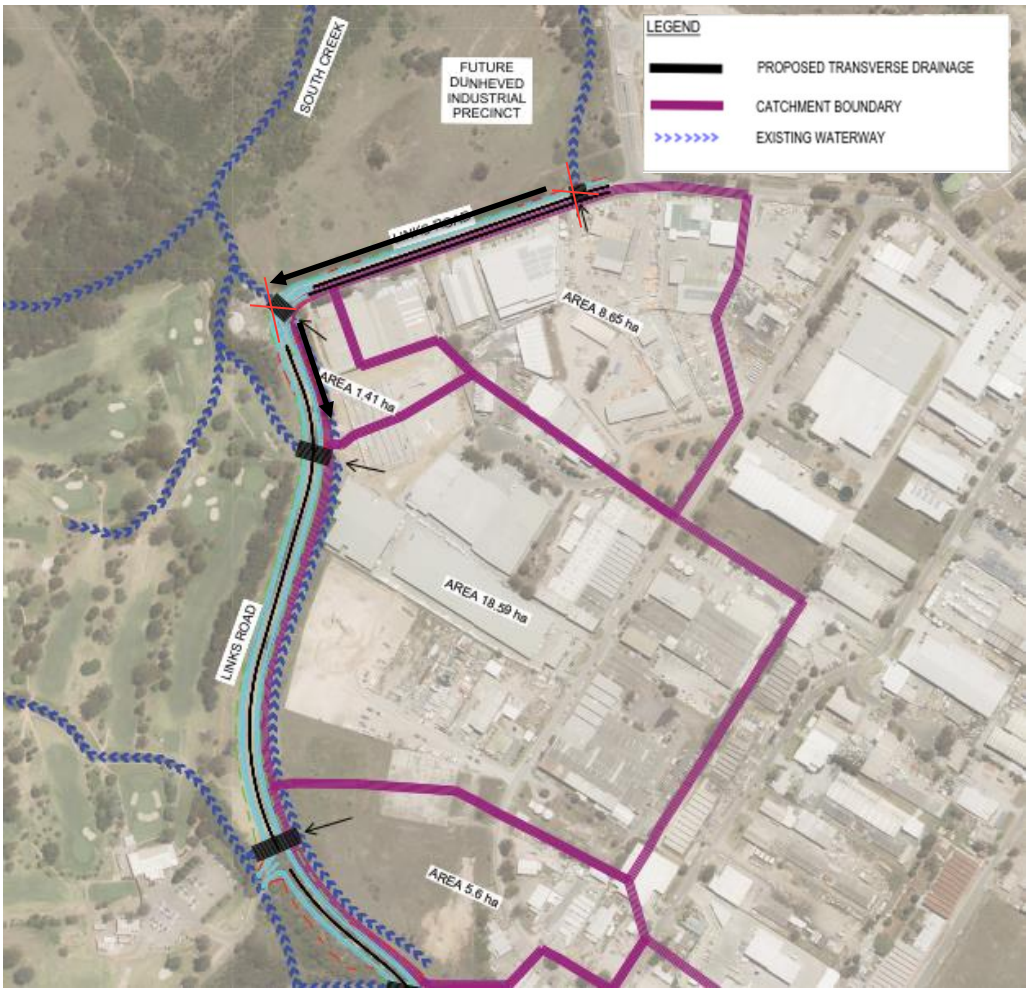

Figure 2.2 Catchment Plan for Portion 1

2.3.5.8 WATER QUALITY

As part of the Water Sensitive Urban Design (WSUD) strategy, linear bio-retention swales have been proposed along the southbound carriageway adjacent to Links Road. The linear bio-swale aligns with the existing open channel which conveys runoff from the existing upstream industrial catchment. The existing capacity of the open channel will generally be maintained or improved upon in some areas. This will off-set the minimal impact of the Links Road widening works downstream of the industrial catchment which has limited stormwater quality improvement measures prior to discharge into South Creek.

An assessment for the effectiveness and treatment of the proposed bio-retention swale was undertaken in MUSIC. Analysis in the MUSIC model utilised the available pre-set parameters from Penrith City Council's MUSIC-link data. Refer to technical memo PS111235-MEM-RFI2-WW submitted as part of the RFI responses, located in Appendix A..

2.3.6 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).

2.3.7 STRUCTURAL PITS

In accordance with Penrith City Council Engineering Specification, new pits greater than 2.0m deep have been structurally designed.

The following pits have depth greater than 2.0 m:

- DL-L0340-A-02
- DL-L0340-A-03
- DL-L0340-A-04
- DL-L0340-A-05
- DL-L0340-A-06
- DL-L0340-A-07
- DL-L0340-A-08
- DL-L0340-A-09
- DL-L0540-A-11
- DL-L0540-J-09
- DL-L0540-J-10
- DL-L0960-B-01

2.4 UTILITIES

Refer to Utilities Drawings (UT package).

A utility services strategy report has been developed and included in Appendix C.

2.5 GEOTECHNICAL

A WSP geotechnical investigation was conducted at the concept design and a geotechnical factual report and interpretative report was prepared, refer to Appendix I. No additional geotechnical investigation has been conducted for the detailed design for Portion 1. All earthworks and foundation treatments shall be constructed in accordance with RMS specification R44.It is expected that foundation treatments E1 and treatments to satisfy Shallow Embankment criteria would be required.

The JBS&G Environmental Site Assessment previously prepared for Links Road Extension and Upgrade in Dunheved has also been used to inform the design.

2.6 LANDSCAPING

No specific landscaping design package has been produced. 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.

2.7 LIGHTING

Refer to Street Lighting Drawings for locations and types.

2.7.1 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.

2.7.2 LIGHTING DESIGN

2.7.2.1 ROAD LIGHTING DESIGN

As part of the Development Application submission, it was assumed that all existing overhead mains including wood poles and road lighting 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 1.
- The pole types specified in the design are to be approved as 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 200W 4K LED luminaries at mounting height of 12m poles with 4.5 m outreach have been proposed, refer to lighting design drawings for technical data. The lighting asset elements of the design are to have a design life in accordance with Table 5 .

2.7.2.2 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.

2.7.2.3 POWER SUPPLY TO LIGHTING

The power supply design to the lighting system has not been undertaken as all utility design works are to be undertaken by other consultant engaged by Lendlease Communities. However, we have assumed that all overhead low voltage distribution services will be underground.

3 PROJECT WIDE 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.

4 ENVIRONMENTAL CONSIDERATIONS

Statement of Environmental Effects (SEE) report has been prepared and has been considered for the detailed design documentation. This Statement of Environmental Effects (SEE) contains all technical studies and environmental considerations required to comply to Penrith City Council environmental requirements. The design report should be read in conjunction with the SEE.

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

JBS&G Australia Pty Ltd have conducted an environmental assessment and have reported that there are areas within the proposed corridor affected by dumped materials containing asbestos. See for a letter from JBS&G Australia Pty Ltd to Lendlease Communities on the recommendations in Appendix L .

5 CONSTRUCTABILITY AND MAINTENANCE

Construction staging package is not required to be developed however constructability and maintenance have been considered with project stakeholders in the Safety in Design documentation contained in Appendix F. The project design team and Lendlease Communities held a Safety in Design Workshop during the concept design phase that considered constructability, maintenance and operation issues.

The SEE documentation assumes construction will start in 2019 and would take about 10 months to complete for the entire project. 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.

6 SAFETY IN DESIGN

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.

Safety in Design register contained in Appendix F, has been updated for the detailed design.

7 PUBLIC TRANSPORT

There are currently limited public transport facilities within the project site. One existing bus stop is provided in each direction on Christie Street northbound and southbound respectively. There are no public transport facilities along the Links Road and no new provisions have been allowed within Portion 1 extent.

8 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 5 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

The above relates to all newly designed elements. It is recommended that condition assessments be considered on existing assets (i.e. drainage structures, utilities) that are proposed to remain. For the applicable retained assets, this assessment 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.

9 ROAD SAFETY AUDIT (RSA)

A Detailed Design Road Safety Audit has been completed for the detailed design stage. The report showing the findings and actions taken be found in Appendix E.

10 DESIGN ISSUES

A non-conformance register has been developed an updated throughout the detailed design stage. This register contains details on design departures encountered throughout the design development. Refer to Appendix D.

There are outstanding to be resolved for the construction certification design phase:

10.1 ROAD GEOMETRY

- The road geometry issues have been consulted with PCC. Refer to Appendix C of the outcomes from the PCC meetings. Subsequent correspondence from council has accepted in principle the design intent, with further detail and commentary provided within this submission where needed.
- Minor tweaks to the batter slopes at the golf course access road interface to avoid spilling over the existing headwall.

10.2 ROAD FURNITURE, SIGNAGE AND LINEMARKING

- Existing Sydney Water signs not identified on survey. It is unclear if these signs are within the extents of the road batter extent or if they are located within the golf course property boundary.
- Batter slopes to be optimised to provide flatter grade where possible.

10.3 DRAINAGE AND FLOODING

- Limited survey information resulting in drainage design sizes based on assumed downstream pipe sizes.
- Environmental, flooding and impacts assessment of catchment redistribution from Ch. 30 existing cross-drainage box culvert now discharging at Ch. 360 has not been undertaken.
- Retained southbound carriageway between Ch. 90 and 270 has non-compliant flow widths of greater 2.5m for a 20yr ARI storm event.
- Trunk drainage line between Ch. 380 to 540 is graded at 0.3% to allow for positive discharge at Ch. 540. Discharge to natural watercourse prior to Ch. 540 not possible due to boundary constraints.
- Self-cleansing velocity of 0.6m/s to be confirmed at next design stage.
- At detailed design further detail will be provided on the existing culvert adjacent to the access road to the Golf Course after further survey and aerial photography is made available to provide clarification on the proposed adjacent footpath treatment.
- Safety requirements and access for deep pits.
- Erosion and Sediment control requirements

10.4 UTILITIES

- Relocation or protection of utilities has been at a concept identification stage only. Further detailing and full integration will be required.

10.5 PAVEMENT

- Localised pavement modifications for stormwater pipes with shallow cover.

APPENDIX A

COUNCIL RFIS & RESPONSES

COUNCIL RFI #01 – 4TH FEBRUARY 2019

WSP RESPONSES REFERENCE:

- 1 IN 20-YEAR RESILIANCE
- INTIAL WSUD CONCEPT

PENRITH

Our Ref: DA18/1163
Contact: Lucy Goldstein
Telephone: (02) 4732 8136

4 February 2019

Attn: Sean Porter
via email [redacted]

RE: Development Application DA18/1163
Proposal: Upgrade and Extension to Links Road, St Marys NSW 2760

A preliminary assessment of your development application has been undertaken.

In principle, the proposed road design is generally supportable. However the following issues have arisen for your consideration and action.

Notwithstanding the above, the proposal is defined as integrated development requiring an approval from Natural Resources Access Regulator (NRAR). Further, the proposal has been referred to Roads and Maritime Services (RMS) for consideration. The referral responses from NRAR and RMS are currently outstanding. As such, this advice is subject to the recommendations of NRAR and RMS. Any further issues raised in their responses shall be provided under the cover of a separate letter.

Owners Consent

The application has been lodged without adequate owners consent. In order to progress with the assessment and determination of the application, owners consent for all affected lots is required to be submitted to Council as a matter of priority.

Engineering

As requested in the Pre-lodgement meeting, plans showing the impact of the 5% Annual Exceedance Probability (1 in 20 year) (AEP) flood event from South Creek upon the new

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road shall be submitted with the application. The new road shall be located above the 5% AEP South Creek flood event.

Environment (Land Contamination)

A review of the accompanying site assessment report (*Environmental Site Assessment: Links Road Extension, Dunheved, NSW* prepared by JBS&G, dated 28 March 2018, Ref. 54340/114380) has been undertaken. This document details the findings of a contaminated land investigation undertaken across the majority of the development site.

Whilst it is acknowledged that the investigation was carried out generally in accordance with relevant EPA guidelines, significant concern is raised regarding land contamination in respect to asbestos material found on the site.

It is understood that the site investigation identified a number of stockpiles along the side of the existing roadway, with further stockpiles located at the southern portion of the site. These Stockpiles included residential and building wastes, along with a number of small stockpiles of asbestos containing materials. Based on the findings of the investigation, the areas of potential environmental concern identified included the stockpiled material, the use of the site as a sealed road and the underlying fill material.

As part of the investigation, a number of soil samples were taken. It is noted that asbestos fines were not found in soil samples above the criteria, however asbestos fines were identified on the ground surface at a number of locations.

In characterising the site, the site assessment report concluded that "*the site is free of any contamination that may represent an unacceptable health risk for the proposed road use, with the exception of the surface asbestos impact".* The report comments that the asbestos impact "*is restricted to the site surface and is associated with materials that have been historically dumped at the surface*", that it "*is not present as contamination to soils, but wastes placed overlying soils*", and advises that "*remedial works are not required for soil*". The report recommends that surface clean up works are carried out to remove the dumped materials, including the identified asbestos containing material. The report does not address whether the footprints of these stockpiles need to be assessed on removal of the rubbish materials.

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However, Clause 11(4) of Sydney Regional Environmental Plan No 20—Hawkesbury-Nepean River (SREP 20) states that consent is required for remediation of contaminated land where it is defined as;

Removing soil or other deposits from, or otherwise remediating, contaminated land. For the purposes of this definition, contaminated land means land on which hazardous substances occur at concentration levels above background levels, where an assessment (carried out in accordance with guidelines circulated to councils by the Department) has indicated the substances pose, or are likely to pose, an immediate or long-term hazard to human health or to the environment.

Given the findings of asbestos on the land, as fragments on the surface and in stockpiles, and the requirement to remove this material as it poses an unacceptable health risk, these removal works would be classified as remediation works under SREP 20. Further, SEPP 55 identifies "development for which another State environmental planning policy or a regional environmental plan requires development consent" as Category 1 remediation work under that instrument.

In turn, this application shall be amended to seek consent for these remedial works, or a separate application will need to be made to Council for these works.

To support an application for remediation, a Remedial Action Plan (RAP) is to be prepared by a suitably qualified environmental consultant with consideration of the relevant EPA guidelines. Further, this RAP will need to include a methodology for addressing the suitability of the soils beneath each of the stockpiles (further sampling or validation of the stockpile footprints as necessary).

Waterways

It is noted that a number of proprietary water quality improvement devices are proposed at the longitudinal drainage outlets to ensure that South Creek and its tributaries are protected against spills occurring on the new pavement. However, no details have been provided regarding the type of proprietary water quality improvement devices proposed and how they will be maintained etc.

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As such, the following information shall be submitted to Council:

i) Water Sensitive Urban Design (WSUD) Strategy report prepared in accordance with Council's WSUD Technical Guidelines
ii) MUSIC modelling which is consistent with the drainage plans and ultimate strategy
iii) Revised Concept drainage plans which include details and locations of all stormwater treatment measures, and
iv) A Draft Operation and maintenance manual should be prepared in accordance with Council's WSUD Technical Guidelines (Refer to WSUD Technical Guidelines for required inclusions).

Note: In preparing the above supporting information, please refer to Council's WSUD Technical Guidelines.

The requested additional information shall be submitted to Council by **Monday 4 March 2019.** Should you wish to discuss any of the above matters, please do not hesitate to contact me on 4732 8136.

Yours Sincerely

[redacted]

Lucy Goldstein
Development Assessment Planner

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MEMO

TO:	Penrith City Council
FROM:	WSP on behalf of Lendlease
SUBJECT:	**Review of Links Road Concept Road Design in relation to 1 in 20 AEP immunity** **DA18/1163**
OUR REF:	PS111235-CIV-MEM-101 RevA.docx
DATE:	**28 February 2019**

This memo is prepared to address the technical Engineering query raised in the Request For Information letter from Penrith City Council (ref: DA18/1163) requiring clarity on the Concept Design's impact of the 5% Annual Exceedance Probability (1 in 20 year) (AEP) flood event from South Creek.

Council have identified that the Links Road Extension shall be designed such that it is located above this flood level.

As previously identified within the concept design report submitted as part of the original DA application, the flood management strategy was to retain existing conditions by minimising the footprint of the new road thereby minimise impact to adjacent properties; however, it is acknowledged that this is not satisfactory to Council and that the level of the road crown is to be above the 1 in 20 year event.

An assessment of the concept design was carried out to re-check its current compliance with the criteria. The outcomes of this have been presented on a long section roll plot of the design alignment which is appended to this memo.

That assessment identifies that by raising the road centreline levels between chainages 380 and 670 by a maximum of 760mm, the crown of the road could be kept above the 1 in 20 year flood levels. The impact on set boundaries remains unchanged except in a localise area at chainage 520 where earthworks fill of 300mm spills over the boundary line due to an existing drainage channel. This will be mitigated by the required headwall to be designed in the next design development phase.

Given that there are sections of the road alignment submitted under the DA application which do not meet the flood immunity criteria, our analysis shows that the road alignment can be raised to meet this criterion. It is requested that this matter is addressed by an appropriately worded condition of DA consent.

Although this design update will be will be presented in the next design phase, we have prepared the attached long section roll plot showing the proposed concept alignment to be adopted in lieu of the road design alignment submitted under DA. This plan shows the flood level along the alignment as well as the previous and newly proposed road alignment levels.

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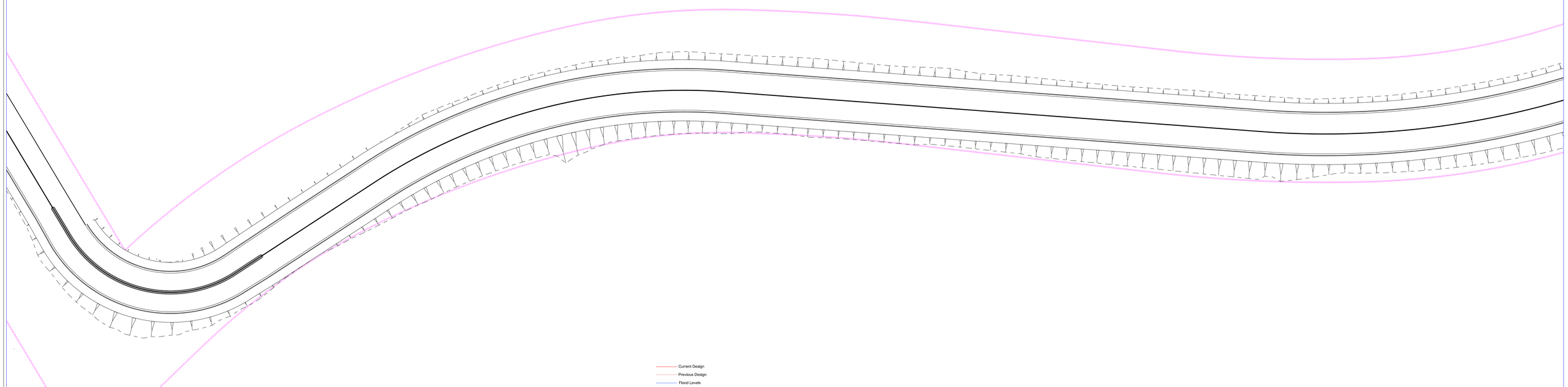
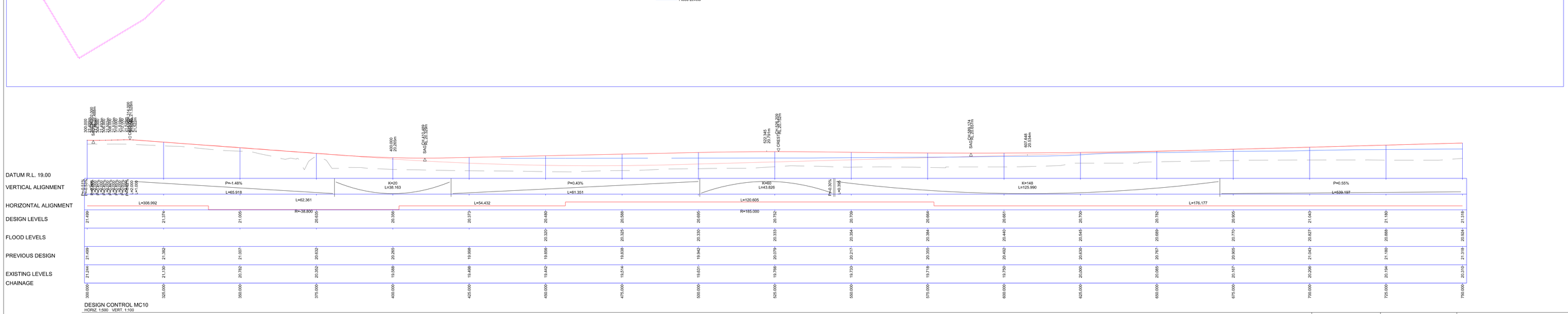
From the assessment undertaken it clearly demonstrated to Council that the revised concept design meets the 5% Annual Exceedance Probability (1 in 20 year) (AEP) flood event criteria.

James Wallis	Nuno Muralha
Senior Civil Engineer	Senior Principal Civil
Project Manager	Engineer





SCALES ON A1 SIZE DRAWING

Horizontal Scale 500m

Vertical Scale 100m

LINKS ROAD
DESIGN UPDATE

A3

ISSUE STATUS

MEMO

TO:	Stephen Masters, Penrith City Council
FROM:	James Wallis, WSP Sean Porter, Lendlease
SUBJECT:	**Links Road Extension and Upgrade Water Quality Treatment Strategy**
OUR REF:	PS111235-WSUD-MEM-0001_Rev1
DATE:	**1 March 2019**

1.1 INTRODUCTION

This technical memo is the Water Sensitive Urban Design (WSUD) Strategy report associated with the Links Road Extension Project. This report has been prepared in accordance with the Council's WSUD Technical Guidelines. The report provides details of the MUSIC modelling outcomes that were used to analyse the water quality run off. Water treatment devices have been selected by Council and modelled accordingly.

Accompanying this report are the revised Concept Design drainage plans [PS111235-SM-DRG] which clearly indicate details and locations of all stormwater treatment measures. The treatment measures have been implemented in accordance with Council requests and while water quality objectives may not be met as per Penrith Development Control Plan 2014 (Penrith DCP), a significant improvement has been identified.

1.2 STORMWATER QUALITY OBJECTIVE

As per the Penrith Development Control Plan 2014 (Penrith DCP), Section C3.2, the development aims to use treatment train methods to achieve the water quality objectives outlined below:

- Post development average annual load reduction for Total Suspended Solids (TSS) – 85%
- Post development average annual load reduction for Total Phosphorus (TP) – 65%
- Post development average annual load reduction for Total Nitrogen (TN) – 45%
- Post development average annual load reduction for gross pollutant – 90%.

It should be noted, that in this submission the stormwater quality objective were site specific. This development is associated with the widening and extension of an existing roadway, not directly classified as full urban development. The design basis and objectives are therefore as per Council discussions and instructions.

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1.3 WATER QUALITY STRATEGY

Due to space constraints associated with the project, a hierarchy of controls has been considered during the development of the water quality strategy. The following solutions were considered in the order listed below:

- Vegetated swales - vegetated swales are used to convey pavement runoff where the road formation permits stormwater to be discharged to the receiving waters via an open channel adjacent to the road. The vegetated swales provide water quality treatment through removal of suspended solids and their associated pollutants. In the event of a spill, these swales can be temporarily bunded by emergency services at their discharge point to prevent contaminated materials from discharging into sensitive water courses.
- Proprietary water quality treatment devices (WQTD) – proprietary devices can be provided in areas of severe space limitations, where water quality or accidental spill management objectives cannot be met by providing the solutions listed above. The proposed units considered are Humeceptor STC27 or equivalent units. These units will provide removal of up to 80% of annual suspended solids load and will provide spillage containment of up to 4,200 litres.

Vegetated swales would require land acquisition as well as access into Dunheved Golf Course for maintenance. For these reasons, Penrith City Council's preference was provision of proprietary water quality treatment device placed in the verge instead of vegetated swales.

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 every longitudinal drainage outlets to ensure that South Creek and its tributaries are protected against accidental spills occurring on the new pavement as a minimum.

There are areas where external catchment enters the proposed road drainage network. This has been highlighted in Attachment A Catchment Plans. The catchments areas encompass the surrounding industrial areas. It is assumed the surrounding industrial areas have made adequate provisions for the treatment of runoff generated prior to discharge into the receiving waterways. 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.

1.4 MODELLING METHODOLOGY

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.2) was utilised to evaluate the treatment train effectiveness (TTE). Modelling has been undertaken in accordance with Penrith City Council WSUD Technical Guidelines with the developed site based on conceptual lot layout and catchment area details (refer to the Attachment A) with water quality treatment devices to assess the TTE.

MUSIC was run using the MUSIC-link function for Penrith City Council data obtained from *eWater*. The input parameters for source and treatment nodes have been obtained via the MUSIC-link function and are consistent with the Penrith City Council WSUD Technical Guidelines.

Catchment areas were subdivided into areas corresponding to sealed roads, roofs and mixed catchment area types. Catchment plan has been provided in Attachment A.

1.5 MUSIC RESULTS

The results extracted from MUSIC model are provided in Table-1 below.

Refer Attachment B for MUSIC-link report.

Table-1 MUSIC modelling results

WQTD ID	Parameter	Post Sources (Untreated)	Post Sources (Treated)	Reduction (%)	Complies
WQTD 1	TSS (kg/yr)	387	77.6	80	N
	TP (kg/yr)	0.64	0.451	29.6	N
	TN (kg/yr)	2.61	1.82	30.2	N
	Gross Pollutant (kg/yr)	30.6	30.4	0.8	N
WQTD 2	TSS (kg/yr)	271	54.3	80	N
	TP (kg/yr)	0.443	0.312	29.6	N
	TN (kg/yr)	2.54	1.77	30.2	N
	Gross Pollutant (kg/yr)	33.4	33.1	0.8	N
WQTD 3	TSS (kg/yr)	660	132	80	N
	TP (kg/yr)	1.08	0.763	29.6	N
	TN (kg/yr)	4.58	3.2	30.2	N
	Gross Pollutant (kg/yr)	57.4	56.9	0.8	N
WQTD 4	TSS (kg/yr)	1280	257	80	N
	TP (kg/yr)	2.16	1.52	29.6	N
	TN (kg/yr)	8.81	6.15	30.2	N
	Gross Pollutant (kg/yr)	103	102	0.8	N
WQTD 5	TSS (kg/yr)	988	198	80	N
	TP (kg/yr)	1.61	1.14	29.6	N
	TN (kg/yr)	6.71	4.69	30.2	N
	Gross Pollutant (kg/yr)	86.5	85.9	0.8	N
WQTD 6	TSS (kg/yr)	86	17.2	80	N
	TP (kg/yr)	0.152	0.107	29.6	N
	TN (kg/yr)	0.617	0.431	30.2	N
	Gross Pollutant (kg/yr)	7.75	7.69	0.8	N
WQTD 7	TSS (kg/yr)	5440	1090	80	N
	TP (kg/yr)	9.16	6.45	29.6	N

WQTD ID	Parameter	Post Sources (Untreated)	Post Sources (Treated)	Reduction (%)	Complies
	TN (kg/yr)	52.4	36.6	30.2	N
	Gross Pollutant (kg/yr)	662	657	0.8	N

1.6 MAINTENANCE STRATEGY

Maintenance access has been considered in placement of the water quality treatment devices. The devices have been placed in verge and should be maintained from Links Road (access bays to be developed) and via Christie Street. Maintenance of the proposed Humeceptor units is to be in accordance with Attachment C Humeceptor Maintenance Guide.

1.7 CONCLUSIONS

The results indicate that the post development water quality objectives will not be met by the proposal. However, due to the constrained nature of site, the proposal provides the best possible outcome by providing management of accidental spill and allowing for some treatment of road runoff.

ATTACHMENT A - WATER QUALITY CATCHMENT PLAN

WATER QUALITY CATCHMENT PLAN

WQTD 1
Catchment Area
Sealed Road - 0.185ha, 100% impervious

WQTD 2
Catchment Area
Sealed Road - 0.076ha, 80% impervious
Mixed (External) - 0.14ha, 90% impervious

WQTD 3
Catchment Area
Sealed Road - 0.385ha, 80% impervious

WQTD 4
Catchment Area
Sealed Road - 0.62ha, 100% impervious

WQTD 5
catchment Area
Sealed Road - 0.6ha, 75% impervious

WQTD 6
Catchment Area
Sealed Road - 0.0525ha, 80% impervious

WQTD 7
Catchment Area
Sealed Road - 1.25ha, 96% impervious
Mixed (External) - 2.77ha, 100% impervious

LEGEND

- PROPRIETARY WATER QUALITY TREATMENT DEVICE (WQTD)
- EXISTING WATERWAY
- WQTD CATCHMENT FLOW PATH
- PROPOSED CULVERT LOCATION
- ROAD CATCHMENT DRAINING TO WQTD
- EXTERNAL CATCHMENT DRAINING TO WQTD

ATTACHMENT B - MUSIC-LINK REPORT

PENRITH CITY COUNCIL

music*link*

MUSIC-*link* Report

Project Details		Company Details	
Project:		**Company:**	
Report Export Date:	27-Feb-19	**Contact:**	
Catchment Name:	Links Road.2.	**Address:**	
Catchment Area:	0.185ha	**Phone:**	
Impervious Area*:	100%	**Email:**	
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Minutes		
Modelling Period:	01-Jan-99 - 31-Dec-08 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.2.1		
MUSIC-link data Version:	6.22		
Study Area:	Penrith		
Scenario:	Penrith Development		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Junction	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	1.39E-07%	GPT Node	7	Urban Source Node	9
TSS	80%				
TP	29.6%				
TN	30.2%				
GP	0.77%				

Comments

Results indicate post development water quality objectives will not be met by the proposal. Due to the constrained nature of site, the proposal does provide the best possible outcome.

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Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Urban01.01	Area Impervious (ha)	None	None	0.185
Urban	Urban01.01	Area Pervious (ha)	None	None	0
Urban	Urban01.01	Total Area (ha)	None	None	0.185
Urban	Urban02.02	Area Impervious (ha)	None	None	0.061
Urban	Urban02.02	Area Impervious (ha)	None	None	0.125
Urban	Urban02.02	Area Pervious (ha)	None	None	0.014
Urban	Urban02.02	Area Pervious (ha)	None	None	0.014
Urban	Urban02.02	Total Area (ha)	None	None	0.076
Urban	Urban02.02	Total Area (ha)	None	None	0.14
Urban	Urban02.03	Area Impervious (ha)	None	None	0.308
Urban	Urban02.03	Area Pervious (ha)	None	None	0.076
Urban	Urban02.03	Total Area (ha)	None	None	0.385
Urban	Urban03.04	Area Impervious (ha)	None	None	0.62
Urban	Urban03.04	Area Pervious (ha)	None	None	0
Urban	Urban03.04	Total Area (ha)	None	None	0.62
Urban	Urban04.05	Area Impervious (ha)	None	None	0.450
Urban	Urban04.05	Area Pervious (ha)	None	None	0.149
Urban	Urban04.05	Total Area (ha)	None	None	0.6
Urban	Urban05.06	Area Impervious (ha)	None	None	0.041
Urban	Urban05.06	Area Pervious (ha)	None	None	0.010
Urban	Urban05.06	Total Area (ha)	None	None	0.052
Urban	Urban08.07	Area Impervious (ha)	None	None	1.202
Urban	Urban08.07	Area Impervious (ha)	None	None	2.77
Urban	Urban08.07	Area Pervious (ha)	None	None	0.047
Urban	Urban08.07	Area Pervious (ha)	None	None	0
Urban	Urban08.07	Total Area (ha)	None	None	1.25
Urban	Urban08.07	Total Area (ha)	None	None	2.77

Only certain parameters are reported when they pass validation

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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
GPT	Humeceptor01	Hi-flow bypass rate (cum/sec)	None	99	100
GPT	Humeceptor02	Hi-flow bypass rate (cum/sec)	None	99	100
GPT	Humeceptor03	Hi-flow bypass rate (cum/sec)	None	99	100
GPT	Humeceptor04	Hi-flow bypass rate (cum/sec)	None	99	100
GPT	Humeceptor05	Hi-flow bypass rate (cum/sec)	None	99	100
GPT	Humeceptor06	Hi-flow bypass rate (cum/sec)	None	99	100
GPT	Humeceptor07	Hi-flow bypass rate (cum/sec)	None	99	100

Only certain parameters are reported when they pass validation

ATTACHMENT C - HUMECEPTOR MAINTENANCE GUIDE

Humes

Strength. Performance. Passion.

HumeCeptor® system
Inspection and maintenance guide

Issue 2

Purpose of this guide

This guide outlines the maintenance procedures and requirements for HumeCeptor® units.

Where the contents of this guide differ from project specifications and drawings, supervisory personnel should consult with a Humes engineer. In the event of any conflict between the information in this guide and local legislative requirements, the legislative requirements will take precedence.

It is the responsibility of the site owner and its contractors to determine the site's suitable access and location for maintenance plant and equipment.

Nothing in this guide is to be construed as a representation, endorsement, promise, guarantee or warranty whether expressed or implied.

Humes makes no representation or warranty, implied or otherwise that, amongst others, the content of this guide is free from errors or omissions or in relation to the adequacy of the information contained in this guide and where appropriate you will seek verification from an independent third party before relying on any information in this guide. Humes is not liable or responsible to any person for any use or reliance of any information arising out of or in connection with this guide.

Safety advice

The HumeCeptor® unit must be maintained in accordance with all relevant health and safety requirements, including the use of PPE and fall protection where required.

Confined space entry

Maintenance of the HumeCeptor® should not require entry, however, if entry into the unit is required, then the device is deemed a confined space. As such, if entering the unit, all equipment and training must comply to SHE regulations. It is the responsibility of the contractor or person/s entering the unit to proceed safely at all times.

Personal safety equipment

The contractor is responsible for the provision of appropriate personal protection equipment including, but not limited to safety boots, hard hat, reflective vest, protective eyewear, gloves and fall protection equipment. Make sure all equipment is used by trained and certified personnel, and is checked for proper operation and safety features prior to use.

Handling

The customer, or their contractor, is responsible for the removal of access lids from the HumeCeptor® unit. The customer or contractor should familiarise themselves with the device and site constraints, and particular attention should be given to safety hazards such as overhead power lines and other services in the vicinity when considering the position of plant and equipment.

Maintenance overview

To ensure ongoing long-term environmental protection HumeCeptor® needs to be maintained (generally annually).

The actual on-going maintenance frequency requirements will be determined through quarterly inspections undertaken during the first year. However, only an annual maintenance period is anticipated for most HumeCeptor® units installed within drainage infrastructure.

Inspection can be performed by anyone, and procedures for inspection are provided in this document.

Generally, comprehensive maintenance is performed from the surface via vacuum truck. Companies capable of performing this maintenance can be found in the Yellow Pages or online by searching sewer cleaning or liquid waste removal. If you require a list of contacts for cleaning your HumeCeptor® please call your nearest Humes office.

HumeCeptor® operation

A HumeCeptor® unit can be divided into two distinct zones comprising:

1. A lower treatment chamber
2. An upper by-pass chamber

Stormwater flows into the by-pass chamber via the stormwater drainage-pipe, where low flows are diverted into the treatment chamber by the weir and drop pipe arrangement.

Note, the treatment chamber is always full of water so water will flow up through the outlet decant pipe (based on the head of water behind the inlet weir) to be discharged back into the by-pass chamber downstream of the weir. The downstream section of the by-pass chamber is connected to the outlet drainage pipe.
Oil and other liquids with a specific gravity less than water rise in the treatment chamber and become trapped since the inlet of outlet decant pipe is submerged.

Sediment settles to the bottom of the lower chamber by gravity forces. The circular design of the treatment chamber is critical to prevent turbulent eddy currents, which inhibit the settling process.

During high flow conditions, stormwater in the by-pass chamber will overtop the weir and be conveyed to the outlet drain directly. Water flowing over the weir creates a backwater effect on the outlet decant pipe (ensuring head stabilization between the inlet drop pipe and outlet decant pipe). This ensures that excessive flow will not be forced through the treatment chamber scouring or re-suspending previously settled material.

The by-pass mechanism is an integral part of the HumeCeptor®, since other oil/grit separator designs and proprietary devices have been noted to scour during high flow conditions (Schueler and Shepp, 1993).

Figure 1 – HumeCeptor® system operation during design flow conditions

Figure 2 – HumeCeptor® system operation during high flow conditions

Model Identification

Even if you do not have the plans of your stormwater drainage system, you will still be able to identify the location of an in-line HumeCeptor® unit(s) as all HumeCeptor® units have a 600 mm diameter cast iron lid, clearly embossed with "HumeCeptor®".

You will be also be able to identify an inlet HumeCeptor® unit(s), by looking through the stormwater inlet grate where the fibreglass insert will be visible.

However once you have found the unit, you may still be uncertain what model it is. Comparing the measured depth from the water level (bottom of insert) to the base of the tank with the dimensions listed in Table 1 below will help to determine the size/model of the unit.

If there is still uncertainty regarding the size of the HumeCeptor® using depth measurements, contact your nearest Humes office for further advice.

There are a few variations on the standard models described above. However, basic maintenance procedures will be the same. The following figures display the different types of HumeCeptor® units available. For further details, please refer to the HumeCeptor® Technical manual.

Table 1 – Depths from pipe invert to base

Model	Pipe invert to base (m)
STC2	1.50
STC3	1.40
STC5	1.80
STC7	2.70
STC9	2.40
STC14	3.40
STC18	3.10
STC23	3.70
STC27	3.50

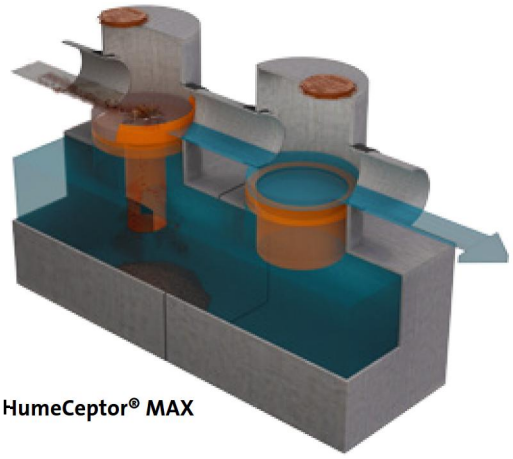
Figure 3 – HumeCeptor® system variations

STC 2 (inlet)

MultiCeptor™

AquaCeptor™

DuoCeptor™



HumeCeptor® MAX

Inspection Procedure

HumeCeptor® units are generally sized such that they only require maintenance (cleaning out) on an annual basis. This being said, it is difficult to know what the actual pollutant loading rate from the particular catchment that the HumeCeptor® services might be (how much pollution enters the device in a given time frame). Therefore, the manufacturer recommends that the HumeCeptor® should be monitored on a 3 monthly basis, which will assist in determining the actual need for maintenance.

The following procedure can be used to inspect the HumeCeptor® and determine the levels of sediment and hydrocarbons (oils) in the device.

1. Locate the HumeCeptor® - all units have a 600mm diameter cast iron lid embossed with"HumeCeptor®"
2. Use the Gatic lifter to remove the lid
3. Conduct a visual inspection of the inlet and outlet pipes to ensure there are no blockages
4. Conduct a visual inspection of the fibreglass insert and check for damage; also check for obstructions in the orifice
5. Identify the location of the oil clean out port and the outlet riser
6. Use the Sludge Judge to determine the levels of sediment and hydrocarbons in the device

The HumeCeptor® is designed to capture and retain sediments and hydrocarbons, therefore, two samples will need to be drawn from the device by using the Sludge Judge. The Sludge Judge is used in the following manner:

Sediment Sampling

1. Lower the Sludge Judge into the outlet riser of the HumeCeptor® all the way to the base of the unit; the float valve will open allowing materials to flow in. It should be lowered in slowly and not plunged to the bottom.
2. When at the bottom of the unit the clear pipe of the Sludge Judge will be filled to the top of weir level with water (and sediment at the bottom). Tug slightly on the rope to set the check valve trapping the mixture inside.
3. When the Sludge Judge has been raised clear of the HumeCeptor®, the amount of sediment in the base of the device can be read using the markers on the clear pipe section.
4. To empty the Sludge Judge, touch the check valve pin against a hard surface; this opens the check valve allowing the contents to drain out.

Oil Sampling

A similar procedure for using the Sludge Judge applies for checking the oil level in the HumeCeptor®, except in this instance the device is used through the oil clean out port rather than the outlet riser.

1. Lower the Sludge Judge into the oil clean out port of the HumeCeptor® to a depth of 1 to 1.5 meters below the fibreglass insert.
2. When at the required depth tug slightly on the rope to set the check valve trapping the mixture inside.
3. When the Sludge Judge has been raised clear of the HumeCeptor®, the amount of oil in the device can be read using the markers on the clear pipe section.
4. To empty the Sludge Judge, touch the check valve pin against a hard surface; this opens the check valve allowing the contents to drain out.

The depths of the sediment and hydrocarbons should be recorded. The HumeCeptor® will require a clean out when either the sediment or oil levels in the device reach the depths outlined in Table 2 below.

It should be noted that for an STC2 model HumeCeptor®, a screw cap will need to be removed to access the Oil Clean Out Port. Ensure that the cap is replaced when work is completed.

Table 2 – Sediment depths indicating maintenance

Model	Max Oil Depth (mm)	Max Sediment Depth (mm)
STC2	350	200
STC3	450	350
STC5	450	600
STC7	450	850
STC9	850	600
STC14	1150	700
STC18	1050	600
STC23	1050	700
STC27	1150	750

Maintenance Procedure

Maintenance of HumeCeptor® is performed using vacuum/eductor trucks this ensures that no requirement for entry into the unit is necessary for maintenance. The vacuum truck industry is a well-established sector of the waste management industry cleaning underground tanks, sewers and catch basins.

A HumeCeptor® unit is cleaned by adhering to the following steps:

1. Complete a Job Hazard Analysis (JHA) and a Work Method Statement (WMS) before undertaking the maintenance procedure.
2. Prepare the site around the HumeCeptor® for cleaning. This involves establishing the job site (traffic control if required), assembling cleaning equipment, positioning the vacuum truck and ensuring correct equipment is available to use (including PPE).
3. Remove the lid above the holding chamber and conduct a visual inspection to assess the condition of the HumeCeptor® and note if there are any blockages or lodged debris
4. Check for oil using a dipstick, tube or sampling device via the oil sample port.
5. Remove and store any free oil separately using a small portable pump via the oil sample port:
   a. Be sure to skim from the top of the water to ensure oil contaminants are removed
   b. Approximately 300 mm of water should also be removed from the top of the water column
   c. The oil/fuel waste can be disposed of separately, as this will incur a higher disposal cost
6. Remove the sludge/sediment from the bottom of the HumeCeptor® using the vacuum truck:
   a. The truck's suction hose should be lowered into the sump of the device via the outlet riser
   b. While extracting the waste, move the hose around in the opening to ensure that the hose is sucking from various locations in the sump to remove all the captured material
   c. The extracted waste can usually be disposed of as general waste at a waste transfer station
7. Clean the interior of the pit using water jet
8. Replace lid, ensuring it is firmly and securely in place

It may be convenient on larger units to de-water some of the relatively clean water from the central zone in the treatment chamber. This will minimise maintenance costs as disposal of essentially clean stormwater can be avoided. Often this can be done in either the sewer or upstream of the pipe (position sandbags to create temporary storage). However, this should only be done with the appropriate authorities consent.

Maintenance Cost

The costs to clean out a HumeCeptor® will vary based on the size of the unit, pollutant volume/type and transportation distances.

Economies of scale will be achieved where there are multiple units for a given location. The time to clean the HumeCeptor® is approximately 30 minutes to an hour, excluding transportation and disposal.

Disposal costs will vary greatly depending on local authority requirements, the type of contaminants washing off your site and the availability of waste disposal facilities.

It should be noted that these costs would be incurred during the maintenance of any type or brand stormwater quality structure and not just the HumeCeptor®.

Maintenance Frequency

It is generally recommended that inspection of the unit to be undertaken every three months for the first year of operation. This schedule may then be relaxed after a year, when confidence is gained regarding the actual pollutant load and run-off generated by the up-stream catchment. A more frequent program may be required where there is greater risk of oil spills.

You may elect to undertake inspection yourself or choose to contract a waste management company to obtain a complete inspection and maintenance package. Contact the nearest Humes office for recommendations/ information regarding companies, which have the capabilities to provide an inspection and maintenance service in your area.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the interceptor can be determined by inserting a dipstick in the oil sample port. Similarly, the depth of sediment can be measured from the surface without entry into the HumeCeptor® via a clear tube (Sediment sampler) - sediment sampler tubes are available from Humes. The sampler is inserted in the 610 mm opening in the "disc" in-line models and through the 100 mm oil sample port in the "inlet" models.

As a general rule an annual maintenance schedule is recommended. However maintenance requirement frequency will vary with the volumes of stormwater pollution generated by your site (number of spills, amount of sediment, etc.). So while annual maintenance is recommended, the frequency of maintenance may be varied (increased or reduced) based on local conditions; if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilised maintenance may only be required every two or three years.

Although HumeCeptor® will continue to operate effectively until sediment completely fills the treatment chamber. It is still deemed good practice that maintenance should be performed "annually" or "once the sediment depth exceeds the guideline values" provided in Table 2, whichever condition is achieved first.

HumeCeptor® units are often installed in areas where the potential for hydrocarbon spillage is great. However HumeCeptor® should be cleaned immediately after any major spill occurs, by a licensed liquid waste contractor. You should also notify the appropriate regulatory agencies as required in the event of a spill.

Removal of Hazardous Material

The requirements for the disposal of material removed from the HumeCeptor® are similar to that of any other stormwater treatment device. Local guidelines should be consulted prior to disposal.

The sediment, once de-watered, may be suitable for disposal in a sanitary landfill. It is recommended to check with the relevant authorities in your local area as some local authorities may require testing of the sediment prior to disposal.

All petroleum waste-products, collected in the HumeCeptor® (oil/chemical/fuel spills), should be removed and disposed of by a licensed waste management contractor.

Example Job Safety Analysis (JSA)/Work Method Statement (WMS)

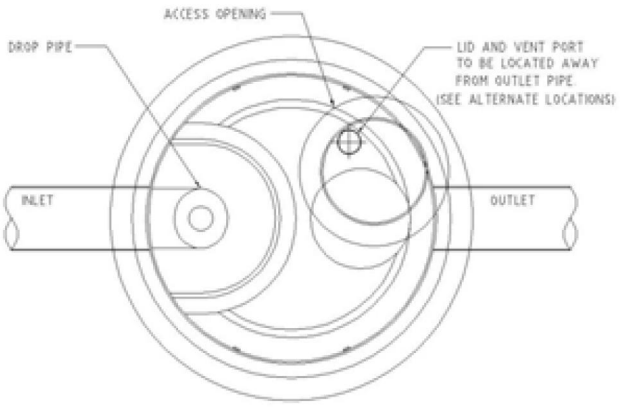
The following JSA/WMS is a guide only. It is the responsibility of the cleaning contractor or asset owner to develop their own JSA/WMS in line with their own WHS requirements and constraints. It also assumes that there will be no entry into the unit during maintenance.

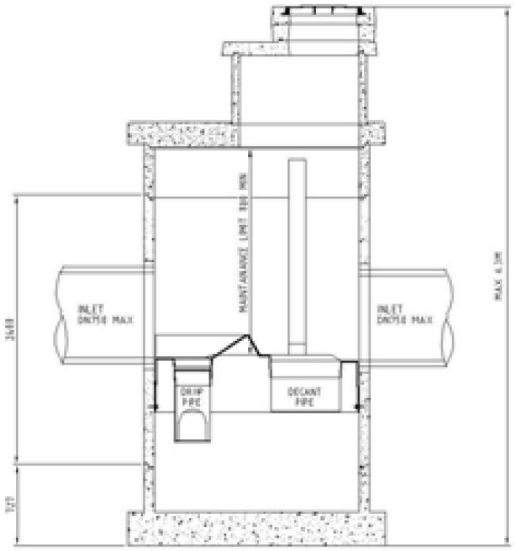
Project/ Address:				**Date:**	
Job: Clean out of HumeCeptor® unit				**Operator:**	
Risk Level:	1 - Extreme	2 - High	3 - Medium	4 – Low	5 - Negligible
Consequence:	Likely to cause very serious harm	Clear potential for serious harm	Similar to risk of driving a car	Little likelihood of any harm	Virtually Harmless
Response:	STOP THE JOB	STOP and Reassess to find better way	Control and ensure controls work	Monitor to ensure risk remains low	Continue work

PROCEDURE	POSSIBLE HAZARDS	INITIAL RISK	CONTROLS	PERSON RESPONSIBLE	END RISK
1. Preliminaries: • Confirm unit locations and types • Familiarise with the technical manual	Nil	-	Refer to relevant manuals	Operator	-
2. Plan the Job: • Room to access and work on the unit without impacting other property or vehicles • Consider water flows and if excessive note and move onto next job • Condition and status of unit • Identify water fill point • Identify waste dump point	• Climbing in/out/around of truck • All units have a high risk of containing syringes	3 4	• Refer to safety plan on moving around vehicles • Wear PPE and never reach into or lift accumulated matter with hands. If a needle stick injury occurs, wash the affected area with soap and water and report the incident to the branch and seek medical attention ASAP.	Operator	4 5
3.Establish Job Site: • Over 60 km/hr will require traffic management • Within 6.4m of overhead power lines will require spotter	• Traffic • Pedestrians • Overhead power lines	2	• Devise a relevant Traffic Management WMS • Ensure barriers and signs redirect pedestrians • Ensure spotter is present	Operator	5
4. Assemble Cleaning Equipment • Position vacuum hose to remove debris from the unit	• Infection • Sharp edges • Manual handling • Falling equipment • High pressure water	3	• Personal hygiene (wash hands prior to smoking/eating) • Wear gloves & remove sharp edges/burrs on equipment • Follow a manual handling WMS • Store equipment securely on vehicle • Inspect vacuum hose fittings firmly secured • Inspect hose daily 7 ensure it has been tested (6 monthly) • Never cap jetting hose • Inspect jetting hose for damage • Never adjust pump pressures or regulators • Maximum reducer on 1" hose is ¾" • No reducers on ½" hose • Fittings to be firmly secured using a spanner	Operator	5
5. Open the Cover • Remove lid using the manhole lifting procedure • If lid is mass concrete and exceeds safe lifting limits, use mechanical lifting device	• Manual Handling • Open Manholes	3	• Refer to a SWP for manual handling • Refer to a SWP for manhole lifting	Operator	5
6. Start Cleaning • Check for oil using a dipstick, tube or sampling device • Remove and store any free oil separately using a small portable pump • If there is any requirement to enter the pit for any reason, confined Space Entry Procedure is to be followed • Decant the relatively clean water from the central zone to either sewer or upstream (approvals from authorities required to discharge to sewer) (OPTIONAL) • Vacuum all material out of the sump until empty clear • Clean the interior of the pit using water jet	• Manual handling • Eye injury from flying debris • Noise • People inside exclusion zone • Confined Space Entry (If required)	3	• Follow a SMP for manual handling • Wear eye protection • Wear hearing protection • Stop operation until area clear. Only essential personnel within exclusion zone • Ensuring minimum slack in hose to prevent whipping • Refer to confined space manuals and SWPs	Operator	5
7. Finish Cleaning • Replace lid ensuring it is fimly & securely in place • Ensure all waste is vacuumed and site is clean prior to packing up • Complete the CWS recording all details and any problems	• Manual handling	3	• Follow a SMP for manual handling	Operator	5

HumeCeptor® unit maintenance record

Customer details			
Company		Phone	
Contact name		Email	
Address		Date	
State		Operator name	
HumeCeptor® unit details			
Model		Type (circle one)	Standard | Inlet | Multi | Aqua Duo | MAX
Cleaning method (circle one)	Vacuum | Eduction		
Layout details			
Plan		Elevation	





Pollutant removal results			
Estimated volume of water removed (L)		Hydrocarbons(%)	
Estimated volume of pollutants/oil (m^3)		Vegetation (%)	
Percentage of pollutant content (%)		Sediments (%)	
Percentage of pollutant capacity (%)		**Total volume (%)**	**100**

Any evidence of gross pollutants (i.e. items larger than drink cans)?	YES	NO
Any evidence of sewage contamination?	YES	NO
Any evidence of any other unexpected contamination?	YES	NO

Describe unexpected contamination (if any):

Any problems cleaning the HumeCeptor® unit (describe briefly):

If problems were experienced were they thenresolved satisfactorily (describe briefly):

Contact information

National sales 1300 361 601

humes.com.au

info@humes.com.au

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ATTACHMENT D - WSUD DEVELOPMENT ASSESSMENT CHECKLIST

7. CHECKLISTS

7.1. Development Application Checklist (lodged with DA)

Water Sensitive Urban Design
Development Application Checklist

Site/ Project Name			
Lot and DP Number:		**DA Number:**	

	Information Required with DA Submission:	**Y**	**N**
1	Has a Water Sensitive Urban Design Strategy been submitted as part of the development application?	Y	
2	Is a BASIX Certificate required? If so, Yes - Attach certificate with DA		N
3	Has the digital version of MUSIC and report on the MUSIC model using data prescribed outlined in Council's Technical Guideline been attached? Have stormwater quality retention criteria (TSS 85%, TP 60%, and TN 45%) and water quantity / drainage requirements been met and documented in the WSUD Strategy? If relevant, have the Water Conservation, Quantity and quantity targets been achieved?	Y N/A	N Refer report for justification
4	Does WSUD Strategy contain the following information? • Review of the **WSUD principles** and ensure that these are considered throughout development of the WSUD strategy. • Confirmation of the **WSUD objectives** that are relevant to the development application. • Confirmation of the **WSUD targets** for potable water conservation, stormwater quality management and stormwater quality management that are relevant to the development application. • Complete a **site analysis** to evaluate the site characteristics that potentially will impact on the feasibility of WSUD for the site. • **WSUD measures** that would be appropriate for the development considering the development scale, site characteristics, stormwater quality management function and stormwater quantity management function. • A **preliminary WSUD strategy** that positions the selected WSUD measures in appropriate locations and arranges the measures in an appropriate series. • **Numerical modelling** utilising MUSIC software to evaluate appropriate sizes of the WSUD measures. • C**oncept designs** of the WSUD measures. • **WSUD strategy report** that summarises the methodology and WSUD outcomes, and provide this with the development application for the site.	 Y Y Y Y Y Y Y Y Y	
5	Have the conceptual plans of the proposed stormwater treatment measures been included on the plans? (Detailed engineering plans will be required for the construction certificate)	Y	

6	Has a Draft Operation and Maintenance Plan which includes details on the following been provided?		
	• Site description (area, imperviousness, land use, annual rainfall, topography etc)	Y	
	• Site access description	Y	
	• Likely pollutant types, sources and estimated loads	Y	
	• Locations, types and descriptions of measures proposed	Y	
	• Operation and maintenance responsibility (council, developer or owner)	Y	
	• Inspection methods	Y	
	• Maintenance methods (frequency, equipment and personnel requirements including Work Health and Safety requirements)	Y	
	• Landscape and weed control requirements		N
	• Operation and maintenance costs		N
	• Waste management and disposal options, and		N
	• Reporting.		N

COUNCIL RFI #02 – 17TH MAY 2019

WSP RESPONSES REFERENCE:

- ENGINEERING MEMO REF: PS111235-MEM-RFI2-ENG
- FINAL WSUD CONCEPT – MEMO REF: PS111235-MEM-RFI2-WW
- TRAFFIC MEMO REF: PS111235-TAP-MEM-001

PENRITH
CITY COUNCIL

Our Ref: DA18/1163
Contact: Lucy Goldstein
Telephone: (02) 4732 8136

17 May 2019

Attn: Sean Porter
via email [redacted]

RE: Development Application DA18/1163
Proposal: Upgrade and Extension to Links Road, St Marys NSW 2760

Reference is made to Council's previous letter dated 4 February 2019. A review of the additional information you submitted dated 4 March 2019 has been undertaken.

I wish to advise that there are a number of outstanding matters, as detailed below, which are required to be addressed in order to progress the application.

In addition to these matters, this letter requests additional information relating to traffic matters, specifically a Warrants Assessment for traffic signals at the Christie Street intersection.

Owners Consent

As previously indicated, your proposal to amend the application by excising a portion of the road (being the Christie Street/Links Road intersection, and the portion of road leading up to the intersection) is not currently supported. In this respect, ongoing discussions are occurring between Council's Traffic Engineers and the RMS to clarify the design requirements of the Christie Street intersection. Given this, the previous request to submit owners' consent for each of the affected lots remains applicable.

Further correspondence regarding this matter will be issued as discussions with the RMS progress.

Engineering

The following engineering matters have arisen, and shall be resolved to progress the application.

- In reviewing your letter dated 4 March 2019, it is understood that you seek to respond to the flooding issues by lifting the road design crown by a maximum 760mm between Chainage 380m and 670m to be above the 5% Annual Exceedance (AEP) flood event. However, there are portions of the road that are located hard up against the lot boundary, which leaves no room for any batter to allow the road to be lifted without encroaching into the neighbouring lot(s). As such, the application shall demonstrate that in lifting the road, all works will remain within the development site boundary.

- Turning paths of a Sydney Water maintenance vehicle size shall be provided for the pump station, and demonstrate that vehicles are able to enter and exit the site clear of the proposed median strip and verges. Advice should be sought from Sydney Water as to the size of the maintenance vehicles, and provide comments on the proposed left in/left out traffic movement to and from the site.

- Turning path shall be provided for the access road to the Golf Club for a Heavy Rigid Vehicle of a minimum 12.5m.

- An access point to the Stormwater Quality Improvement Device (SQIDs) needs to be provided for maintenance purposes, and is to be shown on the plans.

- Pram ramps shall be provided at the access road to the Golf Club and the medium island adjusted accordingly.

- The road pavement design shall be ESA to 1x10^7 in accordance with Council Design Guidelines for Engineering Works.

- The proposed cross-section detail of Links Road MC10 CH 420-1250 shows a footpath with a gradients of 4% which does not comply with Council's Design Guidelines for Engineering Works. As such, the footpath shall have a maximum gradient of 2.5%. The plans shall be amended accordingly.

Traffic

A Warrants Assessment shall be provided for the proposed installation of traffic control lights at the Christie Street intersection.

- As a guide, a signalised intersection may be considered if one of the following warrants is met.

  (a) Traffic Demand:
  For each of four one-hour periods of an average day:
  (i) The major road flow exceeds 600 vehicles/hour in each direction; and
  (ii) The minor road flow exceeds 200 vehicles/hour in one direction.

  OR
  (b) Continuous Traffic
  For each of four one-hour periods of an average day
  (i) The major road flow exceeds 900 vehicles/hour in each direction; and
  (ii) The minor road flow exceeds 100 vehicles/hour in one direction; and
  (iii) The speed of traffic on the major road or limited sight distance from the minor road causes undue delay or hazard to the minor road vehicles; and
  (iv) There is not any other nearby traffic control light site easily accessible to the minor road.

  OR
  (c) Pedestrian safety:
  For each of four one-hour periods of an average day

(i) The pedestrian flow crossing the major road exceeds 150 persons/hour; and
(ii) The major road flow exceeds 600 vehicles/hour in each direction, or where there is a central median of at least 1.2m wide, 1000 vehicles/hour in each direction

OR
(d) Pedestrian safety – high speed road:
For each of four one-hour periods of an average day
(i) The pedestrian flow crossing the major road exceeds 150 persons/hour; and
(ii) The major road flow exceeds 450 vehicles/hour in each direction, or where there is a central median of at least 1.2m wide, 750 vehicles/hour in each direction; and
(iii) The 85th percentile speed on the major road exceeds 75km/hr.

- The installation of a traffic control light is dependent on general warrants in accordance with Roads and Marmite requirements for Traffic Signal Design – Section 2 Warrants. Please note, if the site satisfies the warrants, it does not necessarily mean that a traffic control is the best solution. All traffic data should be analysed and alternative treatments be considered to determine the optimum solution.

  A traffic control light is usually installed at an intersection:
  (a) To provide traffic control at a site with a traffic capacity or road safety problem
  (b) To control conflicting movements with high traffic flows
  (c) To facilitate access to and from local areas in a major/minor road system, including pedestrian movements
  (d) As part of an area wide system of traffic management.

Waterways

- In reviewing the memo prepared by WSP dated 1 March 2019, it is understood that 7x Humeceptors are proposed be installed as part of the subject works. The memo prepared by WSP acknowledges that the proposed system results in non-compliance with Council's Water Sensitive Urban Design (WSUD) Policy.

  Notwithstanding the fact that the Humeceptors do not achieve the pollutant targets under Councils WSUD policy, the proposed system does not meet the objectives of the WSUD Policy, specifically to integrate stormwater management into the landscape. Further to this, the ongoing maintenance of the proposed devices are likely to be significant, and onerous for Council.

  Whilst the memo prepared by WSP states that vegetated swales were considered, but found not to be suitable, no detailed information or evidence has been provided to support this claim.

  Given the Humeceptors do not meet the requirements and objectives of Council's WSUD Policy, and have significant ongoing maintenance burdens, it is recommended that alternate stormwater treatment measures be thoroughly considered, such as vegetated swales. Supporting evidence shall be submitted to show whether alternative stormwater managements are suitable/unsuitable.

PENRITH
CITY COUNCIL

With consideration to the above, a submission of alternate stormwater treatment measures would need to be accompanied by updated supporting documentation, including:

i. WSUD Strategy Report prepared in accordance with Council's WSUD Technical Guidelines
ii. MUSIC modelling which is consistent with the drainage plans and ultimate strategy
iii. Revised Concept drainage plans which include details and locations of additional stormwater treatment measures
iv. A Draft Operation and Maintenance manual should be prepared in accordance with Council's WSUD Technical Guidelines.

Environmental Management

- In respect to the identified asbestos material on the site (as fragments on the surface and in stockpiles), as the removal of this material poses an unacceptable health risk, these removal works would be classified as remediation works under Sydney Regional Environmental Plan No. 20 (SREP 20) and State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55).

  Accordingly, and as per Council's previous letter, it is requested that the application be amended and a Remedial Action Plan be submitted to address the asbestos material.

  However, it is acknowledged that an alternative mechanism is available through the *Work Health Safety Regulation 2017* legislation, which addresses the removal of asbestos material. It is understood that Council has not received any notification and relevant certification documents that the removal of the asbestos material has been undertaken.

  In respect to this matter, you will need to advise how you intend to proceed.

The above information is requested to be provided by **Wednesday 12 June 2019** to enable the progression of the application.

Should you wish to discuss further any of the matters raised in this letter, please contact me on 4732 8136.

Sincerely,

[redacted]

Lucy Goldstein
Development Assessment Planner

TECHNICAL MEMO

TO:	Penrith City Council
FROM:	WSP
SUBJECT:	**Links Road Upgrade** – ENGINEERING Responses to Council RFI DA18/1163 dated 17-05-19
OUR REF:	PS111235-MEM-RFI2-ENG
DATE:	**12 June 2019**

The following technical summary provides commentary with respect to ***Engineering*** comments of Council's letter of 17th May 2019.

- Alignment & Batter spill:

  The road design has been modified by way of adjusting the alignment, shifting the centre line slightly northwards as well as localise batter steepening (still within Council's acceptable guidelines). At the 90degree bend (CH 360) a small 250mm retaining sleeper wall is proposed to ensure no batter spill beyond the land boundary. In doing this flood resilience is maintained, whilst ensuring no encroachment to adjacent properties. Refer to attached design output.

- Turning Paths

  Turing paths were originally submitted within Appendix A of the Design Report.

  Noting there have now been minor changes to the alignment and Golf Club access, revised turning paths have been prepared. These have been appended to this document.

  With specific reference to the Sydney Water Facility, we have recached out to Sydney Water for comments and received the attached email response. They note that the maximum vehicle to allow for is a Crane 12m long x 2.75m wide. As noted within the design report a 12.5m SU Truck was adopted which more than allows for this requirement. These turning paths were included with Appendix A4 of the DA submission.

- Access points to the Stormwater Quality Improvement Device (SQIDs)

  Should the use of SQIDs be progressed, provision has been made for access points to maintain them. Verge widening, and hard stands have now been incorporated into the alignment design. Refer to the attached design outputs. Should Council approve the alternative WSUD strategy, detailed below, then these will be removed.

- Pram Ramps

  Pram ramps have now been provided at the access road to the Golf Club and the medium island has been adjusted.

- Pavement Design

  It is noted that the current pavement design adopts a design ESAs of 6.15x10^6. Council have requested a design traffic ESA of 1x10^7. This will be incorporated. (Preliminary calculations note that approximately 20mm will be added to the to the DGS40 subbase layer, all other pavement layers would remain as currently shown.)

- Footpath cross fall

  Footway cross falls have been flattened from 4.0% to 2.5%. There has been no encroachment to adjacent properties as a result. The attached design output has incorporated this.

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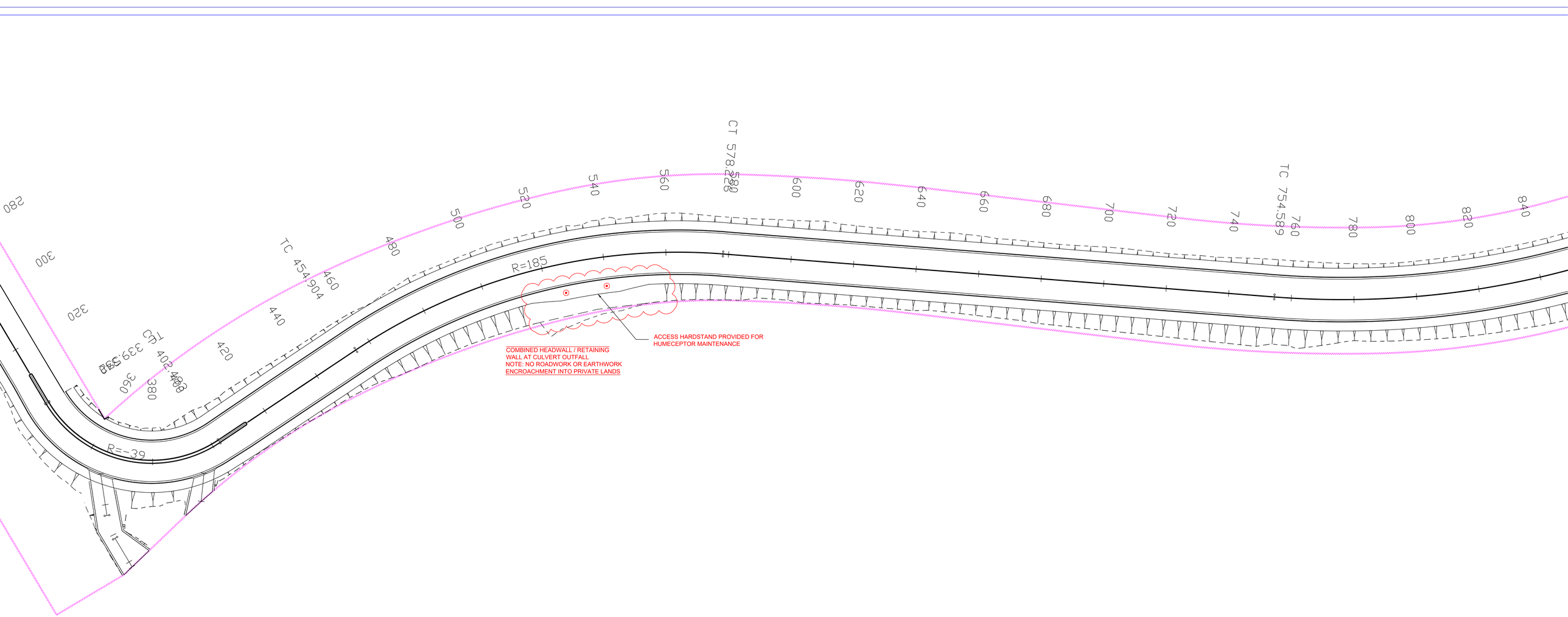
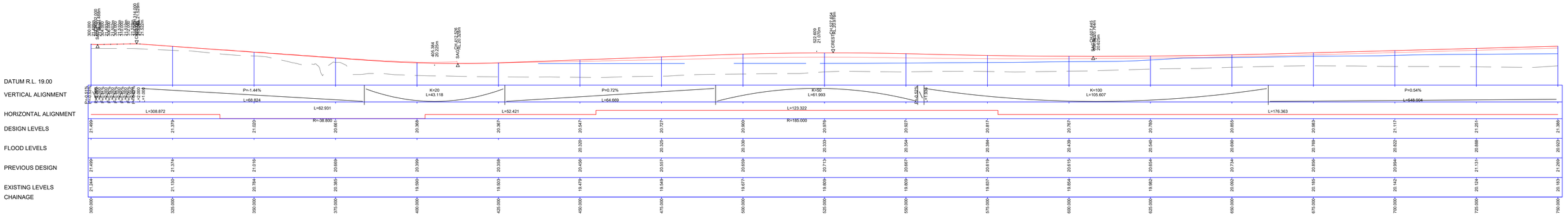




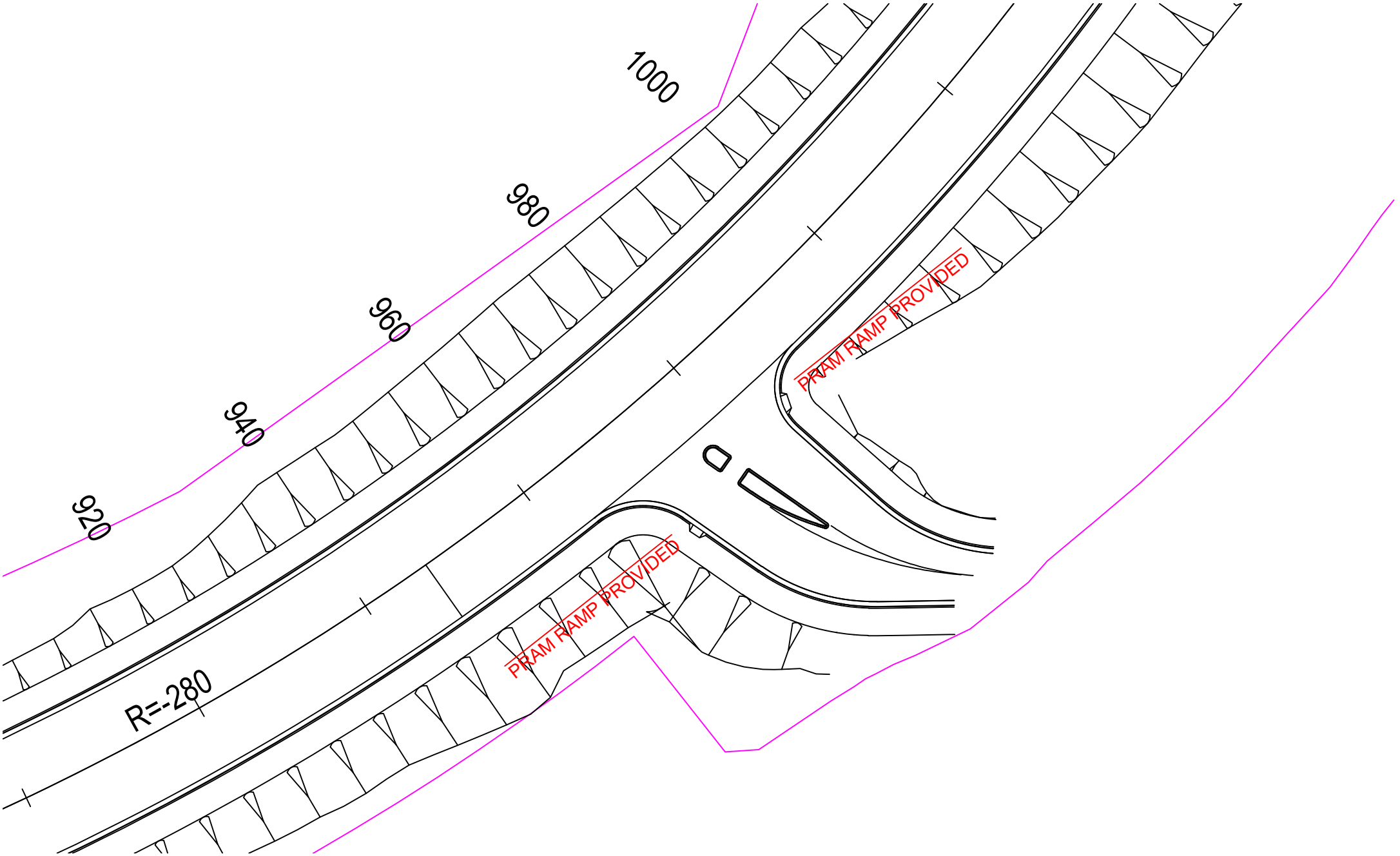
SCALES ON A3 SIZE DRAWING

Horizontal Scale= 500m

Vertical Scale= 100m

ISSUE STATUS

SHEET NUMBER
SHEET 1 OF 1



Wallis, James

From: CHEE, CHENG [redacted]
Sent: Wednesday, 12 June 2019 5:40 PM
To: Wallis, James
Cc: LEONES, ALAN; KUNWER, NAILA; HOUSHIYA, YOUSEF
Subject: RE: Sydney Pump Station on Links Rd

Hi James,
Can you please allow for the following vehicles dimensions. My understanding of C10.4.2 is to determine the minimum width for road design which has allowance for single articulated vehicles. In this instance for SP0366, operations has nominated the following vehicle dimensions.

Vac trucks and recyclers - 10m long x 2.5m wide x 4m high
Crane - Crane 12m long x 2.75m wide

Kind regards,

Eizac Chee
Project Engineer
LCS - Delivery Management
Sydney Water, Desk 114 Level 12, 1 Smith Street, Parramatta NSW 2150
[redacted]

From: HOUSHIYA, YOUSEF
Sent: Friday, 7 June 2019 8:40 AM
To: CHEE, CHENG [redacted]
Cc: LEONES, ALAN [redacted]; KUNWER, NAILA [redacted]
Subject: FW: Sydney Pump Station on Links Rd

Hi Eizac,

Can you please respond to below query from James.

James is from WSP and involved in the design of Links Road upgrade for Lendlease.

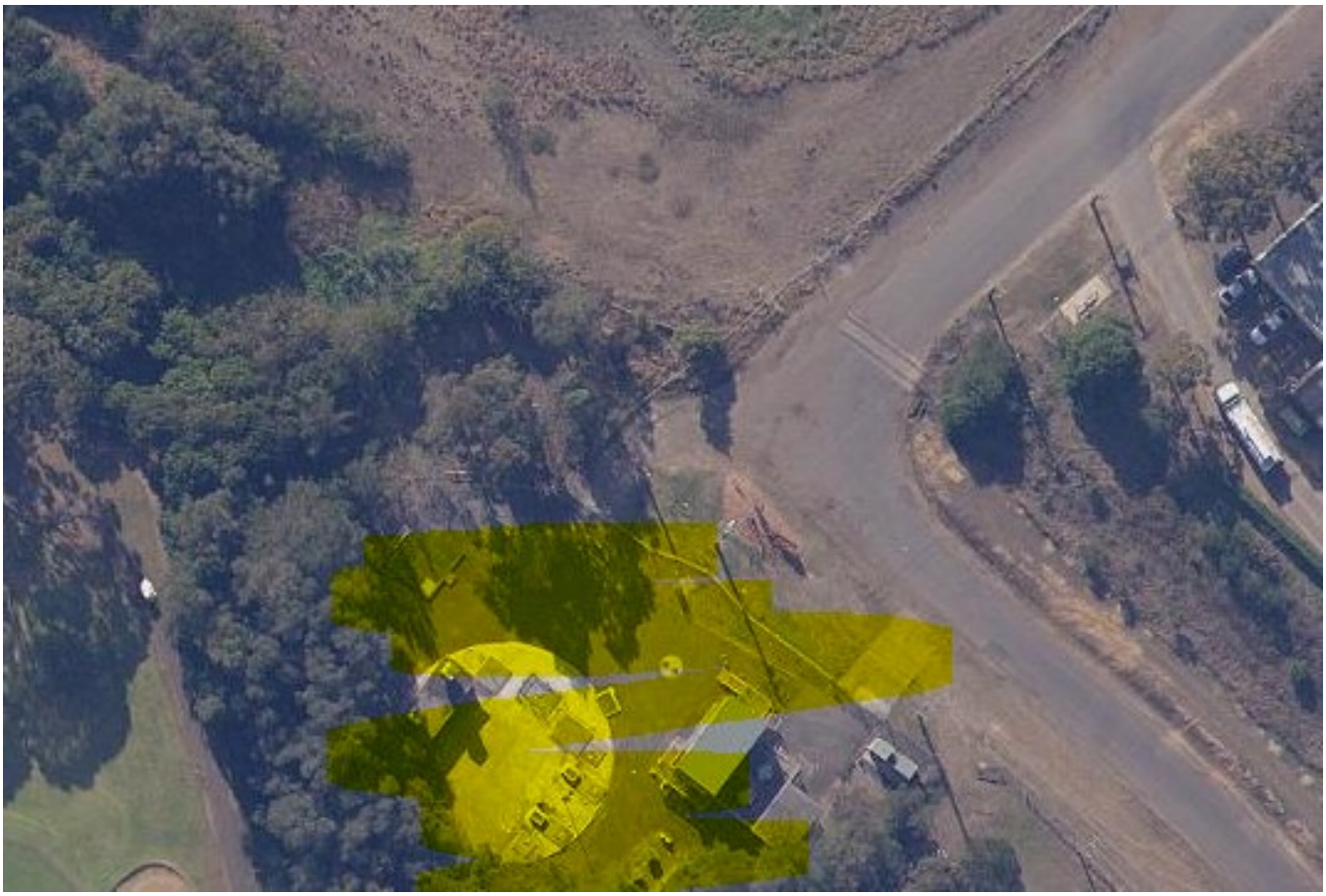
Best regards,
Yousef

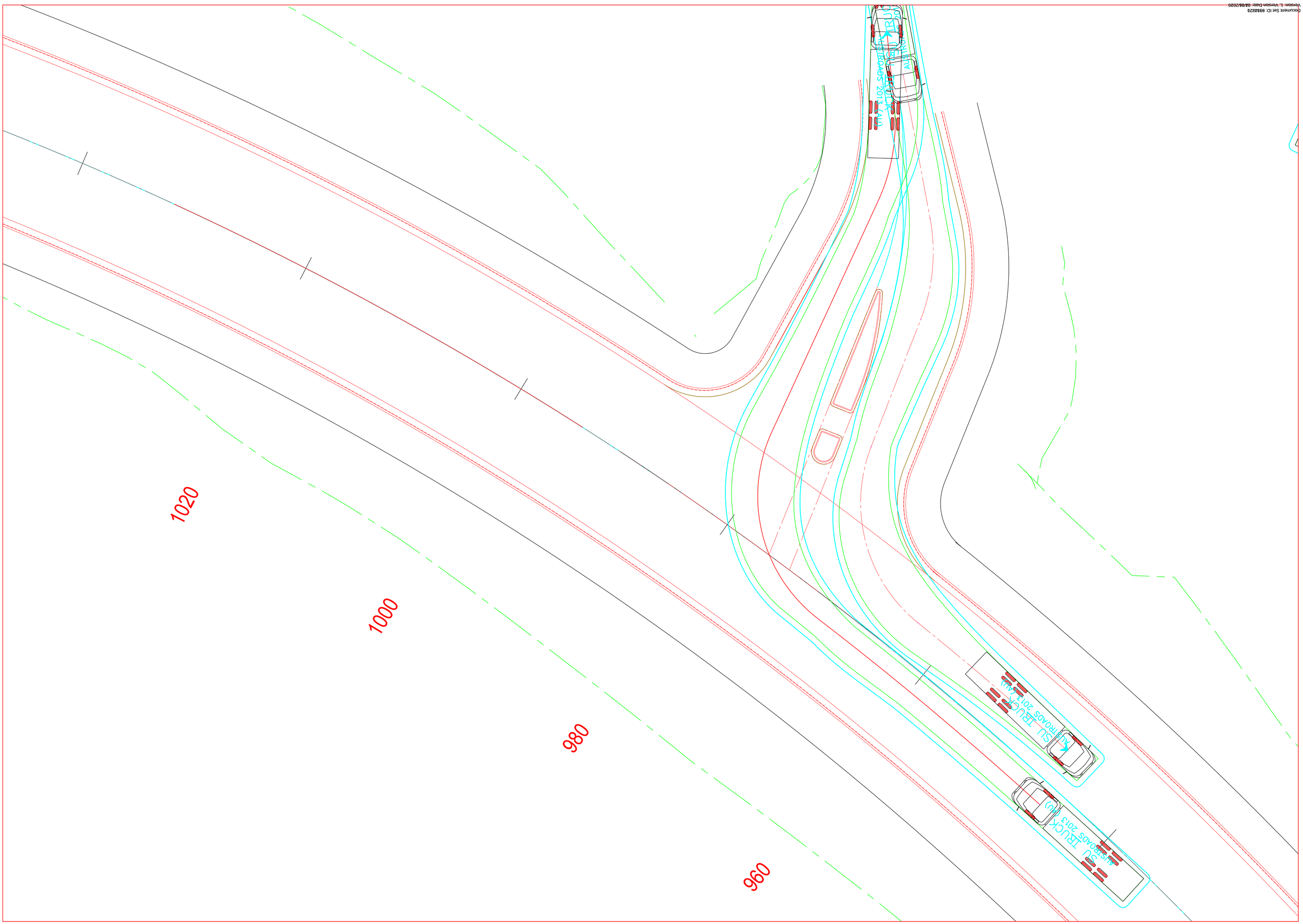
From: Wallis, James [redacted]
Sent: Thursday, 6 June 2019 7:04 PM
To: HOUSHIYA, YOUSEF [redacted]
Subject: Sydney Pump Station on Links Rd

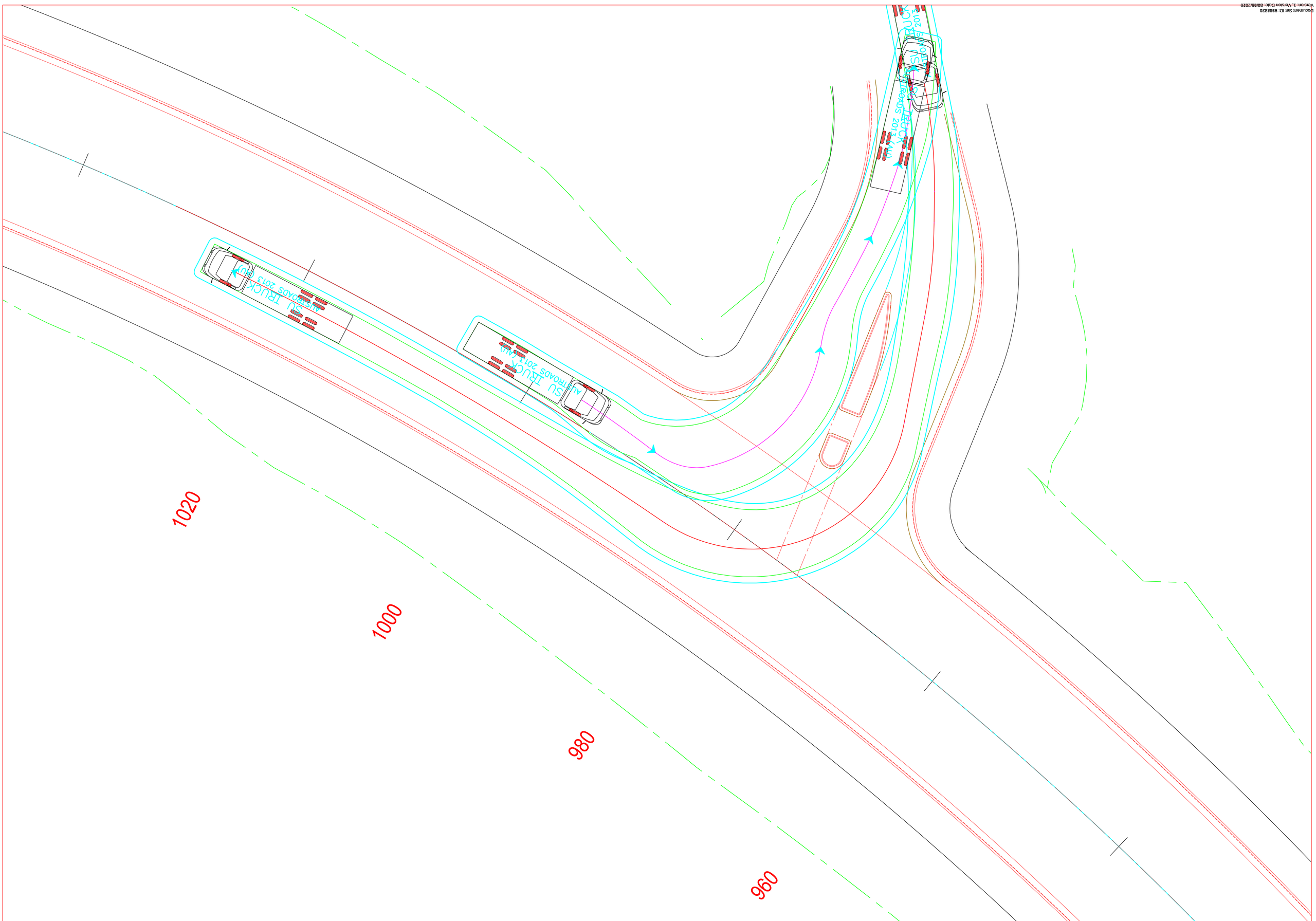
Hi Yousef,

I trust you are well. I was hoping you could help me with a query regarding the Sydney Water Pump station located just off the 90degree bend (aerial below).
As part of the road design we are wanting to understand further the function of this facility , specifically what vehicles would typically need access?
Currently the only guide I've been able to locate is the Sydney Water Civil Tech Spec – where within C10.4.2 which would suggest an 8.8m long 2.4m wide vehicle.
This may influence the design progression of the road here, so a swift response would be much appreciated.

Kind regards
James







LONG RIGID BUS
AUSTROADS 2013 (AV)

LONG RIGID BUS
AUSTROADS 2013 (AV)

LONG RIGID BUS
AUSTROADS 2013 (AV)

1020

1000

980

960

TECHNICAL MEMO

TO:	Penrith City Council
FROM:	WSP
SUBJECT:	**Links Road Upgrade** – WATERWAYS Responses to Council RFI DA18/1163 dated 17-05-19
OUR REF:	PS111235-MEM-RFI2-WW
DATE:	**12 June 2019**

The following technical summary provides commentary with respect to ***Waterways*** comments of Council's letter of 17th May 2019.

The initial 50% stormwater concept submission to Council prior to DA submission identified swales as an option for water transfer and treatment. It is appreciated that within Council's response they noted that no detailed information or evidence has been provided to support our commentary that Swales were initially considered, and as such, these drawings have been attached to this technical note for reference.

During the subsequent review of these designs with Council, the discussions identified that due to the constrained width of the road corridor, and the land footprint of that new swales would require, these could not be accommodated within the land available without the need to acquire additional land along the southern boundary, this would include land acquisition from the golf course which was not acceptable.

Shifting the road alignment further north was discussed, however as impacting the existing catchment drainage with the roadway earthworks channels is to be avoided, this added an additional alignment constraint.

The key constraint of land availability drove the design team to consider proprietary products, appreciating their treatment capabilities are significantly less than a traditional option.

Notwithstanding the above, WSP has undertaken a detailed review of the available water quality management strategies that could be adopted at the Links Road project. The detailed review takes into consideration the numerous constraints associated with the Links Road project including topography, land ownership, maintenance periods and the broader catchment context that the Links Road project forms part of.

In considering each of these elements, an alternative strategy has now been identified, such that it is now considered that the most appropriate and cost effective (from both a land acquisition perspective and an installation / maintenance perspective) solution. This option would be the construction of a linear vegetated swale along the eastern boundary of the revised road reserve.

The linear bio-swale would align with the existing open drainage channel which conveys stormwater runoff from approximately 41.26 hectares of existing upstream catchments that is predominately categorised as 'Industrial'. In so doing, it is proposed to off-set the minimal impact of the Links Road widening and extension works on downstream stormwater quality through the treatment of runoff from an existing

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industrial catchment that appears to have limited stormwater quality improvement measures prior to discharging into South Creek.

An assessment of the existing and proposed Links Road catchments has been undertaken within MUSIC. Estimates of the pollutant loads are as follows:

Pollutant	Pre-Development Road	Post Development Road	Reduction required for Council Compliance	
	kg / year	kg / year	%	kg/year
Total Suspended Solids	3840	5800	85	4930
Total Phosphorus	6.66	9.81	65	6.38
Total Nitrogen	26.7	40.3	45	18.14
Gross Pollutants	317	478	90	430.2

Consideration of the above establishes that the proposed WSUD strategy associated with the Links Road upgrade and extension would need to remove the following pollutant volumes annually:

- 4930 kg/year Total Suspended Solids
- 6.38 kg/year Total Phosphorus
- 18.14 kg/year Total Nitrogen
- 430.2 kg/year Gross Pollutants

Consideration of the adjacent upstream industrial catchment and conceptual modelling within MUSIC estimates that the proposed bio-retention swale within the existing channel east of Links Road would need to cover a surface area of approximately 6600 m^2 to provide a council-compliant water quality improvement outcome to mitigate the impacts of the Links Road upgrade and extension on the receiving waters downstream.

A quantitative analysis for pollutants generated from the proposed road compared and the treatment by bio-retention swales was undertaken. Refer to the table below.

Pollutant	**Pollutants from Proposed Road**	**Pollutant reduced by Bio-retention Swale (6600m^2)**	**Is Bio-retention swale pollutant reduction greater than pollutant generated by proposed road**
Total Suspended Solids (kg/year)	4930	4960	Y
Total Phosphorus (kg/year)	6.38	15.3	Y
Total Nitrogen (kg/year)	18.14	193	Y
Gross Pollutants (kg/year)	430.2	0*	Y

*Gross Pollutants are already removed by the grassed swales prior to reaching the bio-swales.

The above table shows that the reduction in pollutant generated by the external catchment is greater than the pollutant generated by the proposed works.

The intent of this WSUD treatment strategy is to provide bio-swales along the existing drainage channels, as this minimises all impacts to adjacent properties, roadworks, and negates any potential changes in overland catchment flow. Based on our analysis of this site, it affords an area of 4100m^2, less that the area required

above and as such, changes to the channel (widening) would be required, which is undesirable. However, analysing this area in its current state, we are still able to achieve compliance and meet the reduction targets for Phosphorus, Nitrogen and Gross Pollutants. Suspended Solids still achieve a reduction of 70% which although is not the 85% target, is significantly less than the existing pre-development case, and ultimately will result in betterment of the existing condition. Therefore it can be acknowledge that with the addition of bio-swales within the existing grassed channel it allows for pollutants from the proposed road to be offset and improves upon the existing condition by the time flows reach South Creek.

Consideration of the maintenance and operation requirements of the vegetated bio-swales are as follows:

- Regular mowing of the grass within the proposed channels
- Removal of excess debris to prevent blockage
- Re-vegetation of any displaced fauna
- Re-grading of any areas with localised ponding

Should the proposed approach by acceptable by Council we are able to provide additional details on the proposed arrangements of the vegetated bio-swale.

TECHNICAL MEMO

TO:	Penrith Council
FROM:	WSP
SUBJECT:	**Christie Street, Lee Holm Road and Links Road Extension – Signalised Intersection Warrant Review**
OUR REF:	PS111235-TAP-MEM-001
DATE:	**7 June 2019**

Hi James,

Please find attached traffic light warrants for the proposed intersection of Christie Street, Lee Holm Road and Links Road extension as requested by Penrith City Council. As per the Roads and Maritime Services traffic light warrants guidelines the following is required based upon traffic demands.

1. CONTEXT

WSP undertook the *St Marys Development Site Regional Traffic Modelling, Traffic and Transport Assessment* in October 2017. Traffic modelling for this project was undertaken using both Aimsun mesoscopic and SIDRA intersection traffic modelling programs. Intersection traffic counts were undertaken on a weekday between 6am and 10am and 3pm and 7pm to inform the traffic modelling process. Aimsun modelling was then undertaken between 7am and 9am and 4pm and 6pm being the peak two-hour period. Reporting and SIDRA intersection modelling undertaken were reported for a one-hour peak period in the AM and PM which is standard industry practice. The peak period for all reporting and SIDRA model runs was between 8am and 9am and 5pm and 6pm.

The traffic light warrant based on traffic demand alone requires four one-hour periods of traffic volumes of an average day. This information has been sourced from the Aimsun modelling undertaken for future years 2021, 2026 and 2031 when a fourth leg (Links Road extension) connects the current three leg intersection of Christie Street and Lee Holm Road. The traffic volumes for this proposed four-way intersection are further documented following.

2. PREVIOUS WORK

Prior to WSP being involved with the abovementioned project, intersection designs were previously prepared by J Wyndham Prince in consultation with Roads and Maritime and Penrith Council. These intersection designs were provided to WSP for guidance purposes and included a four-way signalised intersection.

3. EXISTING CONDITIONS – 2018

This intersection is currently a priority sign-controlled give-way T intersection. The volumes under existing (2018) conditions are shown in the movement summary below. Based on the existing T intersection, the side road (Lee Holm Road) does not meet the warrants for traffic lights. Christie Street does meet the warrants in each direction. This information below is for one-hour AM and PM peak periods.

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MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd 2018 AM]

2018 Existing AM
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Lee Holm Rd											
1	L2	43	26.8	0.083	11.5	LOS A	0.3	2.5	0.66	0.85	46.9
3	R2	14	38.5	0.540	212.9	LOS F	1.5	14.2	0.99	1.04	10.1
Approach		57	29.6	0.540	60.0	LOS E	1.5	14.2	0.74	0.90	26.4
East: Christie St											
4	L2	43	26.8	0.430	5.9	LOS A	0.0	0.0	0.00	0.03	55.6
5	T1	747	7.7	0.430	0.1	LOS A	0.0	0.0	0.00	0.03	59.6
Approach		791	8.8	0.430	0.4	NA	0.0	0.0	0.00	0.03	59.4
West: Christie St											
11	T1	895	5.3	0.475	0.1	LOS A	0.0	0.0	0.00	0.00	59.8
12	R2	72	16.2	0.127	11.5	LOS A	0.5	3.8	0.69	0.87	47.0
Approach		966	6.1	0.475	0.9	NA	0.5	3.8	0.05	0.06	58.7
All Vehicles		1814	8.0	0.540	2.5	NA	1.5	14.2	0.05	0.08	57.0

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd 2018 PM]

2018 Existing PM
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Lee Holm Rd											
1	L2	96	2.2	0.486	30.3	LOS C	1.7	12.2	0.93	1.04	36.9
3	R2	8	12.5	0.699	494.9	LOS F	1.8	14.3	1.00	1.04	4.9
Approach		104	3.0	0.699	67.8	LOS E	1.8	14.3	0.94	1.04	25.3
East: Christie St											
4	L2	7	28.6	0.671	6.0	LOS A	0.0	0.0	0.00	0.00	55.6
5	T1	1274	3.0	0.671	0.1	LOS A	0.0	0.0	0.00	0.00	59.6
Approach		1281	3.1	0.671	0.2	NA	0.0	0.0	0.00	0.00	59.6
West: Christie St											
11	T1	745	3.1	0.390	0.1	LOS A	0.0	0.0	0.00	0.00	59.9
12	R2	9	33.3	0.081	36.3	LOS C	0.2	2.2	0.93	0.97	33.7
Approach		755	3.5	0.390	0.5	NA	0.2	2.2	0.01	0.01	59.3
All Vehicles		2140	3.2	0.699	3.6	NA	1.8	14.3	0.05	0.06	56.0

4. FUTURE CONDITIONS – 2021, 2026 & 2031

4.1.1 YEAR 2021

Based upon vehicle demands shown in the movement summaries below, the warrants are met for both the major road (Christie Street) in each direction and for the proposed minor road (Links Road extension) in one direction in the AM peak period. In the PM peak period, 129 vehicles/hour travel on the side road under the 200 vehicles/hour guideline.

Between 7am and 8am the following volumes are sourced:

South: Lee Holm Road – 87 vehicles

East: Christie Street – 452 vehicles

North: Links Road – 203 vehicles

West: Christie Street – 1,229 vehicles

Between 4pm and 5pm the following volumes are sourced:

South: Lee Holm Road – 95 vehicles

East: Christie Street – 1,072 vehicles

North: Links Road – 136 vehicles

West: Christie Street – 929 vehicles.

In summary, the warrants are met for at least two single one-hour periods in the AM and are close for the other two single one-hour periods in the PM where approximately 130 vehicles/hour occur.

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd-LinksRd-2021 AM with rezoning]

Christie St & Leeholm Rd & Link Rd
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Leeholm Rd											
1	L2	60	55.0	0.192	32.1	LOS C	2.0	20.1	0.84	0.73	33.6
2	T1	1	0.0	0.192	27.1	LOS C	2.0	20.1	0.84	0.73	33.1
3	R2	4	75.0	0.017	32.6	LOS C	0.1	1.4	0.81	0.63	30.8
Approach		65	55.4	0.192	32.1	LOS C	2.0	20.1	0.83	0.73	33.4
East: Christie St											
4	L2	3	0.0	0.265	13.2	LOS B	5.4	40.2	0.49	0.43	46.7
5	T1	660	8.5	0.321	7.8	LOS A	6.8	51.0	0.51	0.44	52.3
6	R2	2	0.0	0.006	18.1	LOS B	0.0	0.3	0.55	0.62	41.0
Approach		665	8.4	0.321	7.9	LOS A	6.8	51.0	0.51	0.44	52.3
North: Links Rd											
7	L2	23	0.0	0.159	30.9	LOS C	2.3	16.0	0.83	0.67	36.1
8	T1	49	2.0	0.159	26.4	LOS C	2.3	16.0	0.83	0.67	34.5
9	R2	178	6.2	0.591	36.6	LOS D	6.6	48.3	0.95	0.81	34.6
Approach		250	4.8	0.591	34.1	LOS C	6.6	48.3	0.92	0.77	34.7
West: Christie St											
10	L2	104	5.8	0.075	6.2	LOS A	0.3	2.4	0.17	0.59	50.0

11	T1	791	3.2	0.592	9.7	LOS A	12.8	91.6	0.60	0.55	50.4
12	R2	93	2.2	0.592	16.9	LOS B	12.8	91.6	0.68	0.64	44.9
Approach		988	3.3	0.592	10.0	LOS B	12.8	91.6	0.56	0.56	49.8
All Vehicles		1968	7.0	0.592	13.1	LOS B	12.8	91.6	0.60	0.55	47.0

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd-LinksRd-2021 PM with rezoning]

Christie St & Leeholm Rd & Link Rd
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Leeholm Rd											
1	L2	119	25.2	0.359	33.8	LOS C	4.3	37.1	0.89	0.77	33.4
2	T1	7	71.4	0.359	29.1	LOS C	4.3	37.1	0.89	0.77	32.4
3	R2	1	0.0	0.003	30.2	LOS C	0.0	0.2	0.79	0.59	33.0
Approach		127	27.6	0.359	33.5	LOS C	4.3	37.1	0.89	0.77	33.3
East: Christie St											
4	L2	1	0.0	0.436	13.8	LOS B	10.3	75.0	0.55	0.49	46.3
5	T1	1143	4.4	0.529	8.7	LOS A	13.6	99.0	0.58	0.52	51.6
6	R2	5	0.0	0.013	17.0	LOS B	0.1	0.7	0.53	0.64	41.6
Approach		1149	4.4	0.529	8.7	LOS A	13.6	99.0	0.58	0.52	51.6
North: Links Rd											
7	L2	3	0.0	0.014	30.4	LOS C	0.2	1.3	0.80	0.59	35.9
8	T1	3	0.0	0.014	25.9	LOS C	0.2	1.3	0.80	0.59	34.3
9	R2	123	8.9	0.527	39.5	LOS D	4.6	35.0	0.96	0.79	33.6
Approach		129	8.5	0.527	39.0	LOS D	4.6	35.0	0.95	0.78	33.7
West: Christie St											
10	L2	165	1.8	0.117	6.2	LOS A	0.6	3.9	0.18	0.60	50.0
11	T1	670	4.8	0.452	8.7	LOS A	8.8	64.5	0.55	0.49	51.4
12	R2	30	10.0	0.452	15.7	LOS B	8.8	64.5	0.60	0.55	46.1
Approach		865	4.4	0.452	8.5	LOS A	8.8	64.5	0.48	0.51	50.9
All Vehicles		2270	5.9	0.529	11.7	LOS B	13.6	99.0	0.58	0.55	48.3

4.1.2 YEAR 2026

Based upon vehicle demands shown in the movement summaries below, the warrants are met for both the major road (Christie Street) in each direction and for the proposed minor road (Links Road extension) in one direction in both the AM and PM peak periods.

Between 7am and 8am the following volumes are sourced:

South: Lee Holm Road – 85 vehicles

East: Christie Street – 680 vehicles

North: Links Road – 185 vehicles

West: Christie Street – 1,518 vehicles

Between 4pm and 5pm the following volumes are sourced:

South: Lee Holm Road – 116 vehicles

East: Christie Street – 1070 vehicles

North: Links Road – 210 vehicles

West: Christie Street – 888 vehicles.

In summary, the warrants are met for at least three single one-hour periods and are close for the other one single-hour period in the PM where approximately 185 vehicles/hour occur.

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd-LinksRd-2026 AM with rezoning]

Christie St & Leeholm Rd & Link Rd
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Leeholm Rd											
1	L2	66	59.1	0.258	35.4	LOS D	2.3	24.4	0.88	0.75	32.4
2	T1	2	0.0	0.258	30.3	LOS C	2.3	24.4	0.88	0.75	32.0
3	R2	3	0.0	0.012	34.3	LOS C	0.1	0.7	0.85	0.62	31.4
Approach		71	54.9	0.258	35.2	LOS D	2.3	24.4	0.88	0.74	32.3
East: Christie St											
4	L2	2	0.0	0.306	12.1	LOS B	6.2	46.4	0.47	0.41	47.7
5	T1	816	7.5	0.371	6.7	LOS A	8.0	59.6	0.48	0.42	53.3
6	R2	5	20.0	0.018	17.4	LOS B	0.1	0.8	0.53	0.64	41.2
Approach		823	7.5	0.371	6.8	LOS A	8.0	59.6	0.48	0.43	53.2
North: Links Rd											
7	L2	31	0.0	0.218	34.0	LOS C	2.8	19.6	0.88	0.71	34.8
8	T1	52	1.9	0.218	29.5	LOS C	2.8	19.6	0.88	0.71	33.2
9	R2	152	2.0	0.611	40.3	LOS D	5.9	41.8	0.98	0.82	33.5
Approach		235	1.7	0.611	37.1	LOS D	5.9	41.8	0.94	0.78	33.6
West: Christie St											
10	L2	51	2.0	0.036	6.1	LOS A	0.2	1.1	0.16	0.58	50.1
11	T1	863	3.0	0.642	8.7	LOS A	13.0	95.0	0.59	0.54	51.2
12	R2	101	12.9	0.642	16.4	LOS B	13.0	95.0	0.69	0.66	45.1
Approach		1015	3.9	0.642	9.4	LOS A	13.0	95.0	0.57	0.55	50.5
All Vehicles		2144	6.8	0.642	12.3	LOS B	13.0	95.0	0.59	0.54	47.8

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd-LinksRd-2026 PM with rezoning]

Christie St & Leeholm Rd & Link Rd
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h

South: Leeholm Rd											
1	L2	117	22.2	0.285	29.0	LOS C	4.0	34.1	0.82	0.75	35.4
2	T1	14	35.7	0.285	24.3	LOS C	4.0	34.1	0.82	0.75	34.2
3	R2	3	0.0	0.007	27.1	LOS C	0.1	0.6	0.74	0.62	34.3
Approach		134	23.1	0.285	28.5	LOS C	4.0	34.1	0.82	0.75	35.3
East: Christie St											
4	L2	1	0.0	0.488	16.9	LOS B	12.3	88.2	0.65	0.58	43.9
5	T1	1164	2.6	0.592	11.9	LOS B	16.3	116.7	0.68	0.61	49.1
6	R2	12	8.3	0.041	23.8	LOS C	0.3	2.3	0.67	0.68	38.2
Approach		1177	2.6	0.592	12.0	LOS B	16.3	116.7	0.68	0.61	49.0
North: Links Rd											
7	L2	46	0.0	0.093	27.1	LOS C	1.4	10.0	0.76	0.70	36.5
8	T1	4	0.0	0.093	22.6	LOS C	1.4	10.0	0.76	0.70	34.9
9	R2	180	15.0	0.598	36.1	LOS D	6.6	52.2	0.95	0.82	34.7
Approach		230	11.7	0.598	34.0	LOS C	6.6	52.2	0.91	0.79	35.0
West: Christie St											
10	L2	115	0.9	0.081	6.1	LOS A	0.4	2.6	0.17	0.59	50.1
11	T1	672	4.2	0.566	13.3	LOS B	11.3	81.5	0.67	0.59	47.8
12	R2	46	0.0	0.566	22.0	LOS C	11.3	81.5	0.77	0.69	42.0
Approach		833	3.5	0.566	12.8	LOS B	11.3	81.5	0.61	0.60	47.8
All Vehicles		2374	5.0	0.598	15.3	LOS B	16.3	116.7	0.68	0.63	45.7

4.1.3 YEAR 2031

Based upon vehicle demands shown in the movement summaries below, the warrants are met for both the major road (Christie Street) in each direction and for the proposed minor road (Links Road extension) in one direction in the AM peak period. In the PM peak period, 188 vehicles/hour travel on the side road under the 200 vehicles/hour guideline.

Between 7am and 8am the following volumes are sourced:

South: Lee Holm Road – 87 vehicles

East: Christie Street – 834 vehicles

North: Links Road – 174 vehicles

West: Christie Street – 1,157 vehicles

Between 4pm and 5pm the following volumes are sourced:

South: Lee Holm Road – 106 vehicles

East: Christie Street – 1249 vehicles

North: Links Road – 244 vehicles

West: Christie Street – 1,307 vehicles.

In summary, the warrants are met for at least one single one-hour period in the AM and PM and are close for the other two single one-hour periods in the AM and PM where approximately 174 and 188 vehicles/hour occur respectively.

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd-LinksRd-2031 AM with rezoning]

Christie St & Leeholm Rd & Link Rd
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Leeholm Rd											
1	L2	73	49.3	0.213	29.6	LOS C	2.5	24.9	0.81	0.73	34.7
2	T1	8	50.0	0.213	24.6	LOS C	2.5	24.9	0.81	0.73	34.1
3	R2	5	60.0	0.019	30.7	LOS C	0.2	1.6	0.79	0.64	31.8
Approach		86	50.0	0.213	29.2	LOS C	2.5	24.9	0.81	0.72	34.5
East: Christie St											
4	L2	5	0.0	0.353	15.2	LOS B	7.9	57.9	0.57	0.50	45.1
5	T1	839	5.8	0.428	10.0	LOS B	10.1	74.5	0.59	0.52	50.5
6	R2	23	4.3	0.122	30.4	LOS C	0.7	5.2	0.78	0.72	35.5
Approach		867	5.8	0.428	10.6	LOS B	10.1	74.5	0.59	0.52	49.9
North: Links Rd											
7	L2	42	2.4	0.200	28.8	LOS C	3.1	22.5	0.81	0.68	36.7
8	T1	60	6.7	0.200	24.2	LOS C	3.1	22.5	0.81	0.68	35.1
9	R2	305	3.9	0.910	56.0	LOS E	15.7	113.6	1.00	1.14	29.3
Approach		407	4.2	0.910	48.5	LOS D	15.7	113.6	0.95	1.02	30.5
West: Christie St											
10	L2	349	4.6	0.249	6.5	LOS A	1.7	12.4	0.24	0.62	49.8
11	T1	969	4.7	0.894	25.1	LOS C	32.4	239.9	0.81	0.86	40.7
12	R2	96	18.8	0.894	41.1	LOS D	32.4	239.9	0.97	1.11	33.2

Approach	1414	5.7	0.894	21.6	LOS C	32.4	239.9	0.68	0.82	42.2
All Vehicles	2774	6.8	0.910	22.3	LOS C	32.4	239.9	0.70	0.75	41.4

MOVEMENT SUMMARY

Site: I-22 [I-22ChristieSt-LeeholmRd-LinksRd-2031 PM with rezoning]

Christie St & Leeholm Rd & Link Rd
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Leeholm Rd											
1	L2	109	18.3	0.342	33.6	LOS C	4.3	34.8	0.88	0.76	33.8
2	T1	18	22.2	0.342	28.8	LOS C	4.3	34.8	0.88	0.76	32.6
3	R2	3	0.0	0.009	30.5	LOS C	0.1	0.6	0.80	0.62	32.9
Approach		130	18.5	0.342	32.8	LOS C	4.3	34.8	0.88	0.76	33.6
East: Christie St											
4	L2	1	0.0	0.503	14.3	LOS B	12.8	91.6	0.59	0.53	45.8
5	T1	1332	2.9	0.611	9.3	LOS A	17.2	123.4	0.63	0.56	51.1
6	R2	26	3.8	0.094	24.4	LOS C	0.7	5.0	0.69	0.70	38.0
Approach		1359	2.9	0.611	9.6	LOS A	17.2	123.4	0.63	0.57	50.8
North: Links Rd											
7	L2	7	0.0	0.033	30.7	LOS C	0.4	3.0	0.81	0.62	35.8
8	T1	7	0.0	0.033	26.1	LOS C	0.4	3.0	0.81	0.62	34.2
9	R2	174	13.2	0.745	43.7	LOS D	7.2	56.3	1.00	0.91	32.3
Approach		188	12.2	0.745	42.6	LOS D	7.2	56.3	0.99	0.89	32.5
West: Christie St											
10	L2	421	2.4	0.301	6.4	LOS A	1.9	13.7	0.23	0.62	49.8
11	T1	786	2.5	0.747	13.6	LOS B	16.4	117.2	0.69	0.64	47.5
12	R2	71	2.8	0.747	24.6	LOS C	16.4	117.2	0.85	0.82	40.5
Approach		1278	2.5	0.747	11.9	LOS B	16.4	117.2	0.55	0.64	47.9
All Vehicles		2955	4.0	0.747	13.7	LOS B	17.2	123.4	0.63	0.63	46.7

5. SUMMARY

In summary, the traffic light warrants on traffic demand are met in the of situations for future years 2021, 2026 and 2031. Where these traffic demands are not met, they are generally above 175 vehicles/hour on the Links Road extension. Give or take, the required value of 200 vehicles/hour could be achieved in those hours not modelled or purely on day to day variances in travel distributions.

Ryan Miller
Principal Traffic Engineer

COUNCIL REVIEW MEETING
24TH JUNE 2019

- MEETING OUTCOMES SCHEDULE
- PENRITH CITY COUNCIL CORREPONDANCE

Summary of discussions and outcomes during the WSP / PCC design issues review meeting held on 25-06-19

Attending: S Masters, J Skaf, J Wallis & D Park

Issue	PCC comment & action	Register Ref
Existing crossfall along Links Road The new design extends the existing crossfall of Links Road heading towards the bend. The existing crossfall is greater than maximum allowed with Council (6.0%) in areas	Penrith City Council (PCC) acknowledge that this section of Links Rd is to retain the existing pavement and kerb and thus the existing road cross falls have been extrapolated to the new crown location. As such WSP are highlighting to Council that there are areas where the cross fall exceeds 6.0%. Council are in principle accepting of this, but will also be undertaking their own site visit to confirm.	29
Design Speed (60kph/50kph/35kph) The posted speed for Links Rd is 50kph and target design speed is 60kph. Given the constraints of land availability and containing the new road within the road serve, the achievable design speed for the majority of the project extent is only 50kph. Noting that posted and design speed equals 50kph, the alignment at Ch340, R39m curve, is adequate for truck speed of 35kph with 6% super (maximum Council standard without special permission).	PCC acknowledge this restriction is due to the geometry constraints and that there will be sections of Links Road where 60kph design speed is unachievable and in such instances the design speed shall equal the posted speed. At CH340, R39m PCC agreed in principal to reduce the speed at this bend. WSP to consider other traffic calming devices such as transverse line marking. In principle PCC are accepting of the mentioned departures. WSP to provide a sketch to which chainages the various design speeds are achieved with a justification. It is noted that typically this is governed by land availability for the new road.	1
Road Design - Minimum Curve Length There are several locations where the minimum curve lengths (as per Table 7.7 of Austroads Guide to Road Design Part 3) have not been achieved.	PCC are accepting on horizontal curves where the minimum curve lengths have not been achieved at the following locations: - curve length for R350m of MC10 - curve length for R39m of MC10 - curve length for R500m of MC20	43/44/45
Road Design - 90 Degree Bend - Traffic Calming It is noted the design of the 90-degree bend in the road alignment proposes a R39m radius This has a corresponding design speed of 35kph. At concept design submission 35kph advisory speed signs had been provided in advance of this bend.	As per response to item 2, PCC are accepting of the tight radius of the R39m bend, however noted that additional signage (from what was shown at concept) should be incorporated. This includes CAMS. WSP are to also investigate the incorporation of transverse approach line marking. (PCC Suggested Glenmore Park Way as a case study)	68
Road Design - 90 Degree Bend - B-Double tracking and tilt considerations Given the inclusion of HVs in the traffic stream on Links Rd, consideration should be given to "Tilting Truck" in both directions.	It is noted that this curve could have heavy vehicles tilting due to the superelevation at the bend. WSP noted that clearances have been checked and additional "Tilting Truck" signs (W1-8B), in both directions are now being provided. A section will be prepared to demonstrate this. PCC have accepted in principal.	68
Road Design - Sydney Water 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 driveways have been maintained and design to accommodate the vehicles required by Sydney Water. Vertical path analysis will be provided to PCC to demonstrate accessibility.	71
Road Design - Golf Course Access Driveway A new driveway access is proposed to tie into the existing Links Rd to provide access to the golf course. The access is in close proximity to an existing culvert (dia TBC) and protection may be necessary depending availability of batter space.	This access has been modified to adopt a median island with a break to facilitate a footpath crossing (with pram ramps.). It was agreed with PCC that a 1.5m wide footpath will be located on the southern side only. This would enable suitable offset of the proposed works from the existing culvert.	
Verge Adjustments (retaining sleeper wall) It was identified that to maintain full verge widths and manage the spill batters at approx. CH320 to not encroach over the land boundary a small retaining wall (approx. 150mm high) would be required.	It was agreed with PCC that the wall be deleted and minor verge width and crossfall adjustments are undertaken to ensure no encroachment over the adjacent property boundary. This was acceptable to PCC, noting there would still be width behind the kerb to provide a path as part of potential future works.	
Street Lighting - Lighting design level The current design has adopted a lighting criteria p4, with a higher lux level achieved at the 90d bend.	PCC confirmed that the street lights will be Endeavour Energy assets. PCC to confirm the lighting design criteria. WSP has to date designed to P4 lighting category.	
Drainage - Water Quality Targets It is noted that as part of the most recent response to PCC regarding water quality treatment, access verge widening had been proposed where proprietary interceptors were to be installed. This will still be adopted if this treatment method is progressed, however the most recent proposed treatment strategy incorporate bioswales in lieu of proprietary inceptors which is the preferred treatment measure by Water Ways. As such the latest detailed design does not show the access widening.	This was acknowledged by PCC Engineering, and would be confirmed with Waterways internally. WSP will provide a sketch to PCC with the concept for information.	72

Christie Street Intersection / Portion B - General items noted

- B-Doubles should be accommodated however PCC is unsure how B-Double movements are accomodated in the existing situation. ; swept path sketches to be provided.
- Shared Path Connectivity to south side of Christie St is to be reviewed
- Appreciated by all at the meeting that available space is limited and a spatial review exercise to be undertaken to establish practical minimum lane widths
- Appreciated by all that RMS feedback is required prior to finalisation of intersection configuration, and hence acquisition extents is still to be confirmed.
- A follow up session to discuss Portion B will be held as this design progresses further.

Wallis, James

From: John Skaf[redacted]
Sent: Tuesday, 23 July 2019 1:29 PM
To: Wallis, James
Cc: Porter, Sean; Muralha, Nuno; Park, Daniel; Stephen Masters
Subject: RE: Links Rd Upgrade - Design Issues Schedule Review

Hi James,

Apologies for the late response. I've reviewed the prepared record of our meeting held on 25.6.2019.

The only comments I have following a site visit are as such:

- The existing posted speed limit for Links Road is 60kph. As such, the design speed for the road should be 70kph. However in places this is not achievable, sufficient justification for the reduction of the design speed shall be provided to Council for review and acceptance.
- Additional detail of the existing culvert adjacent to the access road to the Gold course is required. Detailed survey information and/or possibly a blow up aerial image showing the existing culvert location with surveyed levels.

If you have any questions regarding the above, please contact me.

Kind Regards,

John Skaf
Senior Engineer - Major Developments
[redacted]
PENRITH
CITY COUNCIL
Follow us

From: Wallis, James[redacted]
Sent: Monday, 22 July 2019 6:27 PM
To: John Skaf[redacted]
Cc: Porter, Sean[redacted] Muralha, Nuno[redacted]; Park, Daniel [redacted]; Stephen Masters [redacted]
Subject: RE: Links Rd Upgrade - Design Issues Schedule Review

Hi John,

I'm just following up the below, confirming you do not have any queries or comments on the record of meeting.

Kind regards
James

James Wallis
Senior Civil Engineer Project Manager
[redacted]

From: Wallis, James
Sent: Thursday, 27 June 2019 6:25 PM
To: Stephen Masters [redacted]
Cc: Porter, Sean [redacted]; Muralha, Nuno [redacted]; Park, Daniel [redacted]
Subject: Links Rd Upgrade - Design Issues Schedule Review

Hi Stephen & John,

Good to meet with you both on Tuesday, a very productive session.
As an outcome of this, please find attached record of the meeting. This has been prepared in a schedule format and covers the responses and outcomes to each of the items discussed.
If you have any queries or issues with any of the notes, please do not hesitate to contact me.

Kind regards
James

James Wallis
Senior Civil Engineer Project Manager

WSP Australia Pty Limited. Level 27, 680 George Street, Sydney, NSW. 2000 Australia
PO Box 5340, West Chatswood NSW 1515, Australia

[redacted]

www.wsp.com

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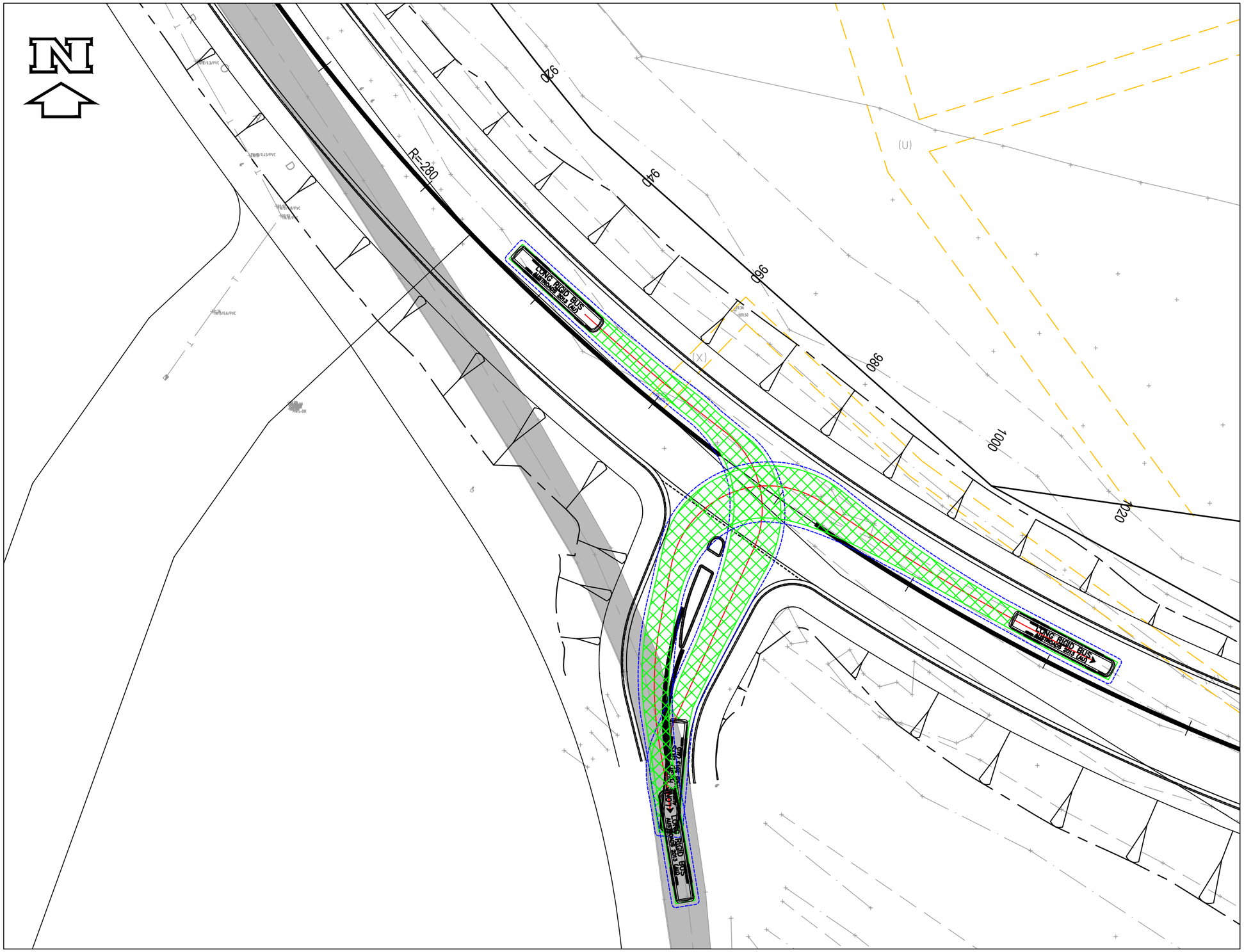
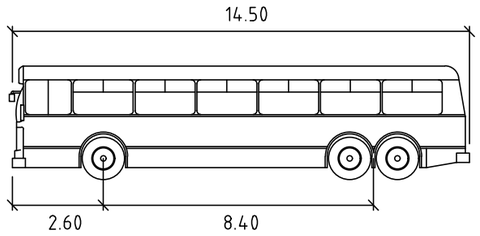
APPENDIX B

VEHICLE SWEPT PATHS





LONG RIGID BUS

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PLOT DATE / TIME: 19 June 2019 - 11:54:32 AM PLOT BY: Betts, Darren

CLIENT: lendlease

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
VEHICLE SWEPT PATHS
GOLF COURSE ACCESS - LONG RIGID BUS

A3

SHEET No.

EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL

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

DRAWINGS / DESIGN PREPARED BY:
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

TITLE	NAME	DATE
DRAWN		
DRG CHECK		
DESIGN		
DESIGN CHECK		
DESIGN MNGR		
PROJECT MNGR		

PREPARED FOR: TBC

RMS REGISTRATION No.: -

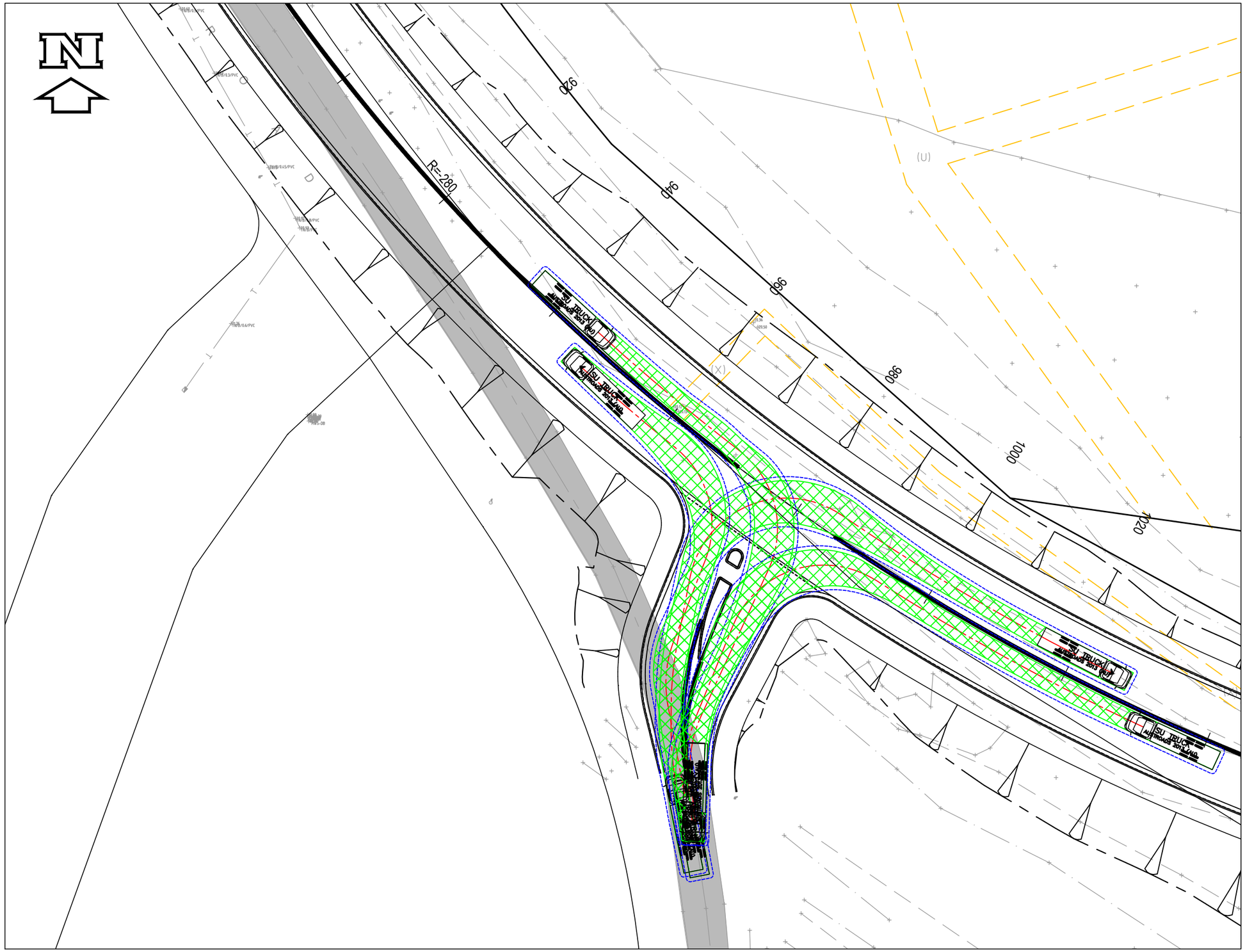
PART:

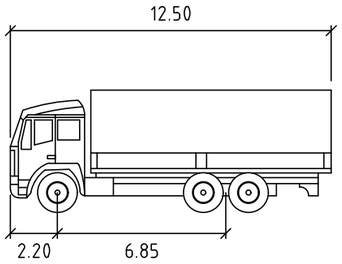
ISSUE STATUS: FOR INFORMATION

EDMS No.:

SHEET No.: A2

ISSUE: -





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NOT FOR CONSTRUCTION

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

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wsp.com

TITLE	NAME	DATE
DRAWN		
DRG CHECK		
DESIGN		
DESIGN CHECK		
DESIGN MNGR		
PROJECT MNGR		

PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
VEHICLE SWEPT PATHS
GOLF COURSE ACCESS - SU TRUCK
SHEET No.

RMS REGISTRATION No.			PART
-			
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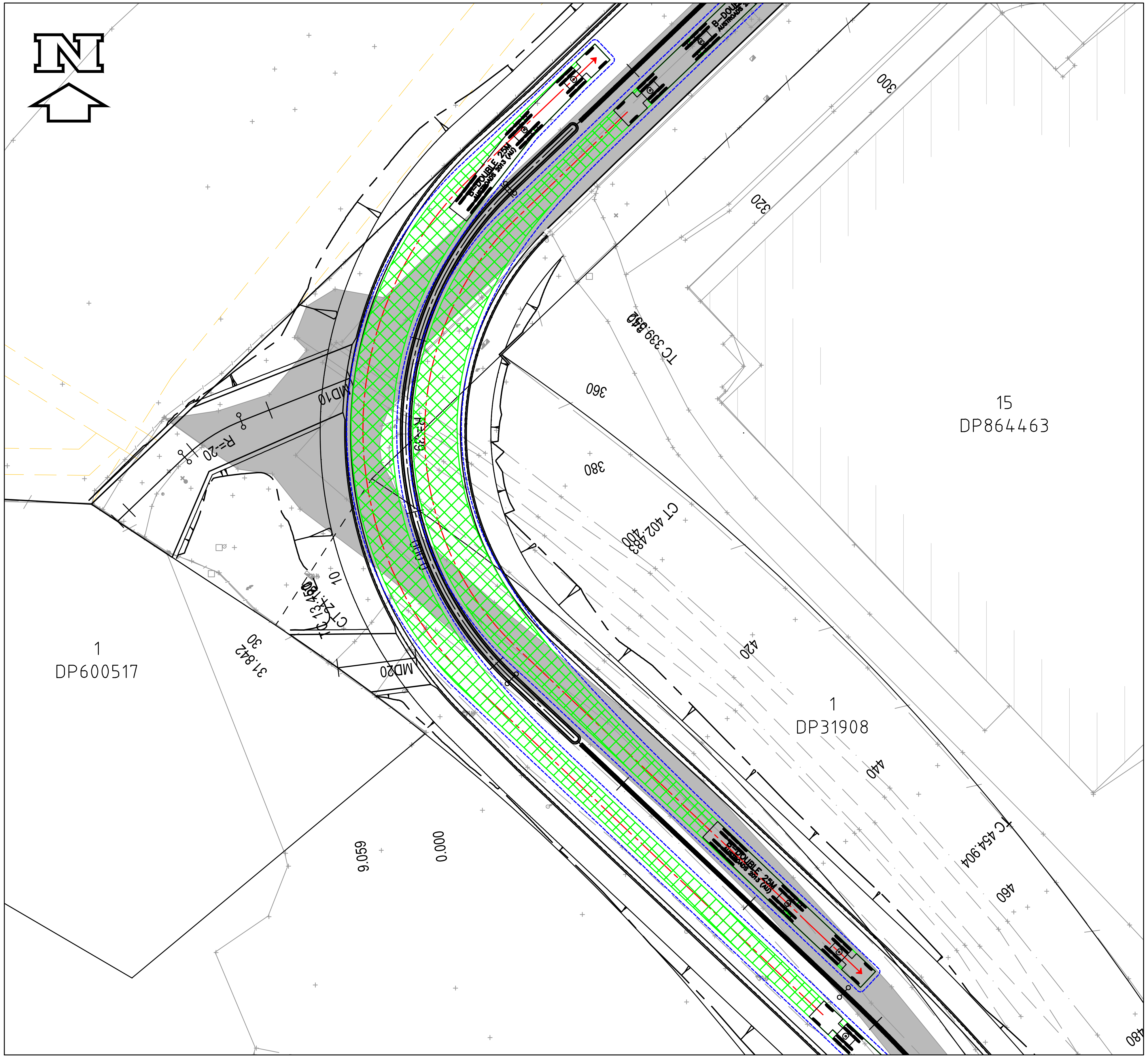
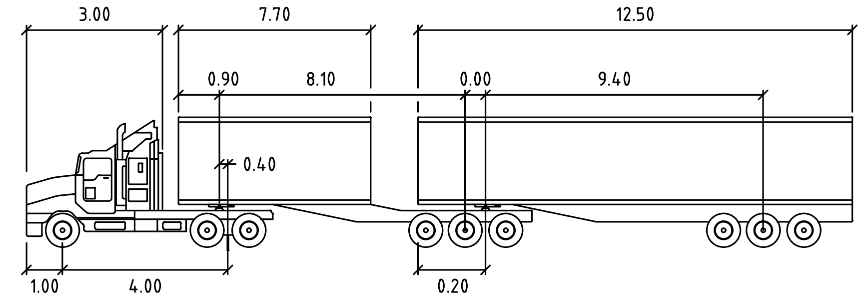
FOR INFORMATION		A2	-





B-DOUBLE 25M

meters

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PLOT BY: Betts, Darren

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CO-ORDINATE SYSTEM: MGA ZONE 56

HEIGHT DATUM: A.H.D.

TITLE	NAME	DATE
DRAWN		
DRG CHECK		
DESIGN		
DESIGN CHECK		
DESIGN MNGR		
PROJECT MNGR		

CLIENT: lendlease

PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
VEHICLE SWEPT PATHS
90 DEGREE BEND - B DOUBLE

A3

SHEET No.

RMS REGISTRATION No. -

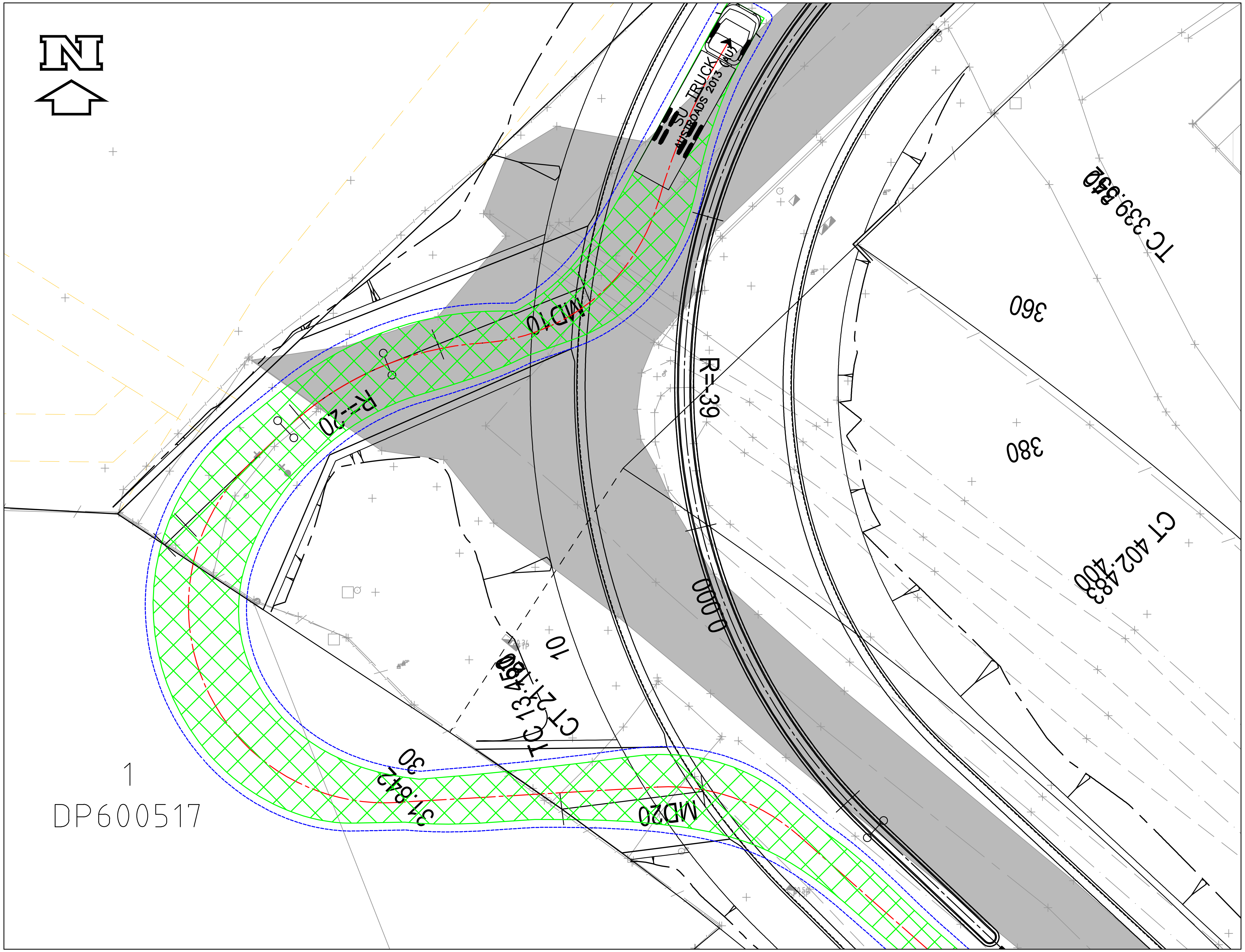
PART

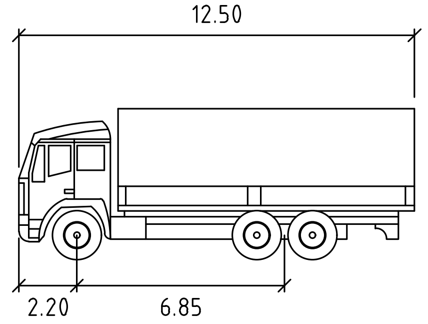
ISSUE STATUS: FOR INFORMATION

EDMS No.

SHEET No. A3

ISSUE -





SU TRUCK

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PLOT BY: Betts, Darren

CLIENT: lendlease

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HEIGHT DATUM: A.H.D.

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TITLE	NAME	DATE
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DESIGN CHECK		
DESIGN MNGR		
PROJECT MNGR		

PREPARED FOR: TBC

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
VEHICLE SWEPT PATHS
PUMP STATION ACCESS - SU TRUCK

A3

SHEET No.

RMS REGISTRATION No. -

PART

ISSUE STATUS: FOR INFORMATION

EDMS No.

SHEET No.: A4

ISSUE: -

APPENDIX C

UTILITY SERVICES STRATEGY AND REPORT

Design
for a better
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LINKS ROAD EXTENSION/UPGRADE, ST MARYS

PS111235-UTILITY SERVICES STRATEGY REPORT

PORTION 1 (CH0 – CH1020)

wsp

Question today
Imagine tomorrow
Create for the future

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

LENDLEASE COMMUNTIES

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REV	DATE	DETAILS
A	26/06/19	Utility Services Strategy Report – Detailed

	NAME	DATE	SIGNATURE
Prepared by:	Michael Middlebrook	26/06/19	
Reviewed by:	Rodney Charlton	26/06/19	
Approved by:	Daniel Park	26/06/19	

TABLE OF CONTENTS

ABBREVIATIONSAND 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

Links Road Extension/ Upgrade project is located approximately 5 kilometres north-east of Penrith and 45 kilometres west of Sydney CBD. The full extent of 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 existing T-Junction is intended to be upgraded to a 4-way signalised intersection.

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 SEE was prepared by WSP to form the Development Application 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.

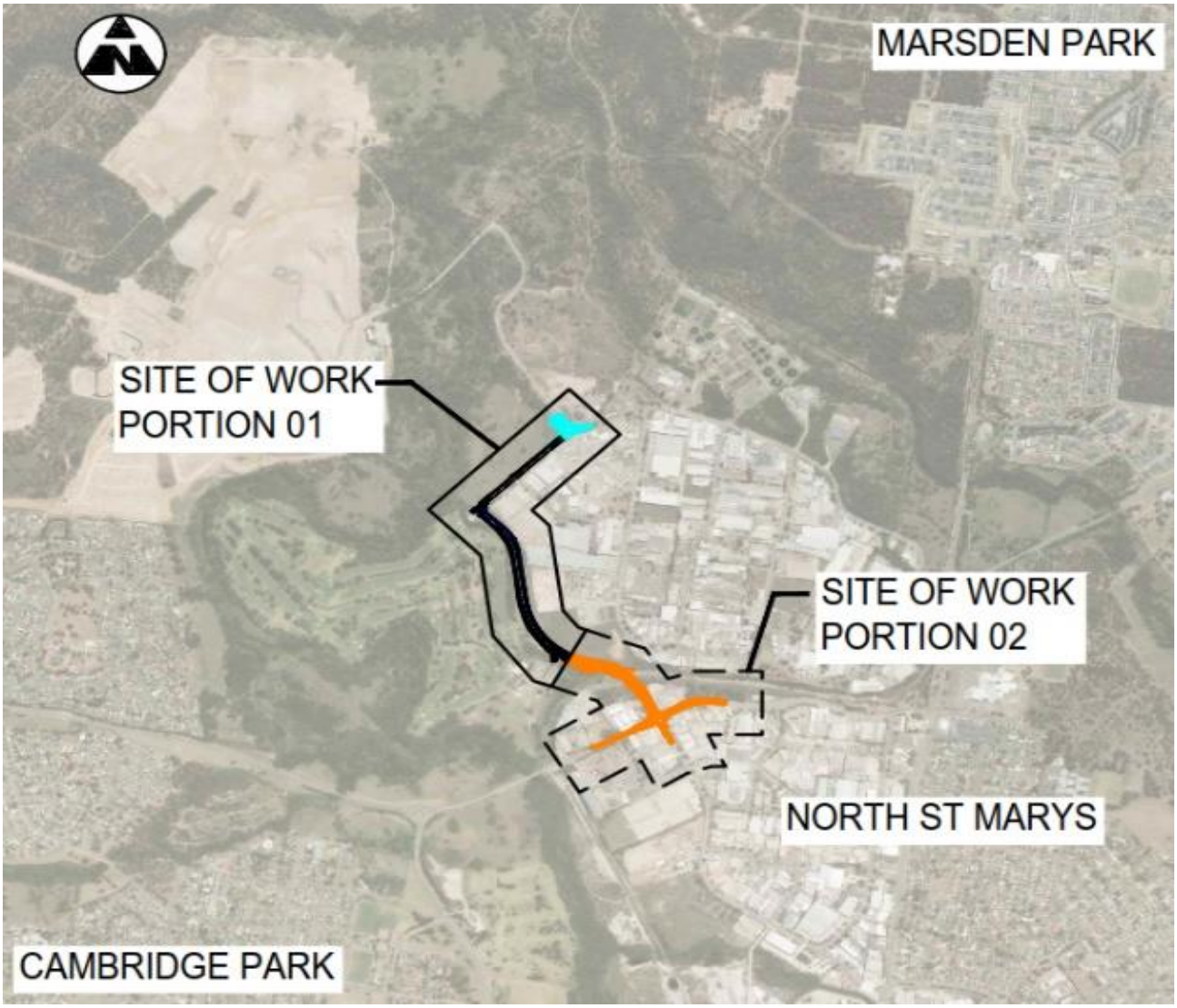

Figure 1.1 Portion 1 and Portion 2 extent of work

The project has been divided into two portions, Portion 1 (CH0 – CH1020) and Portion 2 (CH1020 – CH1500) to expedite the Construction Certification phase of Portion 1. This report details the design development of Portion 1, see Figure 1.1 for the location of Portion 1 and Portion 2 areas.

1.2 PURPOSE OF THIS REPORT

This report documents the design process adopted to produce the utility coordination detailed design for Portion 1.

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 information of the methodology undertaken for clash analysis to date. 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 for the extended of Portion 1.

2 METHODOLOGY AND ASSUMPTIONS

2.1 METHODOLOGY

At the concept design phase, a comprehensive review was undertaken on all documentation provided by Lendlease Communities (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.

Based on the RPS survey data provided by LLC, a 3D utilities model was produced. This model has been used to undertake the below design actions:

- 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 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 detailed design within the 3D model. During this clash detection, impacted utilities were reviewed for treatment options. The provided survey model did not contain accurate depth of the existing utilities as most of the utility strings were positioned on the existing surface level or above the existing surface level. The output of this assessment is documented within this report and in the combined utility plans (Appendix B and Appendix C)

Additional 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;

2.2 ASSUMPTION

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 works is recommended during the design phase, in lieu of the construction phase, to verify the current records and avoid delays during construction;
- 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 RPS 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 SUI Class D quality. These include several rising mains across the length of the project. Further investigation will be required 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 verification in the future phases; and,
- All assets requiring relocation and protectoin are to be designed and constructed by a separate contractor engaged by Lendlease Communities. Alignment of proposed utilities to be in accordance with the Street Opening Conference and utility authority guidelines.
- This report has been done without consultation with 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

2.2.2 SURVEY AND DATA QUALITY LEVELS

The data used to produce a 3D utility model used various sources 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 phase that potholing is undertaken, in lieu of construction phase, 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 DESIGN INTERFACES

During the review of utilities, all relevant multi-disciplinary design elements have been considered in order to provide a well-coordinated, integrated, economic, safe and solution to impacted assets.

3.2 SUMMARY OF EXISTING UTILITIES

There are several public utility assets currently underground and overhead along Links Road. . As part of the Links Rd extensions detailed design, WSP has reviewed the assets along the extent of the proposed works.

The following utility authority owners have been identified 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 tender 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

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:

- 450mm ductile iron main – Constructed in 1982 (Project Asset Tag – W04)
- 750mm ductile iron main – Constructed in 1993 (Project Asset Tag – W05)
- 375mm ductile iron main – Constructed in 2009 (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 relocate the 450mm main due to its location under the proposed full depth road pavement.

It is proposed to leave the 750mm and 375mm 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 will be required to understand any current operational restrictions associated with the assets.

SEWER MAINS – LINKS RD

There is a 900mm concrete gravity sewer main with a 6m easement that is located running parallel to the northbound lane for the full extent of Portion 1. The proposed 1200mm diameter drainage pipe crosses this sewer main at CH340. Due to the limited information available for this pipe, all model data is quality level D, this has been considered as a clash.

It is proposed to relocate this sewer main to allow for the construction of drainage line. The extend of relocation shown on drawing are clash location only and full extent of relocation is to be determined. Current information obtained from Sydney Water indicates that the sewer is a gravity feed main which carries a potential risk for an extensive relocation. Further potholing investigation will be required to confirm if relocation.

SEWER PUMPING STATION (SPS0366)

THE SEWER PUMPING STATION IS LOCATED AT DETAILED DESIGN CH360. THE PROJECT WORKS WILL IMPACT ON ACCESSIBILITY TO THE PUMPING STATION. EMAIL FROM SYDNEY WATER (CHENG CHEE) ON 12/06/19 CONFIRM THE VEHICLE REQUIREMENTS FOR THE PUMP STATION. **WATER MAINS**

There is one 150mm ductile iron main water main that run adjacent to the proposed northbound lane along Links road between CH0 to CH400. The proposed 1200mm drainage pipe clashes with main between CH320 to CH340. Further potholing investigation will be required to confirm if relocation is required.

3.2.2 ENDEAVOUR ENERGY

OVERHEAD 11KV DISTRIBUTION

Existing 11kV overhead electrical distribution supply is currently along Links Roadd. The overhead supply is behind the existing kerb on the eastern side of Links Road and does not clash with the proposed road design until CH360. From CH360 throughout the remaining road , it is proposed disuse the existing overhead electrical along the western side 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.

Existing light pole at CH0 (E08 tag) is currently located within the design road pavement and roundabout intersection.

3.2.3 TELSTRA

OPTICAL FIBRE – LINKS RD

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

The service along Links Road (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 Road is also situated within an existing asbestos conduit. Standard safety practices for handling asbestos material will need to be implemented during construction.

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

3.2.4 JEMENA

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 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 Road 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.

It is proposed to relocated gas main at CH520 to CH540 due to clash with proposed drainage system.

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.

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 civil design report.

4 REVIEW CONSIDERATIONS AND RECOMMENDATIONS

4.1 RECOMMENDATIONS

We recommend that the following actions are performed for the utility relocation and protection works:

1. Potholing of utilities that are proposed to be retained and where clashes have been identified. This is to identify and verify any relocations.
2. Assess in greater detail the coordination of the East West Connector (EWC3) Rd project and its impact on the Links Rd Upgrade project;
3. Review impacted utilities and confirm treatment scope;
4. Confirm with Service Providers (SP):
    a. that abandoned assets can be removed;
    b. the suitability of proposed treatment options; and,
    c. future proofing provisions.
5. Identify any possible early works, assessing the value and practicality of such works;
6. 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;
7. 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,
8. 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

	ID	String IDs	Data Class (AS 5488)	Utility	Owner	HLFC	LLFC	Size	Material	Capacity	MC	Chainage section start	Chainage section end	Existing Location Description	Design Element Clash	Risk	Action	Treatment Advice
	Communication																	
	T01	U-E-C-TEL-CBN-0001	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	100mm	Polyvinylchloride	NA	10	300	380	crosses Links Rd at design CH360 to provide communication connection to the SWC pump station	Issue for Tender road design	Red	Relocate	Clash with 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	U-E-C-TEL-CBN-0144	B	Communications	Telstra NSW, Central	Optic Fibre	Pipe or Conduit	35mm	Polyvinylchloride	NA	10	380	910	Runs within the Links Rd design between design CH380 to CH910 to provide communication to office along Links Rd	Issue for Tender road design	Red	Relocate	Clash with 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
	Electrical																	
	E01	U-E-E-END-AOH-0016	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	10	0	340	Overhead line runs paralled to proposed Links Rd between CH0 to CH340	Issue for Tender 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.
	E02	U-E-E-END-AOH-0014	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	10	340	960	crosses Links Rd near the band of the road at pump station. Design CH340 to CH960	Issue for Tender road design	Yellow	Relocate	Clash with design. Two existing electrical disctribution poles are located within the 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	U-E-E-END-AOH-0019	D	Electrical	Endeavour Energy	Distribution	Pole	Unknown	To be confirmed	11kV	10	1000	1380	Electrical pole located within the designed footway of proposed Links Rd extension towards the souther side between design CH1000 to CH1380	Issue for Tender 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 road allignment.
	E08	U-E-E-END-AOH-0016	A	Electrical	Endeavour Energy	Streetlight	Pole	Unknown	To be confirmed	Unknown	10	0	0	Located at intersection with links road and new proposed road	Issue for Tender road design	Yellow	Relocate	light pole is located within new road alignment
	Gas																	
	G01	U-E-G-JEM-PIP-0002	B	Gas	Jemena Gas West	High Pressure	Pipe or Conduit	150mm	Steel	1050kpa	10	360	380	Crosses Links Rd at the corner near pump station at design CH360 to CH380	Issue for Tender road design	Red	Relocate	Clash with design, High pressure 150mm gas pipeline crosses design at designated location. Action for this asset is required to be relocated.
	G02	U-E-G-JEM-PIP-0047	B	Gas	Jemena Gas West	High Pressure	Pipe or Conduit	150mm	Steel	1050kpa	10	900	1000	Crosses Links Rd and runs within design road between design CH900 to CH960 near the golf course entrance, drainage desig n crosses at change 960	Issue for Tender road design	Red	Relocate	Existing bends are located beneath the concept road allignment. High pressure 150mm gas pipeline crosses design at designated location. Action for this asset is required to be relocated.
	G04	U-E-G-JEM-PIP-0002	C	Gas	Jemena Gas West	High Pressure	Pipe or Conduit	150mm	Steel	1050kpa	10	520	540	Run parallel on southern side of Links road, proposed drainage crosses	Issue for Tender Draiange Design	Red	Relocate	Clash with drainage design. High pressure 150mm gas pipeline crosses drainage at designated location. Action for this asset is required to be relocated.
	Water																	
	W01	U-E-W-SWC-PIP-0806	D	Potable Water	Sydney Water	Potable Water	Pipe or Conduit	150mm	Ductile Iron Cement (mortar) Lined	NA	10	0	380	Within Links Rd from Start of the Proposed Road to Pump station within Links Rd between CH0 to CH380	Issue for Tender road design	Yellow	Relocate	Water main 150mm is within the linked road 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	U-E-W-SWC-PIP-0990	D	Recycled Water	Sydney Water	Recycled Water	Pipe or Conduit	225mm	Polypropylene	NA	10	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	Issue for Tender road design	Yellow	Relocate	Recylced water main 225mm is within the linked road 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	String IDs	Data Class (AS 5488)	Utility	Owner	HLFC	LLFC	Size	Material	Capacity	MC	Chainage section start	Chainage section end	Existing Location Description	Design Element Clash	Risk	Action	Treatment Advice
	W03	U-E-W-SWC-PIP-0986	D	Recycled Water	Sydney Water	Recycled Water	Pipe or Conduit	600mm	Ductile Iron Cement (mortar) Lined	NA	10	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	Issue for Tender road design	Red	Leave in-situ	The 600mm recycled water main is within the Links Rd 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	U-E-W-SWC-PIP-0002	D	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	450mm	Ductile Iron Cement (mortar) Lined	NA	10	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	Issue for Tender road design	Red	Relocate	The 450 sewer rising main is within the Links Rd design allignment. Action for this asset is to relocate.
	W05	U-E-W-SWC-PIP-0005	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	750mm	Ductile Iron Cement (mortar) Lined	NA	10	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	Issue for Tender road design	Red	Leave in-situ	The 750 sewer rising main is within the Links Rd 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	U-E-W-SWC-PIP-0003	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	375mm	Ductile Iron Cement (mortar) Lined	NA	10	0	380	Within Links Rd from Start of the Proposed Round to Pump station within Links Rd between CH0 to CH380	Issue for Tender road design	Red	Leave in-situ	The 375 sewer rising main is within the Links Rd 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	U-E-W-SWC-PIP-0009	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	900mm	Concrete	NA	10	0	900	Runs parellel to Links Rd design,between CH0 to CH900	Issue for Tender road design	Yellow	Leave in-situ	Sewer main 900mm pipe is runs parallel to the Links Rd design. Action for this asset is leave in situ
	W08	U-E-W-SWC-PIP-0035	B	Waste Water	Sydney Water	Waste Water	Pipe or Conduit	375mm	Vitrified Clay	NA	10	920	940	Crosses proposed road design in extension section, between design CH920 to CH940	Issue for Tender road design	Yellow	Relocate	375mm sewer main pipe crosses the Links Rd design. Action for this asset is leave in situ, with Sydney Water approval to build over (i.e. BOA assessment)

APPENDIX C
COMBINED UTILITY DRAWINGS

APPENDIX D

NON-CONFORMANCE REGISTER

Date: 4-07-2019

PENDING - Item captured in register but not yet active
ACTIVE - Item presently under review
CLOSED - Item "signed off"/accepted/agreed
WITHDRAWN - Item no longer an non conformance

Ref No	Design Lot(s)	Discipline	Date Raised	Portion	Control Line	Chainage / Area / Direction	Non-conformance description	Reference / Correspondence	Discussion and Response	Owner	Agreed Disposition	Status					
												Designer	LLC	RMS	PCC	Sign-Off Reference	DATE CLOSED
0006	RG-01	Road Geometry	17-10-2018	1	MC10	All	**Road Design - Horizontal Geometry - Issue Register #44** Horizontal curve radius of MC10 is 39m at CH340 which is only sufficient to cater for 35km/h B-double and doesn't meet the required minimum horizontal raduius of 55m for 50kph design speed. This geometry is due to avoiding further property acquisition, especially for the adjacent property on th eastern side of Links Road at CH340.		This iteam was discussed at the PCC meeting on 25/06/19 and PCC (Stephen Masters) acknoweldged that this geometry is a resultant of the tight road corridor and will accept the non-conformance subject traffic calming options such as signage, transverse linemarkings are considered within the new design.	PCC							
0008	RG-01	Road Geometry	8-11-2018	1	MC10	0-320	**Southbound Existing Crossfall** The existing crossfall on Links Road southbound is >3.0%, reaching a maximum of 7.5% around ch.300. The design extends the existing crossfall on Links Road southbound in line with the strategy to restrict pavement works, as required. This area section of the existing road is to be retained thus the non-conformance is an existing issue.	• PCC Design Guidelines for Engineering Works for Subdivisions and Developments Section 2.2.16	This iteam was discussed at the PCC meeting on 25/06/19 and PCC (Stephen Masters) acknoweldged that this is was an existing issue and that it is to reamin as it is. It was agreed at this meeting to document the non-conformance for PCC to accept.	PCC							
0010	RG-01	Road Geometry	14-11-2018	1	MC10	0-325	**Road Design - Vertical Geometry - Issue Register #49** Ensure vertical grade is smooth from Chainage 0-325 by removing short tangent length. No K value provided when tying in to existing geometry	• AGRD Part 3 Table 4.2.5	Contol line is draped on existing surface in this area, with existing crossfall to be extended to proposed crown. This design approach has been ageeed with Council for constructability purposes. Noted that there is no K Value (or existing longitudinal grading extended) provided between existing longitudinal grading and proposed vertical.	PCC							
0022	RG-01	Road Geometry	16-11-2018	1	MC10	320-420	**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 unknow. An errant vehicle onto the batter of steep slopes is exposed to non-recovery risks.		Longitudinal Grade of Driveways are flatter than 1V:10H with rounding provided. Additionally the batter slope between the driveways is 1V:5H. With no fixed objects located in this area there is sufficient protection for an errant vehicle to recover safely.	PCC							
0023	SM-01	Stormwater Management	26-06-2019	1	MC10	350-530	**Drainage Design - Pipe Grade** Longitudinal pipe has gradient of 0.3% to allow for positive outfall.	Penrith City Council, Design Guidelines for Engineering Works for Subdivisions and Developments, Section 3.9.1, e)		PCC							
0024	SM-01	Stormwater Management	26-06-2019	1	MC10		**Drainage Design - Self-cleansing velocity** Longitudinal pipes do not meet 0.6m/s self cleansing velocity.	Penrith City Council, Design Guidelines for Engineering Works for Subdivisions and Developments		PCC							
0025	SM-01	Stormwater Management	26-06-2019	1	MC10		**Drainage Design - Pit Location** Longitudinal pit location placed on curves and median curves to reduce flow width for 2.5m compliance.	Penrith City Council, Design Guidelines for Engineering Works for Subdivisions and Developments, Section 3.7.1, (6)		PCC							
0026	SM-01	Stormwater Management	26-06-2019	1	MC10		**Drainage Design - Tailwater Levels** Tailwater levels for discharge into receiving waterways	Penrith City Council, Design Guidelines for Engineering Works for Subdivisions and Developments, Section 3.10.2		PCC							
0027	RG-01	Road Geometry	3-07-2019	1	MC10	205 - 340 / LOT 15 / DRIVEWAY ACCESS	**Road Design - Access Driveway to Lot 15 Links Road** According to signage on the southern access gate, the site restricts B-Double access from entering the site. It is assumed therefore that the site is serviced by 19m AV or smaller in an anticlockwise direction with Vehicles exiting the site at the northern driveway crossover. The existing concrete cross overs (north and south) do not currently comply with AS2890.2 for 19m Articulated Vehicles as the width of the driveways are 9.1m Northern and 6.3m Southern Entry. This results in Larger vehicles using the existing verge to successfully turn into the site.			PCC							
0028	RG-01	Road Geometry	3-07-2019	1	MC10	335 / LOT 15 / SOUTHERN ENTRY	**Road Design - Southern Driveway Entry to Lot 15 Links Road** The proposed works do not allow for AV's to turn into the site when travelling in the Northbound direction on the upgraded Links Road. Therefore AV's must be travelling in the Southbound direction to gain access to the site.			PCC							
0029	RG-01	Road Geometry	3-07-2019	1	MC10		**Road Design - Design Speed** The posted speed for Links Rd is 50kph and target design speed is 60kph. Given the constraints of land availability and containing the new road within the road serve, the achievable design speed for the majority of the project extent is only 50kph		PCC acknowledge this restriction is due to the geometry constraints and that there will be sections of Links Road where 60kph design speed is unachievable and in such instances the design speed shall equal the posted speed. At CH340, R39m PCC agreed in principal to reduce the speed at this bend. WSP to consider other traffic calming devices such as transverse line marking. In principle PCC are accepting of the mentioned departures. WSP to provide a sketch to which chainages the various design speeds are achieved with a justification. It is noted that typically this is governed by land availability for the new road.	PCC							
0030	RG-01	Road Geometry	3-07-2019	1	MC10		**Road Design - Design Speed** The posted speed for Links Rd is 50kph and target design speed is 60kph. Given the constraints of land availability and containing the new road within the road serve, the achievable design speed for the majority of the project extent is only 50kph		PCC acknowledge this restriction is due to the geometry constraints and that there will be sections of Links Road where 60kph design speed is unachievable and in such instances the design speed shall equal the posted speed. At CH340, R39m PCC agreed in principal to reduce the speed at this bend. WSP to consider other traffic calming devices such as transverse line marking. In principle PCC are accepting of the mentioned departures. WSP to provide a sketch to which chainages the various design speeds are achieved with a justification. It is noted that typically this is governed by land availability for the new road.	PCC							
0031	RG-01	Road Geometry	3-07-2019	1	MC10		**Road Design - Minimum Curve Length** There are several locations where the minimum curve lengths (as per Table 7.7 of Austroads Guide to Road Design Part 3) have not been achieved.		PCC are accepting on horizontal curves where the minimum curve lengths have not been achieved at the following locations: - curve length for R350m of MC10 - curve length for R39m of MC10 - curve length for R500m of MC20	PCC							
0032	RG-01	Road Geometry	3-07-2019	1	MC10	340	**Road Design - 90 Degree Bend - Traffic Calming** It is noted the design of the 90-degree bend in the road alignment proposes a R39m radius This has a corresponding design speed of 35kph. At concept design submission 35kph advisory speed signs had been provided in advance of this bend.		As per response to item 2, PCC are accepting of the tight radius of the R39m bend, however noted that additional signage (from what was shown at concept) should be incorporated. This includes CAMS. WSP are to also investigate the incorporation of transverse approach line marking. (PCC Suggested Glenmore Park Way as a case study)	PCC							
0033	RG-01	Road Geometry	3-07-2019	1	MC10	340	**Verge Adjustments (retaining sleeper wall)** It was identified that to maintain full verge widths and manage the spill batters at approx. CH320 to not encroach over the land boundary a small retaining wall (approx. 150mm high) would be required.		It was agreed with PCC that the wall be deleted and minor verge width and crossfall adjustments are undertaken to ensure no encroachment over the adjacent property boundary. This was acceptable to PCC, noting there would still be width behind the kerb to provide a path as part of potential future works.	PCC							
0034	RG-01	Road Geometry	3-07-2019	1	MC10	Project	**Drainage - Water Quality Targets** It is noted that as part of the most recent response to PCC regarding water quality treatment, access verge widening had been proposed where proprietary interceptors were to be installed. This will still be adopted if this treatment method is progressed, however the most recent proposed treatment strategy incorporate bioswales in lieu of proprietary inceptors which is the preferred treatment measure by Water Ways. As such the latest detailed design does not show the access widening.		This was acknowledged by PCC Engineering, and would be confirmed with Waterways internally. WSP will provide a sketch to PCC with the concept for information.	PCC							

APPENDIX E

ROAD SAFETY AUDIT – PORTION 1

DESKTOP ROAD SAFETY AUDIT

STAGE 3 – ISSUE FOR TENDER (IFT) DESIGN
(85% COMPLETION)
PORTION 01
(CHAINAGE 00 TO CHAINAGE 1020)

LINKS ROAD EXTENSION
Dunheved Precinct to Golf Club Access Road
ST. MARYS

For
WSP Australia

June 2019

Prepared by

Winning Traffic Solutions Pty Ltd
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Tel: 61 2 9807 9962
Email: terry@winningtraffic.com.au
ABN: 74 091 818 021

Desktop Road Safety Audit Summary
Stage 3 – IFT Design (85% Completion) Portion 01
Links Road Extension, St Marys
Dunheved Precinct to Golf Club Access Road

Report No.	WTS – LR2
Audit For	WSP Australia
Address	Level 27 680 George Street Sydney NSW NSW 2000
Telephone	02 9272 5215
Project Manager	Daniel Park (WSP)
Audit Team	Terry Winning (WTS –Team Leader) Qian Liu (WSP – Team Member)
Audit Type	Stage 3 – IFT Design (85% Completion)
Commencement Meeting	Wednesday 19 June 2019
Audit Date	Wednesday 10 June 2019
Completion Meeting	Monday 24 June 2019
Previous Audit No.	WTS-LR1 Stage 2– Preliminary Design (50% Design Completion)

Summary of Audit

This report presents summary findings of a Desktop Stage 3 – IFT Design Stage (85% Completion), Road Safety Audit of the proposed improvements and upgrade of Links Road, from Dunheved Precinct to Dunheved Golf Club access road within the Penrith City Council administrative boundaries.

WSP in collaboration with Maryland Development Company (Lendlease) are proposing 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.

This Desktop Road Safety Audit (RSA) Report presents findings of the IFT Design (85% Completion) tabled for Portion 1 Dunheved Precinct to Golf Club Access Road (Ch 00 to Ch 1020).

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.

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 gathered data included a review of the previous Preliminary Design stage audit WTS-LR1 Stage 2– Preliminary Design (50% Design Completion) to ensure issues raised had been given due consideration. It was noted that some issues have not been addressed in the IFT Design (85% completion) and have been restated in this Audit (refer Appendix 2) to alert designers to areas where attention will be needed

Of greatest concern arising from the audit is:

- There are some road user safety issues identified in the Preliminary Design stage audit WTS-LR1 Stage 2– Preliminary Design (50% Design Completion) that appear not to have been treated in the tabled IFT Design that need to be reconsidered by the Project Manager (Appendix 2).

- 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.

- 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 high crash barrier employed in the central median and downhill grade (to the east) of 1.5%.

  There were no tabled Stormwater management to 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.

Other identified road user safety issues are addressed in the attached RURAL (refer Appendix 2).

CONTENTS

Attachment

Desktop Road Safety Audit Report
Stage 3 – IFT Design (85% Completion) Portion 01
Links Road Extension, St Marys
Dunheved Precinct to Golf Club Access Road
(Chainage 00 to Chainage 1020)

1. *Introduction*

WSP International Australia has engaged Winning Traffic Solutions Pty. Ltd. (WTS) to undertake an independent Desktop Road Safety Audit of the IFT Design (85% Completion) Portion 1 for the proposed improvements and upgrade of Links Road, from Dunheved Precinct to Dunheved Golf Club Access Road 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

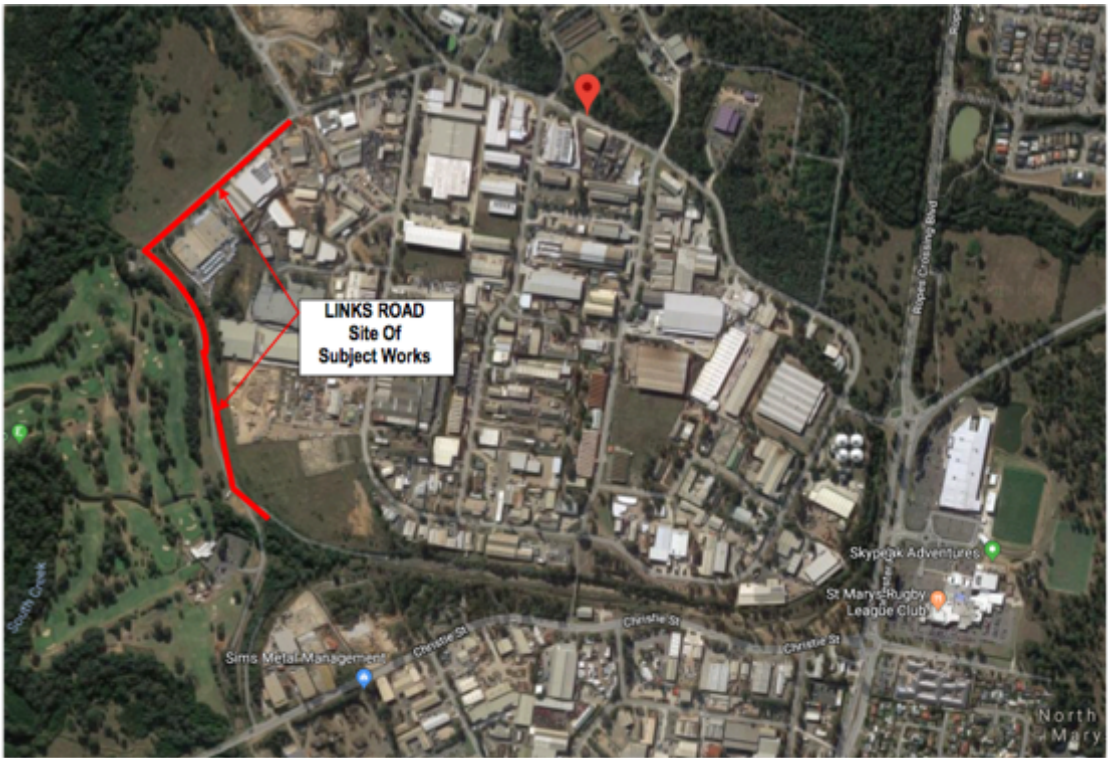

Figure 1

The Audited project is the IFT Design (85% Completion) of the subject length of road for a DA submission to Penrith City Council.

Overall, 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.

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. It 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 user safety deficiencies.

2. ***Project Description***

The tabled design for Portion 1 (refer Appendix 1 Extracts), proposes to retain the general layout of the existing road network generally as a two-lane, two way traffic flow addressing the following site issues:

- Sharp bend (approximately 90 degrees) along Links Road (Ch 380);
- Existing access into the Dunheved Golf Course to be upgraded;
- Future 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.

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 Road Safety Audit at the final design stage is to assist in identifying road user safety considerations as it offers the last opportunity to change the design before construction commences. This audit reviews the plans that will be used to build the project.

Other objectives of the Project are to:

- Check the concept is compatible with the type of road and user expectations;
- Check what design standards are to be employed and assess conformance;
- Check that all likely users have been considered;
- Check the adequacy of the road reservation width;
- Check intersection layouts and other conflict points conform with accepted design practice;
- Alert designers to areas where attention will be needed;
- Check connectivity to the existing road network and assess effects in transition areas.

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
- WSP International Final Civil Design (85% 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:

- Stormwater management plans;

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 3 – Final 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:

- 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 WSP, Daniel Park, at WSP Offices on Wednesday 19 June 2019. The tabled design was discussed with WSP 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 gathered data included a review of the previous Preliminary Design stage audit WTS-LR1 Stage 2– Preliminary Design (50% Design Completion) to ensure issues raised had been given due consideration. It was noted that some issues have not been addressed in the IFT Design (85% completion) and have been restated in this Audit (refer Appendix 2) to alert designers to areas where attention will be needed

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

A completion meeting was conducted on Monday 24 June 2019 with WSP, Mr Park, 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 3 – IFT Design Design (85% Completion) is to identify road user safety issues prior to issuing the design for construction.

The tabled design (refer Appendix 1 Extracts), 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 (Ch 380);
- Existing access into the Dunheved Golf Course to be upgraded;
- Future 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.

A Road User Risk Assessment Log (RURAL) of identified road user safety risks (refer Appendix 2) 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 IFT design phase. There are some road user safety issues identified in the Preliminary Design stage audit WTS-LR1 Stage 2– Preliminary Design (50% Design Completion) that appear not to have been treated in the tabled IFT Design that need to be reconsidered by the Project Manager (refer 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 IFT 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:

- There are some road user safety issues identified in the Preliminary Design stage audit WTS-LR1 Stage 2– Preliminary Design (50% Design Completion) that appear not to have been treated in the tabled IFT Design that need to be reconsidered by the Project Manager (Appendix 2).
- 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.
- 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.

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  There were no tabled Stormwater management to 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.

Other identified road user safety issues are addressed in the attached RURAL (refer Appendix 2).

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 IFT Civil Design Plan (85% completion - refer Appendix 1 Extracts) for Portion 1.

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.

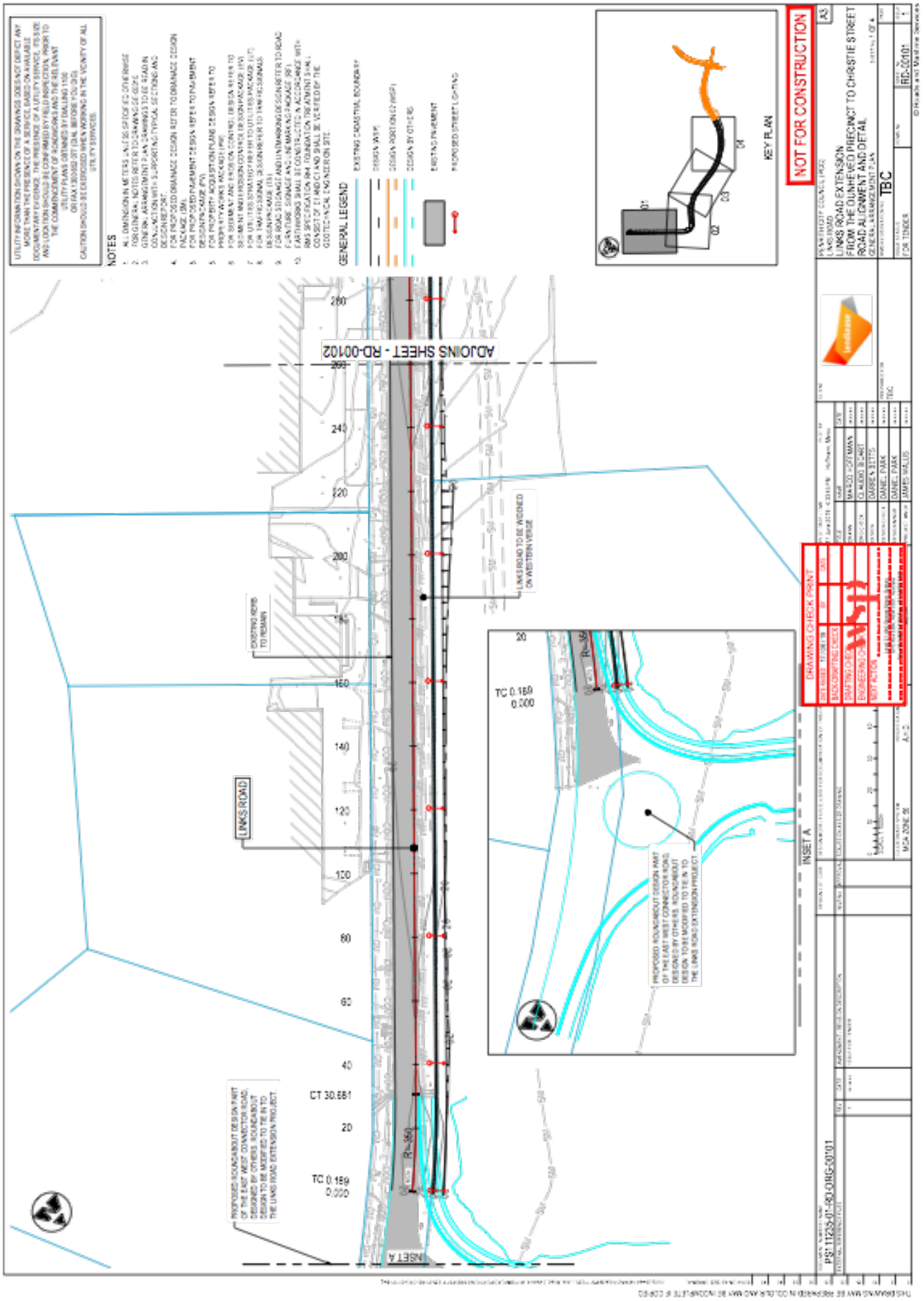
It should be noted in the RURAL (refer Appendix 2) are road user safety issues that are raised for consideration and have been considered by the Project Manager and the intended action(s) listed accordingly.

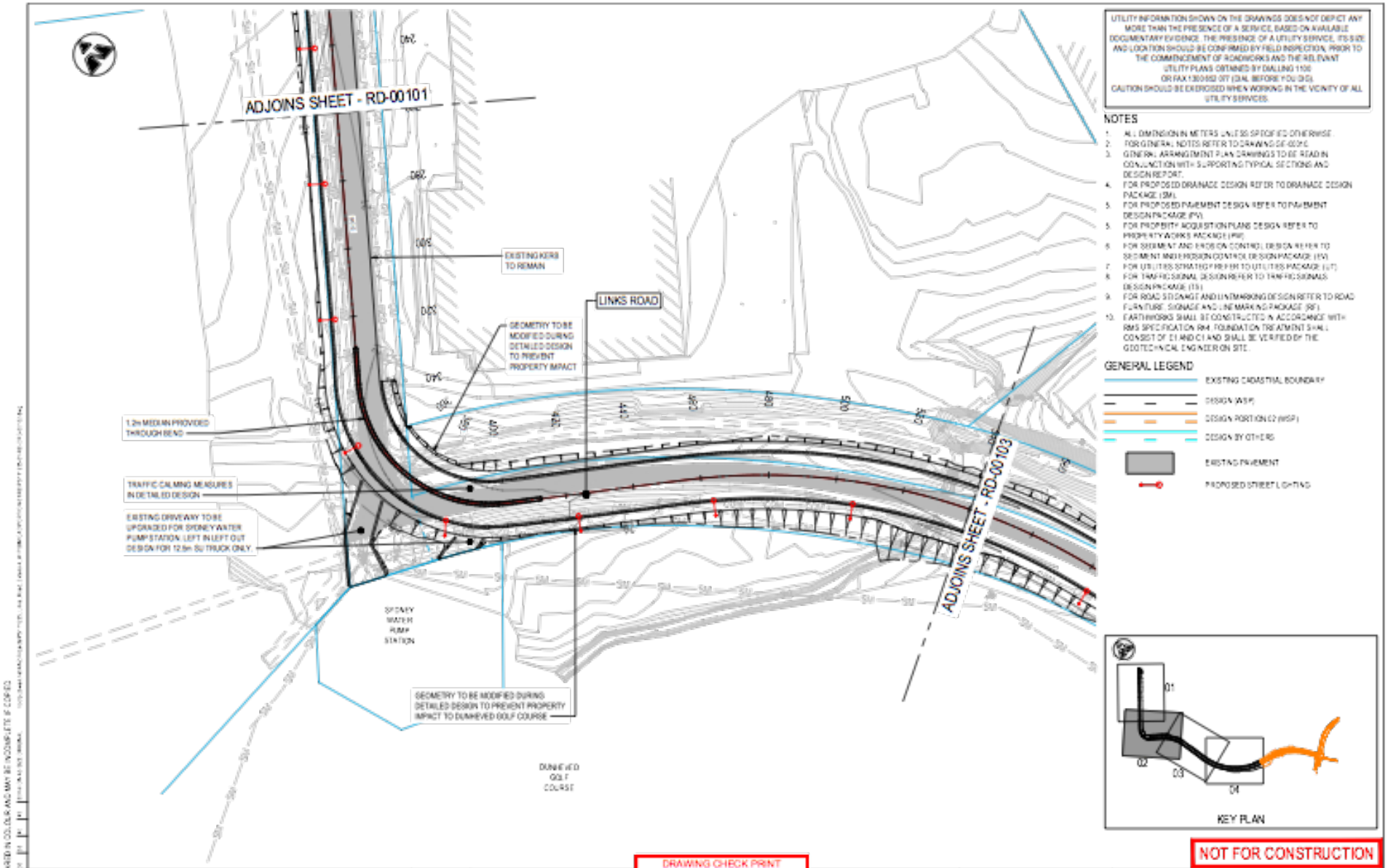
.....	.....
Terry Winning (Team Leader)	**Qian Liu (Team Member)**
Winning Traffic Solutions Pty. Ltd.	WSP International Pty. Ltd.
Level 3 RSA.02.0063	Level 2 RSA.02.1291

DATE: 28 June 2019

APPENDIX 1

Design Plan Extracts





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 1300652 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. FOR GENERAL NOTES REFER TO DRAWING SE-0010.
3. GENERAL ARRANGEMENT PLAN DRAWINGS TO BE READ IN CONJUNCTION WITH SUPPORTING TYPICAL SECTIONS AND DESIGN REPORT.
4. FOR PROPOSED DRAINAGE DESIGN REFER TO DRAINAGE DESIGN PACKAGE (SM).
5. FOR PROPOSED PAVEMENT DESIGN REFER TO PAVEMENT DESIGN PACKAGE (PV).
6. FOR PROPERTY ACQUISITION PLANS DESIGN REFER TO PROPERTY WORKS PACKAGE (PW).
7. FOR SEDIMENT AND EROSION CONTROL DESIGN REFER TO SEDIMENT AND EROSION CONTROL DESIGN PACKAGE (SV).
8. FOR UTILITIES STRATEGY REFER TO UTILITIES PACKAGE (UT).
9. FOR TRAFFIC SIGNAL DESIGN REFER TO TRAFFIC SIGNALS DESIGN PACKAGE (TS).
10. FOR ROAD SIGNAGE AND LINEMARKING DESIGN REFER TO ROAD FURNITURE, SIGNAGE AND LINEMARKING PACKAGE (RF).
11. EARTHWORKS SHALL BE CONSTRUCTED IN ACCORDANCE WITH RMS SPECIFICATION R44. FOUNDATION TREATMENT SHALL CONSIST OF E1 AND C1 AND SHALL BE VERIFIED BY THE GEOTECHNICAL ENGINEER ON SITE.

GENERAL LEGEND

- EXISTING CADASTRAL BOUNDARY
- DESIGN (WSP)
- DESIGN PORTION 2 (WSP)
- DESIGN BY OTHERS
- EXISTING PAVEMENT
- PROPOSED STREET LIGHTING

KEY PLAN

NOT FOR CONSTRUCTION

DRAWING CHECK PRINT
DATE ISSUED: 17/08/19 BY: DATE:
BACK-DRAFTING CHECK
DRAFTING CHECK
ENGINEERING CHECK
NEXT ACTION

PSI 11235-01-RD-ORG-00102

DRAWN	MARCO HOFFMANN		
DESIGN	CLAUDIO STUART		
CHECKED	DARREN SETTS		
RECOMMENDED	DANIEL PARK		
APPROVED	DANIEL PARK		
PROJECT MGR	JAMES WILLIS		

MGA ZONE 56

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN
SHEET 2 OF 4

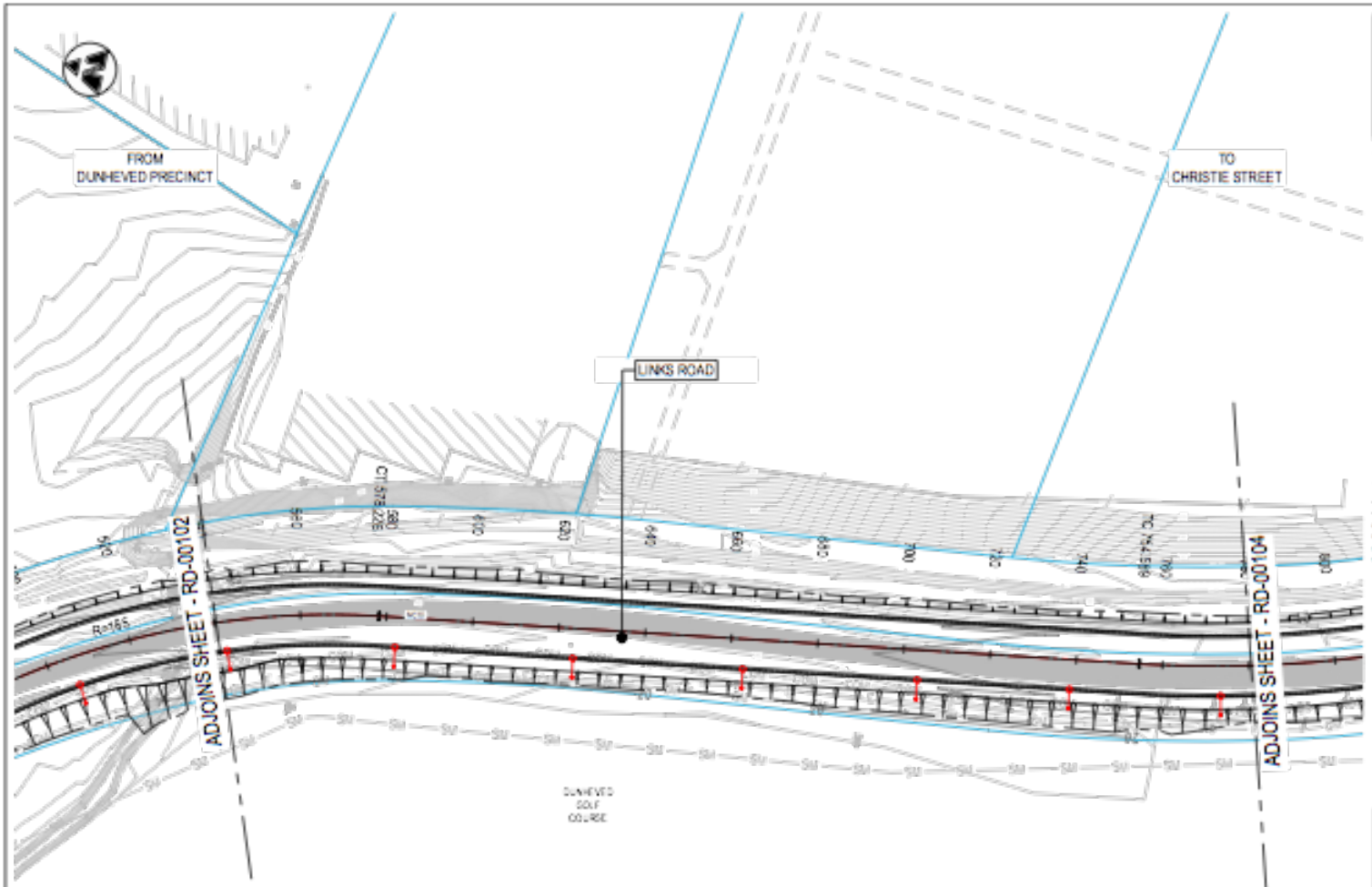
A3

TBC

FOR TENDER

RD-00102

1



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2. FOR GENERAL NOTES REFER TO DRAWING GE-0001
3. GENERAL ARRANGEMENT PLAN DRAWINGS TO BE READ IN CONJUNCTION WITH SUPPORTING TYPICAL SECTIONS AND DESIGN REPORT.
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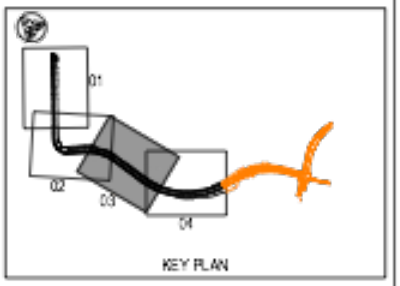
GENERAL LEGEND

- EXISTING CADASTRAL BOUNDARY
- DESIGN (WSP)
- DESIGN PORTION (WSP)
- DESIGN BY OTHERS
- EXISTING PAVEMENT
- PROPOSED STREET LIGHTING



KEY PLAN

NOT FOR CONSTRUCTION

DRAWING CHECK PRINT

PST11235-01-RD-ORG-00103

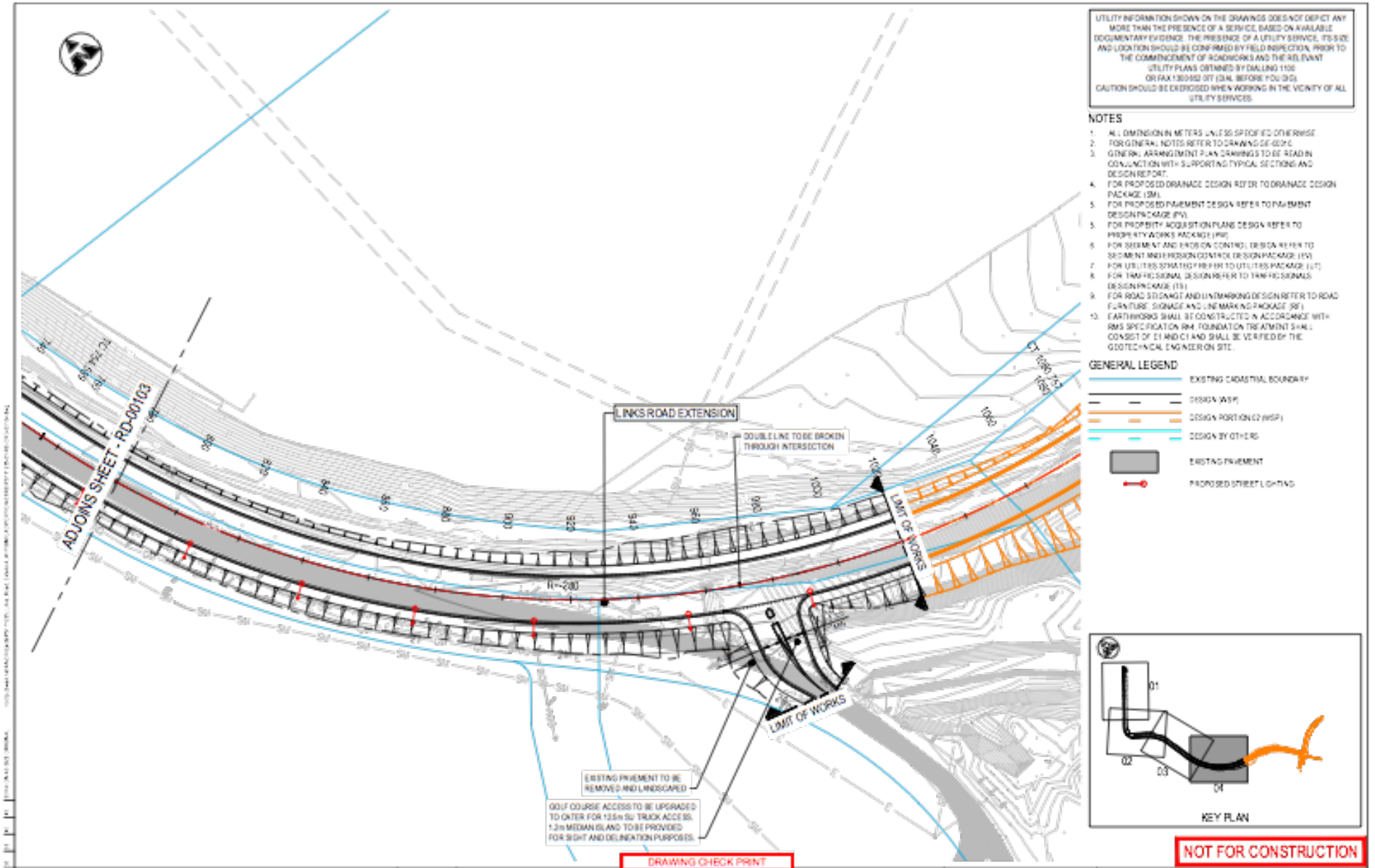
PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
GENERAL ARRANGEMENT PLAN
SHEET No 3 OF 4

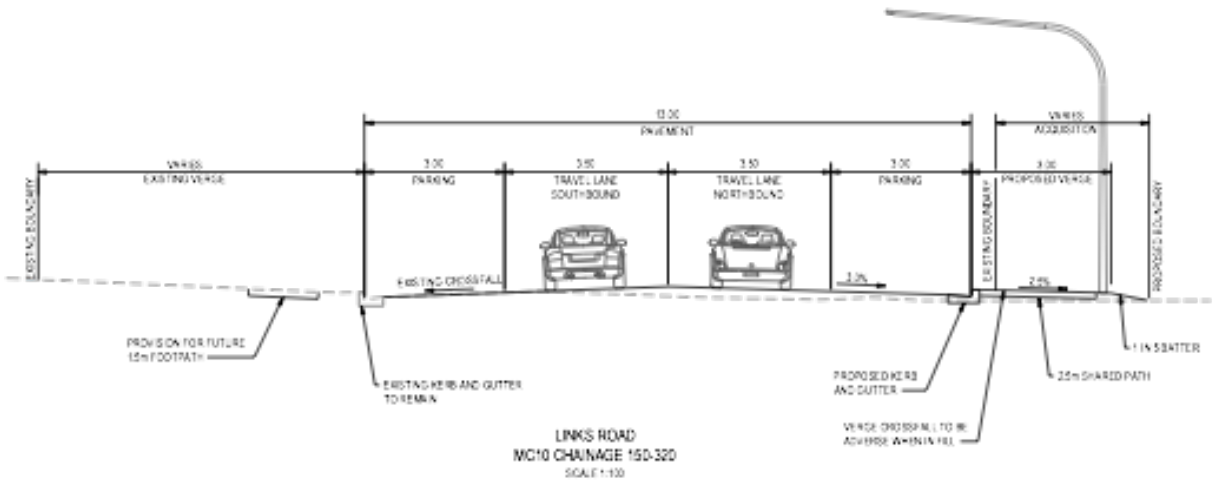
TBC

FOR TENDER

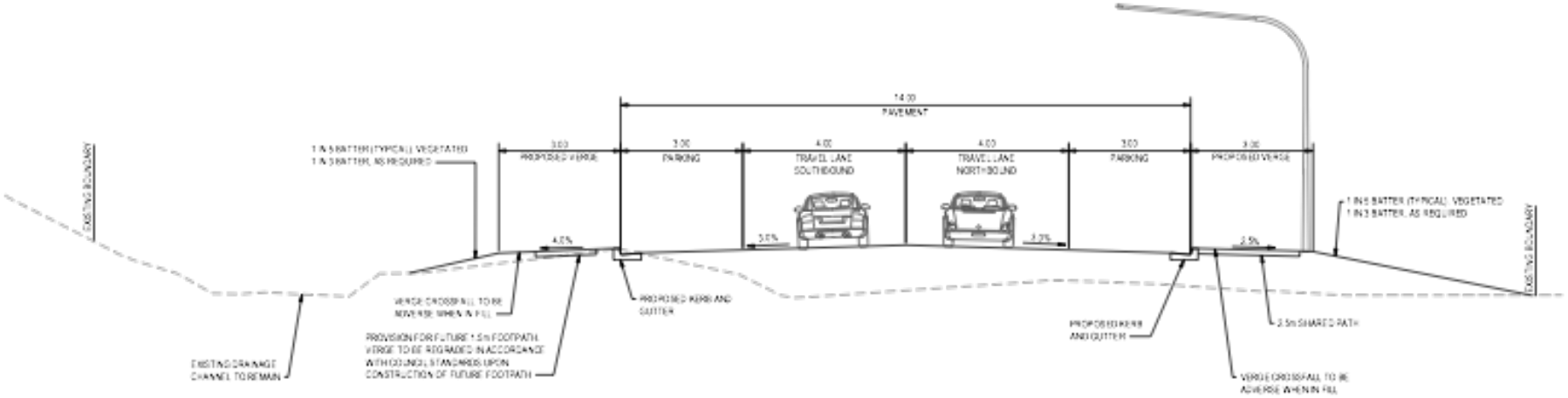
RD-00103

1





LINKS ROAD
MC10 CHAINAGE 150-320
SCALE 1:100



LINKS ROAD
MC10 CHAINAGE 420-1250
SCALE 1:100

NOT FOR CONSTRUCTION

DRAWING CHECK PRINT

PS1 11205-01-RD-ORG-00021

MGA ZONE 56

PENRITH CITY COUNCIL (PCC)
LINKS ROAD
LINKS ROAD EXTENSION
FROM THE DUNHEVED PRECINCT TO CHRISTIE STREET
ROAD ALIGNMENT AND DETAIL
TYPICAL CROSS SECTIONS
SHEET 1 OF 2

TBC

FOR TENDER

RD-00021

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 (Stage 2 Preliminary Design Stage Audit)	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. ***Response -*** *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.*		H	Accept	A meeting was held with Penrith City Council (PCC) on 25/06/2019 to discuss the outstanding issues. This particular item was raised and PCC acknowledged the project constraint environment and provided verbal acceptance of the D50 and P50. PCC requested WSP to document the reasoning to why D60 kph cannot be achieved and in locations. The new road design doesn't meet D60 kph between CH320 to CH620.

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
2	Guidance & Delineation (Stage 2 Preliminary Design Stage Audit)	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. ***Response*** **-** *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.*		M	Reject	RF01 – Road Furniture, signage and linemarking detailed design drawing was produced with CAMs and other regulatory signs proposed.
3	Road Alignment & Cross Sections (Stage 2 Preliminary Design Stage Audit)	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. ***Response*** **-** *Additional Typical Cross Sections to be provided during Detailed Design, in addition to standard cross section sheets.* It should be noted "additional typical cross sections" have not been added to the plans Sheet RD-00022		L	Accept	Design cross sections have been included in the new road design drawing set. Maintenance works could still be undertaken on 1 in 3 batter. Guardrail typically not required as 1 in 3 Batter slope commences at limit of clearzone..

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

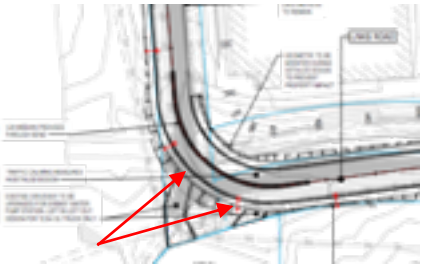
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
LINKS ROAD						
4	At Approx. CH 380 RD-00102 (Stage 2 Preliminary Design Stage Audit)	It is noted the design of the 90-degree bend in the road alignment proposes a 39m radius. Concern is expressed that given the approach 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. ***Response -*** *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.*		H	Accept	A meeting was held with Penrith City Council (PCC) on 25/06/2019 to discuss the outstanding issues. This particular item was raised and PCC acknowledged the project constraint environment and provided verbal acceptance of this design departure. (refer Point 1 above)

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

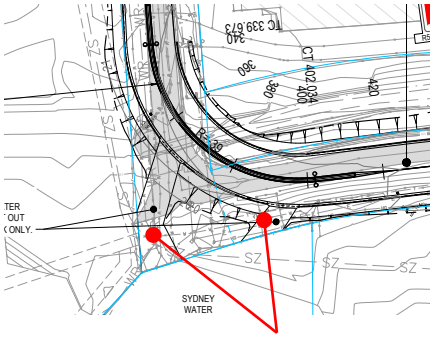
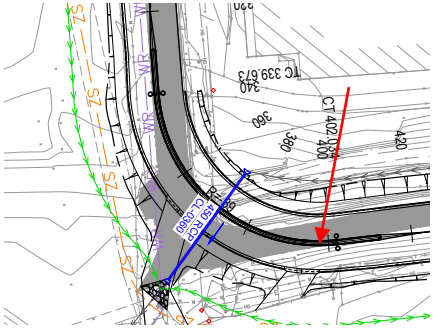
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
5	At Approx. CH 380 RD-00102 (Stage 2 Preliminary Design Stage Audit)	At the same location it is noted that two driveway accesses are provided to Sydney Water pump station. It is considered there are two issues that 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. **Response -** *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.*		H	Reject	Driveway gradients are 1V:10H or flatter with rounding. The Batter Slopes provided on the outside edge of the horizontal curve is 1V:5H Vehicle Swept Path analysis is demonstrated in the Road Design Report Appendices.

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

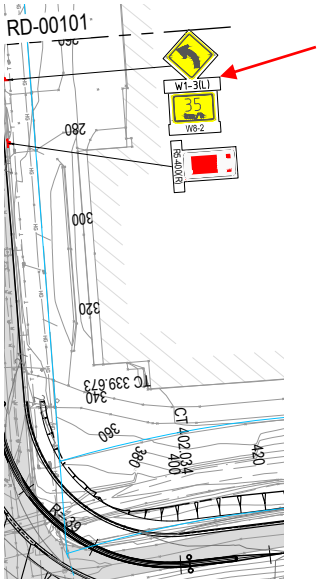
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
6	At Approx. CH 380 RD-00102 (Stage 2 Preliminary Design Stage Audit)	Two existing driveways are located at the outer alignment of the 90-degree bend which provide access to the Sydney Water pump station. These gaps 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. ***Response -*** *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.*		H	Reject	Longitudinal grade of Driveways are flatter than 1V:10H with rounding provided. Additionally, the batter slope between the driveways is 1V:5H. With no fixed objects located in this area there is sufficient protection for an errant vehicle to recover safely.
7	At Approx. CH 380 RD-00102 (Stage 2 Preliminary Design Stage Audit)	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. **NOTE:** there were no Stormwater Management plans tabled with the IFT Design (85% Completion) ***Response -*** *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.*		H	Accept	No crash barrier has been employed on the 1.2m wide median island. A typical cross section of this area has been added to the RD drawing package. The IFT Stormwater Management drawing package proposes new stormwater pits in the median island for collection of water run-off.

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

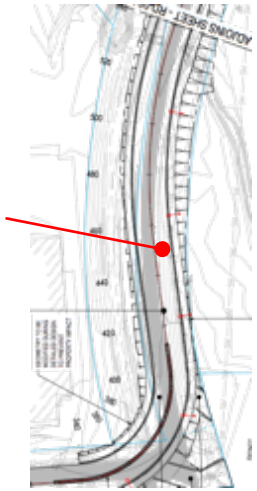
Item No.	Location	Description of Risk	Detail	Priority (L/M/H)	Accept/ Reject	Response
8	At Approx. CH 380 RD-00102 (Stage 2 Preliminary Design Stage Audit)	The road alignment comprises a 90-degree curve. Warning signs such as hazard markers are not provided to indicate the curve. This could result in 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. **Response -** *To be undertaken during Detailed Design and incorporate Council engagement, review and approvals process.* *Ths issue (supply of W1-8B) has been documented and escalated for resolution in next design phase.*		H	Accept	Correct orientation of advisory speeds signs has been resolved. Tight curve has had chevroning added to alert drivers of need to adjust course and which should additionally act as a calm device for road users. Tilting sign has been adopted prior to curve to alert heavy vehicles.

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
9	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. **Response -** *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.* **NOTE: It appears this has not been addressed in the IFT design**		M	Reject	Design is based on 50kph as per item 1. In accordance with Austroad Guide to Road Design Part 3, 0.6xV (design speed) separation length between the two curve is defined, which is 30m on 50kph speed environment. It appears that the current design has 52m straight between the curves, as shown on our RD drawing set.
10	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. ***Response -*** *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.* **NOTE: It appears this has not been addressed in the IFT design.**		M	Reject	Council has recently advised that this is to be a driveway.

APPENDIX F

SAFETY IN DESIGN REGISTER

Project Safety In Design Risk Register
Links Road - St Marys

Prepared by: Andy Clune
Reviewed by: Nuno Muralha

ID	Life Cycle Phase	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	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*	*Geotechnical investigation completed for Portion 1 works.*	*Ensure results of geotechnical investigation informs excavation*	***4 Serious***	***1 Rarely***	*4 Class 3 / L*	*Transferred*	*Results of geotechnical investigation to be distributed to All.*
2	Construction	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	4.14 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 Construction Staging.*	*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	4.14 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 Construction Staging. 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	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	4.8 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*	*Geotechnical investigation outcomes to be used to identify water table*	*Ensure results of geotechnical investigation informs excavation*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*	*Transferred*	*Results of geotechnical investigation to be distributed to All.*
7	Construction	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*	*Geotechnical investigation outcomes to be used to ensure excavation can be completed safely*	*Ensure results of geotechnical investigation informs excavation*	***4 Serious***	***1 Rarely***	*4 Class 3 / L*	*Transferred*	*Results of geotechnical investigation to be distributed to All.*
8	Operation	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	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	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	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	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 construction staging.*	*Ensure Traffic management plans are adhered to, and exclusion zones are provided.*	***3 Moderate***	***1 Rarely***	*3 Class 3 / L*	*Transferred*	*Staging and traffic management will be considered to provide a safe worksite*
13	Construction	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	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	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*	*Contractor to Co-ordinate with Sydney Water*	*Nil*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Transferred*	*Coordination with Sydney Water to be undertaken by Contractor*
16	Construction	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*	*Geotechnical investigation completed for Portion 1 works.*	*Residual risk as contamination identified. If positive protective measures can be implemented*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Transferred*	*Contractor to implement controls.*
17	Construction	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*	*Geotechnical investigation completed for Portion 1 works.*	*Residual risk as contamination identified. If positive protective measures can be implemented*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Transferred*	*Contractor to implement controls.*

Project Safety In Design Risk Register
Links Road - St Marys

Prepared by: Andy Clune
Reviewed by: Nuno Muralha

ID	Life Cycle Phase	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	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	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	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*	*Transferred*	*To be considered in construction staging by contractor.*
21	Construction	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	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	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 of Christie St Intesection.*
24	Construction	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*	*Sydney Water have advised their access requirements for ultimate state.*
25	Operation	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 designof Christie St Intesection.*
26	Operation	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 of Christie St Intesection.*
27	Maintenance	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*
28	O&M	4.11 Public health exposure	*Existing Condition: Unsafe proximity of Existing Endeavor Energy Electrical Telegraph Poles (non-Frangible Object) to Carriageway.Approximate Offset to face of kerb 600mm, therefore located within Clearzone for Design Speed.*	*Utility*	***4 Serious***	***2 Unlikely***	*8 Class 2 / M*		*YES*	*Road safety improved by providing an additional 3.0m of on street parking separating through traffic to the non-frangible objects.*	*Existing Non-Frangible objects will remain within Clearzone*	***3 Moderate***	***2 Unlikely***	*6 Class 2 / M*	*Transferred*	*Existing Conditions improved by Proposed Works.*
29	Construction	4.1 Fall of Person	*Construction / trenching of deep pits.*	*Drainage and Hydrology*	***4 Serious***	***3 Likely***	*12 Class 2 / M*		*YES*	*Contractor to specify safe work conditions for construction of deep pits.*	*Consult with contractor during construction.*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*Transferred*	*To be considered in construction by contractor.*
30	Maintenance	4.1 Fall of Person	*Maintenance of pits and pipes located 5m below surface level.*	*Drainage and Hydrology*	***4 Serious***	***3 Likely***	*12 Class 2 / M*		*YES*	*Maintenance personnel to specify safety procedures for maintenance of deep pits.*	*Ensure maintenance personnel follows safety procedures during maintenance works.*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*Transferred*	*To be considered iby maintenance personnel.*
31	Construction	4.11 Public health exposure	*Excavation of contaminated land during construction of bio-retention swale.*	*Environment*	***4 Serious***	***3 Likely***	*12 Class 2 / M*	*4.10.1 Hazardous substance and hazardous materials identification*	*YES*	*Geotechnical investigation completed for Portion 1 works.*	*Residual risk as contamination identified. If positive protective measures can be implemented*	***2 Minor***	***2 Unlikely***	*4 Class 3 / L*	*Duplicate*	*Contractor to implement controls.*
32	Construction	4.8 Excavation and stockpile collapse	*Construction / trenching of deep pits.*	*Drainage and Hydrology*	***4 Serious***	***3 Likely***	*12 Class 2 / M*		*YES*	*Contractor to specify safe work conditions for construction of deep pits.*	*Consult with contractor during construction.*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*Transferred*	*To be considered in construction by contractor.*
32	Maintenance	4.19 Confined space incident	*Maintenance of new cross-drainage culverts.*	*Drainage and Hydrology*	***4 Serious***	***3 Likely***	*12 Class 2 / M*		*YES*	*Maintenance personnel to specify safety procedures for maintenance of cross-drainage culverts.*	*Ensure maintenance personnel follows safety procedures during maintenance works.*	***3 Moderate***	***3 Likely***	*9 Class 2 / M*	*Transferred*	*To be considered iby maintenance personnel.*

APPENDIX G

PAVEMENT DESIGN CIRCLY OUTPUT

CIRCLY Pro - Version 6.0 (30 January 2015)

Job Title: PS111235 Links Road - Full Depth Reconstruction

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	1.00E+07

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-Full	1	1965.0	0.0	1.00E+00	0.00

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

Details of Layered System:

ID: PS111235-2 Title: PS111235 Links Road - Full Depth Reconstruction SMZ not inc

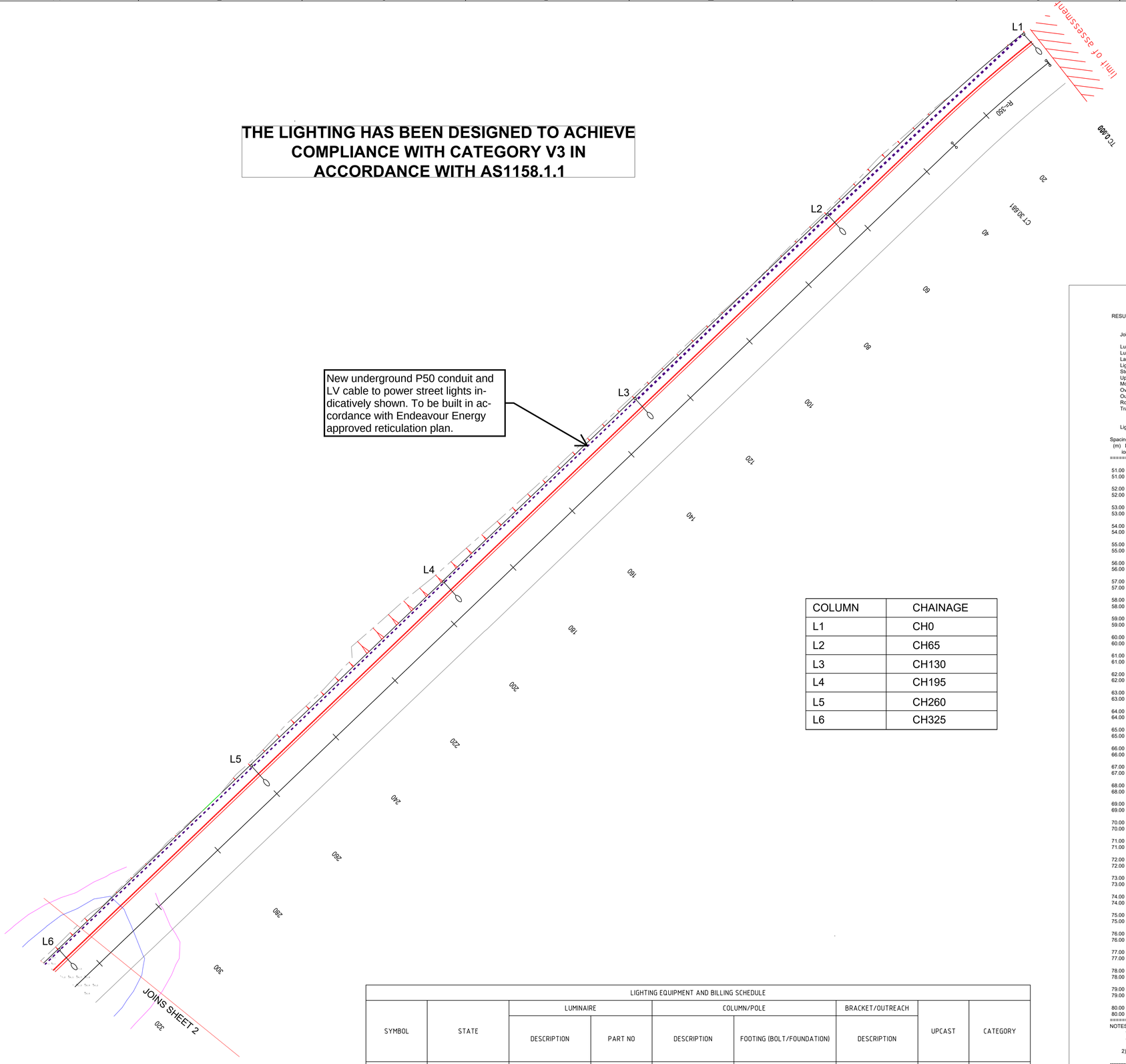
Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	Gran_350	Aniso.	3.50E+02	0.35		2.59E+02	1.75E+02	0.35

```
    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  Location Material              Component  Perform.   Perform.  Traffic
   No.             ID                             Constant   Exponent
Multiplier
    3     top      Sub_CBR3              EZZ         0.009300    7.000     1.600

   Reliability Factors:
   Project Reliability: Austroads 95%
   Layer  Reliability  Material
    No.   Factor       Type
    3      1.00       Subgrade (Austroads 2004)

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

Results:

   Layer  Thickness  Material               Load                      Critical
 CDF
   No.               ID                     ID                        Strain
    1      250.00    Gran_350                                n/a
 n/a
    2      380.00    Gran_250                                n/a
 n/a
    3        0.00    Sub_CBR3               ESA750-Full              8.62E-04
 9.40E-01
```

APPENDIX H

LIGHTING DESIGN CALCULATIONS

THE LIGHTING HAS BEEN DESIGNED TO ACHIEVE COMPLIANCE WITH CATEGORY V3 IN ACCORDANCE WITH AS1158.1.1



COLUMN	CHAINAGE
L1	CH0
L2	CH65
L3	CH130
L4	CH195
L5	CH260
L6	CH325

LIGHTING EQUIPMENT AND BILLING SCHEDULE

SYMBOL	STATE	LUMINAIRE		COLUMN/POLE		BRACKET/OUTREACH	UPCAST	CATEGORY
		DESCRIPTION	PART NO	DESCRIPTION	FOOTING (BOLT/FOUNDATION)	DESCRIPTION		
⟜	New	NEW 200w ROADLED	PL99G01L200	10m IMPACT ABSORBENT MAST	TYPE 3/UNIVERSAL	4.5m Single Outreach	5°	V3

RESULTS FOR RUNNING SAASTAN WITH NOMINATED SPACINGS
[AUSTRALIA MODE]

Job name: Link Rd

Luminaire I-table: RoadLED 200W 4K 216199.cie
Luminaire Description: RoadLED 200W 4K 216199 use 26.0klm
Lamp Wattage & Type: 200wLED
Light Source: LED
Stores Code: Luminous Flux: 26 Klms
Upcast Angle: 5 Degrees Arrangement: 1 Single-Left
Mounting Height: 12 m Maintenance Factor: 0.8
Overhang 1st Row: 1.5 m
Outreach Size: 4.5
Road Surface: CIE R3
Traffic Flow: Two Way ---->
<----

Lighting Category: V3 Carriageway Width: 13.5 m

Spacing (m)	Traffic	Lbar	Uo	Ul	UWLR	TI	Esl	Esr	Comply
	Direction	(>=0.75)	(>=0.33)	(>=0.5)	(=<3)	(=<20)	(>=50)	(>=50)	with V3
51.00	Normal	1.03	0.41	0.96	.57	16.70	94.29	87.76	YES
51.00	Oncoming	1.11	0.42	0.84	.57	11.71	87.76	94.29	YES
52.00	Normal	1.01	0.41	0.94	.57	16.76	94.29	87.84	YES
52.00	Oncoming	1.09	0.42	0.85	.57	11.73	87.84	94.29	YES
53.00	Normal	.99	0.40	0.93	.57	16.82	94.33	87.84	YES
53.00	Oncoming	1.07	0.42	0.85	.57	11.75	87.84	94.33	YES
54.00	Normal	.98	0.40	0.92	.57	16.87	94.35	87.81	YES
54.00	Oncoming	1.05	0.42	0.85	.57	11.77	87.81	94.35	YES
55.00	Normal	.96	0.40	0.90	.57	16.98	94.26	87.80	YES
55.00	Oncoming	1.03	0.42	0.83	.57	11.66	87.80	94.26	YES
56.00	Normal	.94	0.41	0.88	.57	17.05	94.32	87.75	YES
56.00	Oncoming	1.01	0.41	0.82	.57	11.69	87.75	94.32	YES
57.00	Normal	.93	0.40	0.87	.57	17.11	94.31	87.84	YES
57.00	Oncoming	.99	0.41	0.82	.57	11.71	87.84	94.31	YES
58.00	Normal	.91	0.40	0.87	.57	17.17	94.37	87.83	YES
58.00	Oncoming	.98	0.41	0.82	.57	11.75	87.83	94.37	YES
59.00	Normal	.90	0.40	0.86	.57	17.24	94.35	87.82	YES
59.00	Oncoming	.96	0.41	0.81	.57	11.78	87.82	94.35	YES
60.00	Normal	.88	0.40	0.84	.57	17.37	94.26	87.81	YES
60.00	Oncoming	.94	0.41	0.81	.57	11.84	87.81	94.26	YES
61.00	Normal	.87	0.40	0.82	.57	17.44	94.29	87.78	YES
61.00	Oncoming	.93	0.41	0.80	.57	11.88	87.78	94.29	YES
62.00	Normal	.85	0.40	0.80	.57	17.51	94.34	87.83	YES
62.00	Oncoming	.92	0.41	0.80	.57	11.91	87.83	94.34	YES
63.00	Normal	.84	0.40	0.79	.57	17.59	94.35	87.83	YES
63.00	Oncoming	.90	0.41	0.80	.57	11.95	87.83	94.35	YES
64.00	Normal	.83	0.39	0.77	.57	17.68	94.35	87.81	YES
64.00	Oncoming	.89	0.40	0.79	.57	11.99	87.81	94.35	YES
65.00	Normal	.81	0.39	0.75	.57	17.81	94.26	87.81	YES
65.00	Oncoming	.87	0.40	0.78	.57	12.06	87.81	94.26	YES
66.00	Normal	.80	0.39	0.72	.57	17.89	94.30	87.77	YES
66.00	Oncoming	.86	0.41	0.77	.57	12.10	87.77	94.30	YES
67.00	Normal	.79	0.39	0.70	.57	18.05	94.33	87.83	YES
67.00	Oncoming	.85	0.41	0.76	.57	12.14	87.83	94.33	YES
68.00	Normal	.78	0.39	0.69	.57	18.15	94.35	87.82	YES
68.00	Oncoming	.84	0.41	0.76	.57	12.19	87.82	94.35	YES
69.00	Normal	.77	0.39	0.67	.57	18.32	94.34	87.79	YES
69.00	Oncoming	.83	0.41	0.75	.57	12.23	87.79	94.34	YES
70.00	Normal	.76	0.39	0.65	.57	18.46	94.26	87.81	YES
70.00	Oncoming	.81	0.41	0.75	.57	12.31	87.81	94.26	YES
71.00	Normal	.75	0.39	0.64	.57	18.55	94.29	87.85	YES
71.00	Oncoming	.80	0.41	0.73	.57	12.36	87.85	94.29	YES
72.00	Normal	.74	0.38	0.63	.57	18.64	94.36	87.85	NO
72.00	Oncoming	.79	0.40	0.72	.57	12.46	87.85	94.36	YES
73.00	Normal	.73	0.38	0.61	.57	18.48	94.35	87.82	NO
73.00	Oncoming	.78	0.40	0.72	.57	12.51	87.82	94.35	YES
74.00	Normal	.72	0.38	0.60	.57	18.58	94.32	87.78	NO
74.00	Oncoming	.77	0.40	0.71	.57	12.62	87.78	94.32	YES
75.00	Normal	.71	0.37	0.59	.57	18.73	94.26	87.80	NO
75.00	Oncoming	.76	0.40	0.75	.57	12.70	87.80	94.26	YES
76.00	Normal	.70	0.37	0.57	.57	18.81	94.31	87.84	NO
76.00	Oncoming	.75	0.39	0.74	.57	12.75	87.84	94.31	YES
77.00	Normal	.69	0.37	0.54	.57	18.92	94.36	87.84	NO
77.00	Oncoming	.74	0.39	0.73	.57	12.80	87.84	94.36	NO
78.00	Normal	.69	0.37	0.53	.57	19.01	94.36	87.81	NO
78.00	Oncoming	.74	0.39	0.73	.57	12.85	87.81	94.36	NO
79.00	Normal	.68	0.37	0.52	.57	19.11	94.31	87.78	NO
79.00	Oncoming	.73	0.38	0.72	.57	12.91	87.78	94.31	NO
80.00	Normal	.67	0.36	0.50	.57	19.26	94.26	87.80	NO
80.00	Oncoming	.72	0.38	0.70	.57	13.00	87.80	94.26	NO

NOTES: 1) Where 'Normal' &/or 'Oncoming' lines are shown, compliance with the nominated Category, at a particular spacing, is only applicable when there is a 'Yes' on each line i.e. ANY 'No' indicates failure at that spacing.
2) Calculations use the original SAASTAN software

AMENDMENTS/REVISIONS

Rev	Description	Initials	Date
01	Initial Release		

LEGEND

- NEW LUMINAIRE ON NEW COLUMN
- 7.5LUX MAINTAINED (V3)
- 3.75LUX MAINTAINED (V3)

Road Lighting Certification

This design has been produced by bransonjames and is certified to comply with the design brief and relevant current sections of AS/NZS 1158, except at locations noted on the design.

bransonjames disclaims any responsibility or liability in connection with the following;

1. The design has been based on information received by bransonjames from third parties. Such information has not be verified by bransonjames for completeness or correctness.
2. In producing this design, no account has been taken by bransonjames for sloping terrain/carriageways, crests, vehicular barriers, trees and vegetation, or any other object that may interfere with the lighting design.
3. The design must be installed as specified on this drawing, and no variations allowed without written consent from bransonjmaes.
4. bransonjames cannot be responsible for environmental conditions, which may compromise the compliance of the design.
5. Calculated results, shown herein are subject to practical tolerances such as photometric measurement, manufacturing variation, lamp and control gear characteristics, supply voltage and frequency variation.
6. The compliance of this design is dependent upon the luminaire manufacturer supplying luminaires that are representative of the data contained with the appropriate registered laboratory photometric test report.
7. The design is predicated upon the adoption of a maintenance regime that will maintain the performance of the luminaire to a level equal to or above the Maintenance Factors used in the design.

Company Representative: Brendon Hince MIES

Signed .....

Date .....21/06/19.....

GRID POWER DESIGN
Accredited Service Providers Level 3 | Accreditation No.4876
Design Engineering Consultation Project Management
Suite 308, 20A Lexington Drive, Bella Vista NSW 2153
admin@gridpowerdesign.com.au 02 9836 1257
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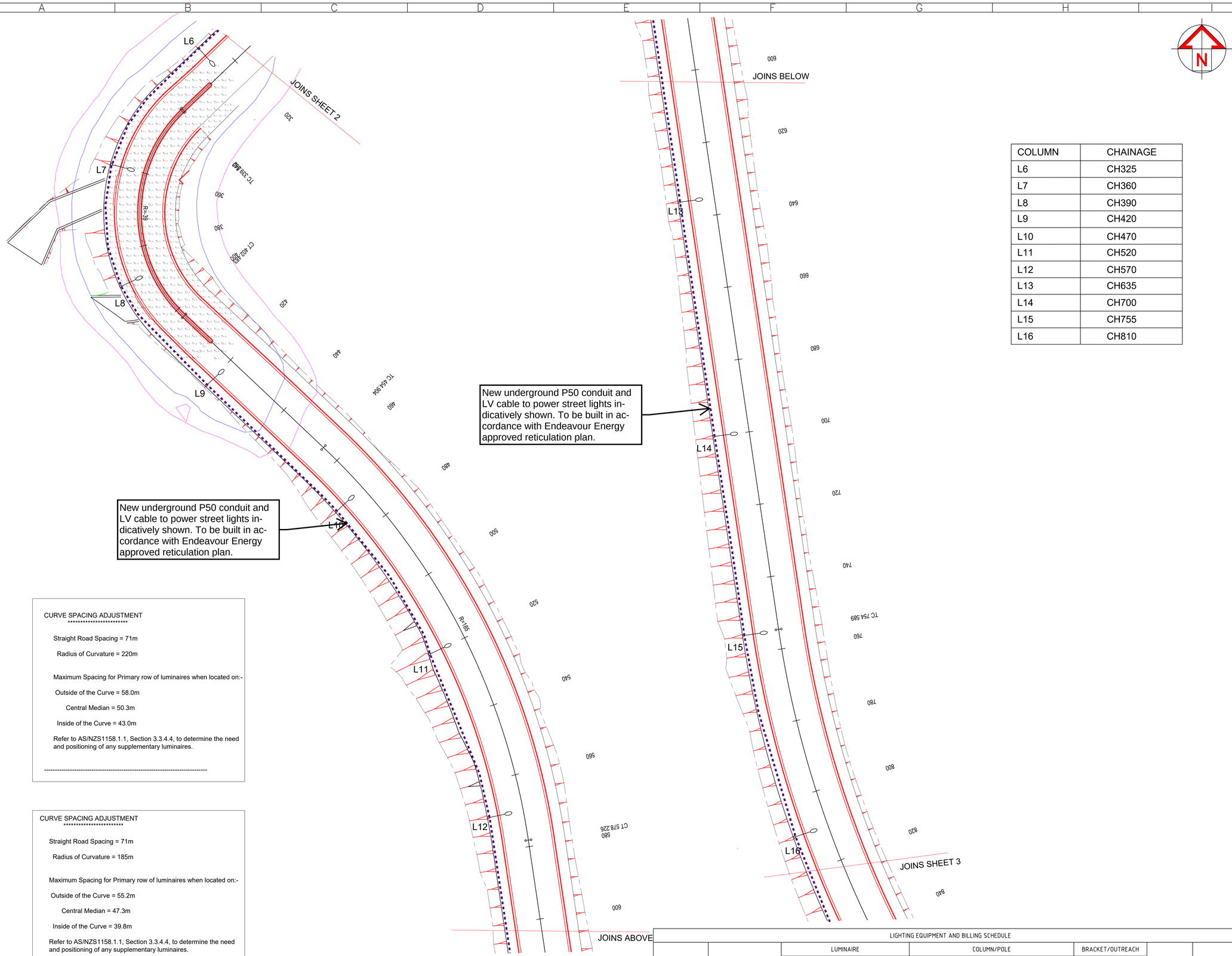
DRAWING TITLE

LINK RD
ST MARYS
ROAD LIGHTING

LIGHTING CERTIFICATION DESIGN

DRAWN	DESIGNED	CHECKED	SCALE (AT FULL SIZE)	DATE
BH	BH		1:500@A1	21/6/19

PROJECT No.	DRAWING No.	REVISION
BJ308	BJ308-Sheet 1	V01



COLUMN	CHAINAGE
L6	CH325
L7	CH360
L8	CH390
L9	CH420
L10	CH470
L11	CH520
L12	CH570
L13	CH635
L14	CH700
L15	CH755
L16	CH810

CURVE SPACING ADJUSTMENT
****

Straight Road Spacing = 71m

Radius of Curvature = 220m

Maximum Spacing for Primary row of luminaires when located on:-

Outside of the Curve = 58.0m

Central Median = 50.3m

Inside of the Curve = 43.0m

Refer to AS/NZS1158.1.1, Section 3.3.4.4, to determine the need and positioning of any supplementary luminaires.

CURVE SPACING ADJUSTMENT
****

Straight Road Spacing = 71m

Radius of Curvature = 185m

Maximum Spacing for Primary row of luminaires when located on:-

Outside of the Curve = 55.2m

Central Median = 47.3m

Inside of the Curve = 39.8m

Refer to AS/NZS1158.1.1, Section 3.3.4.4, to determine the need and positioning of any supplementary luminaires.

LIGHTING EQUIPMENT AND BILLING SCHEDULE

SYMBOL	STATE	LUMINAIRE		COLUMN/POLE		BRACKET/OUTREACH	UPCAST	CATEGORY
		DESCRIPTION	PART NO	DESCRIPTION	FOOTING (BOLT/FOUNDATION)	DESCRIPTION		
	New	NEW 200w ROADLED	PL99G01L200	10m IMPACT ABSORBENT MAST	TYPE 3/UNIVERSAL	4.5m Single Outreach	5°	V3

AMENDMENTS/REVISIONS

Rev	Description	Initials	Date
01	Initial Release		

LEGEND

NEW LUMINAIRE ON NEW COLUMN
7.5LUX MAINTAINED (V3)
3.75LUX MAINTAINED (V3)

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1. The design has been based on information received by bransonjames from third parties. Such information has not be verified by bransonjames for completeness or correctness.
2. In producing this design, no account has been taken by bransonjames for sloping terrain/carriageways, crests, vehicular barriers, trees and vegetation, or any other object that may interfere with the lighting design.
3. The design must be installed as specified on this drawing, and no variations allowed without written consent from bransonjmaes.
4. bransonjames cannot be responsible for environmental conditions, which may compromise the compliance of the design.
5. Calculated results, shown herein are subject to practical tolerances such as photometric measurement, manufacturing variation, lamp and control gear characteristics, supply voltage and frequency variation.
6. The compliance of this design is dependent upon the luminaire manufacturer supplying luminaires that are representative of the data contained with the appropriate registered laboratory photometric test report.
7. The design is predicated upon the adoption of a maintenance regime that will maintain the performance of the luminaire to a level equal to or above the Maintenance factors used in the design.

Company Representative: Brendon Hince MIES

Signed .....

Date .....21/06/19.....

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DRAWING TITLE

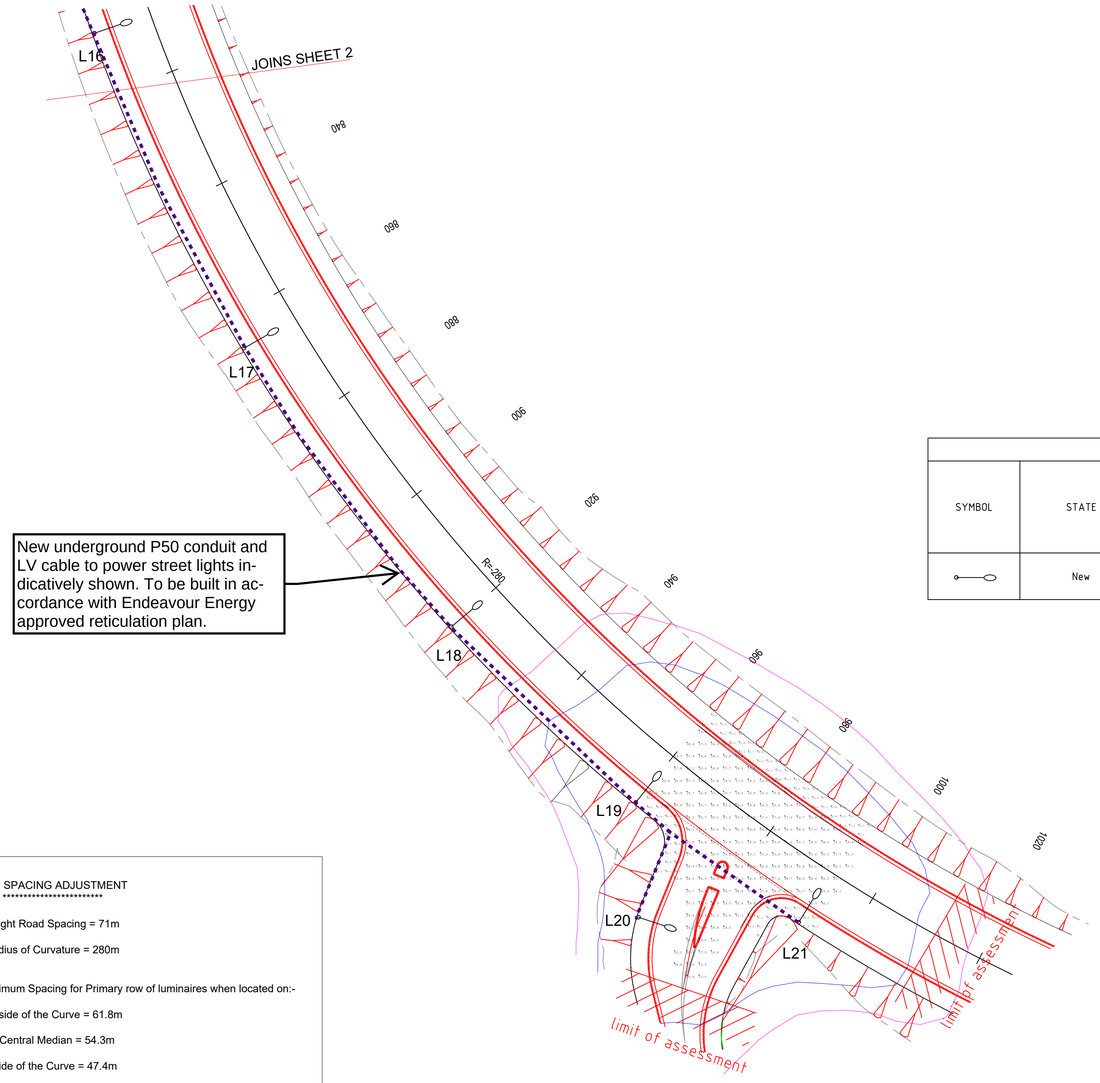
LINK RD
ST MARYS
ROAD LIGHTING

LIGHTING CERTIFICATION DESIGN

DRAWN	DESIGNED	CHECKED	SCALE (AT FULL SIZE)	DATE
BH	BH		1:500@A1	21/6/19

PROJECT No.	DRAWING No.	REVISION
BJ308	BJ308-Sheet 2	V01

A1



New underground P50 conduit and LV cable to power street lights indicatively shown. To be built in accordance with Endeavour Energy approved reticulation plan.

CURVE SPACING ADJUSTMENT
****

Straight Road Spacing = 71m

Radius of Curvature = 280m

Maximum Spacing for Primary row of luminaires when located on:-

Outside of the Curve = 61.8m

Central Median = 54.3m

Inside of the Curve = 47.4m

Refer to AS/NZS1158.1.1, Section 3.3.4.4, to determine the need and positioning of any supplementary luminaires.

COLUMN	CHAINAGE
L16	CH810
L17	CH865
L18	CH920
L19	CH960
L20	CH
L21	CH992

LIGHTING EQUIPMENT AND BILLING SCHEDULE

SYMBOL	STATE	LUMINAIRE		COLUMN/POLE		BRACKET/OUTREACH	UPCAST	CATEGORY
		DESCRIPTION	PART NO	DESCRIPTION	FOOTING (BOLT/FOUNDATION)	DESCRIPTION		
⟜	New	NEW 200w ROADLED	PL99G01L200	10m IMPACT ABSORBENT MAST	TYPE 3/UNIVERSAL	4.5m Single Outreach	5°	V3

Calculation Summary

Label	CalcType	Units	Avg	Max	Min	Min/Avg	Max/Min
Eh ILLUMINANCE INTERSECTION	Illuminance	Lux	22.31	32.6	13.5	0.61	2.41
Es ILLUMINANCE BEND	Illuminance	Lux	16.34	27.7	9.6	0.59	2.88
Es ILLUMINANCE INTERSECTION_1	Illuminance	Lux	19.01	30.7	11.0	0.58	2.79
Eh Illuminance Bend CH320-420	Illuminance	Lux	18.56	30.6	11.8	0.64	2.59

AMENDMENTS/REVISIONS

Rev	Description	Initials	Date
01	Initial Release		

LEGEND

⟜ NEW LUMINAIRE ON NEW COLUMN
7.5LUX MAINTAINED (V3)
3.75LUX MAINTAINED (V3)

Road Lighting Certification

This design has been produced by bransonjames and is certified to comply with the design brief and relevant current sections of AS/NZS 1158, except at locations noted on the design.

bransonjames disclaims any responsibility or liability in connection with the following;

1. The design has been based on information received by bransonjames from third parties. Such information has not be verified by bransonjames for completeness or correctness.
2. In producing this design, no account has been taken by bransonjames for sloping terrain/carriageways, crests, vehicular barriers, trees and vegetation, or any other object that may interfere with the lighting design.
3. The design must be installed as specified on this drawing, and no variations allowed without written consent from bransonjmaes.
4. bransonjames cannot be responsible for environmental conditions, which may compromise the compliance of the design.
5. Calculated results, shown herein are subject to practical tolerances such as photometric measurement, manufacturing variation, lamp and control gear characteristics, supply voltage and frequency variation.
6. The compliance of this design is dependent upon the luminaire manufacturer supplying luminaires that are representative of the data contained with the appropriate registered laboratory photometric test report.
7. The design is predicated upon the adoption of a maintenance regime that will maintain the performance of the luminaire to a level equal to or above the Maintenance factors used in the design.

Company Representative: Brendon Hince MIES

Signed .....

Date .....3/11/18.....

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DRAWING TITLE
LINK RD
ST MARYS
ROAD LIGHTING

LIGHTING CERTIFICATION DESIGN

DRAWN	DESIGNED	CHECKED	SCALE (AT FULL SIZE)	DATE
BH	BH		1:500@A1	21/6/19

PROJECT No.	DRAWING No.	REVISION
BJ308	BJ308-Sheet 3	V01

A1

APPENDIX I

GEOTECHNICAL INTERPRETIVE REPORT

LEND LEASE COMMUNITIES LTD

LINKS ROAD EXTENSION

GEOTECHNICAL INTERPRETATIVE REPORT

MAY 2019

PUBLIC

wsp

Question today
Imagine tomorrow
Create for the future

Links Road Extension
Geotechnical Interpretative Report

Lend Lease Communities Ltd

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REV	DATE	DETAILS
1	31/05/2019	Draft issue for client review

	NAME	DATE	SIGNATURE
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Reviewed by:	David Coles	31/05/2019	
Approved by:	Sudar Aryal	31/05/2019	

TABLE OF CONTENTS

1 PROJECT BACKGROUND

1.1 INTRODUCTION

Lendlease Communities (Lendlease) are proposing to construct an upgrade and extension of Links Road to connect with Christie Street within St Marys, NSW (herein referred collectively as "the site"). 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. This intersection is currently an un-signalised 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 via Christie Street.

The intersection at South Dunheved has been agreed in kind between Lendlease and Penrith City Council through the St Marys Planning Agreement. Concept Design (and associated Environmental Assessments) have been completed and the Development Application was submitted to Penrith City Council in April 2018.

WSP Australia Pty Ltd (WSP) has been engaged by Lendlease to provide the lead engineering services for the Development Application and design of the Links Road Extension and Upgrade. This report presents the geotechnical component of the engineering services.

1.2 SCOPE

- Geotechnical site investigation comprising:
  - Nine (9) deep boreholes, ranging in depth from 3.00m to 5.00m
  - Seven (7) pavement cores, to a depth of 1.50m
- Geotechnical laboratory testing of selected soil samples;
- Geotechnical reporting.

1.3 PURPOSE OF THE REPORT

This Geotechnical Interpretative Report (GIR) has been prepared to document the information required for future design stages of the Links Road Extension and Upgrade. The objectives for this report include:

- presentation of interpreted geological / geotechnical models for design;
- providing recommendations on design geotechnical parameters, applicable for the design of structures involved in the project;
- providing recommendations on earthworks materials planning and management;
- providing recommendations to assist with pavement design;

1.4 PROPOSED STRUCTURES

Based on the Links Road Extension civil design development application drawings (PS111235-GE-DRG-00001, issued 22/11/19), it is evisaged that the project will include regrading / widening of the existing alignment and reconstruction of the pavement. It will require some minor cutting and filling and construction of road drainage structures.

2 SITE DESCRIPTION

2.1 SITE LOCATION

The site is located approximately 5 kilometres north-east of Penrith and 45 kilometres west of Sydney CBD. The site is located primarily along the western end of the existing Links Road in St Marys. The proposed road extension design includes upgrading this portion of Links Road, and then extending the road through Lendlease property and RMS land to the south (a former rail corridor) before terminating at the upgraded intersection of Christie Street and Lee Holm Road.

The site is generally situated within an industrial area, except for Dunheved gold course to the west, vacant land to the north-west and the aforementioned abandoned rail corridor running east-west though the centre of site. The rail corridor is partially forested. Beyond the golf course and vacant land to the west and north lies South Creek.

The approximate site extents and surrounds are presented in Figure 1, Appendix A.

2.2 TOPOGRAPHY

The site lies approximately between 21.0 m AHD (meters Australian Height Datum) to the north of the project, 24.0 m AHD across central regions to 21.6 m AHD to the south. The eastern edge of the site forms a high point and the site slopes trending south towards the former rail corridor. The rail corridor forms a gully before rising to the south towards RMS property. The site is flat to gently sloping in the south around Christie Street and Lee Holm Road.

2.3 SOIL LANDSCAPE

Reference to the 1:100,000 Penrith Soil Landscape Series Sheet 9030 (Soil Conservation Series of NSW, 1990) indicates that the site overlies three soil landscapes, documented on Figure 2, Appendix A.

To the north and west, along the edge of the gold course, the site is underlain by the south creek formation (sc) which is an alluvial formation characterised as floodplains, valley flats and drainage depressions with soils typically comprised of very deep layered sediments over bedrock or relict soils. Soils are plastic clays and known hazards include flooding, seasonal waterlogging, localised permanently high water tables localised erosion hazards and localised surface movement potential.

Across the central regions of the site, around the Lendlease and RMS properties, the soil landscape is characterised as the Berkshire Park (bp) formation which is characterised by alluvial and colluvial soils. The formation is generally flat terrace tops dissected by small drainage channels and narrow drainage lines. Soils vary from Sandy loam, to sandy clay with ironstone nodules, to clayey gravel. Limitations of the soil include impermeable and low fertility soils.

The southern edge of the site overlies the Blacktown soil landscape (bt) which is which is comprised of red-brown, residual clays of moderate to high reactivity.

2.4 REGIONAL GEOLOGY

Reference to the 1:100,000 Penrith Geological Series Sheet 9030 (Geological Survey of NSW, 1991) indicates that the project area is underlain by the Bringelly Shale formation (Rwb) which is characterised by Shale, carbonaceous claystone, claystone, laminate fine to medium grained lithic sandstone, rare coal and tuff. To the north and west edge of site, the site Quaternary alluvial materials defined as fine grained sand, silt and clay overlies Bringelly Shale, while Londonderry Clay - a tertiary alluvium/colluvium, comprised of clay with patches of ferruginized consolidated sand (generally corresponds with the Berkshire Park soil landscape), overlies the bedrock across the central extents of the site.

A geological map is presented in Figure 3, Appendix A.

2.5 ACID SULPHATE ROCK AND SOIL

Acid sulfate soils (ASS) are acidic soil horizons or layers resulting from the aeration of soil materials that are rich in iron sulphides, primarily pyrite (FeS2). They are generally likely to be present in:

- Marine and estuarine sediments of the recent (Holocene) geological age.
- In soils, usually not more than five metres above mean sea level.
- In marine or estuarine settings.

When drainage or excavation brings air into these previously waterlogged soils, the pyrite is oxidised to produce sulfuric acid. The acid reacts with clay minerals and dissolves metals in the soil such as iron and aluminium. The resulting acid and dissolved metals that leach from the soil are often toxic to flora and fauna.

Acid sulfate rock (ASR) includes diverse lithologies that contain sulfide and sulfate minerals (commonly pyrite) and based on experience is known to occur in the lower stratigraphic sequences of the Sydney Basin and other areas of New South Wales. ASR are unlikely to be present in the project area.

According to the National Acid Sulfate Soils Atlas and CSIRO ASRIS website (http://www.asris.csiro.au/), the site is given a rating of C4: Extremely low probability/very low confidence, which is defined as: 1 – 5% chance of occurrence in mapping unit with any occurrences in small localised areas, no necessary analytical data available and classifier has little knowledge or experience with ASS, hence classification is provisional.

No samples were collected for acid sulfate soil or rock analysis as part of this geotechnical investigation.

2.6 SALINITY

The 2002 salinity potential map of Western Sydney (Department of Infrastructure Planning and Natural Resources (DIPNR) indicates the different levels of salinity potential across the Western Sydney region. The project is located in an area of ‘moderate to high’ salinity potential, which relates to areas within the Wianamatta Group Shales, Blacktown (bt) and Berkshire Park (bp) soil landscape groups.

3 GEOTECHNICAL INVESTIGATION

3.1 INTRODUCTION

The geotechnical investigation was carried out between 19 February 2019 to 21 February 2019. Planned investigation locations were spaced at regular intervals along the proposed alignment and adjacent streets (Christie Street and Lee Holm Road) to characterise the geotechnical properties of subsurface materials for the proposed road extension and comprised nine deep boreholes and seven pavement holes. The geotechnical investigation programme was managed full time by experienced WSP geotechnical engineers who were responsible for supervising subcontractors, collecting samples, directing in-situ testing, and preparing engineering logs. All soil and rock encountered during the geotechnical investigation was logged in accordance with AS1726-2017 (Geotechnical Site Investigations).

A summary of the completed geotechnical investigations is presented in Table 3.1 and investigation locations are presented in Figure 1, Appendix A. Engineering logs, together with photographs of the pavement cores and DCP test results are presented in Appendix B and Appendix C for boreholes and pavement core holes respectively.

Table 3.1 Geotechnical investigation summary

INVESTIGATION TYPE	NUMBER OF INVESTIGATION LOCATIONS		DEPTH RANGE (m bgl)
	PLANNED	COMPLETED	
Deep Boreholes	9	6*	3.45 – 4.95
Pavement Holes	7	7	0.28 – 1.50
IN-SITU TEST TYPE	**NUMBER OF TESTS**		**NUMBER OF TEST LOCATIONS**
SPT	19		6
DCP	6		6

Note: *BH03, BH04 and BH05 deferred to a later stage. See section 3.3.

3.2 SURVEY

Easting and northing co-ordinates for all investigation locations were extracted from a handheld GPS unit (generally accurate to approximately +/- 5 m) in Map Grid Australia (MGA 94) Zone56 format. Co-ordinates are presented on individual engineering logs in Appendix B and detailed in Table 3.2 and Table 3.3 for deep boreholes and pavement core holes respectively. Reduced Levels (RLs) were inferred from a combination of GPS readings, Google maps and detailed survey plans available.

3.3 BOREHOLE DRILLING

Borehole drilling was conducted by Terratest Pty Ltd (Terratest) under supervision of a qualified WSP geotechnical engineer. Six boreholes were drilled using a Comacchio MCT200 drilling rig between the 19 and 21 February 2019.

Standard penetration tests (SPT) were carried out at a regular interval. Recovered soil was sampled and logged in accordance with AS 1726-2017 (Geotechnical Site Investigations).

Three boreholes were not able to be drilled (BH03, BH04 and BH05) as safe access to site could not be obtained. Suspected asbestos containing material (ACM) waste had been illegally dumped at the entrance to the Lendlease property. These boreholes were postponed until further notice from Lendlease.

At BH09, no SPT was carried out at 0.5mbgl. This was due to a risk of services identified by bedding sand encountered at nearby PC07. Once natural soil was encountered, SPTs continued as planned.

A summary of the borehole locations and depths is presented in Table 3.2.

Table 3.2 Summary of Borehole Locations and Depths

HOLE ID	TERMINATION DEPTH (m bgl)	TERMINATION REASON	EASTING*	NORTHING*	RL (m AHD)
BH01	4.63	Refusal	293228	6263618	23.5
BH02	3.80	Refusal	293167	6263675	24.1
BH06	3.45	Target Depth	292820	6263970	21.0
BH07	3.45	Target Depth	292795	6264166	21.5
BH08	3.45	Target Depth	292706	6264338	20.5
BH09	4.95	Target Depth	292764	6264476	21.0

Note: *Easting and Northing accurate to approximately +/- 5 m.

3.4 PAVEMENT HOLE DRILLING

Pavement hole drilling was carried out by Terratest Pty Ltd (Terratest) under supervision of a qualified WSP geotechnical engineer. Seven pavement holes were drilled using a truck mounted Geoprobe rig between the 19 - 20 February 2019.

The pavement core was logged and photographed and a dynamic cone penetration (DCP) test was carried out from beneath the gravelly base coarse at each pavement hole location. Recovered soil was sampled and logged in accordance with AS 1726-2017 (Geotechnical Site Investigations).

PC04 did not reach target depth, nor was a DCP test carried out at this location. At 0.27mbgl suspected bedding sand was encountered, indicating a high-risk potential of buried services. The pavement hole was subsequently terminated due to no other suitable near location.

A summary of the pavement hole locations is presented in Table 3.3 with the pavement engineering logs, pavement core photographs, DCP results and explanatory notes presented in Appendix C.

Table 3.3 Summary of Pavement Hole Locations and Depths

HOLE ID	TERMINATION DEPTH (m bgl)	TERMINATION REASON	EASTING*	NORTHING*	RL (m AHD)
PC01	1.50	Target Depth	292868	6263877	20.5
PC02	1.50	Target Depth	292796	6264062	21.0
PC03	1.50	Target Depth	292750	6264265	21.0
PC04	0.28	Services Encountered	292696	6264411	21.0
PC05	1.50	Target Depth	293136	6263539	22.0
PC06	1.50	Target Depth	293306	6263628	24.2
PC07	1.50	Target Depth	293289	6263505	23.4

Note: *Easting and Northing accurate to approximately +/- 5 m.

4 GEOTECHNICAL RESULTS

4.1 SUBSURFACE CONDITIONS

4.1.1 BOREHOLES AND PAVEMENT CORES

Materials encountered at investigation locations varied across the project extents and generally included pavement, fill, alluvium, residual soil and weathered rock.

A summary of the material encountered in the boreholes is summarised in Table 4.1 and Table 4.2.

Table 4.1 Material Description, Depth and SPT N Values recorded in the borehole logs

HOLE ID	BOREHOLE DEPTH (M)	INFERRED DEPTH TO BASE OF UNIT (m bgl)					SPT TESTING	
		PAVEMENT / TOPSOIL	FILL	ALLUVIUM	RESIDUAL SOIL	WEATHERED ROCK	DEPTH (m bgl)	'N' VALUE
BH01	4.63	-	0.20	-	4.50	4.63 (T)*	0.50 – 0.95	20
							1.50 – 1.95	19
							3.00 – 3.45	19
							4.40 – 4.63	R
BH02	3.80	0.05	-	-	3.80 (T)*	-	0.50 – 0.95	25
							1.50 – 1.95	28
							3.00 – 3.45	38
BH06	3.45	-	0.30	3.45(T)*	-	-	0.50 – 0.95	13
							1.50 – 1.95	20
							3.00 – 3.45	11
BH07	3.45	0.10	-	2.60	3.45 (T)*	-	0.50 – 0.95	5
							1.50 – 1.95	15
							3.00 – 3.45	9
BH08	3.45	-	1.00	3.45 (T)*	-	-	0.50 – 0.95	19
							1.50 – 1.95	16
							3.00 – 3.45	8
BH09	4.95	0.05	0.50	3.30	4.95 (T)*	-	1.50 – 1.95	6
							3.00 – 3.45	18
							4.50 – 4.95	16

Note: *(T) = Hole termination depth

Table 4.2 Pavement Hole Stratum Depths and DCP Depth Range recorded in the logs

HOLE ID	PAVEMENT HOLE DEPTH (M)	INFERRED DEPTH TO BASE OF UNIT (m bgl)					DCP RANGE	
		PAVEMENT	FILL	ALLUVIUM	RESIDUAL SOIL	WEATHERED ROCK	DEPTH FROM (m bgl)	DEPTH TO (m bgl)
PC01	1.50	0.05	0.40	1.50 (T)	-	-	0.30	2.10
PC02	1.50	0.23	0.60	1.50 (T)	-	-	0.80	1.90
PC03	1.50	0.04	0.60	1.50 (T)	-	-	0.60	2.40
PC04	0.28	0.12	0.28 (T)	-	-	-	NA	NA
PC05	1.50	0.30	0.70	-	1.50 (T)	-	0.80	1.60
PC06	1.50	0.30	1.00	-	1.50 (T)	-	1.00	1.50
PC07	1.50	0.12	0.40	-	1.50 (T)	-	0.50	1.60

Note: *(T) = Hole Termination Depth

4.2 IN-SITU TESTING

Standard penetration tests (SPT) were carried out at each borehole location where appropriate at depths of 0.5, 1.5, 3.0, and 4.5mbgl to assess the in-situ strength of the subsurface material.

Dynamic cone penetrometer (DCP) testing was carried out in accordance with AS 1289 6.3.2, at each pavement hole location (except PC04), to assess the in-situ consistency / relative density and to facilitate an in-situ CBR correlation of the subsurface soils. Tests were terminated once blow count exceeded 20 blows per 100mm, or a maximum depth of 2.4mbgl. A summary of DCP test results is presented in Appendix C.

4.3 GROUNDWATER OBSERVATIONS

No free groundwater was encountered at any of the investigation locations. However, it should be noted groundwater levels may vary due to climatic and seasonal conditions and therefore, groundwater observations at the time of the investigation may not be representative the long-term groundwater conditions. No standpipe piezometers were installed as part of this investigation.

4.4 LABORATORY RESULTS

Selected soil and rock samples collected during the investigation were tested at a NATA accredited laboratory (Resource Laboratories Pty Ltd). A summary of the laboratory tests carried out are presented in Table 4.3. Laboratory test reports are presented in Appendix D.

Table 4.3 Summary of Laboratory Testing

LABORATORY TEST	TEST METHOD	QUANTITY
CBR Testing 10-day soak method	RMS T111, T117	6
Atterberg Limits	RMS T108, T109, T113	4
Moisture Content	RMS T120	6
Particle Size Distribution	AS1289.1.1, 3.6.1	5

4.4.1 COMPACTION AND CALIFORNIA BEARING RATIO (CBR)

Two samples collected from boreholes and four samples collected from pavement holes were analysed for compaction properties and CBR using the 10-day RMS soak method. Soil samples were compacted (standard compaction) to 100 % dry density, utilising a 4.5kg surcharge. The results of the testing are summarised in Table 4.4.

Table 4.4 Compaction and CBR Test Results

HOLE ID	SAMPLE DEPTH (m bgl)	MATERIAL TYPE	OMC (%)	MDD (t/m^3)	SWELL (%)	CBR (%)	FMC (%)
BH07	0.10 – 0.90	Silty Sandy Clay (Alluvium)	13.4	1.86	0.4	20	10.6
BH09	0.50 – 0.90	Silty Clay (Alluvium)	13.9	1.91	0.4	8	13.9
PC01	0.40 – 1.50	Sandy Clay (Alluvium)	13.8	1.86	0.1	16	19.9
PC03	0.60 – 2.50	Silty Sandy Clay (Alluvium)	14.3	1.85	0.8	11	13.7
PC05	0.70 – 1.50	Sandy Clay (Residual)	15.8	1.82	0.4	12	19.6
PC07	0.50 – 1.50	Sandy Clay (Residual)	15.0	1.85	3.1	2.5	13.9

Note: OMC = Optimum Moisture Content, MDD = Maximum Dry Density, CBR = California Bearing Ratio, FMC = Field Moisture Content

4.4.2 ATTERBERG LIMITS

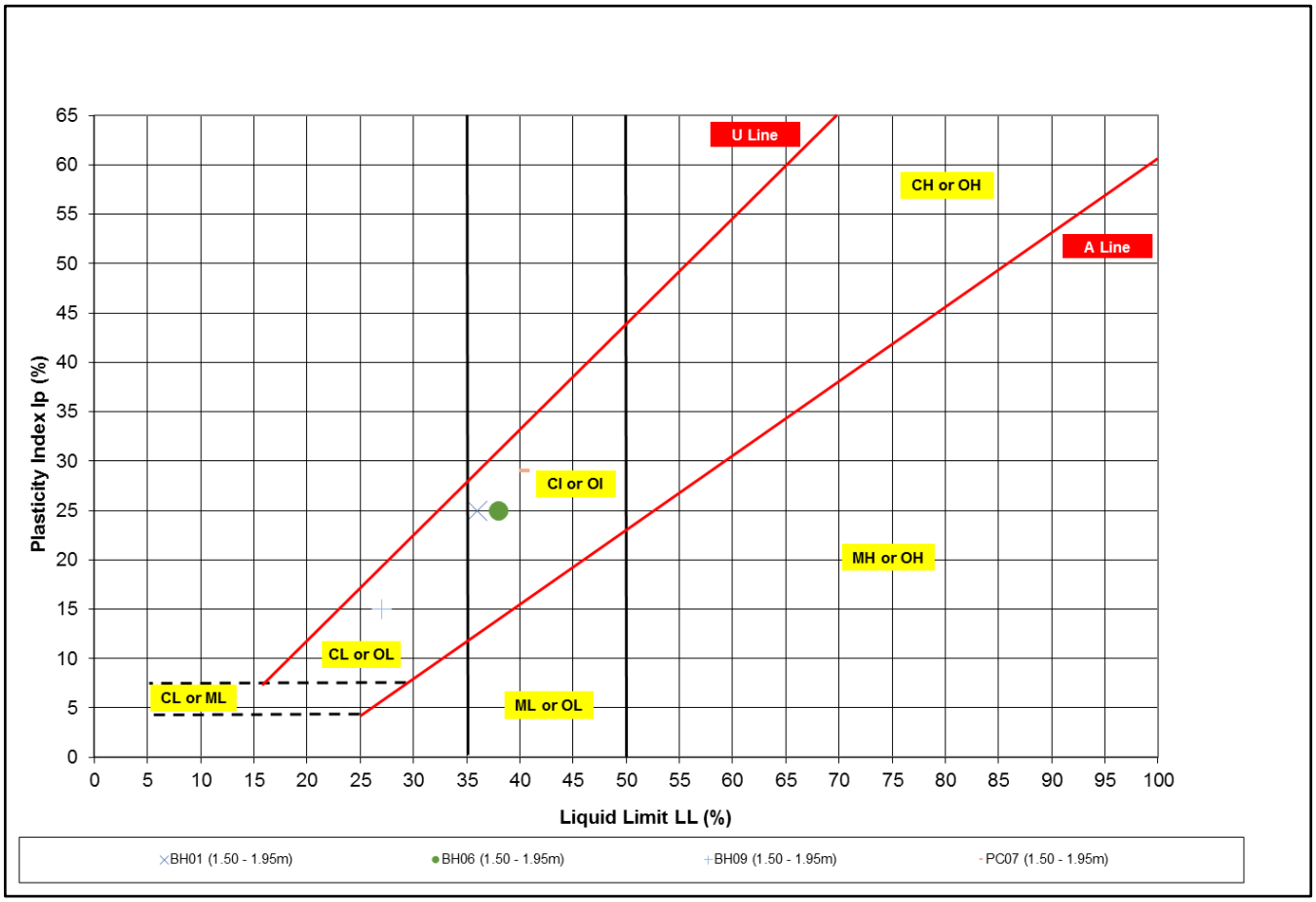
Atterberg limit and linear shrinkage tests were carried out on four selected soil samples to assess the plasticity of the subsurface materials. Results from the Atterberg limit tests are summarised in Table 4.5. The samples tested can be classified as low to medium plasticity as shown in the Casagrande Plot in Figure 1.

Table 4.5 Atterberg Limit Test Results

HOLE ID	SAMPLE DEPTH (m bgl)	MATERIAL TYPE	LL (%)	PL (%)	PI (%)	PLASTICITY	LS (%)
BH01	1.50 – 1.95	Silty Clay (Alluvium)	36	11	25	Medium	8.0
BH06	1.50 – 1.95	Silty Sandy Clay (Alluvium)	38	13	25	Medium	10.5
BH09	1.50 – 1.95	Silty Clay (Alluvium)	27	12	15	Low	6.0
PC07	0.50 – 1.50	Sandy Clay (Residual)	40	11	29	Medium	12.5

Note: LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage

Figure 1 Casagrande Plot



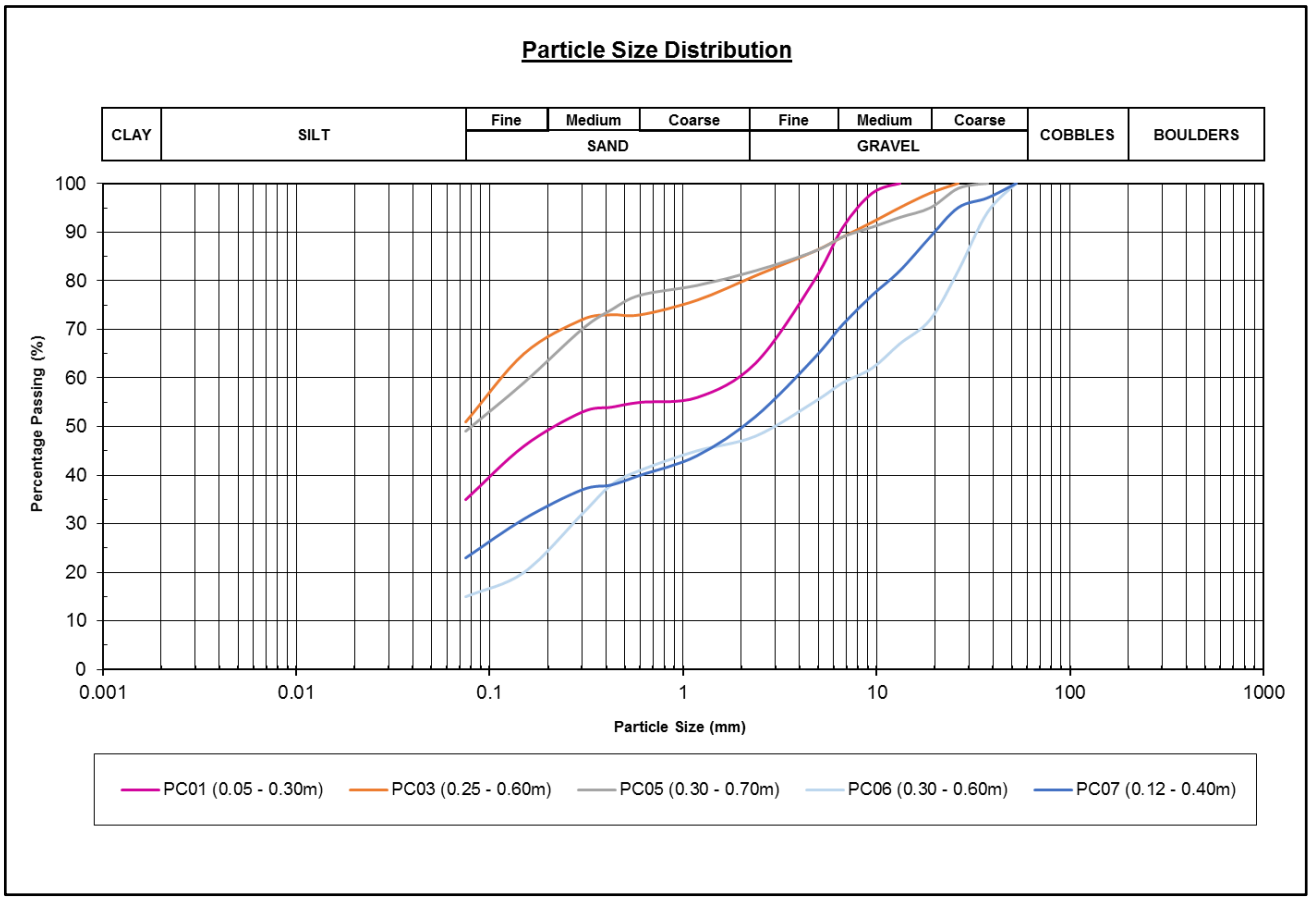
4.4.3 PARTICLE SIZE DISTRIBUTION

Particle size distribution tests were carried out on selected samples to classify the soil and assess the range of particle sizes encountered. Soil classifications based on the particle size distribution tests are summarised in Table 4.6 and graphically presented in Figure 2.

Table 4.6 Particle Size Distribution Test Results

HOLE ID	SAMPLE DEPTH (m bgl)	MATERIAL DESCRIPTION	CLAY / SILT (%)	SAND (%)	GRAVEL (%)
PC01	0.05 – 0.30	Gravelly CLAY with SAND (Fill)	35	28	37
PC03	0.25 – 0.60	Sandy CLAY with gravel (Fill)	51	30	19
PC05	0.30 – 0.70	Sandy CLAY with gravel (Fill)	49	33	18
PC06	0.30 – 0.60	Clayey Sandy GRAVEL (Fill)	15	33	52
PC07	0.12 – 0.40	Clayey Sandy GRAVEL (Fill)	23	29	48

Figure 2 Particle Size Distribution Plot



5 GEOTECHNICAL DISCUSSION

5.1 GEOTECHNICAL UNITS

5.1.1 UNIT 1 - PAVEMENT

Pavement cores were cut from all pavement holes (PC01 to PC07). Photographs of the cores can be found attached to the geotechnical logs in Appendix C. Pavement thicknesses ranged from 0.04 – 0.3m thick and generally comprised flexible asphalt pavement. Pavement thicknesses were thickest along Christie Street, with asphalt in two layers have a combined thickness of 0.3m. The encountered pavement at Lee Holm Road was also in two layers with a thickness of 0.12m. Links Road pavement was generally thin at 0.03m to 0.12m over concrete or lime stabilised / bound fill.

5.1.2 UNIT 2 - FILL

Fill was encountered at all investigation locations other than BH02 and BH07. Fill encountered can be broadly considered in two categories: pavement fill (base coarse) and 'other' fill. Pavement fill was encountered at all investigation locations at which pavement was also encountered except for BH02, where the thin asphalt layer was poured directly on natural residual soils. Pavement fill varied but generally comprised sandy clay, sandy gravel or gravelly sand, and was bound / stabilised along Links Road and Christie Street.

Non-pavement fill was encountered at BH01, BH06 and BH08. Fill encountered at BH01 fill was 0.2m thick and comprised gravelly sand forming an unsealed road surface. Fill material encountered at BH06 (0.3m thick) and BH08 (1.0m thick) generally comprised cohesive material (silty clays and clayey silts). Fill at BH08 was particularly hard and cuttings from the drill auger were unusually shaped as shown in Figure 3.

Figure 3 Drill cuttings returned from fill at BH08, approximate depth of 0.5mbgl. Note unusual corrugated shape.

5.1.3 UNIT 3 - ALLUVIUM

Alluvial soils were encountered at all investigation locations except BH01, BH02, PC06 and PC07 and typically comprised silty clays / sandy clays / sandy silt with of low to medium plasticity and a consistency ranging from firm to very stiff.

5.1.4 UNIT 4 - RESIDUAL SOIL

Residual soils were encountered at investigation locations except BH01, BH02, PC06 and PC07 and typically comprised silty clays and sandy clays of low to high plasticity and a consistency ranging from stiff to very stiff.

5.1.5 UNIT 5 - WEATHERED ROCK

Weathered rock was encountered in boreholes BH01 and inferred within BH02. The recovered weathered rock was visually identified as shale.

5.2 GEOTECHNICAL DESIGN PARAMETERS

A summary of the preliminary geotechnical parameters recommended for geotechnical design are presented in Table 5.1. The design parameters were developed based on interpretation of all field investigation and laboratory test results, consideration of published correlations and engineering judgement. Further geotechnical testing and assessment may be required to verify any design assumptions during detailed design and construction stages.

Table 5.1 Preliminary Geotechnical Design Parameters

GEOTECHNICAL UNIT	CONSISTENCY / STENGTH	UNIT WEIGHT Ɣ (kN/m^3)	UNDRAINED SHEAR STRENGTH (kPa)	EFFECTIVE COHESION c' (kPa)	EFFECTIVE FRICTION ANGLE Φ' (°)
2. Fill / Topsoil	-	18	-	-	-
3. Alluvial	Firm	18	25	2	26
	Stiff	18	50	2	26
	Very Stiff	19	100	3	27
4. Residual	Stiff	18	50	2	26
	Very Stiff	19	100	3	27
5. Rock	Very Low Strength	21	300	10	29

5.3 EARTHWORKS

5.3.1 SITE PREPARATION

Fill / topsoil (inherently unsuitable material) should be stripped and stockpiled for reuse as landscaping (non-engineered) material where appropriate. Additional unsuitable material, potentially not identified during the geotechnical investigation, may include man made waste, perishable materials, other organics and any materials with a California Bearing Ratio (CBR) value less than 1% (CBR < 1). Such materials should be excavated, further stockpiled and /or disposed off-site in general accordance with NSW EPA Waste Classification Guidelines.

Prior to the construction of any structural layers with engineered fill, the natural subgrade should be proof-rolled under supervision of a suitably qualified geotechnical engineer. Any soft spots, saturated or heaving ground should be allowed to dry to optimum moisture content (OMC) or be excavated and replaced with suitable material, compacted in general accordance with the Roads and Maritime Services (RMS) Specification "R44 – Earthworks", where appropriate, and subsequently proof rolled for verification of subgrade performance.

5.3.2 EXCAVATABILITY OF SITE MATERIALS

Excavation of the fill / topsoil, alluvial and residual soils across the site should be practicable using conventional earthmoving plant such as a 14-tonne (or greater) tracked excavator. At greater depths, where weathered rock is encountered and material strength increases, larger excavators fitted with rock teeth or ripping may be required.

It should be recognised that the excavatability assessment is based on subsurface materials encountered at the investigation locations only, and that conditions may prove more difficult (or easier) for excavatability beyond these locations and / or at greater depths. Prior to construction, engaged contractors should be required to examine the engineering logs to make their own assessment of excavation plant and production rates.

5.3.3 REUSE OF SITE WON MATERIALS

Tables 5.2 highlight the suitability of available site won materials for use in road formations, based on the geotechnical laboratory results presented within Section 4 of this report, compared against the materials properties requirements of the RMS QA Earthworks Specification R44. Site won materials would only be suitable for earth fill due to its grading, plasticity and CBR characteristics. Further testing would be required during construction to confirm that "actual use" of site won materials comply with specification requirements.

Table 5.2 Onsite Material Suitability for Road Formation in line with R44

FORMATION MATERIAL	TOPSOIL / FILL	ALLUVIAL	RESIDUAL	ROCK
Upper Zone of Formation	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Select Material Zone				
Rock Fill				
Earth Fill		Suitable	Suitable	Suitable

5.3.4 COMPACTION OF SITE WON MATERIALS

Site won material reused as earth fill should be placed, compacted and tested in general accordance with the RMS Specification "R44" for road formations.

5.4 PAVEMENTS

5.4.1 FOUNDATIONS

Pavement and road foundation design across the site extents is assumed, at this stage, to comply respectively with Austroads (2002) Guide to Pavement Technology Part 2 and RMS Specification "R44 – Earthworks".

Foundation preparation or treatments for embankments should be in accordance with the Specification R44.

5.4.2 DESIGN CBR VALUES

The results of the laboratory testing indicate an average 10 day soaked CBR value of 12%, or tenth percentile CBR value of 5% (if compacted to 100% standard maximum dry density). Assuming adoption of the tenth percentile value allows for variability along the alignment and construction / compaction variability, the testing results indicate that a CBR value of 5% appears to reasonably represent the in-situ alluvial and residual materials expected to be encountered across the site extents. In addition to the CBR value, shrink/swell portential should also be considered. All swell testing results, except from the hole PC07, show a value of <1%.

5.5 SLOPES AND EXCAVATIONS

Cut slopes and excavations across the site extents will encounter existing fill / topsoil, alluvial and residual soils ranging from firm to very stiff clays. The design requirement for any retained or unsupported cut slopes and fill embankments, as part of detailed design, is unknown at this stage. Future slope batters and retaining wall systems should consider the soil/rock profile at specific locations, geotechnical parameters detailed in Table 5.1, local groundwater conditions and relevant Australian Standards and design loads.

Preliminary design recommendations for unsupported temporary (short term) or permanent (long term) cut slopes and fill embankments are presented in Table 5.4.

Table 5.3 Temporary and Permanent Batter Slopes

GEOTECHNICAL UNIT	CONSISTENCY	CUT SLOPE		EMBANKMENT (NOTE 1)	
		PERMANENT	TEMPORARY	PERMANENT	TEMPORARY
2. Fill / topsoil	-	3H: 1V	2H: 1V	N/A	N/A
3. Alluvial	Firm				
	Stiff	2H: 1V	1.5H: 1V	2H: 1V	1.5H: 1V
	Very Stiff				
4. Residual	Stiff				
	Very Stiff				

Note 1. If compacted to RMS Specification R44

At this stage, recommendations are indicative only and should be subject to confirmation by slope stability analyses with actual site conditions. Cut slopes and embankments should be designed to meet the Factor of Safety (FOS) criteria presented in Table 5.5.

Table 5.4 Factor of Safety Criteria for Slope Stability Analysis

FOS FOR CUT SLOPE		FOS FOR EMBANKMENT	
PERMANENT	TEMPORARY	PERMANENT	TEMPORARY
1.5 (minimum)	1.3 (minimum)	1.5 (minimum)	1.3 (minimum)

It is recommended that cut excavation should be inspected by a suitably qualified geotechnical engineer during construction to confirm design assumptions.

Slope batter management should include diversion of surface water run-off, as concentrated surface water flows on the slopes may cause localised softening, leading to erosion and instability of the slope face materials. Additionally, slope batters should be vegetated to protect from surface erosion.

5.6 GEOTECHNICAL DISCUSSION REVISION

The geotechnical information presented within Section 5 of this report will be subject to revision once BH03, BH04 and BH05 are completed and the additional information obtained is reviewed.

6 LIMITATIONS

This report should be read in conjunction with the appended “Limitations of Geotechnical Site Investigation”, in Appendix E which provides important information regarding geotechnical investigations and assessments.

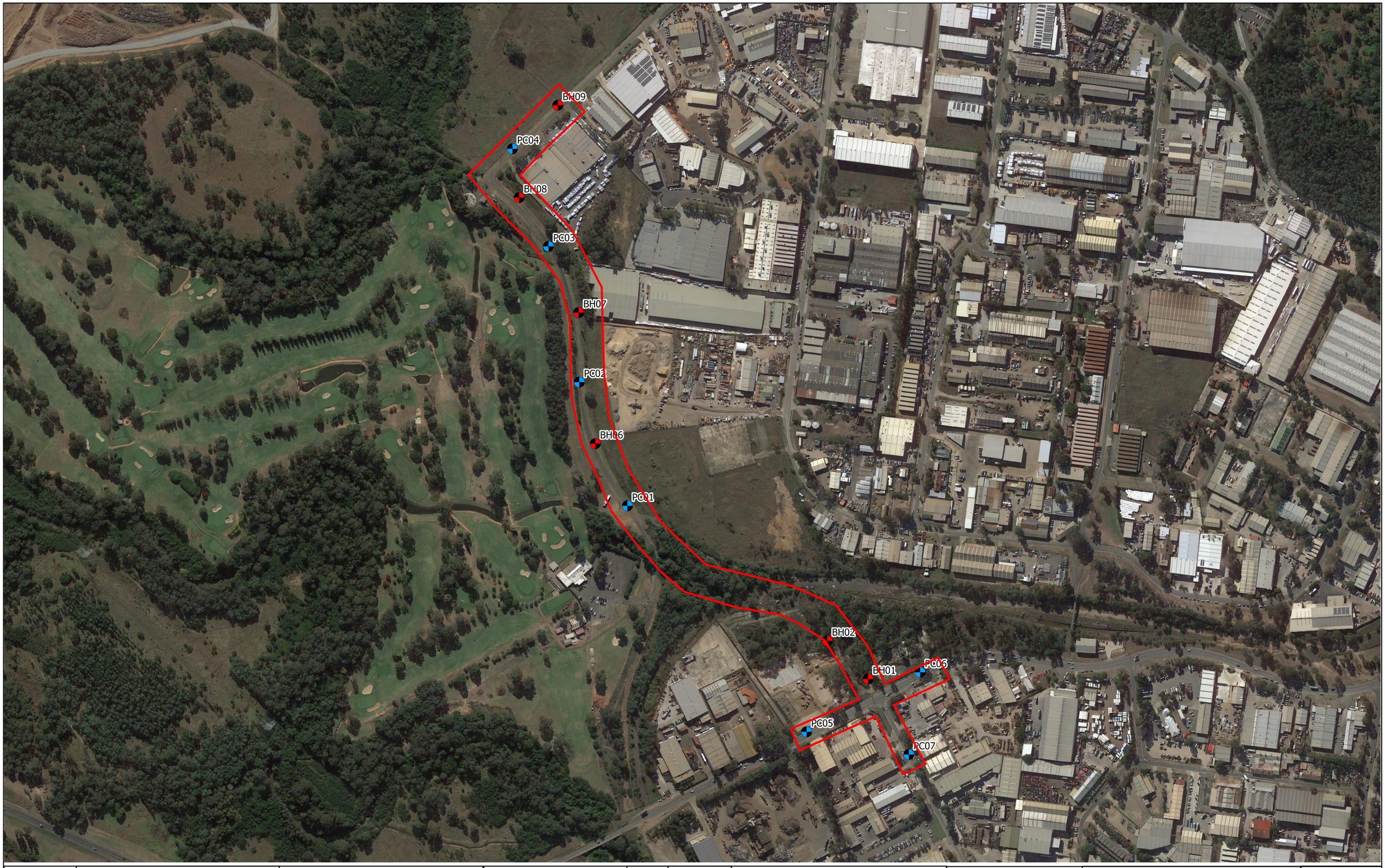
Any changes to the scope of development of this site, or significant variation in subsurface conditions from those anticipated should be reported to WSP for reassessment.

7 REFERENCES

- 1:100,000 Penrith Soil Landscape Series Sheet 9030 (Soil Conservation Series of NSW, 1990);
- 1:100,000 Penrith Geological Series Sheet 9030 (Geological Survey of NSW, 1991);
- Austroads (2002) Guide to Pavement Technology Part 2;
- Roads and Maritime Services, 2014, QA Specification R44: Earthworks, 5TH Ed;
- Standards Australia, 2007, Guidelines for Earthworks for Commercial and Residential Developments, AS3798: 2007;
- Standards Australia, 2009, Methods of Testing Soils for Engineering Purposes, AS1289-2009;
- Standards Australia, 2017, Geotechnical Site Investigations, AS1726-2017.

APPENDIX A

FIGURES



Projection	MGA Zone 56
Datum	AHD
Sources	Google Maps

Scale 1:5,000 @ A4

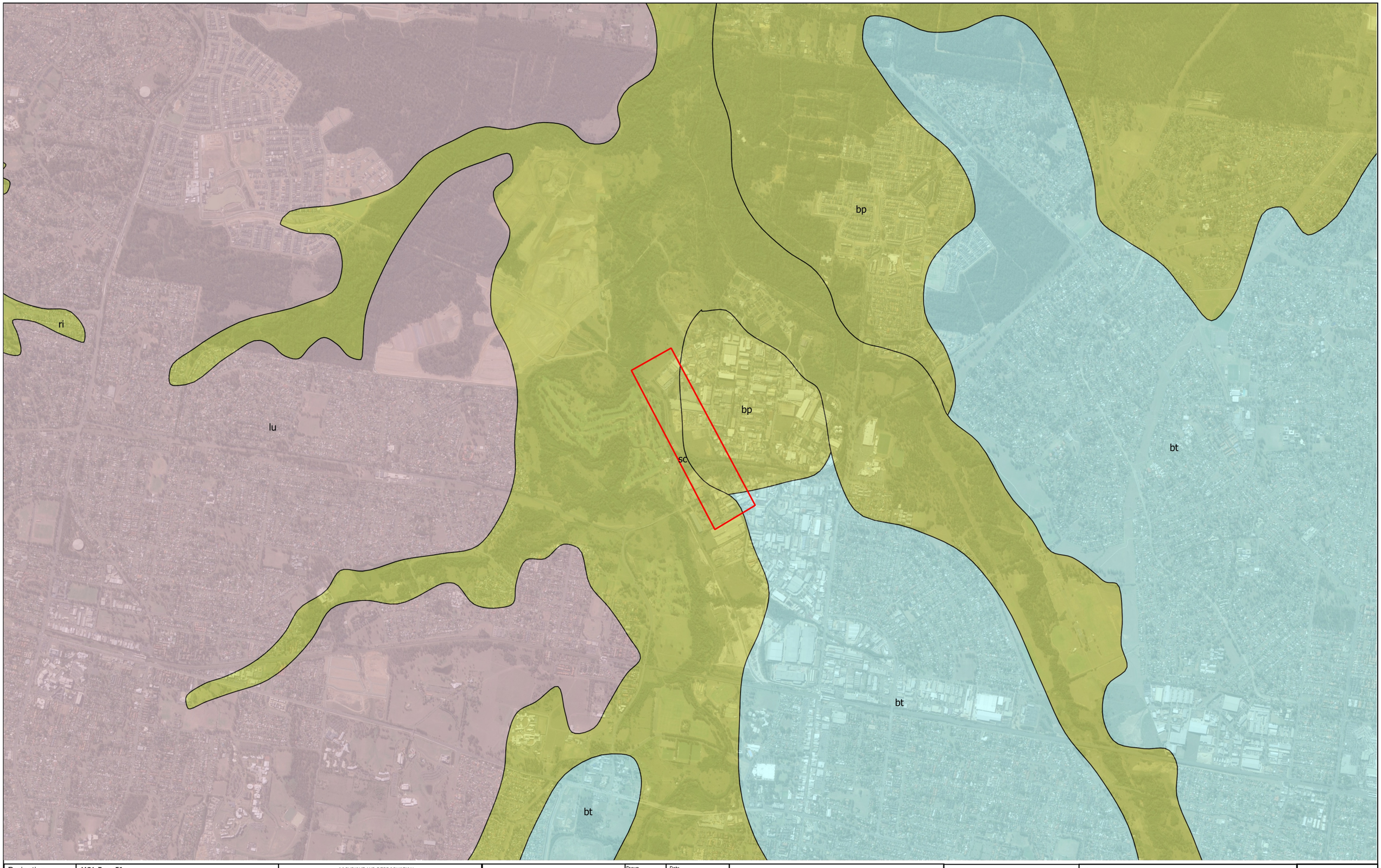
Drawn	GW	Date	31/05/19
Approved	DC	Date	31/05/19

Legend
Investigation Locations
Site Boundary
Boreholes
Pavement Core

wsp

Project
LINKS ROAD EXTENSION
Borehole and Pavement Hole Investigation Plan

Project No.	PS111235
Figure No.	1
Rev	A



Projection	MGA Zone 56	
Datum	AHD	
Sources	Clark, N.R, and Jones, D.C, (Eds), 1991. Penrith 1:100,000 Geological sheet 9030, New South Wales Geological Survey, Sydney	

Scale 1:25,000 @A4

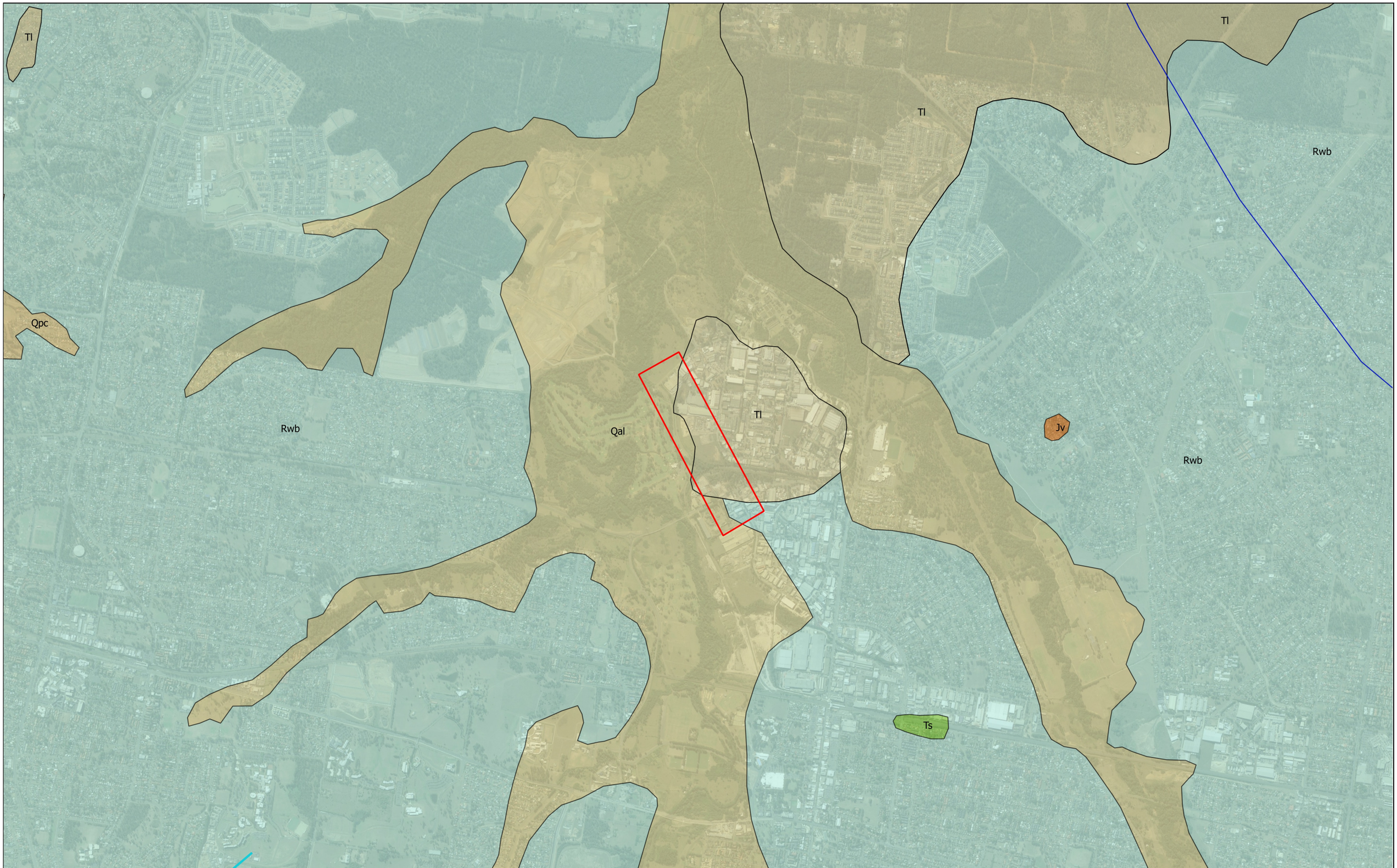
Drawn	GW	Date	31/05/19
Approved	DC	Date	31/05/19

Legend
- Site Boundary

Penrith Soil Landscape
- bt
- bp
- sc

Project
LINKS ROAD EXTENSION
Soil Landscapes

Project No. PS111235
Figure No. 2
Rev A



Projection	MGA Zone 56
Datum	AHD
Sources	Clark, N.R, and Jones, D.C, (Eds), 1991. Penrith 1:100,000 Geological sheet 9030, New South Wales Geological Survey, Sydney

Scale
1:25,000
@ A4

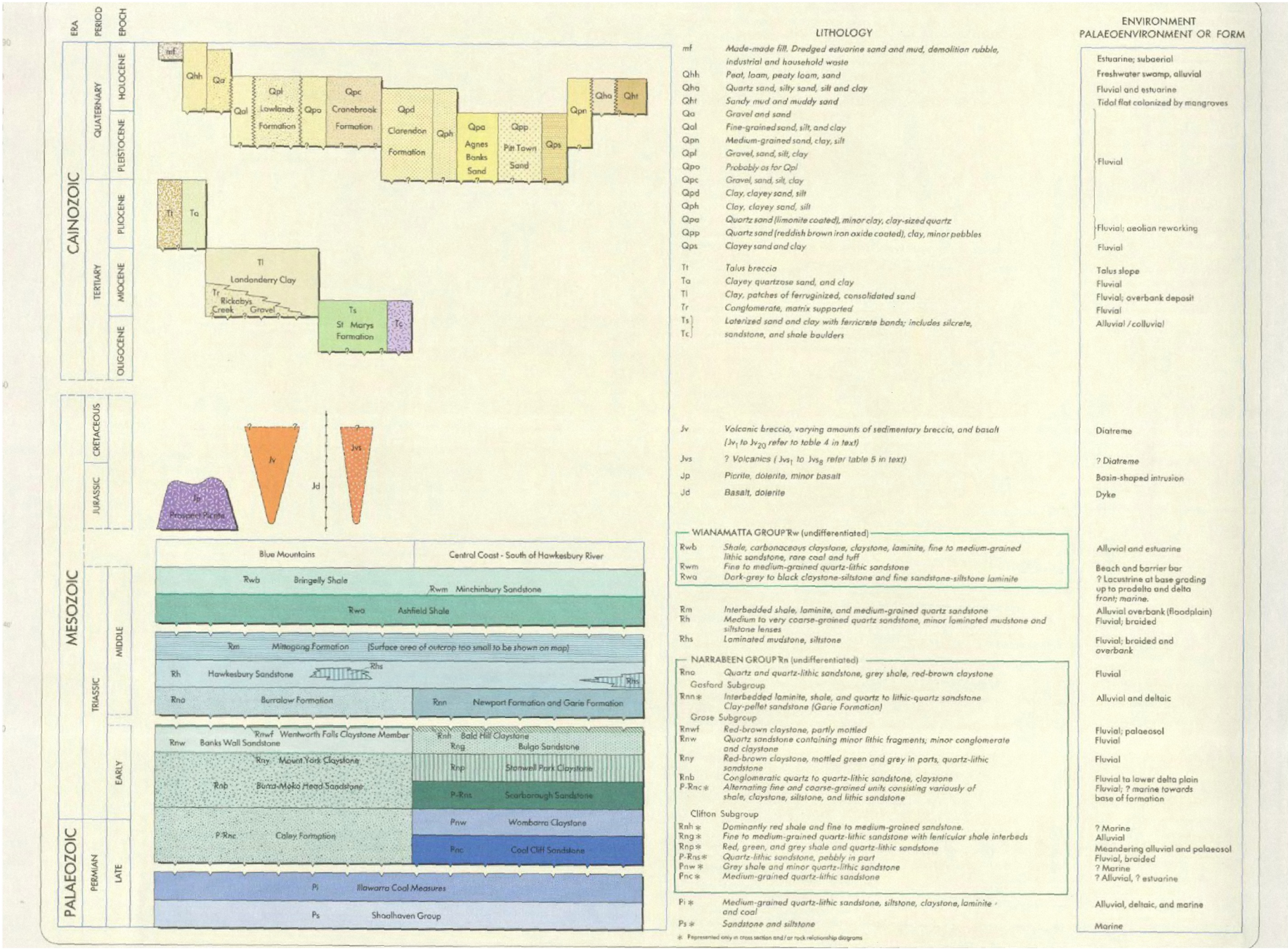
Drawn	GW
Date	31/05/19
Approved	DC
Date	31/05/19

Legend
See Figure 3b for Geological Legend and Stratigraphy
Site Boundary

wsp

Project
LINKS ROAD EXTENSION
Regional Geology

Project No.	PS111235
Figure No.	3a
Rev.	A



Proiection	MGA Zone 56
Datum	AHD
Sources	Clark, N.R, and Jones, D.C, (Eds), 1991. Penrith 1:100,000 Geological sheet 9030, New South Wales Geological Survey, Sydney

Project
LINKS ROAD EXTENSION
Regional Geology

Project No.	
PS111235	
Figure No.	Rev
3b	A

APPENDIX B

BOREHOLE LOGS

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

BH01

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Borehole Location:	**RMS Land**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Comacchio/ Truck**	Hole Angle:	**-90°**	Surface RL:	**23.5 m AHD**
Borehole Diameter:	**125/225 mm**	Bearing:	**---**	Co-ords:	**E 293228 N 6263618 MGA94 56**

Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/TC	Nil	NFGWE	23.5	0.20					FILL: Gravelly SAND (Lightly Bound); fine to coarse grained, grey / pale brown, fine to coarse, well graded, angular to sub-angular gravel.	D			UNSEALED ROAD SURFACE
			23.0	0.5	SPT 6, 9, 11 N=20	B		CI-CH	Silty CLAY; medium to high plasticity, grey and red/ brown, trace fine grained sand, trace fine grained, sub-rounded gravel.	MC<PL		250 - >600	RESIDUAL SOIL
			22.5	1.0									
			22.0	1.5	SPT 5, 9, 10 N=19	SPT						300 - >600	
			21.5	2.0									
			21.0	2.5									
			20.5	3.0	SPT 18, 8, 11 N=19	SPT						>600	
				3.30				CI-CH	Silty Gravelly CLAY; medium to high plasticity, red / brown, fine to coarse grained, angular, iron stained gravel. Becoming inferred extremely low strength, extremely weathered SHALE.				
			20.0	3.5									
			19.5	4.0		D			Colour change to grey and pale brown at 3.8m.				
			19.0	4.5	SPT 8, 20 HB N=R	SPT			SHALE; grey to grey-brown, inferred very low to low strength, highly weathered.				WEATHERED ROCK
									END OF BOREHOLE AT 4.63 m Refusal				

This Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

BH02

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Borehole Location:	**RMS Land**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Comacchio/ Truck**	Hole Angle:	**-90°**	Surface RL:	**24.1 m AHD**
Borehole Diameter:	**125/225 mm**	Bearing:	**---**	Co-ords:	**E 293167 N 6263675 MGA94 56**

Borehole Information							Field Material Description					
METHOD	SUPPORT	WATER	RL (m AHD) / DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD	Nil	NFGWE	0.05 24.0				CI-CH	ASPHALTIC PAVEMENT; maximum aggregate size 25mm, black/ dark grey, angular.	MC<PL			AC PAVEMENT FILL
								Silty Sandy CLAY; medium to high plasticity, red-brown mottled grey, fine grained sand, trace fine to coarse grained, sub-rounded to sub-angular, ironstone and sandstone gravel, trace 100mm sandstone cobbles.				RESIDUAL SOIL
			0.5 23.5	SPT 9, 13, 12 N=25	B						>600	
			0.90 1.0 23.0		D		CL-CI	Silty Sandy CLAY; low to medium plasticity, grey mottled red-brown, fine grained sand.				
			1.5 22.5	SPT 11, 13, 15 N=28	SPT						>600	
			2.0 22.0									
			2.5 21.5									
			3.0 21.0	SPT 7, 15, 23 N=38	SPT			as above, with fine to medium grained, sub-rounded to sub-angular gravel (inferred extremely low strength, extremely weathered, iron stained shale).			>600	
			3.5 20.5									
								END OF BOREHOLE AT 3.80 m Refusal				
			20.0									
			19.5									

This Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

BH06

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Borehole Location:	**Links Road Verge**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Comacchio/ Truck**	Hole Angle:	**-90°**	Surface RL:	**21.0 m AHD**
Borehole Diameter:	**125/225 mm**	Bearing:	**---**	Co-ords:	**E 292820 N 6263970 MGA94 56**

Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/TC	Nil	NFGWE				D			FILL: Sandy Clayey SILT; low plasticity, dark brown, fine grained sand.	MC<PL			TOPSOIL
				0.30									
			20.5	0.5	SPT 4, 5, 8 N=13	B		ML	Sandy Clayey SILT; low plasticity brown / orange, fine grained sand.				ALLUVIAL SOIL
			20.0	1.0 1.0		B		CI-CH	Silty Sandy CLAY; medium to high plasticity, red-brown, fine grained sand.				
			19.5	1.5	SPT 6, 11, 9 N=20	SPT							
			19.0	2.0									
			18.5	2.5 2.5		D		CL-CI	Sandy Silty CLAY; low to medium plasticity, dark brown, fine grained sand.				increase in moisture content observed
			18.0	3.0	SPT 4, 6, 5 N=11	SPT							
			17.5						END OF BOREHOLE AT 3.45 m Target depth				
			17.0										
			16.5										

This Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

BH07

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Borehole Location:	**Links Road Verge**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Comacchio/ Truck**	Hole Angle:	**-90°**	Surface RL:	**21.5 m AHD**
Borehole Diameter:	**125/225 mm**	Bearing:	**---**	Co-ords:	**E 292795 N 6264166 MGA94 56**

Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/TC	Nil	NFGWE	21.0	0.10					TOPSOIL: Silty Clayey SAND; brown.	M			TOPSOIL
				0.5	SPT 3, 2, 3 N=5	B		CL	Silty Sandy CLAY; low plasticity, brown, fine grained sand, trace fine to medium grained gravel. Becoming darker with depth.	MC<PL			ALLUVIAL SOIL
			20.5	1.0									
				1.25				CL-CI	Silty Sandy CLAY; low to medium plasticity, red-brown mottled grey, trace fine grained sand.			160 - 300	
			20.0	1.5	SPT 5, 7, 8 N=15	SPT							
			19.5	2.0									
			19.0	2.5									
				2.60				CI-CH	Silty CLAY; medium to high plasticity, dark brown / grey and red-brown mottles, trace fine grained sand.	MC>PL		140 - 160	RESIDUAL SOIL
			18.5	3.0	SPT 3, 4, 5 N=9	SPT							
			18.0						END OF BOREHOLE AT 3.45 m Target depth				
			17.5										
			17.0										

This Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

BH08

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Borehole Location:	**Links Road Verge (Berm)**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Comacchio/ Truck**	Hole Angle:	**-90°**	Surface RL:	**20.5 m AHD**
Borehole Diameter:	**125/225 mm**	Bearing:	**---**	Co-ords:	**E 292706 N 6264338 MGA94 56**

Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/TC	Nil	NFGWE	20.0	0.5	SPT 8, 8, 11 N=19	D, SPT			FILL: Silty CLAY; medium to high plasticity, red-brown, with fine grained sand.	MC<PL	VS S F St VSt H / FB VL L MD D VD	>600	FILL
			19.5	1.0 / 1.0		B		CI-CH	Silty CLAY; medium to high plasticity, grey with minor red-brown mottles, trace fine grained sand. Sand content increased and more orange with depth.				ALLUVIAL SOIL
			19.0	1.5	SPT 5, 7, 9 N=16	SPT						>600	
			18.5	2.0 / 2.0		D		CL	Silty Sandy CLAY; low plasticity, orange-brown mottled grey, fine grained sand.				
			18.0	2.5									
			17.5	3.0	SPT 4, 3, 5 N=8	SPT						140 - 160	
			17.0						END OF BOREHOLE AT 3.45 m Target depth				
			16.5										
			16.0										

This Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

BH09

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Borehole Location:	**Links Road North**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Comacchio/ Truck**	Hole Angle:	**-90°**	Surface RL:	**21.0 m AHD**
Borehole Diameter:	**125/225 mm**	Bearing:	**---**	Co-ords:	**E 292764 N 6264476 MGA94 56**

Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC / AD/TC	Nil	NFGWE	20.94	0.06					ASPHALTIC PAVEMENT; max aggregate size 70mm, black, angular.				AC PAVEMENT FILL
						D			FILL: Gravelly SAND (Lightly Bound to 0.2mm); fine to medium grained, brown, fine to medium grained, sub-rounded gravel, with clay.	M			FILL
			20.5	0.5		B		CL-CI	Silty CLAY; low to medium plasticity, red-brown mottled brown, with fine grained sand, trace fine to medium grained gravel.	MC<PL			ALLUVIAL SOIL SPT skipped at 0.5m due to underground services potential
			20.0	1.0					As above, becoming light brown.				
			19.5	1.5	SPT 2, 3, 3 N=6	SPT						100 - 110	
			19.0	2.0									
			18.5	2.5				CL-CI	Silty Sandy CLAY, low to medium plasticity, grey mottled light brown, trace fine ironstone gravel.	MC=PL			
									Gravel content increasing with depth.				
			18.0	3.0	SPT 4, 6, 12 N=18	SPT						150 - 180	
			17.64	3.30				CL-CI	Gravelly Silty CLAY; low to medium plasticity, dark brown, fine to medium grained, sub-rounded ironstone gravel.	MC>PL			RESIDUAL SOIL
			17.5	3.5		D			Gravel content increasing with depth.				
			17.0	4.0									
			16.5	4.5	SPT 7, 7, 9 N=16	SPT			END OF BOREHOLE AT 4.95 m Target depth				

This Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

APPENDIX C

PAVEMENT CORE LOGS AND DCPS

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC01

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**20/2/19**
Project:	**Links Road Extension**	Date Completed:	**20/2/19**
Hole Location:	**Links Road**	Recorded By:	**AB**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**20.5 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 292868.05 N 6263876.65 MGA94 56**

Pavement Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE		0.05					ASPHALTIC CONCRETE; maximum aggregate size 15mm, grey, well graded, angular.				AC PAVEMENT FILL
AD/TC						D			FILL: Gravelly CLAY; low plasticity, brown, fine to medium grained gravel, with fine to medium grained sand	D			FILL
				0.40				CL	Sandy CLAY; low plasticity, grey-brown, fine grained sand.	MC<PL			ALLUVIAL SOIL
			20.0	0.5									
						B			As above, pale brown mottled orange.				
			19.5	1.0									
			19.0	1.5					END OF PAVEMENT BOREHOLE AT 1.50 m Target depth				

This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

PointID : PC01 Depth Range: 0.00 - 0.05 m

	TITLE: Lendlease Links Road Extension Core Photo - PC01	DRAWN	DATE: 28/05/2019
		CHECKED	DATE: 28/05/2019
		SCALE: Not To Scale	A4
		PROJECT No: PS111235	FIGURE No: 1/1

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC02

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**20/2/19**
Project:	**Links Road Extension**	Date Completed:	**20/2/19**
Hole Location:	**Links Road**	Recorded By:	**AB**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**21.0 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 292795.95 N 6264062.36 MGA94 56**

Pavement Borehole Information						Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE		0.03					ASPHALTIC CONCRETE (3 LAYERS): 0 - 0.03m: maximum aggregate size 15mm, grey, well graded, angular. 0.03 - 0.18m: maximum aggregate size 20mm, pale grey/orange, poorly graded, sub-angular to sub-rounded ironstone gravel 0.18 - 0.23m: as above, maximum aggregate size 15mm, grey/brown				AC PAVEMENT FILL FILL
AD/TC				0.23					FILL; CEMENT BOUND SOIL (2 LAYERS): 0.03 - 0.18mm: medium to coarse grained, pale grey/orange, poorly graded, sub-angular to sub-rounded ironstone gravel. 0.18-0.23m: as above, medium grained, grey/brown.	D			
			20.5	0.5					FILL: Sandy GRAVEL; fine to medium grained, brown, sub-angular, fine to medium grained sand, with low plasticity fines.				
				0.60				CL	Sandy CLAY; low plasticity, pale brown/ orange, fine grained sand.	MC<PL			ALLUVIAL SOIL
			20.0	1.0		B							
			19.5	1.5					END OF PAVEMENT BOREHOLE AT 1.50 m Target depth				

This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

PointID : PC02 Depth Range: 0.00 - 0.23 m

	TITLE Lendlease Links Road Extension Core Photo - PC02	DRAWN	DATE 28/05/2019
		CHECKED	DATE 28/05/2019
		SCALE Not To Scale	A4
		PROJECT No PS111235	FIGURE No 1/1

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC03

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Hole Location:	**Links Road**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**21.0 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 292750 N 6264265 MGA94 56**

Pavement Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE		0.04					ASPHALTIC CONCRETE; maximum aggregate size 18mm, black.				AC PAVEMENT FILL
									FILL: CEMENT BOUND SOIL (2 LAYERS): 0.04 - 0.13m: Gravelly SAND; medium to coarse grained, brown, medium to coarse grained, sub-rounded, iron stained gravel. 0.13 - 0.25m: as above, 50mm irregular shaped cobbles.				FILL
AD/TC				0.25		D			FILL: Sandy CLAY; low to medium plasticity, brown, fine to medium grained sand, with fine to medium grained, angular to sub-angular gravel.	M			
			20.5	0.5									
				0.60				CL-CI	Sandy Silty CLAY; low to medium plasticity, brown mottled yellow-brown, fine grained sand	MC<PL			ALLUVIAL SOIL
			20.0	1.0		B							
			19.5	1.5					END OF PAVEMENT BOREHOLE AT 1.50 m Target depth				

This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

PointID : PC03 Depth Range: 0.00 - 0.25 m

	TITLE: Lendlease Links Road Extension Core Photo - PC03	DRAWN	DATE: 28/05/2019
		CHECKED	DATE: 28/05/2019
		SCALE: Not To Scale	A4
		PROJECT No: PS111235	FIGURE No: 1/1

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC04

SHEET : 1 OF 1

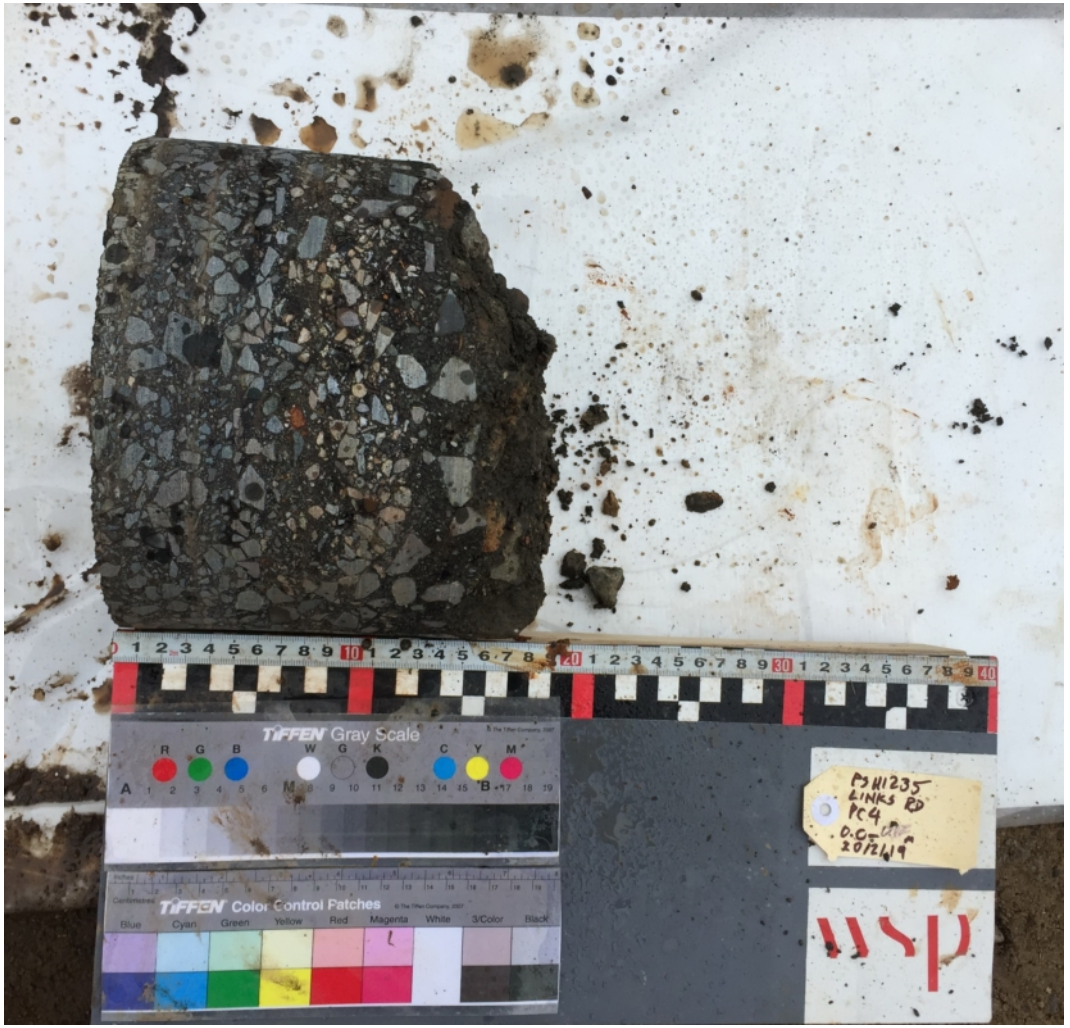
Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Hole Location:	**Links Road**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**21.0 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 292696 N 6264411 MGA94 56**

Pavement Borehole Information | **Field Material Description**

METHOD	SUPPORT	WATER	RL (m AHD)	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE		0.12					ASPHALTIC CONCRETE (2 LAYERS): 0 - 0.05m: maximum aggregate size 20mm, black. 0.05 - 0.12m: as above, lighter colour, more fine aggregates.	D			AC PAVEMENT FILL
HA						D			FILL: Bound Gravelly SAND; medium to coarse grained, dark grey, medium to coarse, black, angular gravel.				FILL
				0.25 0.27		D			FILL: Gravelly SAND; medium to coarse grained, dark brown / black fine to coarse grained, angular gravel.				0.27 - 0.28mm: Bedding Sand
									FILL: SAND (Bedding Sand); medium grained, white. END OF PAVEMENT BOREHOLE AT 0.28 m Services present				
			20.5										
			20.0										
			19.5										

This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.



PointID : PC04 Depth Range: 0.00 - 0.17 m

	TITLE: Lendlease Links Road Extension Core Photo - PC04	DRAWN	DATE 28/05/2019
		CHECKED	DATE 28/05/2019
		SCALE Not To Scale	A4
		PROJECT No PS111235	FIGURE No 1/1

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC05

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**20/2/19**
Project:	**Links Road Extension**	Date Completed:	**20/2/19**
Hole Location:	**Christie Street**	Recorded By:	**AB**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**22.0 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 293136.43 N 6263539.03 MGA94 56**

Pavement Borehole Information						Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD) / DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE						ASPHALTIC CONCRETE (2 LAYERS): 0 - 0.07m: maximum aggregate size 10mm, grey, well graded, angular. 0.07 - 0.3m: as above, maximum aggregate size 40mm.				AC PAVEMENT FILL
AD/TC	Nil		0.30 21.5 0.5		D			FILL: Sandy CLAY (Bound); low plasticity, brown / grey fine to medium grained sand, with fine to medium grained, sub-angular gravel, trace sandstone cobbles, with geotextile layer.	MC<PL			FILL
			0.70				CL	Sandy CLAY; low plasticity, grey, fine grained sand				RESIDUAL SOIL
			21.0 1.0		B			as above, pale brown mottled orange.				
			20.5 1.5					END OF PAVEMENT BOREHOLE AT 1.50 m Target depth				

This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

PointID : PC05 Depth Range: 0.00 - 0.30 m

	TITLE: Lendlease Links Road Extension Core Photo - PC05	DRAWN	DATE: 28/05/2019
		CHECKED	DATE: 28/05/2019
		SCALE: Not To Scale	A4
		PROJECT No: PS111235	FIGURE No: 1/1

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC06

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**20/2/19**
Project:	**Links Road Extension**	Date Completed:	**20/2/19**
Hole Location:	**Christie Street**	Recorded By:	**AB**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**24.2 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 293306.2 N 6263628.64 MGA94 56**

Pavement Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD) / DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE	24.0 / 0.30					ASPHALTIC CONRETE (2 LAYERS): 0 - 0.07m: maximum aggregate size 10mm, grey, well graded, angular. 0.07 - 0.3m: as above, maximum aggregate size 40mm.				AC PAVEMENT FILL
AD/TC			0.5 / 23.5		D			FILL: Clayey Sandy GRAVEL (Lightly Bound); fine to coarse grained, pale brown, sub-angular, medium to coarse grained sand, with low plasticity fines, trace sandstone cobbles.	D			FILL
			1.0 / 23.0		B		CL	Sandy CLAY; low plasticity, grey, fine grained sand. as above, pale brown mottled orange.	MC<PL			RESIDUAL SOIL
			1.5 / 22.5					END OF PAVEMENT BOREHOLE AT 1.50 m Target depth				

This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

PointID : PC06 Depth Range: 0.00 - 0.30 m

	TITLE Lendlease Links Road Extension Core Photo - PC06	DRAWN	DATE 28/05/2019
		CHECKED	DATE 28/05/2019
		SCALE Not To Scale	A4
		PROJECT No PS111235	FIGURE No 1/1

PAVEMENT CORE ENGINEERING LOG

PAVEMENT BOREHOLE NO.

PC07

SHEET : 1 OF 1

Client:	**Lendlease**	Date Commenced:	**21/2/19**
Project:	**Links Road Extension**	Date Completed:	**21/2/19**
Hole Location:	**Lee Holms Road**	Recorded By:	**DW**
Project Number:	**PS111235**	Log Checked By:	**DC**

Drill Model/Mounting:	**Truck Mounted 4x4/ Truck**	Hole Angle:	**-90°**	Surface RL:	**23.4 m AHD**
Borehole Diameter:	**180 mm**	Bearing:	**---**	Co-ords:	**E 293289 N 6263505 MGA94 56**

Pavement Borehole Information							Field Material Description						
METHOD	SUPPORT	WATER	RL (m AHD) / DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	POCKET PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
CC	Nil	NFGWE	0.12					ASPHALTIC CONCRETE (2 LAYERS): 0.0 - 0.05m: maximum aggregate size 15mm. 0.05 - 0.12m: maximum aggregate size 35mm.				AC PAVEMENT FILL
AD					D			FILL: Clayey Sandy GRAVEL; fine to coarse grained, sub-angular (slag or conglomerate), brown, fine to coarse grained sand, low plasticity fines.	M			FILL
			23.0 0.40				CI-CH	Sandy CLAY; medium to high plasticity, grey mottled brown, fine to medium grained sand, trace fine to medium grained gravel.	MC<PL			RESIDUAL SOIL
			0.5									
			22.5									
			1.0		B							
			22.0									
			1.5					END OF PAVEMENT BOREHOLE AT 1.50 m Target depth				
			21.5									

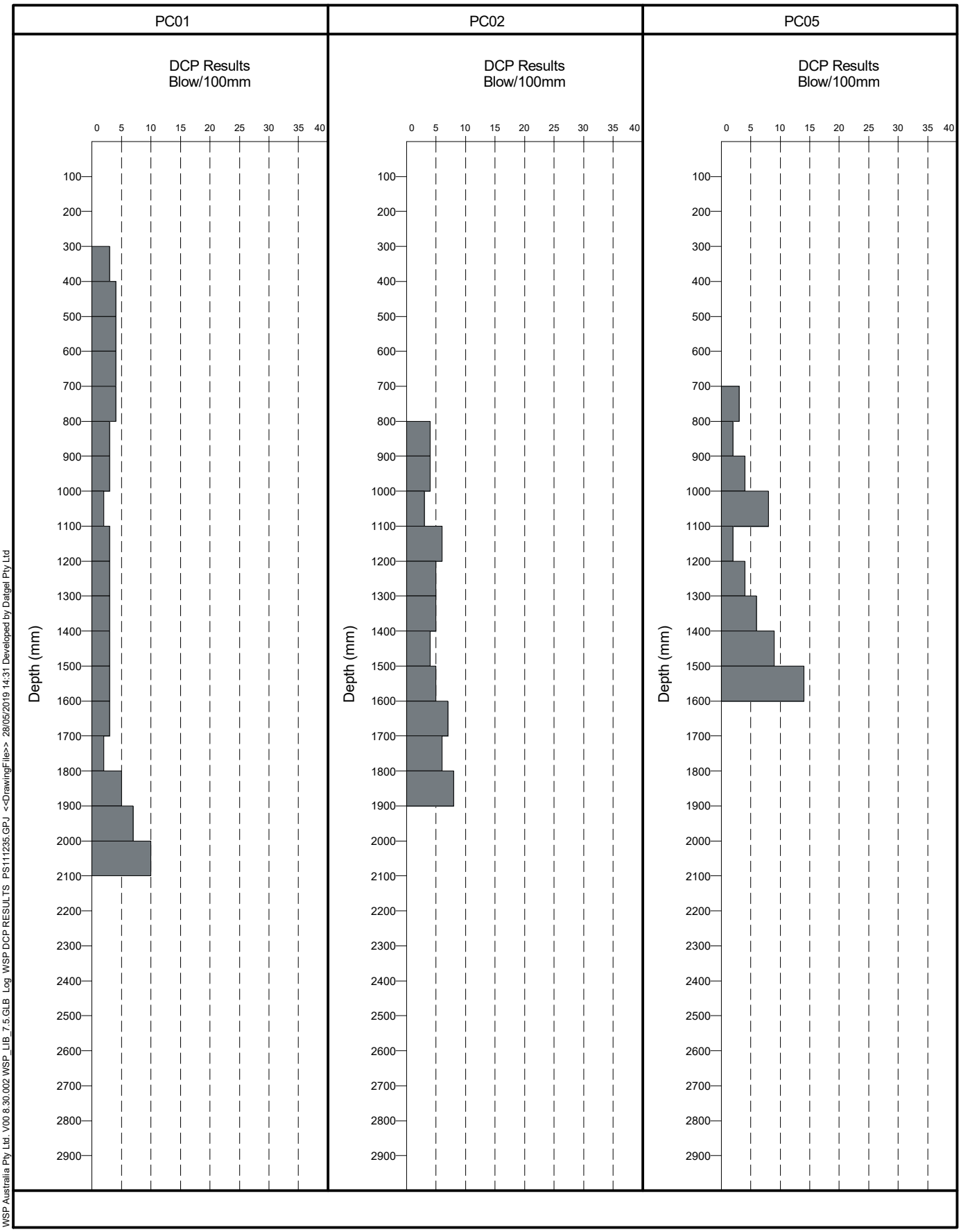
This Pavement Borehole log should be read in conjunction with WSP's accompanying explanatory notes.

PointID : PC07 Depth Range: 0.00 - 0.12 m

	TITLE: Lendlease Links Road Extension Core Photo - PC07	DRAWN	DATE: 28/05/2019
		CHECKED	DATE: 28/05/2019
		SCALE: Not To Scale	A4
		PROJECT No: PS111235	FIGURE No: 1/1

Dynamic Cone Penetrometer Test Results

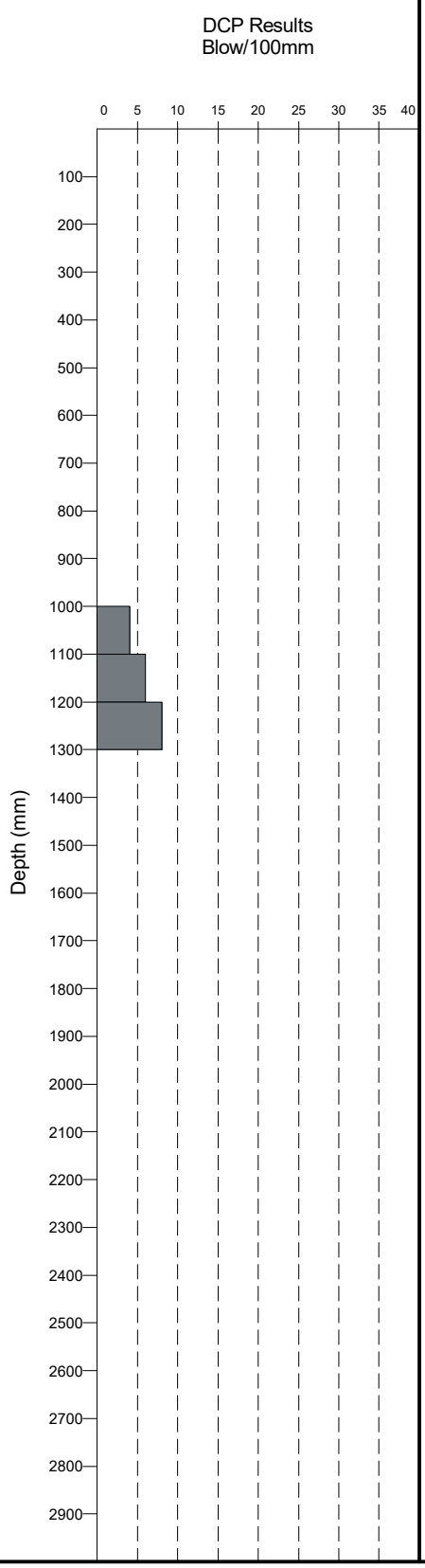
Client:	**Lendlease**	Date Commenced:	**20/2/19**
Project:	**Links Road Extension**		
Location:	**Links Road**	Recorded By:	**AB**
Project Number:	**PS111235**	Checked By:	**DC**



Dynamic Cone Penetrometer Test Results

Client:	**Lendlease**	Date Commenced:	**20/2/19**
Project:	**Links Road Extension**		
Location:	**Christie Street**	Recorded By:	**AB**
Project Number:	**PS111235**	Checked By:	**DC**

PC06



APPENDIX D

LABORATORY CERTIFICATES

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | Fax: (02) 9674 7755 | Email: info@resourcelab.com.au

Test Report

Customer: WSP Australia Pty Limited
Project: PS111235
Location: Links Road, St Marys

Job number: 19-0014
Report number: 1
Page: 1 of 1

Moisture Content

Sampling method: Tested as received

Test method(s): RMS T105, T120

	Results				
Laboratory sample no.	18082	18084	18086	18089	18093
Customer sample no.	PC1 0.40-1.50m	PC3 0.60-2.50m	PC5 0.70-1.50m	PC7 0.50-1.50m	BH7 0.10-0.90m
Date sampled	19/02/2019	20/02/2019	19/02/2019	20/02/2019	21/02/2019
Material description	clayey SILT, trace of sand, brown mottled dark grey/red	clayey SILT, with sand, trace of gravel, pale brown mottled yellow-brown/ grey	silty CLAY, trace of sand and gravel, mottled brown/grey/ red	silty CLAY, with sand, trace of gravel, mottled grey/brown/red	clayey SILT, with sand, trace of gravel, brown mottled red/pale brown
Moisture content (%)	19.9	13.7	19.6	13.9	10.6

Laboratory sample no.	18094				
Customer sample no.	BH9 0.50-0.90m				
Date sampled	21/02/2019				
Material description	sandy silty CLAY, trace of gravel, brown mottled red/pale brown				
Moisture content (%)	13.9				

Approved Signatory: [redacted] E. Maldonado **Date:** 26/03/2019

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Accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: **17062**

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | Fax: (02) 9674 7755 | Email: info@resourcelab.com.au

Test Report

Customer: WSP Australia Pty Limited
Job number: 19-0014
Project: PS111235
Report number: 2
Location: Links Road, St Marys
Page: 1 of 1

Particle Size Distribution

Sampling method: Tested as received
Test method(s): AS 1289.1.1, 3.6.1

	Results				
Laboratory sample no.	18081	18083	18085	18087	18088
Customer sample no.	PC1 0.05-0.30m	PC3 0.25-0.60m	PC5 0.30-0.70m	PC6 0.30-0.60m	PC7 0.12-0.40m
Date sampled	19/02/2019	20/02/2019	19/02/2019	19/02/2019	20/02/2019
Material description	silty clayey GRAVEL, with sand, dark brown	clayey SILT, with sand and gravel, brown	sandy silty CLAY, with gravel, mottled grey/ brown/red	sandy GRAVEL, with clay and silt, brown	clayey GRAVEL, with sand and silt, red-brown
% Passing AS Sieve					
75.0mm					
63.0mm					
53.0mm				100	100
37.5mm			100	94	97
26.5mm		100	99	82	95
19.0mm		98	95	72	89
13.2mm	100	95	93	67	82
9.5mm	98	92	91	62	77
6.7mm	91	89	89	59	71
4.75mm	80	86	86	55	64
2.36mm	63	81	82	48	52
1.18mm	56	76	79	45	44
600µm	55	73	77	41	40
425µm	54	73	74	38	38
300µm	53	72	70	32	37
150µm	46	65	59	20	31
75µm	35	51	49	15	23

Approved Signatory: [redacted] E. Maldonado **Date:** 26/03/2019

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Test Report

Customer: WSP Australia Pty Limited
Project: PS111235
Location: Links Road, St Marys

Job number: 19-0014
Report number: 3

Soil Index Properties

Sampling method: Tested as received

Test method(s): RMS T105, T108, T109, T113

	Results				
Laboratory sample no.	18089	18091	18092	18095	
Customer sample no.	PC7 0.50-1.50m	BH1 1.50-1.95m	BH6 1.50-1.95m	BH9 1.50-1.95m	
Date sampled	20/02/2019	21/02/2019	21/02/2019	21/02/2019	
Material description	silty CLAY, with sand, trace of gravel, mottled grey/brown/red	silty CLAY, with sand, trace of gravel, grey mottled red/brown	silty CLAY, trace of sand, red-brown mottled brown/ grey/dark grey	clayey SILT, trace of sand and gravel, mottled brown/grey	
Liquid limit (%)	40	36	38	27	
Plastic limit (%)	11	11	13	12	
Plasticity index (%)	29	25	25	15	
Linear shrinkage (%)	12.5	8.0	10.5	6.0	
Cracking / Curling / Crumbling	Curling	Curling	Curling	Cracking	
Sample history	Air dried	Air dried	Air dried	Air dried	
Preparation	Dry sieved	Dry sieved	Dry sieved	Dry sieved	

Approved Signatory: [redacted] E. Maldonado **Date:** 26/03/2019

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Test Report

Customer: WSP Australia Pty Limited
Job number: 19-0014
Project: PS111235
Report number: 4
Location: Links Road, St Marys
Page: 1 of 2

California Bearing Ratio

Sampling method: Tested as received
Test method(s): RMS T105, T111, T117, T120

	Results			
Laboratory sample no.	18082	18084	18086	18089
Customer sample no.	PC1 0.40-1.50m	PC3 0.60-2.50m	PC5 0.70-1.50m	PC7 0.50-1.50m
Date sampled	19/02/2019	20/02/2019	19/02/2019	20/02/2019
Material description	clayey SILT, trace of sand, brown mottled dark grey/red	clayey SILT, with sand, trace of gravel, pale brown mottled yellow-brown/grey	silty CLAY, trace of sand and gravel, mottled brown/grey/ red	silty CLAY, with sand, trace of gravel, mottled grey/brown/red
Maximum dry density (t/m^3)	1.86	1.85	1.82	1.85
Optimum moisture content (%)	13.8	14.3	15.8	15.0
Field moisture content (%)	19.9	13.7	19.6	13.9
Oversize retained on 19.0mm sieve (%)	0	0	0	1
Dry density before soak (t/m^3)	1.86	1.86	1.82	1.85
Dry density after soak (t/m^3)	1.86	1.84	1.81	1.80
Moisture content before soak (%)	13.6	14.0	15.4	14.6
Moisture content after soak (%)	15.2	16.6	17.2	17.5
Moisture content after test - top 30mm (%)	15.7	17.3	17.4	19.4
Moisture content after test - full depth (%)	15.1	15.8	17.0	17.1
Density ratio before soaking (%)	100	100	100	100
Moisture ratio before soaking (%)	99	98	98	98
Period of soaking (days)	10	10	10	10
Compactive effort	Standard	Standard	Standard	Standard
Mass of surcharge applied (kg)	4.5	4.5	4.5	4.5
Swell after soaking (%)	0.1	0.8	0.4	3.1
Penetration (mm)	5.0	2.5	2.5	5.0
CBR Value (%)	**16**	**11**	**12**	**2.5**

Notes: Specified LDR: 100 ±1%, LMR: 100% -3%/+2%.

Approved Signatory: [redacted] E. Maldonado **Date:** 26/03/2019

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NATA Accredited Laboratory Number: **17062**

resource laboratories
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ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | Fax: (02) 9674 7755 | Email: info@resourcelab.com.au

Test Report

Customer: WSP Australia Pty Limited
Job number: 19-0014
Project: PS111235
Report number: 4
Location: Links Road, St Marys

California Bearing Ratio

Sampling method: Tested as received
Test method(s): RMS T105, T111, T117, T120

	Results			
Laboratory sample no.	18093	18094		
Customer sample no.	BH7 0.10-0.90m	BH9 0.50-0.90m		
Date sampled	21/02/2019	21/02/2019		
Material description	clayey SILT, with sand, trace of gravel, brown mottled red/pale brown	sandy silty CLAY, trace of gravel, brown mottled red/pale brown		
Maximum dry density (t/m^3)	1.86	1.91		
Optimum moisture content (%)	13.4	13.9		
Field moisture content (%)	10.6	13.9		
Oversize retained on 19.0mm sieve (%)	0	1		
Dry density before soak (t/m^3)	1.86	1.92		
Dry density after soak (t/m^3)	1.85	1.91		
Moisture content before soak (%)	13.2	13.5		
Moisture content after soak (%)	15.2	15.1		
Moisture content after test - top 30mm (%)	15.2	15.3		
Moisture content after test - full depth (%)	14.9	15.0		
Density ratio before soaking (%)	100	100		
Moisture ratio before soaking (%)	99	97		
Period of soaking (days)	10	10		
Compactive effort	Standard	Standard		
Mass of surcharge applied (kg)	4.5	4.5		
Swell after soaking (%)	0.4	0.4		
Penetration (mm)	5.0	2.5		
CBR Value (%)	**20**	**8**		

Notes: Specified LDR: 100 ±1%, LMR: 100% -3%/+2%.

Approved Signatory: [redacted] E. Maldonado **Date:** 26/03/2019

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NATA Accredited Laboratory Number: **17062**

APPENDIX E

LIMITATIONS

Limitation Statement: Geotechnical Site Investigation

SCOPE OF SERVICES

This geotechnical site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

GEOTECHNICAL INVESTIGATION

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. This report was prepared expressly for the client and expressly for purposes indicated by the client or his representative. Use by any other persons for any purpose, or by the client for a different purpose, might result in problems. The client should not use this report for other than its intended purpose without seeking additional geotechnical advice.

THIS GEOTECHNICAL REPORT IS BASED ON PROJECT-SPECIFIC FACTORS

This geotechnical engineering report is based on a subsurface investigation which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas. Unless further geotechnical advice is obtained this geotechnical engineering report cannot be used:

- when the nature of any proposed development is changed
- when the size, configuration location or orientation of any proposed development is modified.

This geotechnical engineering report cannot be applied to an adjacent site.

THE LIMITATIONS OF SITE INVESTIGATION

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations; however this often does not result in any overall cost savings for the project. The investigation program undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation program and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation, and can not always be definitive. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected than borehole investigation, however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

Limitation Statement: Geotechnical Site Investigation

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical engineering report is based on conditions which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events, and should be consulted to determine if additional tests are necessary.

AVOID MISINTERPRETATION

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

BORE/PROFILE LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be made to 'Guidelines for the Provision of Geotechnical Information in Construction Contracts' published by the Institution of Engineers Australia, National Headquarters, Canberra 1987.

GEOTECHNICAL INVOLVEMENT DURING CONSTRUCTION

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problems if they arise.

REPORT FOR BENEFIT OF CLIENT

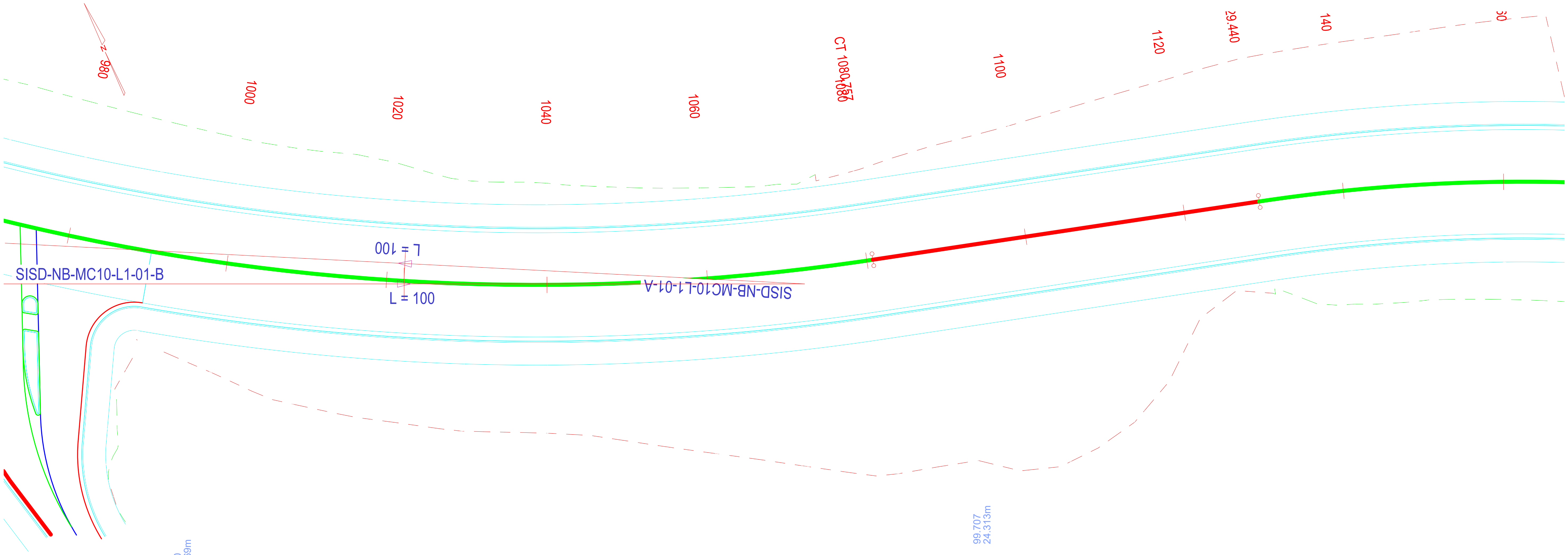
The report has been prepared for the benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

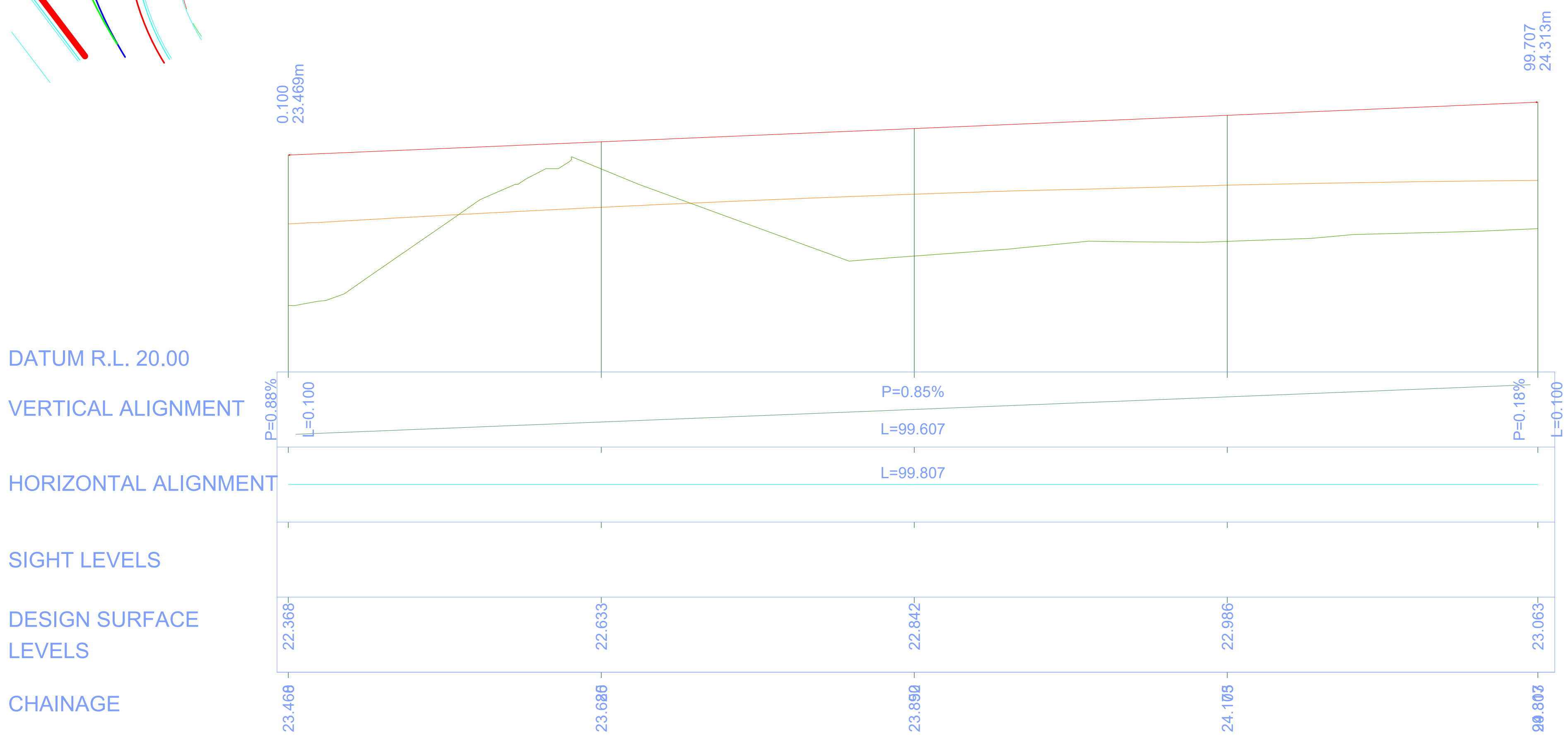
OTHER LIMITATIONS

WSP will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

APPENDIX J

SIGHT DISTANCE CHECKS





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CLIENT	NSW GOVERNMENT Transport Roads & Maritime Services
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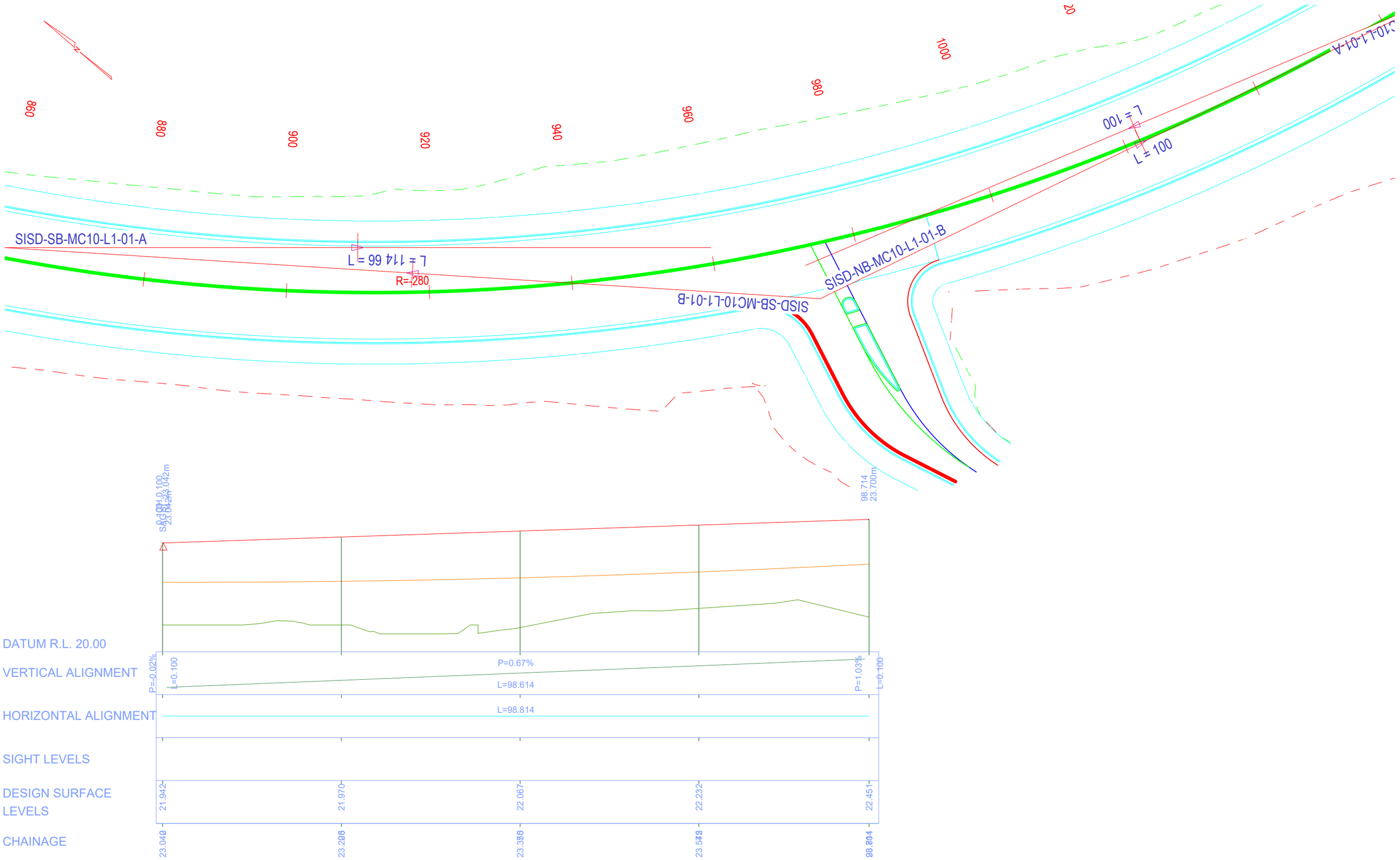

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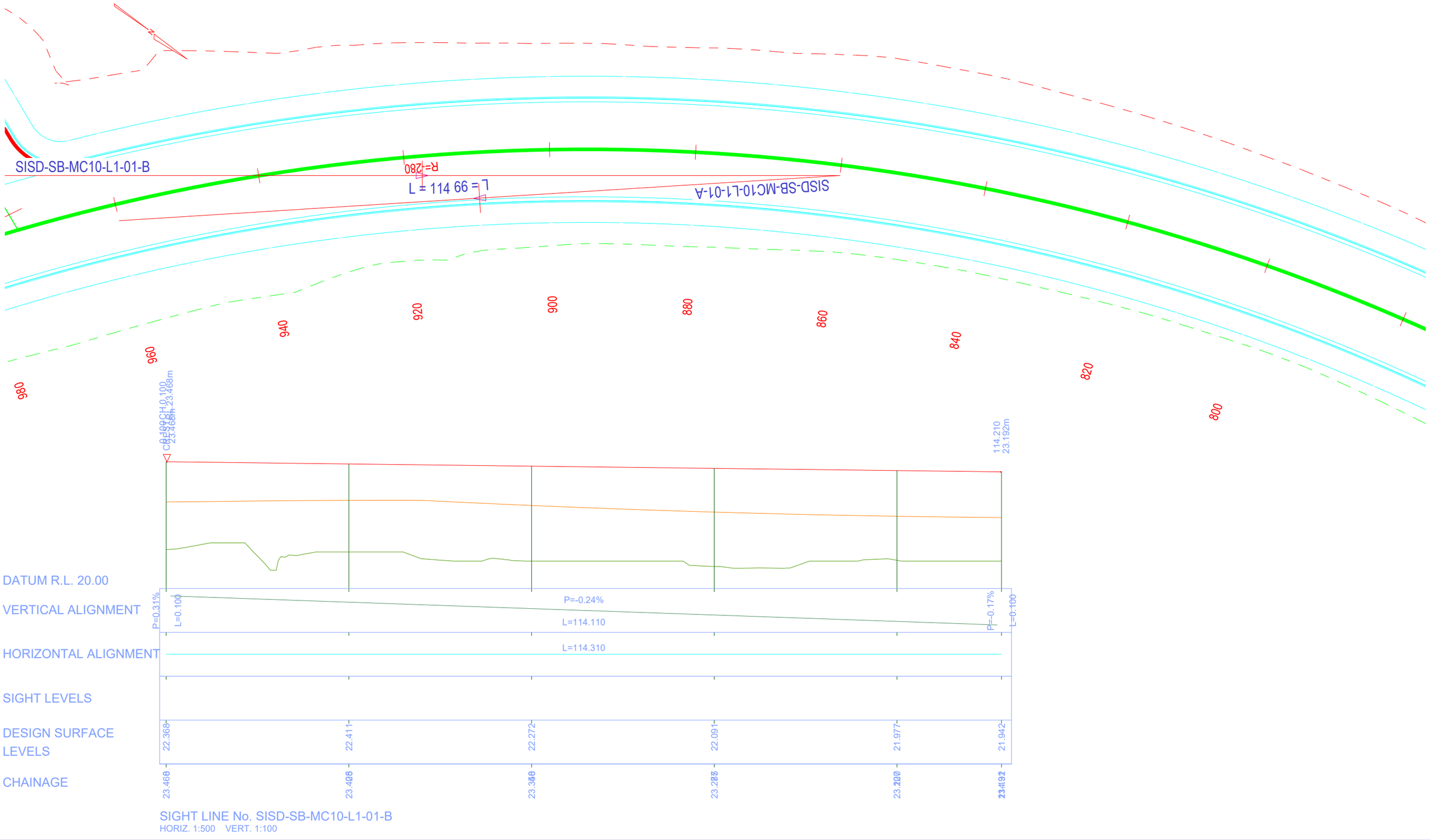

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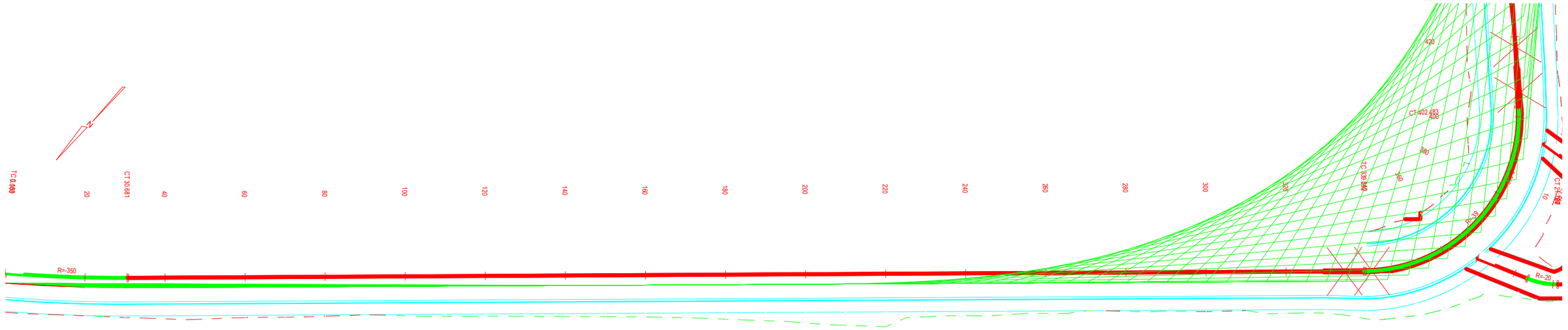

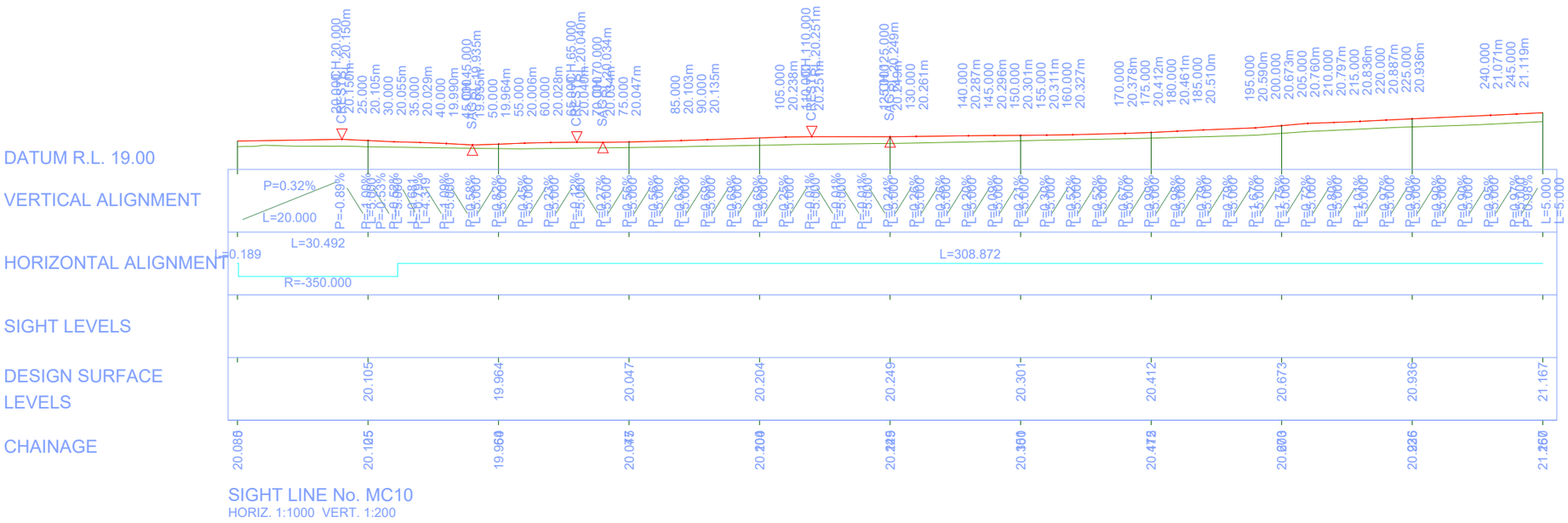

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CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

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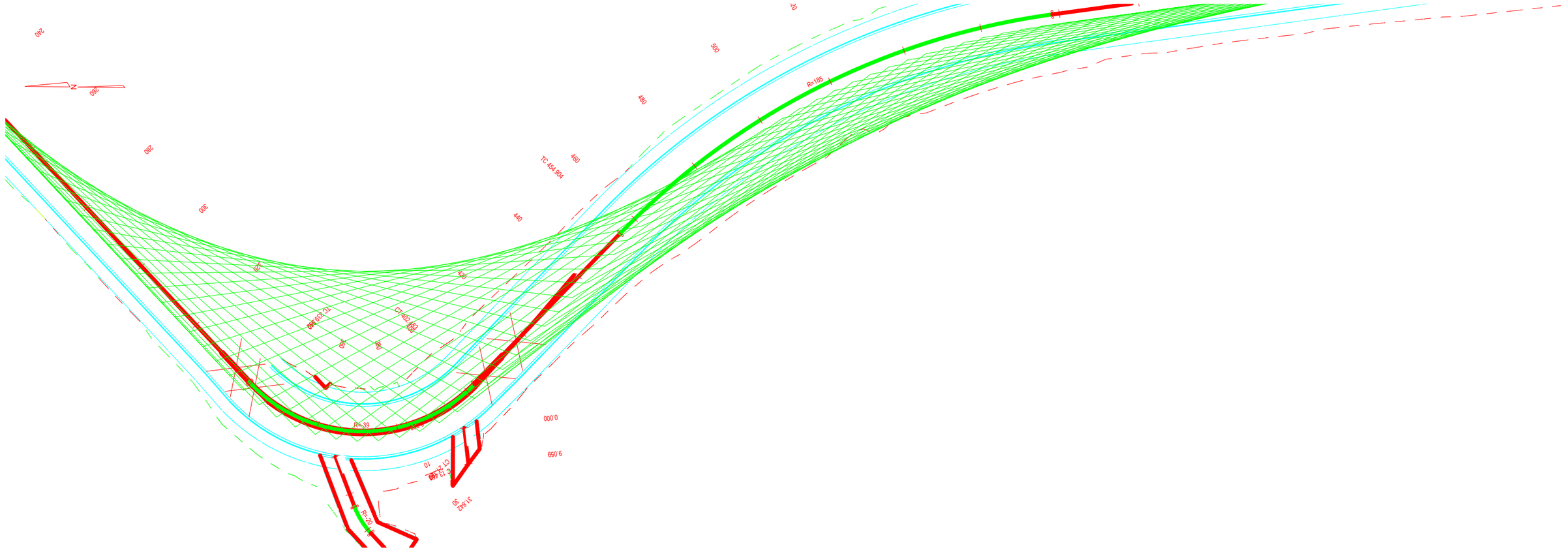

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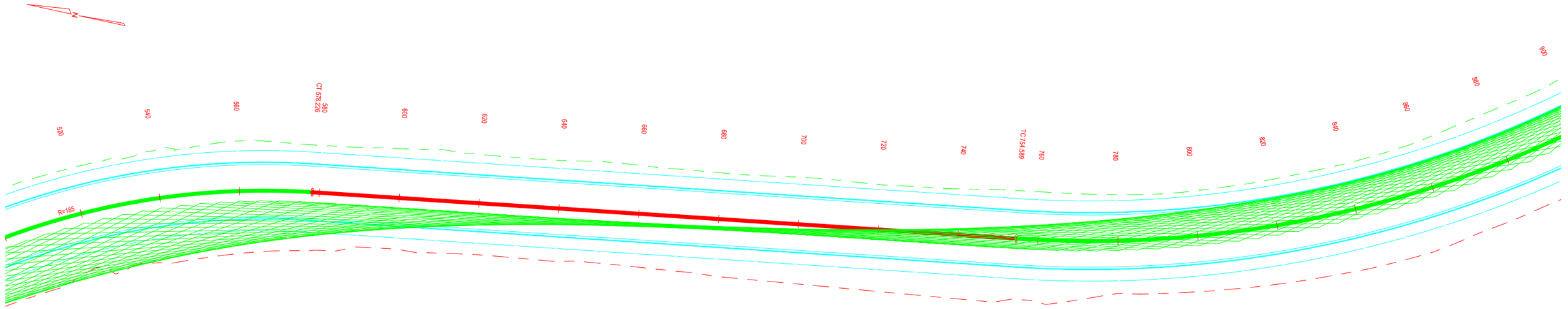

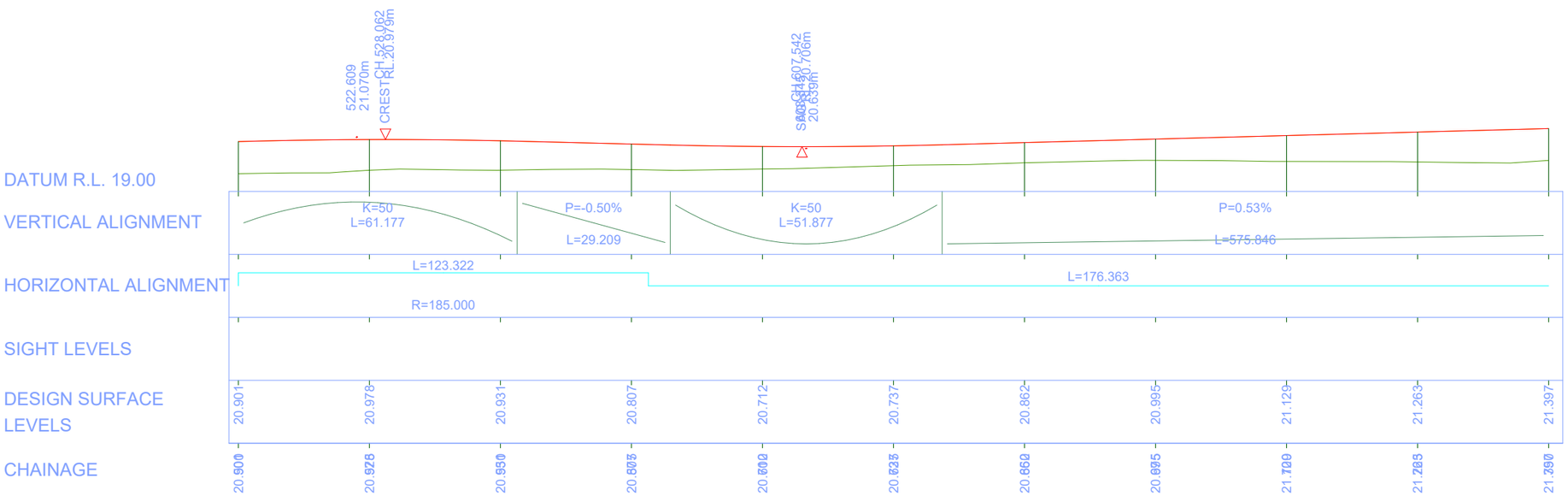

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CLIENT: Transport Roads & Maritime Services (NSW Government)

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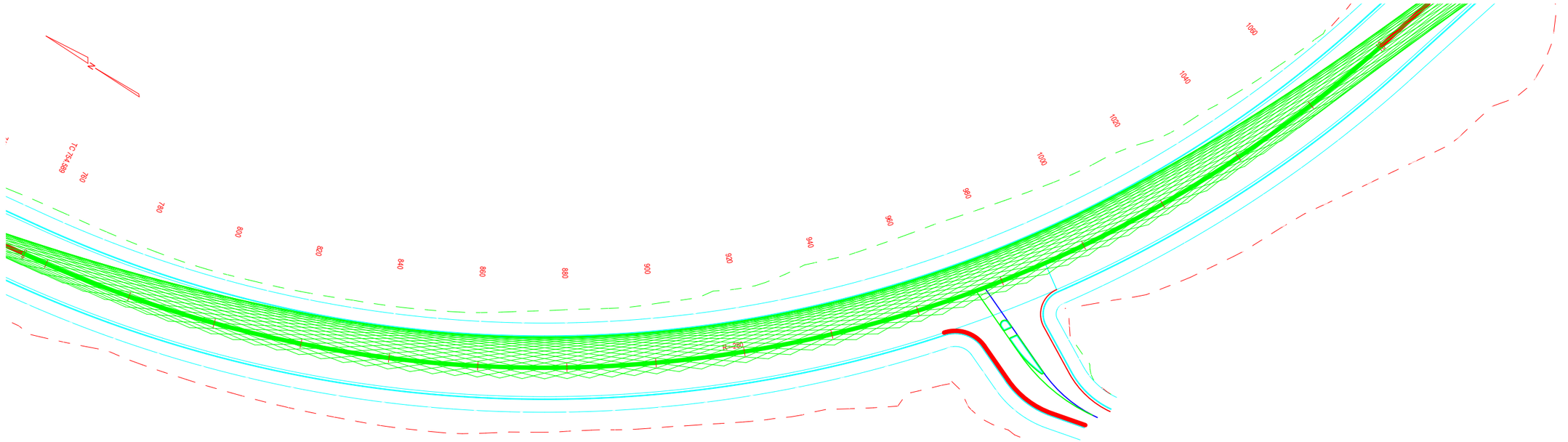

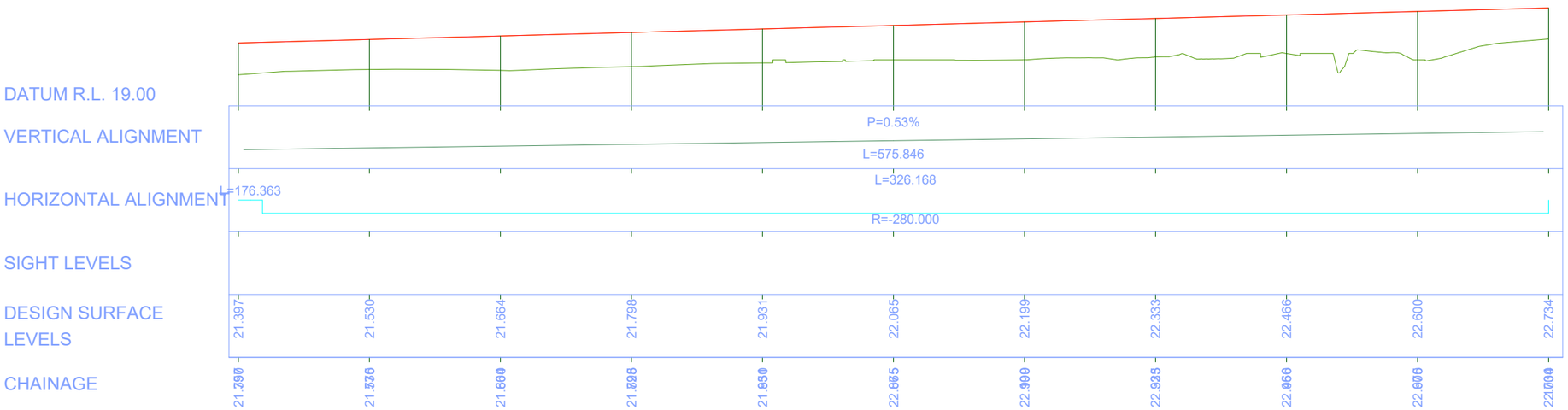

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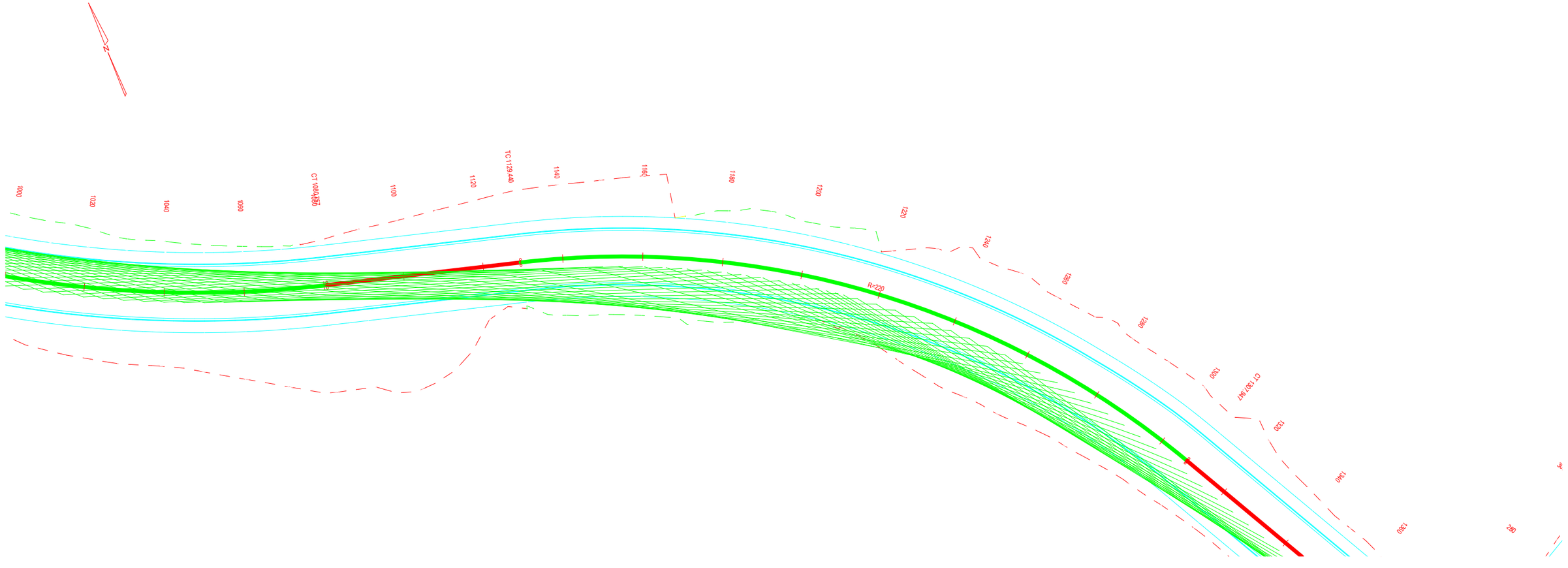

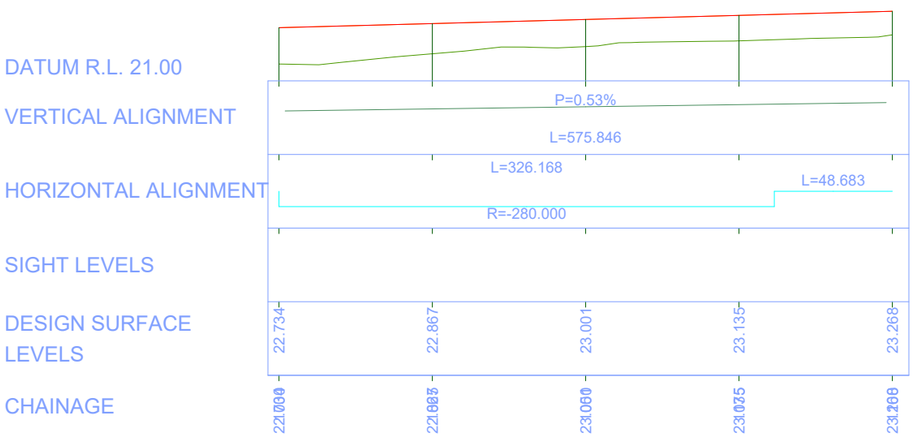

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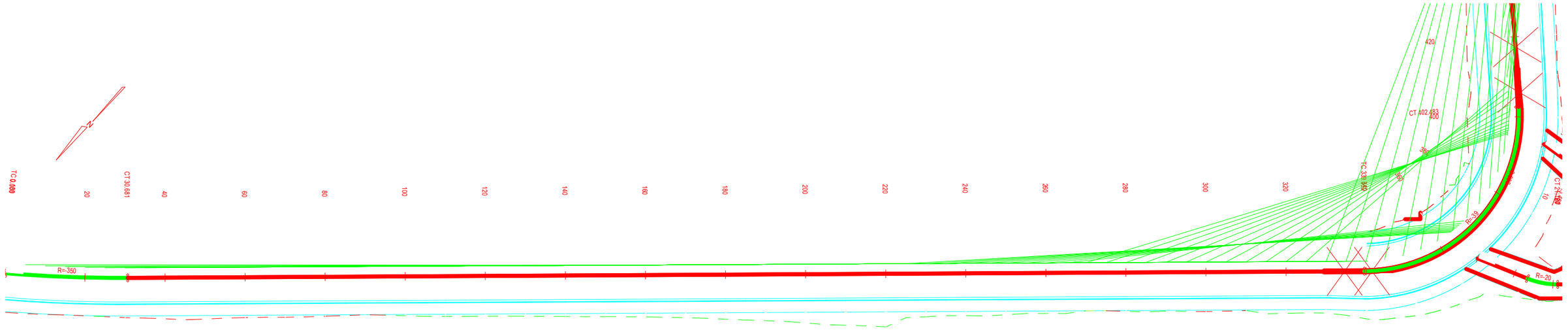

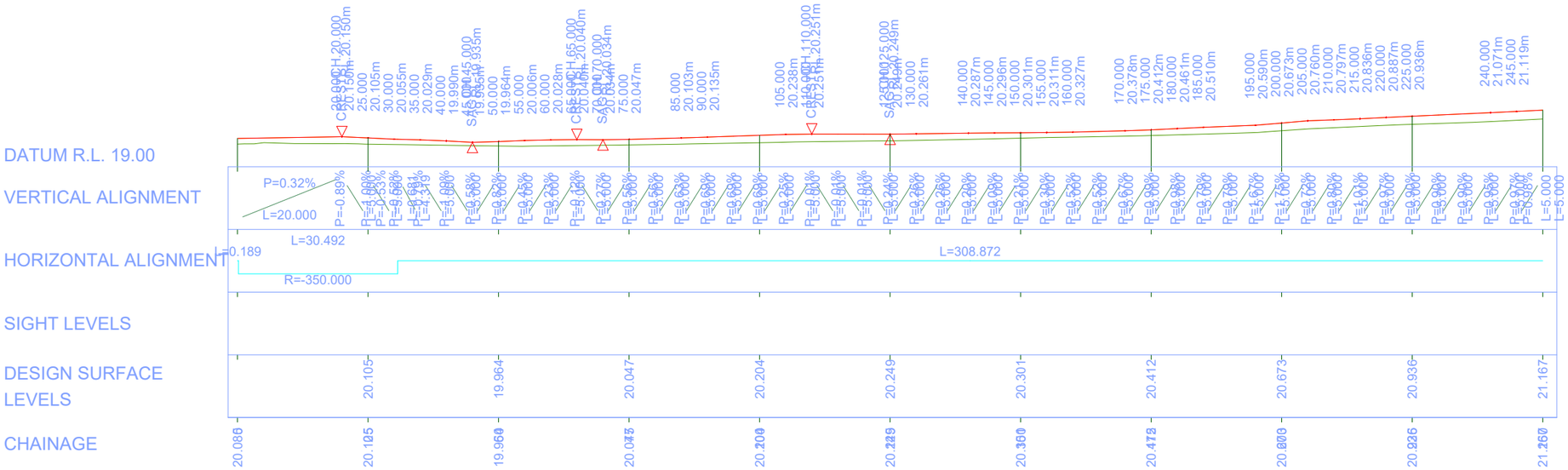

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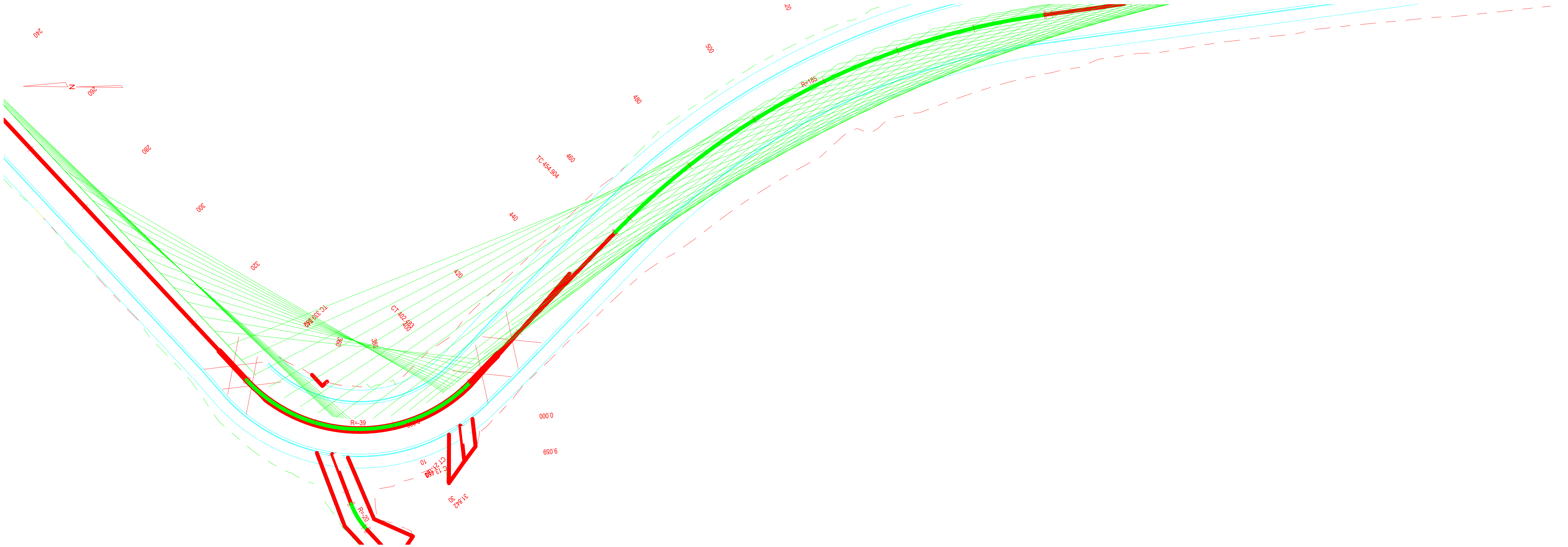

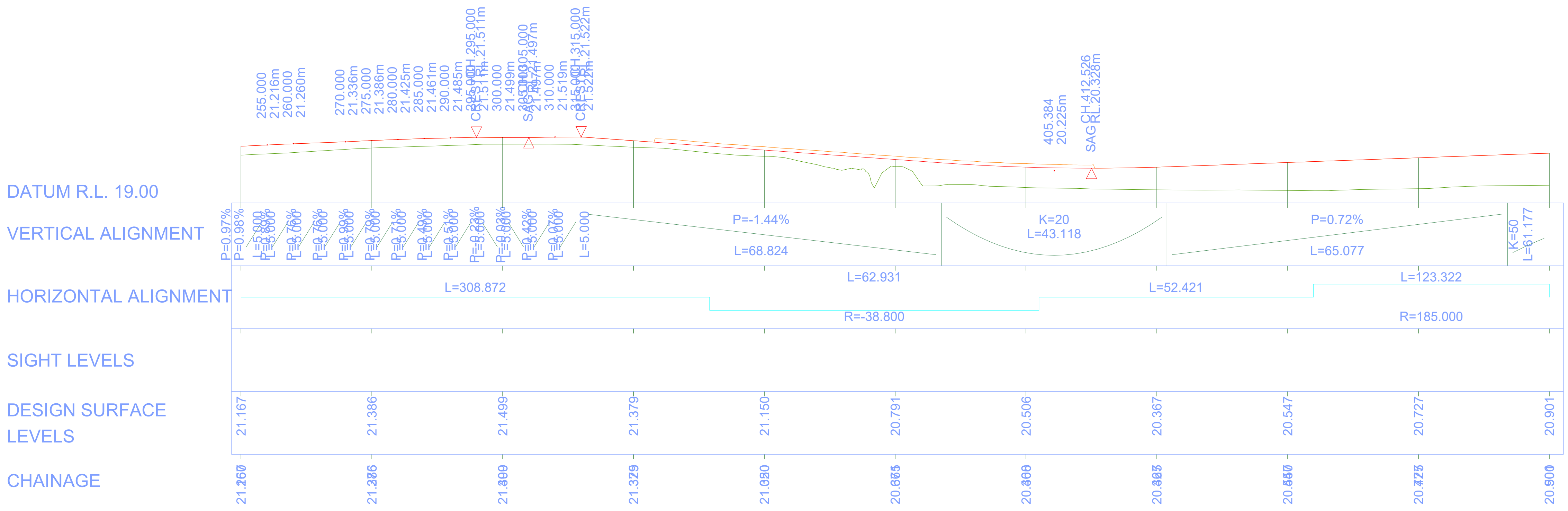

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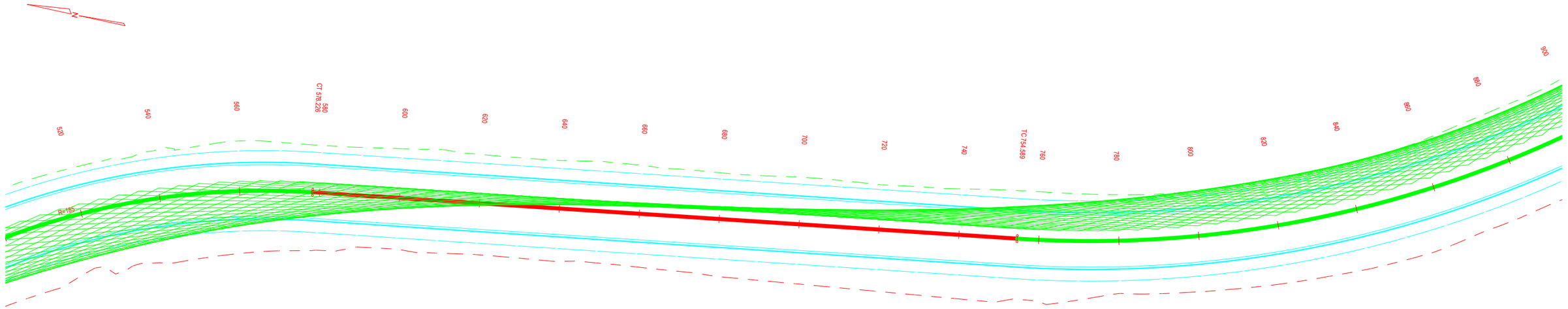

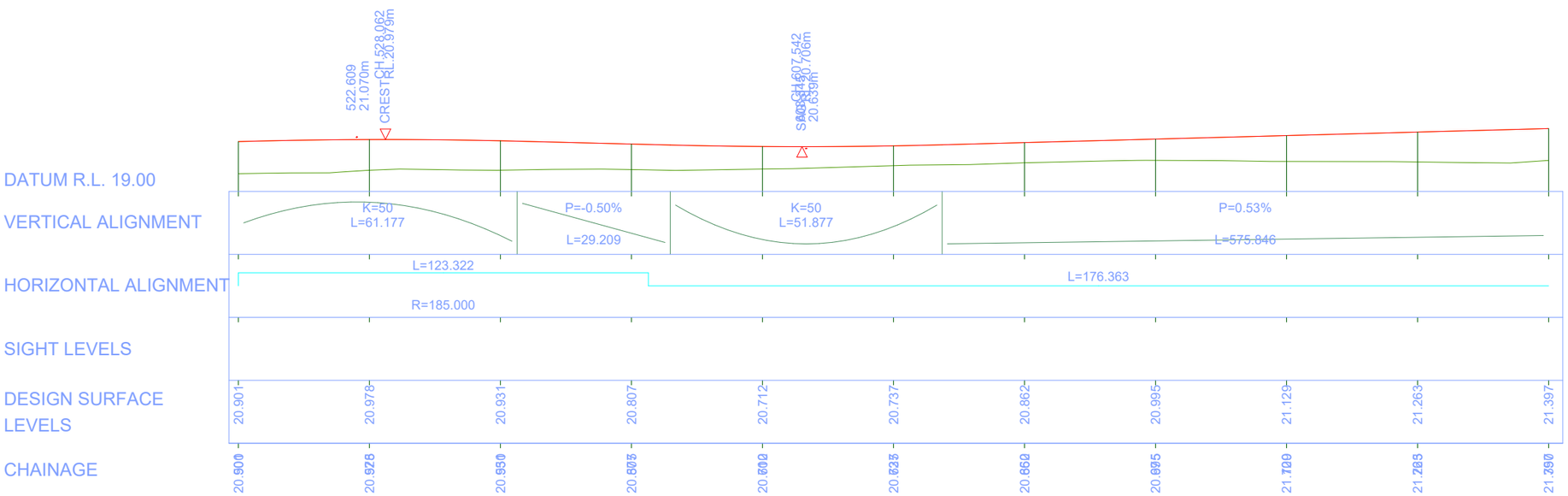

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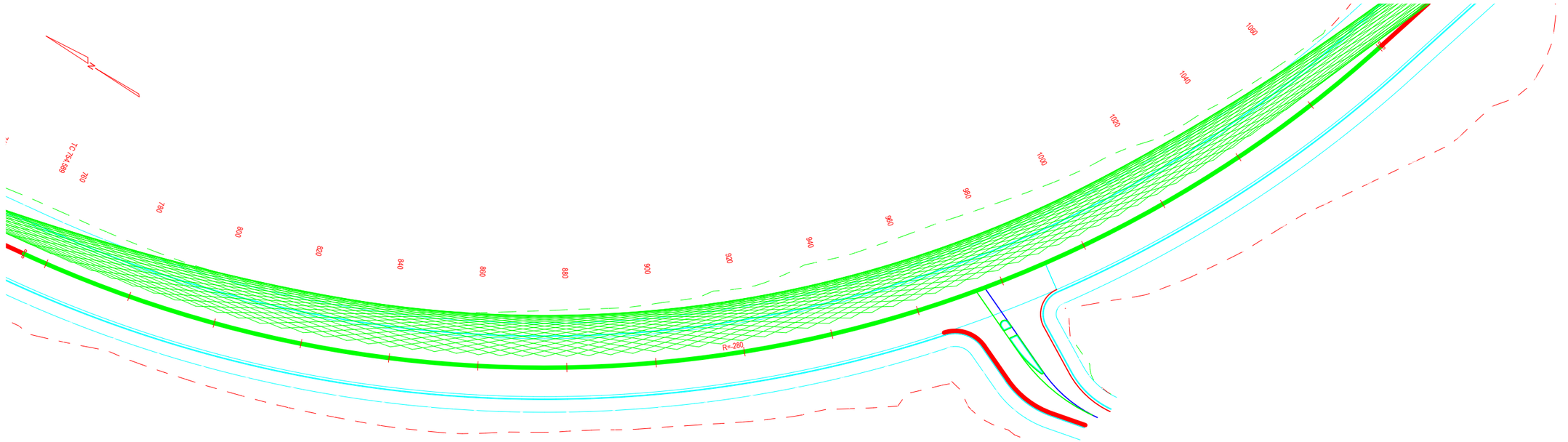
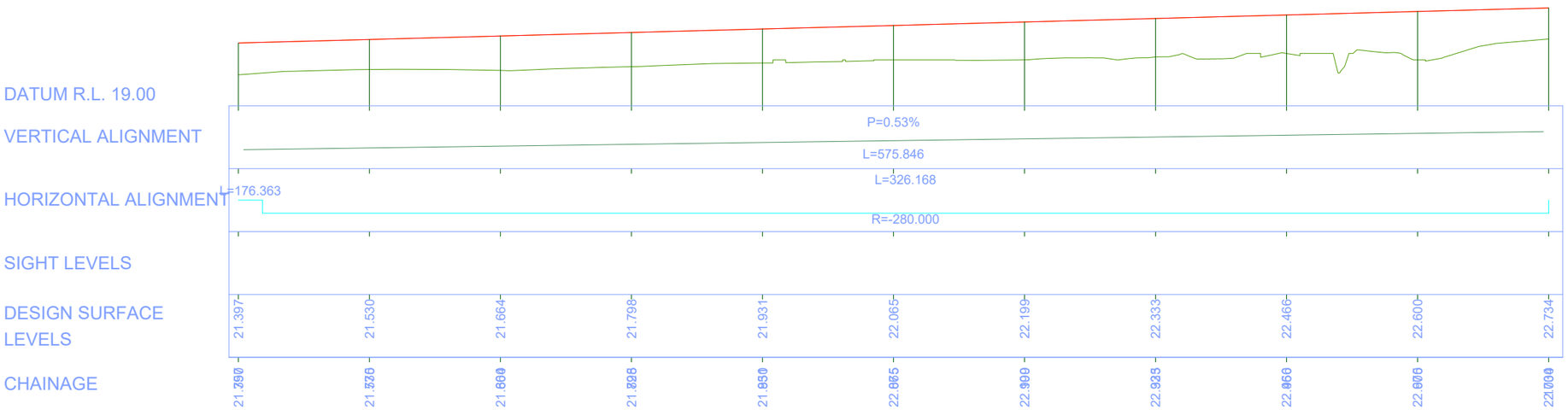
50mm ON A3 SIZE ORIGINAL

DRAWING FILE LOCATION / NAME: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze / plot-LSEC-SSD-SB-03				DESIGN LOT CODE	DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze\Links Rd Freeze.dpj		PLOT DATE / TIME: 18/06/2019	PLOT BY	CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services	A3
EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL	SCALES ON A3 SIZE DRAWING: 1000 / 200	DRAWINGS / DESIGN PREPARED BY: COMPANY NAME / LOGO	TITLE / NAME / DATE: DRAWN; DRG CHECK; DESIGN; DESIGN CHECK; DESIGN MNGR; PROJECT MNGR		- 500 TO 750	SHEET 2 OF
						CO-ORDINATE SYSTEM: MGA ZONE 56	HEIGHT DATUM: AHD		PREPARED FOR	RMS REGISTRATION No.	PART
										ISSUE STATUS	EDMS No. / SHEET No. / ISSUE





SIGHT LINE No. MC10
HORIZ. 1:1000 VERT. 1:200

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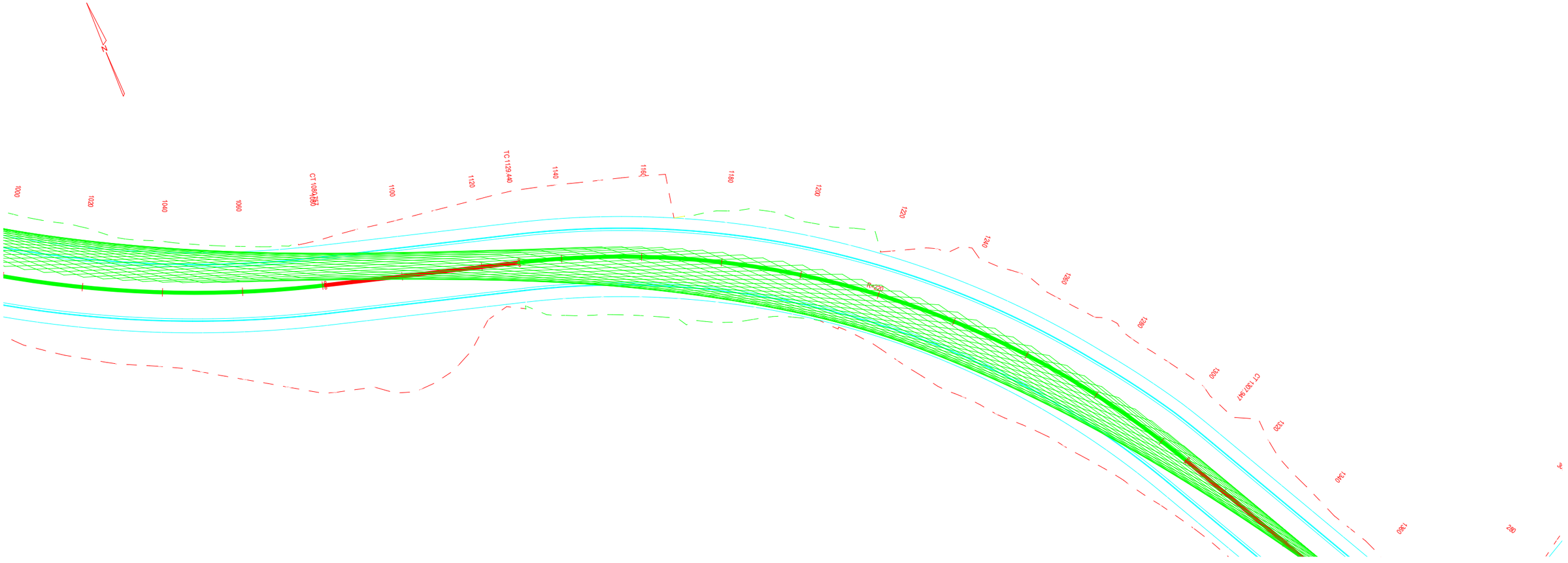
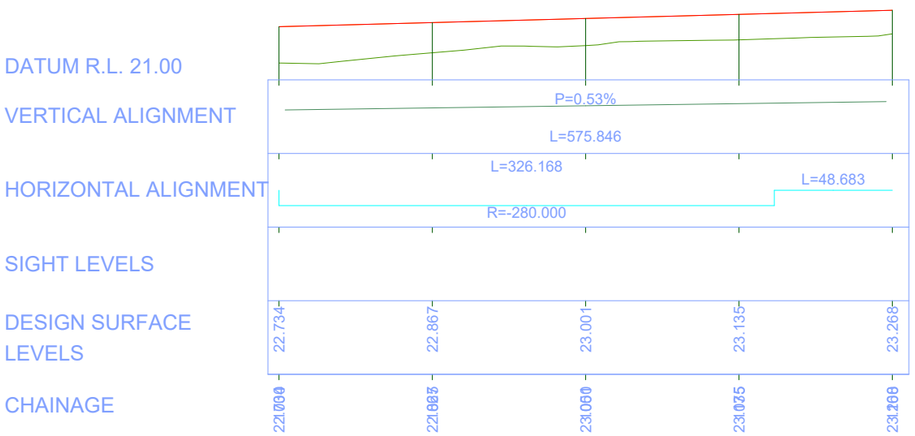
50mm ON A3 SIZE ORIGINAL

DRAWING FILE LOCATION / NAME: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze / plot-LSEC-SSD-SB-04				DESIGN LOT CODE	DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze\Links Rd Freeze.dpj		PLOT DATE / TIME: 18/06/2019	PLOT BY	CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services	A3
EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL	SCALES ON A3 SIZE DRAWING: 1000 / 200	DRAWINGS / DESIGN PREPARED BY: COMPANY NAME / LOGO	TITLE / NAME / DATE: DRAWN; DRG CHECK; DESIGN; DESIGN CHECK; DESIGN MNGR; PROJECT MNGR		- 750 TO 1000 SHEET 3 OF
						CO-ORDINATE SYSTEM: MGA ZONE 56	HEIGHT DATUM: AHD		PREPARED FOR	RMS REGISTRATION No. / PART
										ISSUE STATUS / EDMS No. / SHEET No. / ISSUE





SIGHT LINE No. MC10
HORIZ. 1:1000 VERT. 1:200

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED
50mm ON A3 SIZE ORIGINAL

DRAWING FILE LOCATION / NAME: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze / plot-LSEC-SSD-SB-05				DESIGN LOT CODE	DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze\Links Rd Freeze.dgn		PLOT DATE / TIME: 28/06/2019	PLOT BY	CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services		A3
EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL	SCALES ON A3 SIZE DRAWING: 1000 / 200	DRAWINGS / DESIGN PREPARED BY: COMPANY NAME / LOGO	TITLE	NAME	DATE	- 1000 TO 1100	SHEET 4 OF
								DRAWN				
								DRG CHECK				
								DESIGN				
								DESIGN CHECK				
								DESIGN MNGR				
								PROJECT MNGR				
						CO-ORDINATE SYSTEM: MGA ZONE 56	HEIGHT DATUM: AHD				PREPARED FOR	RMS REGISTRATION No. / PART
												ISSUE STATUS / EDMS No. / SHEET No. / ISSUE

Sight Distance Report

Project: Links Rd Freeze
Directory: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze
User: AUDB501627
Created: 2019-06-18T13:17:40

Parameters

General	
Centreline:	F CTRL MASTER->MC10
Ground tin:	F DES RD
Start chainage:	0.000
End chainage:	1402.733
Chainage interval:	5.000
Trial interval:	5.000
Minimum distance:	Calculated by safe limit
Maximum distance:	145.000
Assumed safe at ends?	true
Eye & Target	
Eye height:	1.100
Eye offset:	-2.500
Target height:	0.200
Target offset:	-2.500
Safe Limit	
Speed value:	30
Reaction time:	1.50
Deceleration coefficient:	0.36
Safe distance rounding:	5 (up)

Sight distance reverse

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
1400.000	145.000	25.000	passed	Object				
1395.000	145.000	25.000	passed	Object				
1390.000	145.000	25.000	passed	Object				
1385.000	145.000	25.000	passed	Object				
1380.000	145.000	25.000	passed	Object				
1375.000	145.000	25.000	passed	Object				
1370.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
1365.000	145.000	25.000	passed	Object				
1360.000	145.000	25.000	passed	Object				
1355.000	143.628	25.000	passed	Tin	1267.500	11.576	24.230	F DES RD
1350.000	140.802	25.000	passed	Tin	1265.000	11.566	24.235	F DES RD
1345.000	138.194	25.000	passed	Tin	1262.500	11.562	24.240	F DES RD
1340.000	135.838	25.000	passed	Tin	1260.000	11.566	24.245	F DES RD
1335.000	133.756	25.000	passed	Tin	1257.500	11.579	24.252	F DES RD
1330.000	131.986	25.000	passed	Tin	1255.000	11.600	24.259	F DES RD
1325.000	130.553	25.000	passed	Tin	1250.000	11.548	24.252	F DES RD
1320.000	129.461	25.000	passed	Tin	1247.516	11.593	24.262	F DES RD
1315.000	128.779	25.000	passed	Tin	1242.500	11.570	24.255	F DES RD
1310.000	128.520	25.000	passed	Tin	1240.000	11.640	24.267	F DES RD
1305.000	128.577	25.000	passed	Tin	1235.000	11.650	24.262	F DES RD
1300.000	128.761	25.000	passed	Tin	1230.000	11.679	24.257	F DES RD
1295.000	129.072	25.000	passed	Tin	1225.000	11.727	24.252	F DES RD
1290.000	129.532	25.000	passed	Tin	1220.563	11.810	24.253	F DES RD
1285.000	131.046	25.000	passed	Tin	1222.038	12.061	24.308	F DES RD
1280.000	134.485	25.000	passed	Tin	1223.252	12.344	24.369	F DES RD
1275.000	140.463	25.000	passed	Tin	1224.430	12.662	24.437	F DES RD
1270.000	145.000	25.000	passed	Object				
1265.000	145.000	25.000	passed	Object				
1260.000	145.000	25.000	passed	Object				
1255.000	145.000	25.000	passed	Object				
1250.000	145.000	25.000	passed	Object				
1245.000	145.000	25.000	passed	Object				
1240.000	145.000	25.000	passed	Object				
1235.000	145.000	25.000	passed	Object				
1230.000	145.000	25.000	passed	Object				
1225.000	145.000	25.000	passed	Object				
1220.000	145.000	25.000	passed	Object				
1215.000	145.000	25.000	passed	Object				
1210.000	145.000	25.000	passed	Object				
1205.000	145.000	25.000	passed	Object				
1200.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
1195.000	145.000	25.000	passed	Object				
1190.000	145.000	25.000	passed	Object				
1185.000	145.000	25.000	passed	Object				
1180.000	145.000	25.000	passed	Object				
1175.000	145.000	25.000	passed	Object				
1170.000	145.000	25.000	passed	Object				
1165.000	145.000	25.000	passed	Object				
1160.000	145.000	25.000	passed	Object				
1155.000	145.000	25.000	passed	Object				
1150.000	145.000	25.000	passed	Object				
1145.000	145.000	25.000	passed	Object				
1140.000	145.000	25.000	passed	Object				
1135.000	145.000	25.000	passed	Object				
1130.000	145.000	25.000	passed	Object				
1125.000	145.000	25.000	passed	Object				
1120.000	145.000	25.000	passed	Object				
1115.000	145.000	25.000	passed	Object				
1110.000	145.000	25.000	passed	Object				
1105.000	145.000	25.000	passed	Object				
1100.000	145.000	25.000	passed	Object				
1095.000	145.000	25.000	passed	Object				
1090.000	145.000	25.000	passed	Object				
1085.000	145.000	25.000	passed	Object				
1080.000	145.000	25.000	passed	Object				
1075.000	145.000	25.000	passed	Object				
1070.000	145.000	25.000	passed	Object				
1065.000	145.000	25.000	passed	Object				
1060.000	145.000	25.000	passed	Object				
1055.000	145.000	25.000	passed	Object				
1050.000	145.000	25.000	passed	Object				
1045.000	145.000	25.000	passed	Object				
1040.000	145.000	25.000	passed	Object				
1035.000	145.000	25.000	passed	Object				
1030.000	145.000	25.000	passed	Object				
1025.000	145.000	25.000	passed	Object				
1020.000	145.000	25.000	passed	Object				
1015.000	145.000	25.000	passed	Object				
1010.000	145.000	25.000	passed	Object				
1005.000	145.000	25.000	passed	Object				
1000.000	145.000	25.000	passed	Object				
995.000	145.000	25.000	passed	Object				
990.000	145.000	25.000	passed	Object				
985.000	145.000	25.000	passed	Object				
980.000	145.000	25.000	passed	Object				
975.000	145.000	25.000	passed	Object				
970.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
965.000	145.000	25.000	passed	Object				
960.000	145.000	25.000	passed	Object				
955.000	145.000	25.000	passed	Object				
950.000	145.000	25.000	passed	Object				
945.000	145.000	25.000	passed	Object				
940.000	145.000	25.000	passed	Object				
935.000	145.000	25.000	passed	Object				
930.000	145.000	25.000	passed	Object				
925.000	145.000	25.000	passed	Object				
920.000	145.000	25.000	passed	Object				
915.000	145.000	25.000	passed	Object				
910.000	145.000	25.000	passed	Object				
905.000	145.000	25.000	passed	Object				
900.000	145.000	25.000	passed	Object				
895.000	145.000	25.000	passed	Object				
890.000	145.000	25.000	passed	Object				
885.000	145.000	25.000	passed	Object				
880.000	145.000	25.000	passed	Object				
875.000	145.000	25.000	passed	Object				
870.000	145.000	25.000	passed	Object				
865.000	145.000	25.000	passed	Object				
860.000	145.000	25.000	passed	Object				
855.000	145.000	25.000	passed	Object				
850.000	145.000	25.000	passed	Object				
845.000	145.000	25.000	passed	Object				
840.000	145.000	25.000	passed	Object				
835.000	145.000	25.000	passed	Object				
830.000	145.000	25.000	passed	Object				
825.000	145.000	25.000	passed	Object				
820.000	145.000	25.000	passed	Object				
815.000	145.000	25.000	passed	Object				
810.000	145.000	25.000	passed	Object				
805.000	145.000	25.000	passed	Object				
800.000	145.000	25.000	passed	Object				
795.000	145.000	25.000	passed	Object				
790.000	145.000	25.000	passed	Object				
785.000	145.000	25.000	passed	Object				
780.000	145.000	25.000	passed	Object				
775.000	145.000	25.000	passed	Object				
770.000	145.000	25.000	passed	Object				
765.000	145.000	25.000	passed	Object				
760.000	145.000	25.000	passed	Object				
755.000	145.000	25.000	passed	Object				
750.000	145.000	25.000	passed	Object				
745.000	145.000	25.000	passed	Object				
740.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
735.000	145.000	25.000	passed	Object				
730.000	145.000	25.000	passed	Object				
725.000	145.000	25.000	passed	Object				
720.000	145.000	25.000	passed	Object				
715.000	145.000	25.000	passed	Object				
710.000	145.000	25.000	passed	Object				
705.000	145.000	25.000	passed	Object				
700.000	145.000	25.000	passed	Object				
695.000	145.000	25.000	passed	Object				
690.000	145.000	25.000	passed	Object				
685.000	145.000	25.000	passed	Object				
680.000	145.000	25.000	passed	Object				
675.000	145.000	25.000	passed	Object				
670.000	145.000	25.000	passed	Object				
665.000	145.000	25.000	passed	Object				
660.000	145.000	25.000	passed	Object				
655.000	145.000	25.000	passed	Object				
650.000	145.000	25.000	passed	Object				
645.000	145.000	25.000	passed	Object				
640.000	145.000	25.000	passed	Object				
635.000	145.000	25.000	passed	Object				
630.000	145.000	25.000	passed	Object				
625.000	145.000	25.000	passed	Object				
620.000	145.000	25.000	passed	Object				
615.000	145.000	25.000	passed	Object				
610.000	145.000	25.000	passed	Object				
605.000	145.000	25.000	passed	Object				
600.000	145.000	25.000	passed	Object				
595.000	145.000	25.000	passed	Object				
590.000	145.000	25.000	passed	Object				
585.000	145.000	25.000	passed	Object				
580.000	145.000	25.000	passed	Object				
575.000	145.000	25.000	passed	Object				
570.000	145.000	25.000	passed	Object				
565.000	145.000	25.000	passed	Object				
560.000	145.000	25.000	passed	Object				
555.000	145.000	25.000	passed	Object				
550.000	145.000	25.000	passed	Object				
545.000	145.000	25.000	passed	Object				
540.000	145.000	25.000	passed	Object				
535.000	145.000	25.000	passed	Object				
530.000	145.000	25.000	passed	Object				
525.000	145.000	25.000	passed	Object				
520.000	145.000	25.000	passed	Object				
515.000	145.000	25.000	passed	Object				
510.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
505.000	145.000	25.000	passed	Object				
500.000	145.000	25.000	passed	Object				
495.000	145.000	25.000	passed	Object				
490.000	145.000	25.000	passed	Object				
485.000	145.000	25.000	passed	Object				
480.000	145.000	25.000	passed	Object				
475.000	145.000	25.000	passed	Object				
470.000	145.000	25.000	passed	Object				
465.000	145.000	25.000	passed	Object				
460.000	145.000	25.000	passed	Object				
455.000	145.000	25.000	passed	Object				
450.000	145.000	25.000	passed	Object				
445.000	145.000	25.000	passed	Object				
440.000	145.000	25.000	passed	Object				
435.000	145.000	25.000	passed	Object				
430.000	145.000	25.000	passed	Object				
425.000	145.000	25.000	passed	Object				
420.000	145.000	25.000	passed	Object				
415.000	145.000	25.000	passed	Object				
410.000	145.000	25.000	passed	Object				
405.000	145.000	25.000	passed	Object				
400.000	145.000	25.000	passed	Object				
395.000	145.000	25.000	passed	Object				
390.000	145.000	25.000	passed	Object				
385.000	145.000	25.000	passed	Object				
380.000	145.000	25.000	passed	Object				
375.000	145.000	25.000	passed	Object				
370.000	145.000	25.000	passed	Object				
365.000	145.000	25.000	passed	Object				
360.000	145.000	25.000	passed	Object				
355.000	145.000	25.000	passed	Object				
350.000	145.000	25.000	passed	Object				
345.000	145.000	25.000	passed	Object				
340.000	145.000	25.000	passed	Object				
335.000	145.000	25.000	passed	Object				
330.000	145.000	25.000	passed	Object				
325.000	145.000	25.000	passed	Object				
320.000	145.000	25.000	passed	Object				
315.000	145.000	25.000	passed	Object				
310.000	145.000	25.000	passed	Object				
305.000	145.000	25.000	passed	Object				
300.000	145.000	25.000	passed	Object				
295.000	145.000	25.000	passed	Object				
290.000	145.000	25.000	passed	Object				
285.000	145.000	25.000	passed	Object				
280.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
275.000	145.000	25.000	passed	Object				
270.000	145.000	25.000	passed	Object				
265.000	145.000	25.000	passed	Object				
260.000	145.000	25.000	passed	Object				
255.000	145.000	25.000	passed	Object				
250.000	145.000	25.000	passed	Object				
245.000	145.000	25.000	passed	Object				
240.000	145.000	25.000	passed	Object				
235.000	145.000	25.000	passed	Object				
230.000	145.000	25.000	passed	Object				
225.000	145.000	25.000	passed	Object				
220.000	145.000	25.000	passed	Object				
215.000	145.000	25.000	passed	Object				
210.000	145.000	25.000	passed	Object				
205.000	145.000	25.000	passed	Object				
200.000	145.000	25.000	passed	Object				
195.000	145.000	25.000	passed	Object				
190.000	145.000	25.000	passed	Object				
185.000	145.000	25.000	passed	Object				
180.000	145.000	25.000	passed	Object				
175.000	145.000	25.000	passed	Object				
170.000	145.000	25.000	passed	Object				
165.000	145.000	25.000	passed	Object				
160.000	145.000	25.000	passed	Object				
155.000	145.000	25.000	passed	Object				
150.000	145.000	25.000	passed	Object				
145.000	145.000	25.000	passed	Object				
140.000	140.000	25.000	passed	Object				
135.000	135.000	25.000	passed	Object				
130.000	130.000	25.000	passed	Object				
125.000	125.000	25.000	passed	Object				
120.000	120.000	25.000	passed	Object				
115.000	115.000	25.000	passed	Object				
110.000	110.000	25.000	passed	Object				
105.000	105.000	25.000	passed	Object				
100.000	100.000	25.000	passed	Object				
95.000	95.000	25.000	passed	Object				
90.000	90.000	25.000	passed	Object				
85.000	85.000	25.000	passed	Object				
80.000	80.000	25.000	passed	Object				
75.000	75.000	25.000	passed	Object				
70.000	70.000	25.000	passed	Object				
65.000	65.000	25.000	passed	Object				
60.000	60.000	25.000	passed	Object				
55.000	55.000	25.000	passed	Object				
50.000	50.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
45.000	45.000	25.000	passed	Object				
40.000	40.000	25.000	passed	Object				
35.000	35.000	25.000	passed	Object				
30.000	30.000	25.000	passed	Object				
25.000	25.000	25.000	passed	Object				
20.000	20.000	25.000	passed	Object				
15.000	15.000	25.000	passed	Object				
10.000	10.000	25.000	passed	Object				
5.000	5.000	25.000	passed	Object				

Generated by 12d Model at 2019-06-18T13:17:40

Sight Distance Report

Project: Links Rd Freeze
Directory: U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze
User: AUDB501627
Created: 2019-06-18T13:02:19

Parameters

General	
Centreline:	F CTRL MASTER->MC10
Ground tin:	F DES RD
Start chainage:	0.000
End chainage:	1402.733
Chainage interval:	5.000
Trial interval:	5.000
Minimum distance:	Calculated by safe limit
Maximum distance:	145.000
Assumed safe at ends?	true
Eye & Target	
Eye height:	1.100
Eye offset:	-2.500
Target height:	0.200
Target offset:	-2.500
Safe Limit	
Speed value:	30
Reaction time:	1.50
Deceleration coefficient:	0.36
Safe distance rounding:	5 (up)

Sight distance forward

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
5.000	145.000	25.000	passed	Object				
10.000	145.000	25.000	passed	Object				
15.000	145.000	25.000	passed	Object				
20.000	145.000	25.000	passed	Object				
25.000	145.000	25.000	passed	Object				
30.000	145.000	25.000	passed	Object				
35.000	145.000	25.000	passed	Object				
40.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
45.000	145.000	25.000	passed	Object				
50.000	145.000	25.000	passed	Object				
55.000	145.000	25.000	passed	Object				
60.000	145.000	25.000	passed	Object				
65.000	145.000	25.000	passed	Object				
70.000	145.000	25.000	passed	Object				
75.000	145.000	25.000	passed	Object				
80.000	145.000	25.000	passed	Object				
85.000	145.000	25.000	passed	Object				
90.000	145.000	25.000	passed	Object				
95.000	145.000	25.000	passed	Object				
100.000	145.000	25.000	passed	Object				
105.000	145.000	25.000	passed	Object				
110.000	145.000	25.000	passed	Object				
115.000	145.000	25.000	passed	Object				
120.000	145.000	25.000	passed	Object				
125.000	145.000	25.000	passed	Object				
130.000	145.000	25.000	passed	Object				
135.000	145.000	25.000	passed	Object				
140.000	145.000	25.000	passed	Object				
145.000	145.000	25.000	passed	Object				
150.000	145.000	25.000	passed	Object				
155.000	145.000	25.000	passed	Object				
160.000	145.000	25.000	passed	Object				
165.000	145.000	25.000	passed	Object				
170.000	145.000	25.000	passed	Object				
175.000	145.000	25.000	passed	Object				
180.000	145.000	25.000	passed	Object				
185.000	145.000	25.000	passed	Object				
190.000	144.372	25.000	passed	Tin	310.000	-2.500	21.347	F DES RD
195.000	139.711	25.000	passed	Tin	315.000	-2.500	21.339	F DES RD
200.000	135.317	25.000	passed	Tin	315.000	-2.500	21.339	F DES RD
205.000	131.132	25.000	passed	Tin	315.000	-2.500	21.339	F DES RD
210.000	126.921	25.000	passed	Tin	315.000	-2.500	21.339	F DES RD
215.000	123.489	25.000	passed	Tin	315.000	-2.500	21.339	F DES RD
220.000	120.417	25.000	passed	Tin	315.000	-2.507	21.338	F DES RD
225.000	139.224	25.000	passed	Tin	340.584	-8.502	21.019	F DES RD
230.000	134.588	25.000	passed	Tin	340.602	-8.620	21.029	F DES RD
235.000	129.992	25.000	passed	Tin	340.623	-8.750	21.040	F DES RD

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
240.000	125.442	25.000	passed	Tin	340.647	-8.894	21.053	F DES RD
245.000	120.958	25.000	passed	Tin	340.674	-9.060	21.067	F DES RD
250.000	116.543	25.000	passed	Tin	340.706	-9.248	21.083	F DES RD
255.000	112.206	25.000	passed	Tin	340.741	-9.459	21.100	F DES RD
260.000	107.951	25.000	passed	Tin	340.787	-9.692	21.120	F DES RD
265.000	103.933	25.000	passed	Tin	342.691	-10.071	21.122	F DES RD
270.000	125.472	25.000	passed	Tin	389.449	-11.582	20.621	F DES RD
275.000	120.909	25.000	passed	Tin	389.721	-11.648	20.631	F DES RD
280.000	116.392	25.000	passed	Tin	390.015	-11.719	20.641	F DES RD
285.000	112.025	25.000	passed	Tin	390.441	-11.817	20.656	F DES RD
290.000	107.886	25.000	passed	Tin	391.093	-11.942	20.674	F DES RD
295.000	103.910	25.000	passed	Tin	391.883	-12.084	20.694	F DES RD
300.000	100.031	25.000	passed	Tin	392.730	-12.226	20.714	F DES RD
305.000	96.376	25.000	passed	Tin	393.764	-12.385	20.736	F DES RD
310.000	93.087	25.000	passed	Tin	395.187	-12.579	20.762	F DES RD
315.000	90.021	25.000	passed	Tin	396.846	-12.760	20.791	F DES RD
320.000	86.492	25.000	passed	Tin	397.770	-12.823	20.814	F DES RD
325.000	83.075	25.000	passed	Tin	398.589	-12.869	20.833	F DES RD
330.000	145.000	25.000	passed	Object				
335.000	145.000	25.000	passed	Object				
340.000	145.000	25.000	passed	Object				
345.000	145.000	25.000	passed	Object				
350.000	145.000	25.000	passed	Object				
355.000	145.000	25.000	passed	Object				
360.000	145.000	25.000	passed	Object				
365.000	145.000	25.000	passed	Object				
370.000	145.000	25.000	passed	Object				
375.000	145.000	25.000	passed	Object				
380.000	145.000	25.000	passed	Object				
385.000	145.000	25.000	passed	Object				
390.000	145.000	25.000	passed	Object				
395.000	145.000	25.000	passed	Object				
400.000	145.000	25.000	passed	Object				
405.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
410.000	145.000	25.000	passed	Object				
415.000	145.000	25.000	passed	Object				
420.000	145.000	25.000	passed	Object				
425.000	145.000	25.000	passed	Object				
430.000	145.000	25.000	passed	Object				
435.000	145.000	25.000	passed	Object				
440.000	145.000	25.000	passed	Object				
445.000	145.000	25.000	passed	Object				
450.000	145.000	25.000	passed	Object				
455.000	145.000	25.000	passed	Object				
460.000	145.000	25.000	passed	Object				
465.000	145.000	25.000	passed	Object				
470.000	145.000	25.000	passed	Object				
475.000	145.000	25.000	passed	Object				
480.000	145.000	25.000	passed	Object				
485.000	145.000	25.000	passed	Object				
490.000	145.000	25.000	passed	Object				
495.000	145.000	25.000	passed	Object				
500.000	145.000	25.000	passed	Object				
505.000	145.000	25.000	passed	Object				
510.000	145.000	25.000	passed	Object				
515.000	145.000	25.000	passed	Object				
520.000	145.000	25.000	passed	Object				
525.000	145.000	25.000	passed	Object				
530.000	145.000	25.000	passed	Object				
535.000	145.000	25.000	passed	Object				
540.000	145.000	25.000	passed	Object				
545.000	145.000	25.000	passed	Object				
550.000	145.000	25.000	passed	Object				
555.000	145.000	25.000	passed	Object				
560.000	145.000	25.000	passed	Object				
565.000	145.000	25.000	passed	Object				
570.000	145.000	25.000	passed	Object				
575.000	145.000	25.000	passed	Object				
580.000	145.000	25.000	passed	Object				
585.000	145.000	25.000	passed	Object				
590.000	145.000	25.000	passed	Object				
595.000	145.000	25.000	passed	Object				
600.000	145.000	25.000	passed	Object				
605.000	145.000	25.000	passed	Object				
610.000	145.000	25.000	passed	Object				
615.000	145.000	25.000	passed	Object				
620.000	145.000	25.000	passed	Object				
625.000	145.000	25.000	passed	Object				
630.000	145.000	25.000	passed	Object				
635.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
640.000	145.000	25.000	passed	Object				
645.000	145.000	25.000	passed	Object				
650.000	145.000	25.000	passed	Object				
655.000	145.000	25.000	passed	Object				
660.000	145.000	25.000	passed	Object				
665.000	145.000	25.000	passed	Object				
670.000	145.000	25.000	passed	Object				
675.000	145.000	25.000	passed	Object				
680.000	145.000	25.000	passed	Object				
685.000	145.000	25.000	passed	Object				
690.000	145.000	25.000	passed	Object				
695.000	145.000	25.000	passed	Object				
700.000	145.000	25.000	passed	Object				
705.000	145.000	25.000	passed	Object				
710.000	145.000	25.000	passed	Object				
715.000	145.000	25.000	passed	Object				
720.000	145.000	25.000	passed	Object				
725.000	145.000	25.000	passed	Object				
730.000	145.000	25.000	passed	Object				
735.000	145.000	25.000	passed	Object				
740.000	145.000	25.000	passed	Object				
745.000	145.000	25.000	passed	Object				
750.000	145.000	25.000	passed	Object				
755.000	145.000	25.000	passed	Object				
760.000	145.000	25.000	passed	Object				
765.000	145.000	25.000	passed	Object				
770.000	145.000	25.000	passed	Object				
775.000	145.000	25.000	passed	Object				
780.000	145.000	25.000	passed	Object				
785.000	145.000	25.000	passed	Object				
790.000	145.000	25.000	passed	Object				
795.000	145.000	25.000	passed	Object				
800.000	145.000	25.000	passed	Object				
805.000	145.000	25.000	passed	Object				
810.000	145.000	25.000	passed	Object				
815.000	145.000	25.000	passed	Object				
820.000	145.000	25.000	passed	Object				
825.000	145.000	25.000	passed	Object				
830.000	145.000	25.000	passed	Object				
835.000	145.000	25.000	passed	Object				
840.000	145.000	25.000	passed	Object				
845.000	145.000	25.000	passed	Object				
850.000	145.000	25.000	passed	Object				
855.000	145.000	25.000	passed	Object				
860.000	145.000	25.000	passed	Object				
865.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
870.000	145.000	25.000	passed	Object				
875.000	145.000	25.000	passed	Object				
880.000	145.000	25.000	passed	Object				
885.000	145.000	25.000	passed	Object				
890.000	145.000	25.000	passed	Object				
895.000	145.000	25.000	passed	Object				
900.000	145.000	25.000	passed	Object				
905.000	145.000	25.000	passed	Object				
910.000	145.000	25.000	passed	Object				
915.000	145.000	25.000	passed	Object				
920.000	145.000	25.000	passed	Object				
925.000	145.000	25.000	passed	Object				
930.000	145.000	25.000	passed	Object				
935.000	145.000	25.000	passed	Object				
940.000	145.000	25.000	passed	Object				
945.000	145.000	25.000	passed	Object				
950.000	145.000	25.000	passed	Object				
955.000	145.000	25.000	passed	Object				
960.000	145.000	25.000	passed	Object				
965.000	145.000	25.000	passed	Object				
970.000	145.000	25.000	passed	Object				
975.000	145.000	25.000	passed	Object				
980.000	145.000	25.000	passed	Object				
985.000	145.000	25.000	passed	Object				
990.000	145.000	25.000	passed	Object				
995.000	145.000	25.000	passed	Object				
1000.000	145.000	25.000	passed	Object				
1005.000	145.000	25.000	passed	Object				
1010.000	145.000	25.000	passed	Object				
1015.000	145.000	25.000	passed	Object				
1020.000	145.000	25.000	passed	Object				
1025.000	145.000	25.000	passed	Object				
1030.000	145.000	25.000	passed	Object				
1035.000	145.000	25.000	passed	Object				
1040.000	145.000	25.000	passed	Object				
1045.000	145.000	25.000	passed	Object				
1050.000	145.000	25.000	passed	Object				
1055.000	145.000	25.000	passed	Object				
1060.000	145.000	25.000	passed	Object				
1065.000	145.000	25.000	passed	Object				
1070.000	145.000	25.000	passed	Object				
1075.000	145.000	25.000	passed	Object				
1080.000	145.000	25.000	passed	Object				
1085.000	145.000	25.000	passed	Object				
1090.000	145.000	25.000	passed	Object				
1095.000	145.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
1100.000	145.000	25.000	passed	Object				
1105.000	145.000	25.000	passed	Object				
1110.000	145.000	25.000	passed	Object				
1115.000	145.000	25.000	passed	Object				
1120.000	145.000	25.000	passed	Object				
1125.000	145.000	25.000	passed	Object				
1130.000	145.000	25.000	passed	Object				
1135.000	145.000	25.000	passed	Object				
1140.000	145.000	25.000	passed	Object				
1145.000	145.000	25.000	passed	Object				
1150.000	145.000	25.000	passed	Object				
1155.000	145.000	25.000	passed	Object				
1160.000	145.000	25.000	passed	Object				
1165.000	145.000	25.000	passed	Object				
1170.000	145.000	25.000	passed	Object				
1175.000	145.000	25.000	passed	Object				
1180.000	145.000	25.000	passed	Object				
1185.000	145.000	25.000	passed	Object				
1190.000	145.000	25.000	passed	Object				
1195.000	145.000	25.000	passed	Object				
1200.000	145.000	25.000	passed	Object				
1205.000	145.000	25.000	passed	Object				
1210.000	145.000	25.000	passed	Object				
1215.000	145.000	25.000	passed	Object				
1220.000	145.000	25.000	passed	Object				
1225.000	145.000	25.000	passed	Object				
1230.000	145.000	25.000	passed	Object				
1235.000	145.000	25.000	passed	Object				
1240.000	145.000	25.000	passed	Object				
1245.000	145.000	25.000	passed	Object				
1250.000	145.000	25.000	passed	Object				
1255.000	145.000	25.000	passed	Object				
1260.000	140.000	25.000	passed	Object				
1265.000	135.000	25.000	passed	Object				
1270.000	130.000	25.000	passed	Object				
1275.000	125.000	25.000	passed	Object				
1280.000	120.000	25.000	passed	Object				
1285.000	115.000	25.000	passed	Object				
1290.000	110.000	25.000	passed	Object				
1295.000	105.000	25.000	passed	Object				
1300.000	100.000	25.000	passed	Object				
1305.000	95.000	25.000	passed	Object				
1310.000	90.000	25.000	passed	Object				
1315.000	85.000	25.000	passed	Object				
1320.000	80.000	25.000	passed	Object				
1325.000	75.000	25.000	passed	Object				

CHAINAGE	SIGHT DISTANCE ACHIEVED	SIGHT DISTANCE REQUIRED	STATUS	OBSTRUCTION				
				TYPE	CHAINAGE	OFFSET	HEIGHT	NAME
1330.000	70.000	25.000	passed	Object				
1335.000	65.000	25.000	passed	Object				
1340.000	60.000	25.000	passed	Object				
1345.000	55.000	25.000	passed	Object				
1350.000	50.000	25.000	passed	Object				
1355.000	45.000	25.000	passed	Object				
1360.000	40.000	25.000	passed	Object				
1365.000	35.000	25.000	passed	Object				
1370.000	30.000	25.000	passed	Object				
1375.000	25.000	25.000	passed	Object				
1380.000	20.000	25.000	passed	Object				
1385.000	15.000	25.000	passed	Object				
1390.000	10.000	25.000	passed	Object				
1395.000	5.000	25.000	passed	Object				

Generated by 12d Model at 2019-06-18T13:02:19

APPENDIX K

AQUAPLANING

12D AQUAPLANING RISK ASSESSMENT
12D MODEL VERSION 12.0C1k

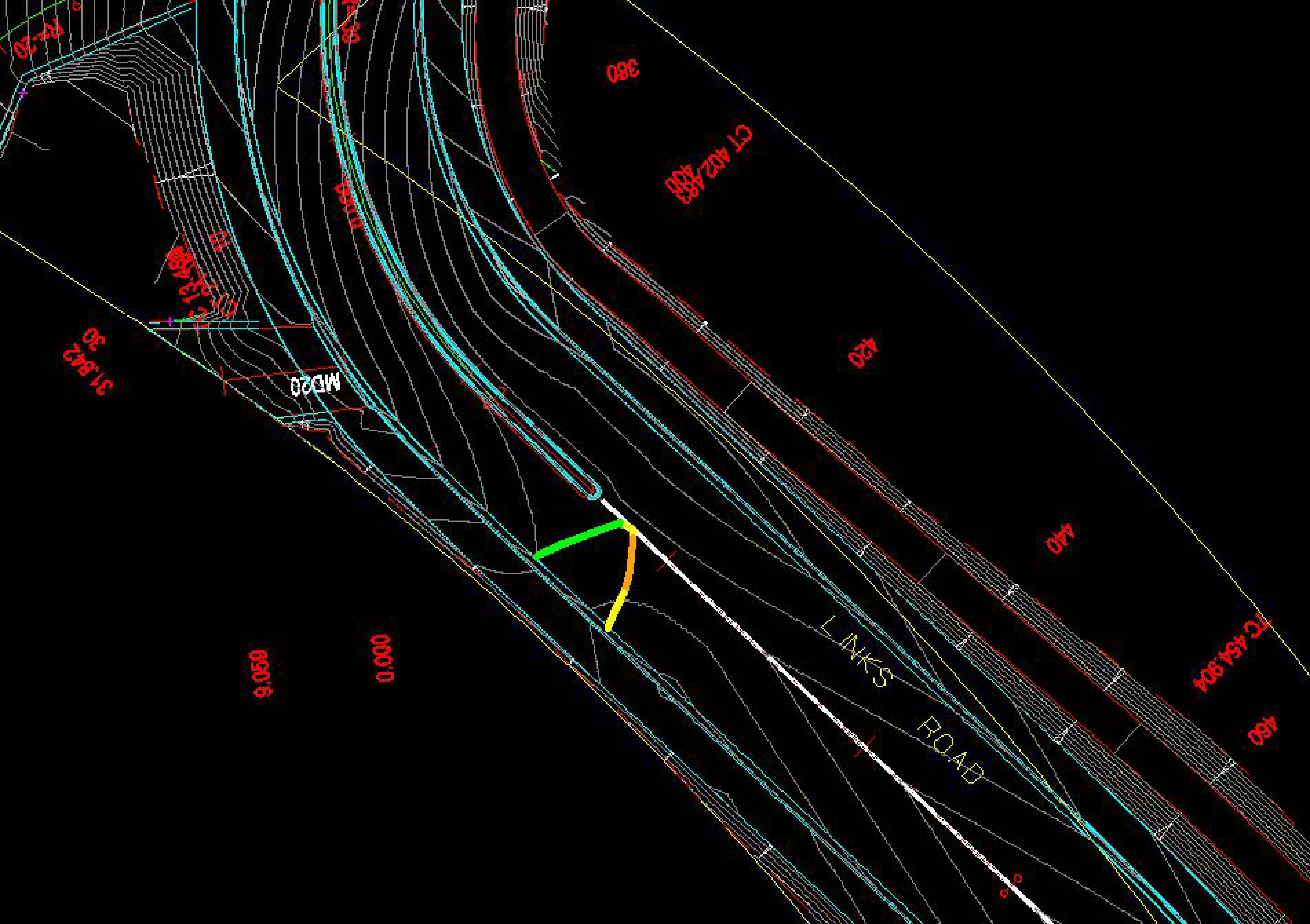
12D PROJECT: Links Rd Freeze
12D WORKING FOLDER:
U:\Projects\PS111235_Links_Road_Extens\4_WIP\BIM\12d\Design\Road\Links Rd Freeze
DATE: 24-JUN-2019 15:37:56
ASSESSOR: AUDB501627
VERIFIER:

MODEL OF FLOW PATHS: F AQUA CHECK
ROAD PAVEMENT TIN: F DES RD
REFERENCE STRING: F CTRL MASTER->MC10
RAINFALL INTENSITY (mm/hr): 50.0
PAVEMENT TEXTURE DEPTH (mm): 0.4
FLOW PATH SLOPE: EQUAL-AREA SLOPE

WATER FILM DEPTH RISKS
UNACCEPTABLE RISK >= 4.0 mm
HIGH (ACCEPTABLE) RISK >= 3.2 mm
MODERATE (ACCEPTABLE) RISK >= 2.5 mm
LOW (DESIRABLE) RISK < 2.5 mm

WATER FILM DEPTH PREDICTION
GALLAWAY (1979)

FLOW PATH ID	POINT	LENGTH (m)	DESIGN RL (m)	SLOPE (%)	DEPTH (mm)	DEPTH RISK	DEPTH RATE (mm/m)	WARNING
420 R0	1	1.525	20.368	1.94	0.45	LOW	0.30	
420 R0	2	3.050	20.345	1.53	0.87	LOW	0.28	
420 R0	3	4.575	20.342	0.79	1.59	LOW	0.35	
420 R0	4	6.100	20.333	0.68	1.99	LOW	0.33	
420 R0	5	7.626	20.332	0.46	2.71	MODERATE	0.36	
420 R0	6	9.151	20.331	0.34	3.42	HIGH	0.37	
420 R0	7	10.676	20.324	0.38	3.49	HIGH	0.33	
420 R0	8	12.201	20.310	0.50	3.27	HIGH	0.27	
420 R0	9	13.726	20.293	0.64	3.09	MODERATE	0.23	
420 R0	10	15.251	20.271	0.79	2.94	MODERATE	0.19	


LINKS ROAD
380
CT 402.463
420
440
460
TC 454.904
MD20
31.842
30
9.059
0.000

APPENDIX L

JBS&G AUSTRALIA PTY LTD TO LENDLEASE COMMUNITIES CONTAMINATION ASSESSMENT

54340-120872
L01 (Response to PCC - Road Upgrade) rev A

27 February 2019

ATT: Sean Porter
Development Manager
Lend Lease NSW/ACT Communities
Level 2, 88 Philip St
PARRAMATTA NSW 2150
Via email: [redacted]

Contamination Assessment in Support of Upgrade and Extension to Links Road, St Marys NSW
Response to Penrith City Council Contentions on Site Contamination

Dear Mr Porter,

Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) has been previously engaged by the Maryland Development Company Pty Ltd (Maryland, the client) to prepare an environmental site assessment of a road corridor as associated with Links Rd and a proposed extension of Links Rd at St Marys NSW. This has been previously issued as *Maryland Development Company Pty Ltd Environmental Site Assessment Links Road Extension Dunheved, NSW*, 28 March 2018, JBS&G Australia Pty Ltd (JBS&G 2018).

JBS&G (2018) Environmental Assessment

JBS&G (2018) has previously reported that the area of the proposed road corridor is affected by a range of historically dumped / tipped materials that are present overlying the current site surface. The dumped / tipped materials were observed to contain isolated areas of asbestos containing materials. Assessment of soils along the extent of the road corridor did not identify chemical concentrations of any constituents, or otherwise aesthetic indicators of contamination, that were considered inconsistent with a proposed ongoing use as a roadway. The site was found to be suitable from a contamination perspective to be used as a roadway.

JBS&G (2018) recommended that the tipped / dumped materials should be cleaned up / removed prior to the commencement of construction works.

Penrith City Council Response to Environmental Assessment

Penrith City Council (PCC) in consideration of development application DA18/1163 have provided a review of JBS&G (2018), and an opinion that the works recommended in JBS&G (2018) to remove dumped / tipped materials constitutes remediation works as per SREP 20 and SEPP 55. Specific reference is made to Clause 11(4) of SREP 20, and how it relates to fragments of asbestos containing material as identified as having ben historically dumped on the site as meeting a definition of contaminated land, and rectification of this as remediation of contaminated land.

EPA, Workcover and Safe Work Australia Policy as to Clean-Up / Removal of Dumped Asbestos

Consistent with JBS&G (2018), it is not considered that the proposed works to remove the surface occurrences of historically dumped / tipped wastes meets the intended definition of remediation of contaminated land. This is consistent with guidance provided for asbestos waste in *Guidelines for the NSW Site Auditor Scheme 3rd Edition*, 2017, NSW EPA (EPA 2017). EPA (2017) is an approved guideline under the *Contaminated Land Management Act 1997* (CLM Act). *Managing Land Contamination Planning Guidelines SEPP 55 – Remediation of Land*, April 1999, Department of Urban Affairs and Planning (DUAP 1999) refers to earlier revisions of EPA (2017).

EPA (2017) instructs that a range of other instruments are available to deal with asbestos and asbestos waste rather than strict regulation through guidelines created under the CLM Act. EPA (2017) includes specific reference to Workcover and Safe Work Australia publications on the management of asbestos and the *Protection of the Environment Operations (Scheduled Activities and Waste) Regulation 2014* (POEO SA&W Reg)

An outline for managing dumped asbestos, as well as asbestos contamination on sites where asbestos was historically used / manufactured, is provided to *Managing Asbestos in or on soil*, March 2014, WorkCover NSW (Workcover 2014). With specific regard as to whether asbestos clean-ups should be regulated or undertaken consistent with the CLM Act, and further by inference whether the occurrence of asbestos is appropriate to be classified as contaminated land; It is stated that incidents of illegal dumping, or sites that contain non-friable asbestos material (such as fibro) should be managed consistent with the framework outlined in the document. Of relevance to the site, Workcover (2014) instructs:

- Removal of asbestos fragments by hand-picking;
- Raking of surface soils (if present underlying affected area) to ensure all materials removed;
- Handling of collected asbestos consistent with *How to safely remove asbestos code of practice*, 2011, Safe Work Australia;
- Use of a Class A or Class B asbestos removal contractor as dependent on the form and extent of asbestos;
- Soil sampling to confirm removal of asbestos where friable forms, or fines, are observed; and
- Use of a Licensed Asbestos Assessor to confirm removal works have been completed and undertake air monitoring.

It is specifically noted in WorkCover (2014) that instances of asbestos impact as consistent with those observed on the site and assessed in JBS&G (2018) should not be reported to the NSW EPA as contamination as per the meaning to the CLM Act.

Of specific relevance to the proposed asbestos removal for the site, the works as recommended by JBS&G (2018) would be undertaken consistent with clauses 452 and 453 of the *Work Health Safety Regulation 2017* (WHS Reg). The undertaking of the removal works would be controlled by Part 8.7 of the WHS Reg. The appropriate removal of the hazardous material (i.e. asbestos) would require to be confirmed by a licensed Asbestos Assessor as consistent with clauses 473 and 474 of the WHS Reg. Management of worker exposures, and/or the surrounding environment, during the removal works is required to be undertaken consistent with Part 8.5 of the WHS Reg.

Conclusion and Recommendation

On the basis of guidance provided by the NSW EPA, Safe Work Australia and Workcover NSW it is considered more appropriate to require removal of asbestos hazards from the site to be undertaken in accordance with the provisions of the WHS Reg, *Code of Practice How to Safely Remove Asbestos*, September 2016, SafeWork NSW and Workcover (2014). This should include validation of the removal of the asbestos hazard by a Licensed Asbestos Assessor.

Should you require clarification, please contact the undersigned on 02 8245 0300 or by email mparkinson@jbsg.com.au.

Yours sincerely:

Matthew Parkinson
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Attachment: 1, Limitations

Attachment 1 – Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.