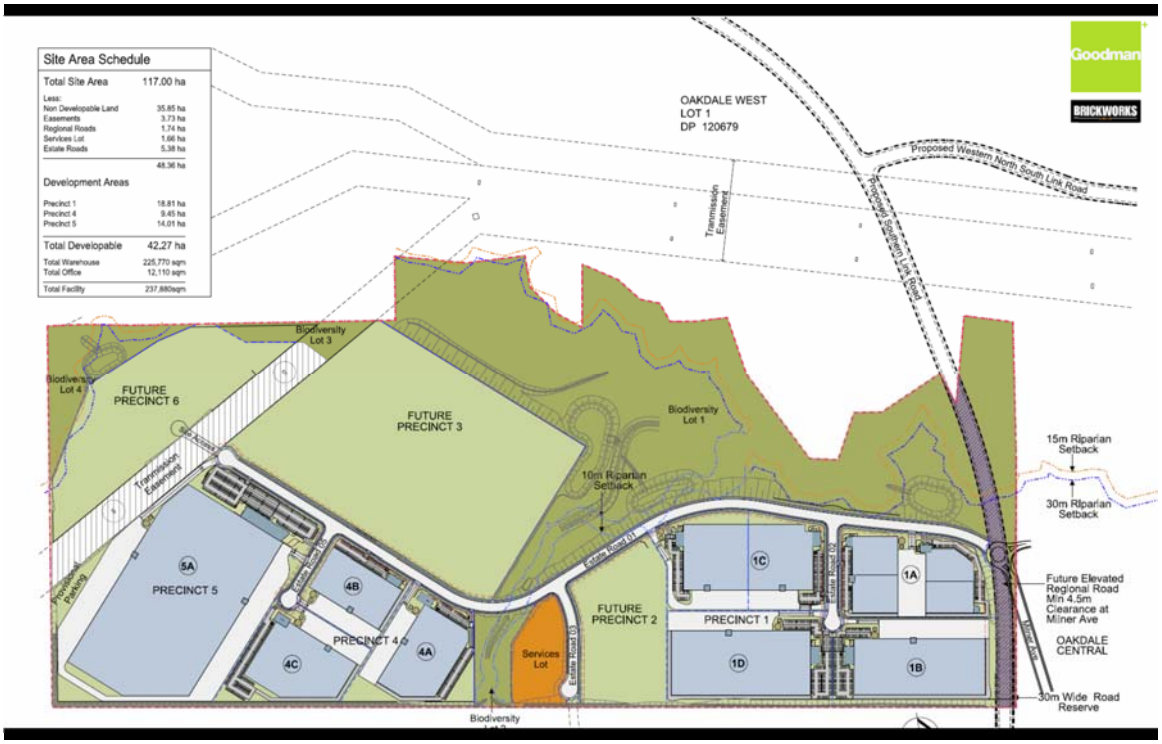
Oakdale South Development

State Significant Development Application



Civil, Stormwater and Infrastructure Services Report

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Finalisation signatures

The design described in this report is considered to have been finalised.

	Signature	Date
Andrew Tweedie Civil Engineer (Author)		08/09/2015
Frank Xie Lead Designer / Civil Engineer		08/09/2015
Anthony McLandsborough Director		08/09/2015

Notes: The finalisation signatures shown above do not provide evidence of approval to the design. Approval signatures are shown on the title sheet of the design plans.

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Abbreviations

OSE	Oakdale South Estate
OEH	Office of Environment and Heritage
EP	Equivalent Persons
ET	Equivalent Tenancy
IWM	Integrated Water Management
MG	Goodman Property Services (Aust) Pty Ltd
STP	Sewerage Treatment Plant
SWC	Sydney Water Corporation
WELS	Water Efficiency Labelling
EIS	Environmental Impact Statement
SSDA	State Significant Development Application

Executive Summary

Goodman Property Services (Aust) Pty Ltd is developing the Oakdale South site for the purposes of providing a warehouse and distribution complex. The Oakdale South site is a precinct within the wider 'Oakdale' Estate development and forms part of a progressive development designed to make 'Oakdale' a regional distribution park of warehouses, distribution centres and freight logistics facilities.

The Oakdale South project is a staged development including bulk earthworks, civil works, and services infrastructure and stormwater management.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the project relevant to earthworks, stormwater, roadworks and infrastructure servicing. Its outlines the proposed components of the design including, Civil Design and Infrastructure, Road geometry and pavement design and Sedimentation and Erosion Control, Stormwater Management (On Site Detention, Piped and Overland Flows, Water Sensitive Urban Design) and Construction.

The development will be constructed over three stages with each construction stage consisting of the construction of the estate road, bio-retention basin, lead-in services and utility reticulation as required to service each civil stage.

The bulk earthworks within the Services Lot will be constructed as part of Stage 1 along with the creek realignment and associated swales, open channels and surface treatment for scour protection.

The site is located in the Penrith City Council Local Government area and in order to meet the council requirements for Hydraulic Design and Water Sensitive Urban Design, DRAINs and MUSIC modelling software has been used to calculate the required output results.

The Precinct based bio-retention basins have been designed to both attenuate stormwater flows and treat the nutrients to Penrith City Council treatment rates. The Precinct Site Detention is designed to mitigate post development flows to pre-developed flows for peak Average Reoccurrence Interval (ARI) events and has been sized to ensure that for all storm events up to and including the 1:100 ARI event, the development does not increase stormwater flows in any downstream areas.

The Site Catchment plan is separated into five areas (A-E), with areas A-D all draining into bio-retention basins. All stormwater runoff within catchment E bypasses the basins and drains directly into Ropes Creek. This is due to the existing ground levels within catchment E which do not allow gravity drainage within any of the proposed basins. Catchment E is contained wholly within the existing transmission easement.

This report also identifies the strategy for infrastructure services required to service the site including potable water, sewer, power, telecommunications and gas. The infrastructure to service this development forms part of an overall strategy for infrastructure to the 'Oakdale' Estate which in most cases requires the infrastructure to be extended into Oakdale South to service the required Precinct area based on the staged construction.

This report also details the proposed estate road and pavement construction methodology along with the typical retaining wall details for both cut and fill construction.

This report, the design drawings and the calculations form the response to the relevant Secretary's Environmental Assessment Requirements with respect to the overall Masterplan and the staged construction works as documented in the Staging Plan shown in Appendix A.

Compliance with Secretary's Environmental Assessment Reports (SEARs)

This report responds to the SEAR's issued by the NSW Planning and Environment on 22nd April 2015. The table below summaries all key civil / infrastructure issues raised in the SEAR's and how they have been dealt with.

Key Issue	Response
Soils and Water	
an outline of the proposed water requirements, including a consolidated site water balance, details of water supply sources, usage data and efficiency measures	A Water Balance section has been included in this report. Refer Section 7 for all site water balance details, water supply source, usage calculations and efficiency measures.
A detailed assessment of potential soil (including contamination and acid sulphate soil), surface water, groundwater and salinity impacts of the proposed development, including adequate mitigation and monitoring measures	A soil salinity and aggressivity investigation has been undertaken by PSM which covers this issue. Refer to Report PSM1541-112L dated 9th July 2015 Refer to the Appendix T of the EIS.
A assessment of the potential impact of the development on Ropes Creek, it's on-site tributaries and riparian areas	This study has been carried out by Aecom as part of the Ropes Creek Realignment study. Refer to Section 9 and Appendix M of the EIS.
A description of the surface and stormwater management designed in accordance with Water Sensitive Urban Design principles, including on site detention, and measures to treat or reuse water	A detailed description of all Stormwater Management including WSUD design principles is included within Section 6 of this report
Description of the proposed erosion and sediment controls during construction and operations	A detailed description of the Erosion and Sediment Control measures is included within Section 3 of this report. Note also a full set of Erosion and Sediment Control plans has been provided. Refer Appendix E of the EIS
Proposed cut and fill works associated with the development, and measures to minimize the extent of cut and fill	Refer to Section 2 of this report Appendix E of the EIS
Infrastructure Requirements	
Provision of a detailed written and/or geographical description of the infrastructure required on site	Refer to Section 10 within this report for a description of all proposed infrastructure services to the site. We have also included a full set of services and utilities coordination plans within our drawings set. Refer Appendix E of the EIS
Identification of any infrastructure upgrades required off-site to facilitate the development, and describe any arrangements to ensure that the upgrades will be implemented in a timely manner and maintained	Refer to Section 10 within this report.
An infrastructure delivery and staging plan including a description of how infrastructure on and off site will be coordinated and funded to ensure it is in place prior to commencement of construction	Refer Section 10 and Appendix E for infrastructure delivery and staging plan

Table 1 – SEARS Compliance

Agency Consultation

This report summarises all consultation and correspondence undertaken with the relevant authorities during the design phase. The following table summarises these consultations and the relevant correspondence. It should be noted not all authorities were consulted during the initial design phase. The reason for no consolation is summarized below.

Agency Consulted	Correspondence
Penrith City Council **(12 January 2015)**	Correspondence was entered into with Mr Mark Cremona, Acting Senior Engineer for Penrith City Council on 12th January 2015. Confirmation was received by Mr Cremona that the OSE was within the Penrith City Council LGA. It was also confirmed that all stormwater design needed to confirm with the Penrith City Council Design Guidelines for Engineering Works and the C3 Water Management DCP. Mr Cremona also confirmed the requirement for OSD sizing and the required water treatment rates for the bio-retention basins. All stormwater design is based on these relevant Council documents and is referenced in Section 6 of this report.
Sydney Water **(15 July 2015)**	A meeting was held with Sydney Water on 15 July 2015 in order to confirm the infrastructure servicing requirements for Oakdale South and in parallel the future Oakdale West.
Endeavour Energy **(18/03/14, 25/02/15, 18/03/15)**	Over the past 18 months numerous meetings have been held with Endeavour Energy (EE) in relation to servicing the proposed development site. Currently EE have indicated that a new Zone Substation will ultimately be required to service the development

Table 2 – Agency Consultation

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1 Introduction

"This report has been prepared to inform a State Significant Development Application (SSDA) for the staged development of the Oakdale South Estate (OSE). The aim of the report is to assess the potential impacts of the proposed development with respect to the Civil and Infrastructure and has been prepared in accordance with Penrith City Council current design guidelines, the relevant Australian Standards and the relevant Austroad Guidelines. The report responds to the Secretary's Environmental Assessment Requirements (SEARs) as they relate to Civil and Infrastructure, specifically as outlined in the SEAR Compliance Table above. This report supports an Environmental Impact Statement (EIS) prepared in respect of the proposal and should be read in conjunction with the EIS and development plans submitted with the SSDA.

The SSDA for the OSE seeks approval for:

An overarching planning framework to guide the staged development of the OSE including:

- An Indicative Master Plan and Structure Plan;
- Development Controls for the OSE;
- A Biodiversity Offset Strategy.

Stage 1 Development of the Estate including:

1. A package of estate-wide site preparation works to be implemented in stages including:

- Subdivision;
- Bulk earthworks (including construction of detention basins); and
- Construction of retaining walls, road and utility infrastructure/services.
- Environmental management measures and protocols for the site.

2. Development for the purposes of warehousing and distribution including:

- The construction of warehouse buildings in Precincts 1, 4 and 5;
- The construction of hardstand, loading, car parking and landscaping in Precincts 1, 4 and 5;
- The fit out and use of buildings in Precincts 1, 4 and 5 for generic warehousing and distribution uses."

1.1 Scope of Report

Objective of Report

The objective of this civil, stormwater and infrastructure services report is to outline the design criteria used for the Engineering design of all components of the development and compare to the requirements of the Penrith City Council Development Control Plans (DCP).

Summary

This report generally discusses the design philosophy behind the following components of the design for Oakdale South Estate (OSE):

- Earthworks
- Sedimentation and Erosion Control
- Retaining Walls
- Road Design
- Stormwater Management
    - On Site Detention (OSD)
    - Piped and Overland Flows
    - Water Sensitive Urban Design (WSUD)
    - Water Balance across the site
- Flood Modelling
- Creek Realignment
- Servicing
    - Water
    - Sewerage
    - Communications
    - Gas
    - Electrical
- Infrastructure Staging
- Construction
    - Clearing and Grubbing
    - Demolition
    - Earthworks
    - Roadworks and Services
    - Program
    - Plant and Equipment

Supporting documentation that is referenced and commented on within the report include the following sections;

- Flooding (Cardno)
- Creek realignment and associated riparian works (Aecom)
- Geotechnical review (PSM)
- Salinity Management Report (PSM)

The proposed site plan covering the entire Oakdale South development along with all proposed lot layouts are attached within Appendix A.

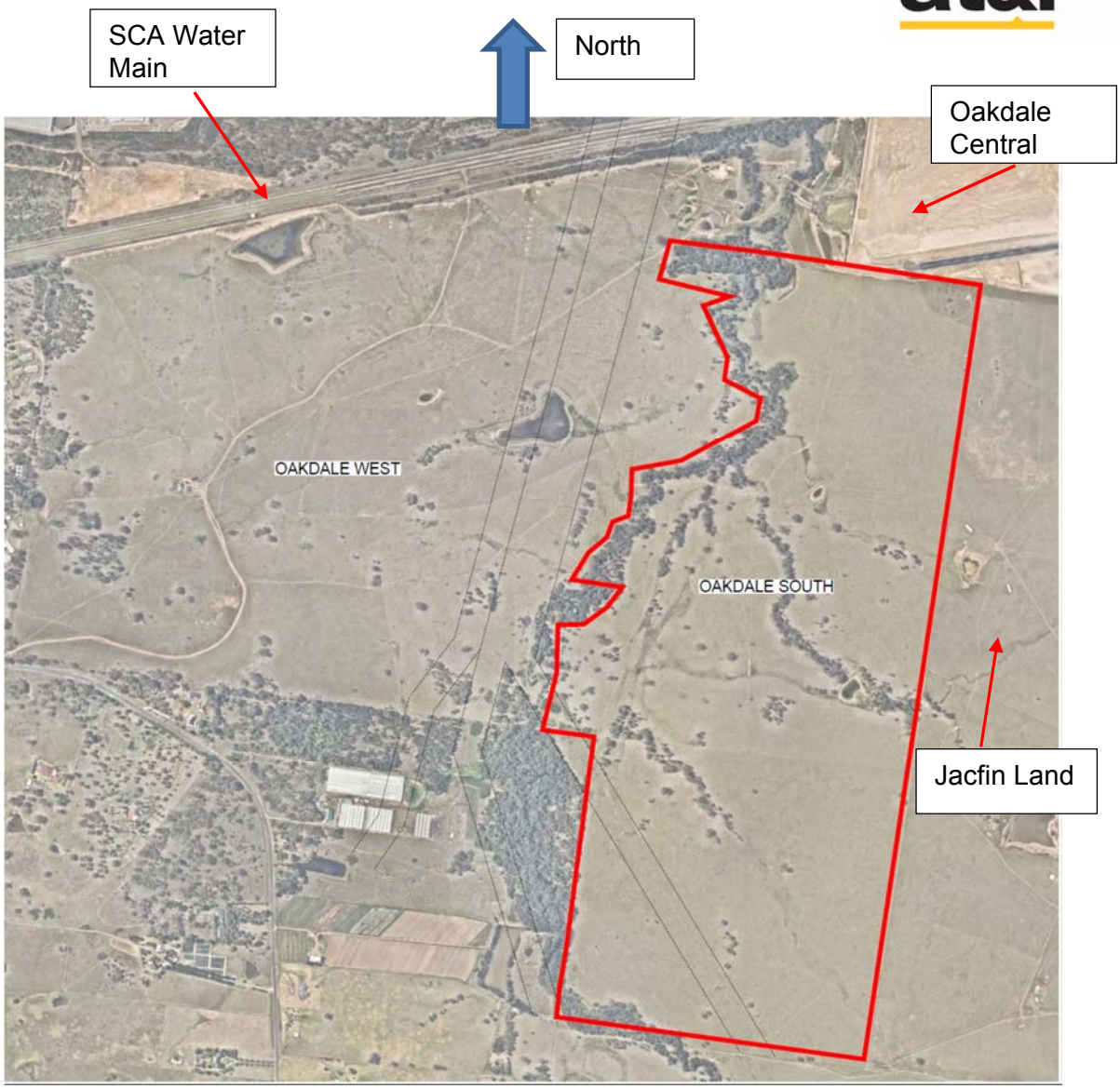

Figure 1 – Locality Plan

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2 Earthworks

2.1 Existing Geology

Based on a Geotechnical Report undertaken by Pells Sullivan Meynink (PSM) in February 2015 the following sub surface soils were encountered across the site:

- Topsoil – Sandy Clay Depth 0.0 -0.1m
- Natural Soil – Sandy Clay to Clay : Depth 0.1 to 0.4m
- Bedrock – Sandstone, Siltstone, Shale: Depth 0.8 to 5.0m

2.2 Cut/Fill Requirements

The site will require bulk and detail earthworks to be carried out across the various stages.

The site falls approximately 30m from the high points along the eastern boundary to the low points along Ropes Creek.

It is noted that following an options analysis process which included numerous design options by;

- Either maximising cut to fill and minimising import,
- Multiple smaller earthworks pads and minimising both cut / fill and retaining walls
- Maximising import and minimising cut and retaining walls

Ultimately in reviewing the various options and reviewing the cost benefit of each of the options and then taking into consideration the market availability of surplus fill, it was decided to maximise import and minimise cut across the site. By doing so we have maximised site utilisation creating large flat pads. This design limits the height of required retaining to a maximum of 10-12m for cut walls and generally 6m for fill walls.

STAGE No.	NET CUT (m^3)	NET FILL (m^3)	BALANCE (m^3) Import required
1	-226,000	+850,000	624,000
2	-412,000	+748,000	339,000
3	-21,000	+68,000	47,000
Total	-659,000	+1,666,000	1,007,000

Note these volumes are based on the current design, further detailed design may alter these.

Table 3 – Cut/Fill Summary

The import of material will be classified as either Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM) or as specified by in the Geotechnical Engineering Specification for the project. We anticipate for a development of this

scale and the close proximity of fill to the site, 100 truck and dog movements per day during the filling process would be estimated.

Topsoil is only proposed to be stripped from cut areas and or areas that have less than 1 metre of filling over. In all other areas, topsoil is to be left insitu with filling to occur directly over. Where topsoil has been stripped, the topsoil will be blended with the either cut material or imported material and used as general fill.

It is not proposed to export any topsoil from the site.

3 Sedimentation and Erosion Control

3.1 Sedimentation and Erosion Control (Construction)

Soil and Water Management Plans (SWMP) has been prepared in accordance with the NSW Department of Housing Publication titled: Managing Urban Stormwater-Soils and Construction (2004) for the whole site. Refer to AT&L Civil drawings within Appendix E of the EIS.

3.2 Sources of Pollution

The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

- Earthworks undertaken immediately prior to rainfall periods
- Work areas that have not been stabilised
- Extraction of construction water from waterways during low rainfall periods
- Clearing of vegetation and the methods adopted, particularly in advance of construction works
- Stripping of topsoil, particularly in advance of construction works
- Bulk earthworks and construction of pavements
- Works within drainage paths, including depressions and waterways
- Stockpiling of excavated materials
- Storage and transfer of oils, fuels, fertilisers and chemicals
- Maintenance of plant and equipment
- Ineffective implementation of erosion and sediment control measures
- Inadequate maintenance of environmental control measures
- Time taken for the rehabilitation / revegetation of disturbed areas

3.3 Potential Impacts

The major potential impacts on the riparian environment relate to erosion of distributed areas or stockpiles and sediment transportation. Potential adverse impacts from erosion and sediment transportation can include:

- Loss of topsoil
- Increased water turbidity
- Decreased levels of dissolved oxygen
- Changed salinity levels
- Changed pH levels
- Smothering of stream beds and aquatic vegetation
- Reduction in aquatic habitat diversity
- Increased maintenance costs
- Decrease in waterway capacity leading to increased flood levels and durations

3.4 Construction Methodology

The following construction methodology will be followed to minimise the impact of sedimentation due to construction works:

- Diversion of “clean” water away from the disturbed areas and discharge via suitable scour protection.
- Provision of hay bale type flow diverters to catch drainage and divert to “clean” water drains.
- Diversion of sediment-laden water into temporary sediment control basins to capture the design storm volume and undertake flocculation (if required).
- Provision of construction traffic shaker grids and wash-down to prevent vehicles carrying soils beyond the site.
- Provision of catch drains to carry sediment-laden water to sediment basins.
- Provision of silt fences to filter and retain sediments at source.
- Where future construction and building works are not proposed, the rapid stabilisation of disturbed and exposed ground surfaces with hydro-seeding

Note these sediment and erosion control measures will be in place for each Stage of the works. Upon completion of Stage 1, the control measures will remain in place during construction of Stage 2 and 3 until the individual lots are developed on.

3.5 Site Inspection and Maintenance

The inspection and maintenance requirements outlined in this section will need to be carried out as long as either earthworks or quarrying is being conducted and all areas re-established.

The Contractor’s site Superintendent will inspect the site after every rainfall event and at least weekly, and will:

- Inspect and assess the effectiveness of the SWMP and identify any inadequacies that may arise during normal work activities or from a revised construction methodology. Construct additional erosion and sediment control works as necessary to ensure the desired protection is given to downstream lands and waterways
- Ensure that drains operate properly and to effect any repairs
- Remove spilled sand or other materials from hazard areas, including lands closer than 5 metres from areas of likely concentrated or high velocity flows especially waterways and paved areas
- Remove trapped sediment whenever less than design capacity remains within the structure
- Ensure rehabilitated lands have affectively reduced the erosion hazard and to initiate upgrading or repair as appropriate
- Maintain erosion and sediment control measures in a fully functioning condition until all construction activity is completed and the site has been rehabilitated
- Remove temporary soil conservation structures as the last activity in the rehabilitation

3.6 Conclusion

The erosion control measures proposed for the site will comply with the requirements of Penrith City Council and The Department of Environment, Climate Change and Water (DECC).

The proposed SWMP will ensure that the best management practice is applied to the development site in controlling and minimising the negative impacts of soil erosion.

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4 Retaining Walls

4.1 Retaining Walls

Where possible, batter slopes will be provided to accommodate level changes. Where this is not possible retaining walls will be constructed along the estate road, lots and basins based on the current civil and earthworks design. An Austral product or other similar face block will be adopted for all retaining walls as detailed on the civil drawings.

The proposed retaining walls will be built to the manufacturers design guideline requirements and verified by a structural engineer prior to construction. This practice was adopted on Oakdale Central and considered input from the geotechnical engineer, utility coordination as well as entry and exit points from proposed lots.

Significant retaining is required along the eastern boundary where it is required to cut down from existing to create the new building pads. It is proposed to use a soil nail wall to retain the existing earth.

All retaining walls will be constructed on a stage basis. Where the walls are not constructed a batter of 1 in 4 will be maintained for stability purposes.

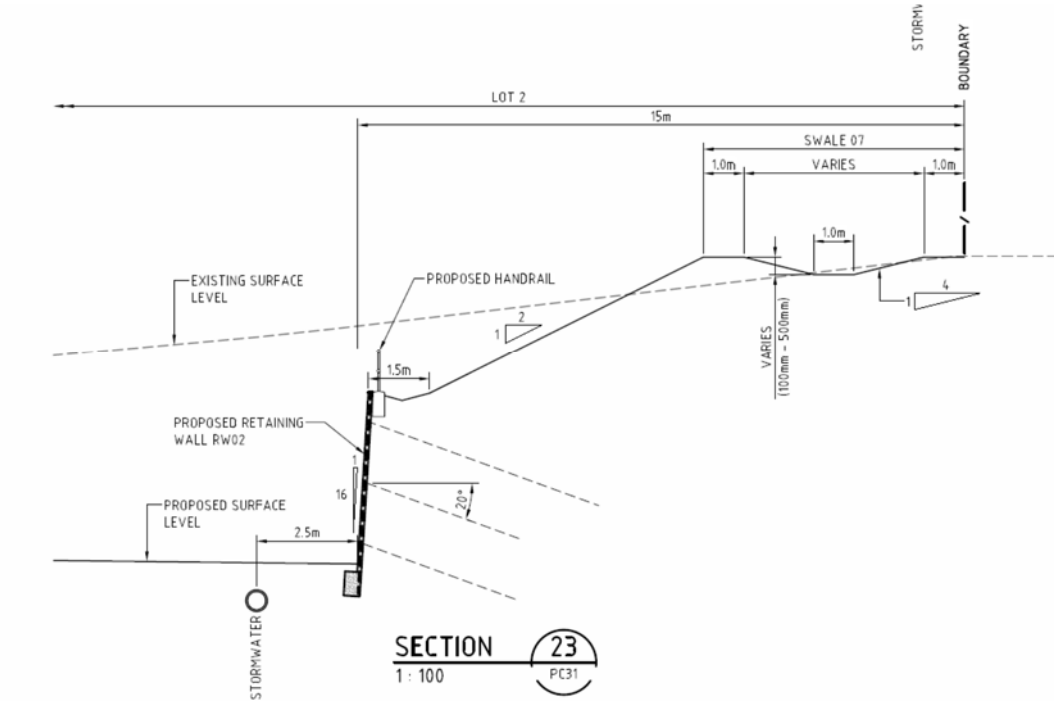

Figure 2 – Eastern Boundary Interface

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5 Road Design

5.1 Horizontal and Vertical Geometry

The Estate Road extension from Millner Avenue and the cul-de-sac's have generally been designed to meet Austroads requirements and Australian Standards to accommodate B-Double truck movements.

The proposed road reserve as described below does not conform to Penrith City Council's standard road reserves which requires a minimum 20.6m road reserve. This greater road reserve width has been adopted as it was used on the adjacent Oakdale Central development. To ensure consistency between the two developments the Oakdale Central road reserve alignment has been adopted for the design base for the OSE. It should be noted the road reserve being adopted for the OSE exceeds the road reserve widths as specified in the Penrith City Council and hence a more conservative option.

The Estate Road is designed as such:

- 23.0m wide Road Reserve
- 15.5m wide Carriageway comprising:
    - 2x 3.5m wide traffic lanes
    - 2x 4.25m wide traffic lanes adjacent kerb
- Verge ranging between 3.5m to 4.0m wide depending on if 2.5m shared path is present.
- Cul-De-Sac have been shown at 30m Diameter to accommodate the largest design vehicle
- The largest design vehicle is a B-Double
- Design Speed of Road = 60km/hr
- No guard fences have been shown and these will assessed at detailed design stage in accordance with Austroads.
- The road is proposed to be constructed over the existing Ropes Creek Tributary. A box culvert 4.2m wide by 1.2m high is proposed to ensure the Ropes Creek Tributary drains beneath the proposed road. Refer to the Civil drawings for culvert plan location and sections.

Refer to Figures 3 and 4 below indicating typical road sections. Figure 2 is the typical arrangement incorporating the 2.5m wide shared path whilst Figure 3 is the typical section indicating standard 1.2m wide footpaths on each verge.

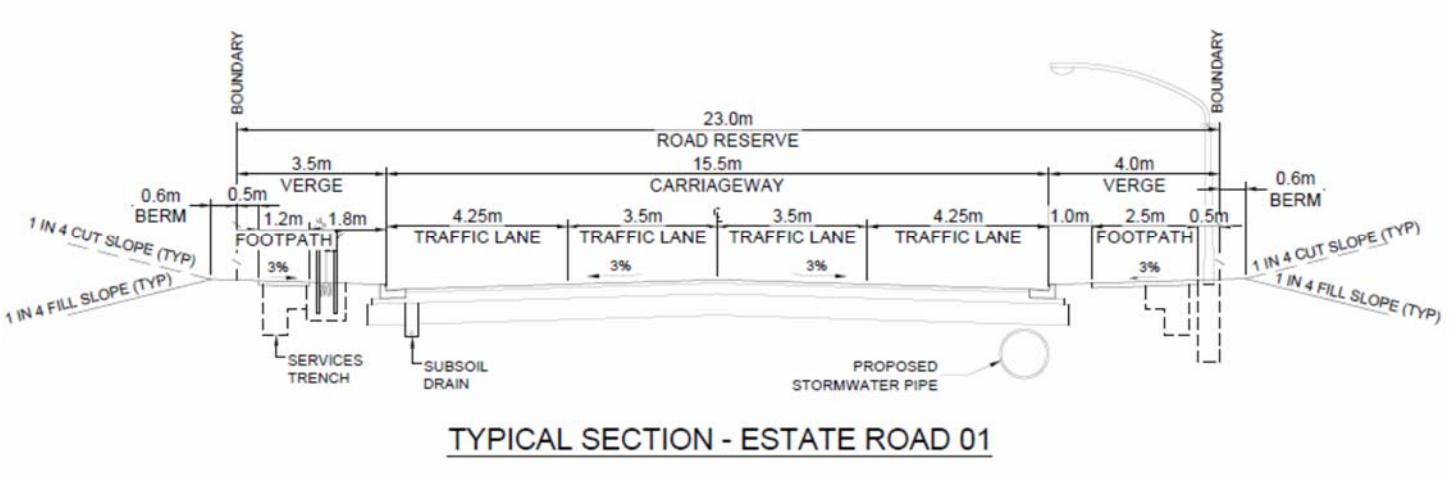

Figure 3 - Typical Estate Road Section (with 2.5m shared path)

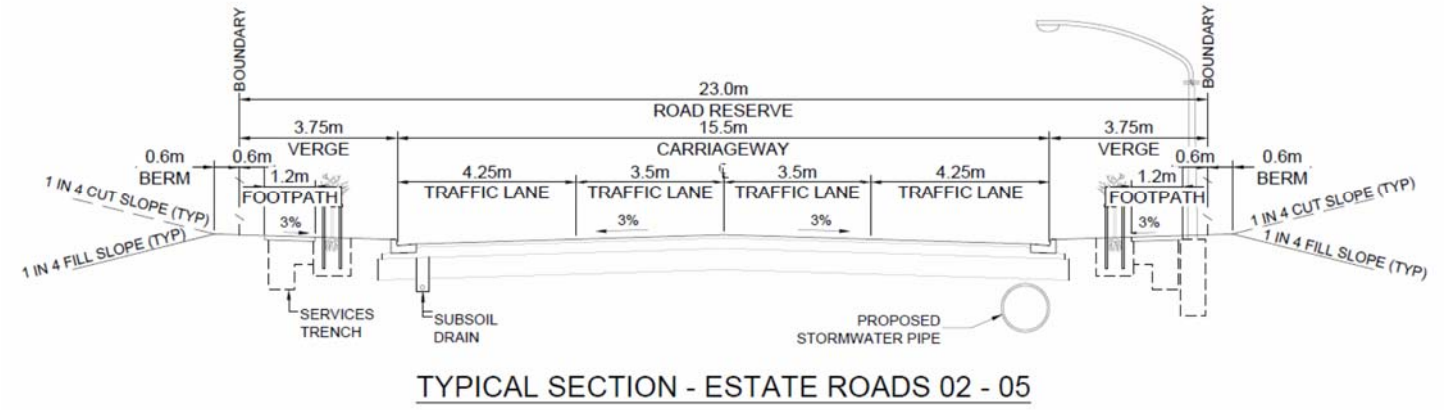

Figure 4 - Typical Estate Road Section (without 2.5m shared path)

5.2 Pavement

Pavement will be designed based on the requirements of Austroads Pavement Design Guide – A Guide to the Structural Design of Road Pavements and recommendations provided by Pells Sullivan Meynink (PSM) in report PSM1541-019L dated February 2012.

The basis of this design is:

- Design Traffic Loading : N =1x10^7 ESA
- Design subgrade CBR = 2% with a reduction if the subgrade is CBR 5%

Based on these parameters the pavement design is as follows:

- 35mm AC 14 320 Bitumen
- 35mm AC 14 320 Bitumen

- 7mm Spray Seal
- 250mm DGB 20 (placed in two layers)
- 500mm Select Sandstone Fill with minimum CBR= 35% (placed in three layers)

If the subgrade CBR = 5% the bottom 200mm of select sandstone fill can be replaced with select fill with minimum CBR of 5%.

CBR testing is proposed to the undertaken at the subgrade level to confirm this pavement design.

5.3 Batter Design

All external batters to the development have been limited to 1 in 4 as a minimum generally. The area below the future SLR have been cut to 1 in 10 to provide a landscape buffer.

Any temporary batters constructed during the works will be in accordance with the geotechnical report and ongoing advice from the Level 1 supervisor

5.4 Southern Link Road Location

The southern Link Road (SLR) has been located to provide the overall best outcome for the development and in doing so we have undertaken a review of the concerns raised within the SEARS response letters. These are summarised as follows;

5.4.1 Proposed Roundabout Location

The proposed Roundabout does not form part of this application and has been previously approved as part of the SSD 6078.

Additional to that approval we are seeking to construct the 3rd leg of the roundabout to facilitate the OSE development.

Over the past two years a series of meetings have been held with DoP to work through the various route options for the SLR. Whilst a number of options were developed, no final design was agreed.

We have reviewed the constructability of the SLR in relation to the roundabout under. A plan and typical section has been prepared to demonstrate the bridge option, refer Appendix G. It is proposed three sections of 'Super-T' girders will be required to span the roundabout. A central headstock and columns will be located within the centre island of the roundabout with appropriate clearances as required by the Austroad guidelines.

We have also adjusted the location of the SLR to ensure there is no impact to the existing Jacfin Concept and Stage 1 Project Approval. It would appear the existing Aecom option would have some impact on these approvals. We have no direct communications with Jacfin and have based this on the available information on the Departments Web Page.

5.4.2 Interconnectivity to the Rest of the BWSEA

As part of the OSE proposal, Road 3 has been identified to ultimately provide access to the adjacent Jacfin development. Trunk sewer and water is also proposed to allow for the future development.

5.5 Conclusion

All road design as demonstrated above is in accordance with Austroads Standards and the requirements of Penrith City Council, as a minimum.

A professional geotechnical engineer will be engaged to design the structural pavement. This is also in accordance with Austroads Pavement Design Guide – A Guide to Structural Design of Road Pavements.

6 Stormwater Management

6.1 Existing Site Stormwater Drainage

Currently the site comprises farmland and is classified as a “greenfield” site with an entire coverage of pervious areas.

The site slopes down from east to west with the existing site draining via overland flow into the Ropes Creek to the west of the site.

There are two existing tributaries of Ropes Creek and a floodway within the middle section of the site which currently drain the majority of the site into the adjacent Ropes Creek. Refer to SKC008 within Appendix A for a pre-development stormwater catchment plan indicating the location of these catchments.

6.2 Proposed Site Stormwater Drainage

As discussed in Section 2.2 of this report, due to the existing steep grades across the site extensive filling is required to ensure level pads are created for proposed roads and on lot pads.

As a result of this filling the northern and southern Ropes Creek Tributaries will be filled in. These tributaries are shown in Catchment C and F within SCK008. To compensate for the overland flows from the land to the east of the site which pre-development drained into these tributaries, a combination of swale drains and pipe and pit networks at the eastern boundary of the site will capture these flows.

All overland flows to the east of the site adjacent Catchment G and F will be collected by swale drains and pits and pipes and directed into the Ropes Creek Tributary within Catchment E

All overland flows to the east of the site adjacent Catchment C will be collected by swale drains and pits and pipes and drain along the southern boundary of the site to discharge into Ropes Creek.

All stormwater on the lots and within the road reserve is proposed to be collected via pits and pipes and connect into one of the four On-Site Detention basins to the west adjacent Ropes Creek. All basins will have an outlet structure and overflow weir system to drain into Ropes Creek. Scour protection will be provided on these outlet structures to minimize the effects of erosion on the existing Ropes Creek. Refer to Section 6.3.3 and 6.3.4 of this report for a more detailed description of these post developed catchment areas.

Refer to the Civil Drawings for layout and details for the proposed stormwater network across the site.

6.3 Council Requirements & Recommendations

All estate level stormwater drainage for the OSE development is designed to comply with the following:

- Penrith City Council Design Guidelines for Engineering Works

- Penrith City Council Water Sensitive Urban Design (WSUD) Policy December 2013
- C3 Water Management DCP.

A summary of the design requirements adopted is listed below:

- Precinct based basins will serve the development as detention and bio-retention basins
- All stormwater drainage within the access road and bio-retention basins will be dedicated to Penrith City Council. Maintenance and repair works of the stormwater drainage network outside of the lots will be the responsibility of Penrith City Council. All stormwater drainage within the lots will be the responsibility of the individual property owners.
- OSD to be sized to ensure that for all rainwater events up to and including the 1:100 ARI event, new developments do not increase stormwater peak flows in any downstream areas.
- OSD to mitigate post development flows to pre-developed flows for peak Average Reoccurrence Interval (ARI) events.
- All OSD basins have been designed with a 3.0m wide sprayed seal access road along the berm to ensure maintenance vehicles can access the entire exterior of the basin
- WSUD to achieve target reductions:
    - 85% Total Suspended Solids (TSS)
    - 60% Total Phosphorus (TP)
    - 45% Total Nitrogen (TN)
    - 90% Gross Pollutants (GP)
- Finished Floor Levels (FFL) to have minimum 500mm freeboard to 100 year overland flows.
- A gross pollutant trap (GPT) will be installed within each development site on the final downstream stormwater pit prior to discharging. As these GPT's will be located on-lot as they will be owned and maintained by the individual property owner.

Rainwater tanks are desirable for re-use for irrigation, toilet and other non-potable water uses. Rainwater tank size is determined in accordance with the Penrith City Council C3 Water Management DCP. Refer to Section 7 of this report for a more detailed description on rainwater harvest tanks.

6.3.1 Modelling Software

DRAINs modelling software has been used to calculate the Hydraulic Grade Line (HGL) of the estate level stormwater pipes. DRAINs is a computer program used for designing and analyzing urban stormwater drainage systems and catchments. It is widely accepted by Council's across NSW as the basis for stormwater design and has been confirmed by Penrith City Council as the preferred stormwater software analysis package. DRAINs data files and output results are attached in Appendix D.

MUSIC modelling software has been used to evaluate pollutant loads from each developed lot. For a detailed description of the MUSIC modelling refer to Section 4.2.6 of this report. MUSIC data files and output results are attached in Appendix D.

6.3.2 Hydrology

- Pipe drainage shall be designed to accommodate the 20-year ARI storm event.
- The combined piped and overland flow paths shall be designed to accommodate the 100-year ARI storm event.
- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flowpath capable of carrying the total 100-year ARI storm event shall be provided. Alternatively the pipe and inlet system may be upgrade to accommodate the 100 year ARI storm event.
- Rainfall intensities shall be as per the Intensity-Frequency-Duration table in accordance with the Australian Rainfall and Runoff (AR&R) volume 2.
- Times of concentration for each sub catchment shall be determined using the kinematic wave equation.
- Runoff coefficients shall be calculated in accordance with AR&R. The fraction impervious shall be determined from analysis of the sub catchments.
- Flow width in gutter shall not exceed 2.5m for the minor design storm event.
- Velocity depth ratios shall not exceed 0.4 for all storms up to and including the 100 year ARI event.
- Inlet pits to be spaced so that flow width shall not exceed 80l/sec
- Bypass from any pit on grade shall not exceed 15% of the total flow at the pit
- Blockage factors of 20% and 50% shall be adopted for pits on grade and at sags respectively.

6.3.3 Hydraulics

- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design. The HGL shall be shown on all drainage long sections.
- The minimum pipe size shall be 375mm diameter RCP.
- Maximum spacing between pits shall not exceed 75m.
- The minimum pipe grade shall be 0.5%.
- All pipes shall be Rubber Ring Jointed unless noted otherwise.
- The minimum cover over pipes shall be 450mm in grassed areas and 600mm within carriageways.
- Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased.

- All trafficable shall be Reinforced Concrete Pipes or Fibre Reinforced Cement equivalent.
- The pipe friction coefficients to adopted shall be:

Materials	Mannings – n	Colebrook-White – k	Min. Pipe Class
RCP	0.012	0.6	3
FRC	0.01	0.15	3

Table 4 – Pipe Details

- All pipes classes shall be designed for the ultimate service loads and where applicable, construction loads will be designed for.
- Pipes discharging to the overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level.
- Pit Loss coefficients shall be calculated in accordance with Missouri Charts.
- A minimum 150mm freeboard shall be maintained between pit HGL and pit surface levels.
- Overland flowpaths shall maintain a minimum of 300mm freeboard to all habitable floor levels.
- Pits deeper than 1.2m shall contain step irons at 300 mm centres.

6.3.4 Catchments

A Stormwater Catchment Plan for each Catchment and the overall site is shown in Appendix A. As indicated in the Catchment Plan each of the basins are bio-retention basins designed to both attenuate stormwater flows and treat the nutrients to Penrith City Council treatment rates. These treatment rates are from the Penrith City Council C3 Water Management DCP.

It should be noted whilst Catchments A, B, C and D all drain into bio-retention basins, all stormwater runoff within Catchment E bypasses the basins and drains directly into Ropes Creek. The existing ground levels within Catchment E do not allow gravity drainage within any of the proposed basins.

All runoff within this catchment has been allowed to drain un-attenuated and untreated. However this area has been allowed for in the overall hydraulic calculations in determining basins sizes and bio-retention areas and is therefore considered acceptable from the perspective of Council's adopted standards.

The proposed stormwater catchment associated with each Catchment is

- Catchment A = 173,000m2 (17.3Ha)

- Catchment B = 100,001m2 (10.01Ha)
- Catchment C = 412,700m2 (41.27Ha)
- Catchment D = 709,000m2 (7.09ha)
- Catchment E (bypass) = 47,800m2 (4.78Ha)

6.3.5 On-Site Detention (OSD)

As discussed in Section 6.1, OSD is required within the development to mitigate post developed flows to pre-developed flow rates for peak Average Recurrence Intervals (ARIs).

A summary of the OSD requirements for each catchment is as follows:

Catchment A

All stormwater runoff from Catchment A will drain into the adjacent bio-retention Basin A to the north west of Road 01

The OSD within the basin has been designed to achieve the following outcomes:

- OSD volume of 4,581m^3 (capacity of the basin from extended detention RL 57.0 to weir of basin RL 58.85)
- Post developed peak flows to be mitigated to pre-developed peak flows for all storm events between and including the 1 and 100 year events. Refer to Table 5

Duration	Pre Developed Flows (m^3/s)	Post Developed Flows (m^3/s)
1 YR ARI	0.461	0.438
2 YR ARI	1.43	0.812
5 YR ARI	2.8	1.12
10 YR ARI	3.3	1.16
20 YR ARI	3.96	1.21
100 YR ARI	5.16	1.791

Table 5 – Pre-Post Developed Flows from Bio-Retention Basin A

Catchment B

All stormwater runoff from Catchment B will drain into the bio-retention Basin B adjacent to Ropes Creek to the west of Road 01.

The OSD within the basin has been designed to generally achieve the following outcomes:

- OSD volume of 3,265m^3 (capacity of the basin from extended detention RL 59.8 to weir of basin RL 61.65)
- Post developed peak flows to be mitigated to pre-developed peak flows for all storm events between and including the 1 and 100 year events. Refer to Table 6

Duration	Pre Developed Flows (m^3/s)	Post Developed Flows (m^3/s)
1 YR ARI	0.267	0.126
2 YR ARI	0.825	0.249
5 YR ARI	1.62	0.561
10 YR ARI	1.91	0.713
20 YR ARI	2.29	0.746
100 YR ARI	2.98	0.894

Table 6 – Pre-Post Developed Flows from Bio-Retention Basin B

Catchment C

All stormwater runoff from Catchment C will drain into the adjacent bio-retention Basin C adjacent Ropes Creek to the west of Road 01

The OSD within the basin has been designed to generally achieve the following outcomes:

- OSD volume of 12,540m^3 (capacity of the basin from extended detention RL 58.4 to weir of basin RL 60.65)
- Post developed peak flows to be mitigated to pre-developed peak flows for all storm events between and including the 1 and 100 year events. Refer to Table 7

Duration	Pre Developed Flows (m^3/s)	Post Developed Flows (m^3/s)
1 YR ARI	1.1	0.633
2 YR ARI	3.4	1.26
5 YR ARI	6.69	2.1
10 YR ARI	7.88	2.62
20 YR ARI	9.44	3.32
100 YR ARI	12.3	4.61

Table 7 – Pre-Post Developed Flows from Bio-Retention Basin C

Catchment D

All stormwater runoff from Catchment D will drain into the adjacent bio-retention Basin D at the southern end of the development

The OSD within the basin has been designed to generally achieve the following outcomes:

- OSD volume of 2,759m^3 (capacity of the basin from extended detention RL 61.5 to weir of basin RL 63.35)
- Post developed peak flows to be mitigated to pre-developed peak flows for all storm events between and including the 1 and 100 year events. Refer to Table 8

Duration	Pre Developed Flows (m^3/s)	Post Developed Flows (m^3/s)
1 YR ARI	0.189	0.106
2 YR ARI	0.584	0.202
5 YR ARI	1.15	0.482
10 YR ARI	1.35	0.563
20 YR ARI	1.62	0.585
100 YR ARI	2.11	0.921

Table 8 – Pre-Post Developed Flows from Bio-Retention Basin D

6.3.6 Overland Flows

Overland flows within the access roads, carparks and hardstanding areas have been designed to be safely conveyed within the road carriageway to comply with flow widths and velocities within the Penrith City Council Design Guidelines for Engineering Works.

The 100 year ARI flood level determined by Cardno within Ropes Creek adjacent to the proposed basins have been adopted as the tailwater levels for the hydraulic modelling of the basin and stormwater network for all catchments.

6.3.7 Water Sensitive Urban Design (WSUD)

Water Sensitive Urban Design encompasses all aspects of urban water cycle management, including water supply, wastewater and stormwater management. WSUD is intended to minimise the impacts of development upon the water cycle and achieve more sustainable forms of urban development.

The WSUD strategy, MUSIC Model and subsequent WSUD designs prepared by AT & L are based upon requirements within the Penrith City Council C3 Water Management DCP.

All stormwater runoff from catchments A, B, C and D as mentioned in Section 6.3.4 is proposed to drain into Bio-Retention basins for the water to be treated and discharged at rates acceptable to Penrith City Council. A summary of the Basin

parameters is indicated in Table 13 and details and cross sections included on the Civil drawings.

Discharge from the basins will be controlled via a rock lined swale that will intersect the existing creek system. These discharge swales will be design and documented to meet the OoW Guidelines for outlet structures on waterfront land.

Refer to attached Civil Drawings list in Appendix B.

6.3.7.1 WSUD Modelling – MUSIC Model

The MUSIC Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 5.00.10) was used to evaluate pollutant loads from each of the proposed lots for Post-development (treated) conditions based on the proposed site development.

A conceptual view of the MUSIC model used in this report can be found in Appendix D.

Pluviograph data (6 minute rainfall intensity and evapotranspiration) for Horsley Park (Station 067119) was used in the MUSIC model.

6.3.7.2 Catchment Areas and MUSIC Parameters

All building lot catchment areas were assumed to 65% roofed. Of the non-roofed areas, 90% of this area was assumed to be impervious. To provide a more accurate model, separate catchment nodes were created to simulate the roofed area and non-roofed areas for each lot.

MUSIC model input parameters for these catchments including rainfall-runoff, base flow concentration and stormflow concentration parameters were selected as per the Penrith City Council Water Sensitive Urban Technical Guidelines June 2015 document. The parameters used for the various catchment areas can be seen in tables 9, 10, 11 and 12.

Rainfall-Runoff Parameters

Parameter	Unit	Figure
Rainfall Threshold	mm/day	1.40
Soil Storage Capacity	Mm	150
Initial Storage	% of Capacity	30
Field Capacity	Mm	70
Infiltration Capacity Coefficient	a	150
Infiltration Capacity Coefficient	b	3.5
Initial Depth (Ground Water)	mm	10
Daily Recharge Rate	%	25
Daily Baseflow Rate	%	10
Daily Seepage Rate	%	0.00

Table 9 – Rainfall-Runoff Parameters – All Catchment Areas

Base Flow/Stormflow Concentration Parameters – Impervious (Roofed) Areas

Pollutant	Baseflow Concentration Parameter – Mean (log mg/L)	Baseflow Concentration Parameter – Std Dev (log mg/L)	Stormflow Concentration Parameters – Mean (log mg/L)	Stormflow Concentration Parameters – Std Dev (log mg/L)
TSS	0.000	0.000	1.300	0.320
Phosphorus	0.000	0.000	-0.890	0.250
Nitrogen	0.000	0.000	0.300	0.190

Table 10 – Base Flow/Stormflow Concentration Parameters – Impervious (Roofed) Areas

Base Flow/Stormflow Concentration Parameters – Pervious Areas

Pollutant	Baseflow Concentration Parameter – Mean (log mg/L)	Baseflow Concentration Parameter – Std Dev (log mg/L)	Stormflow Concentration Parameters – Mean (log mg/L)	Stormflow Concentration Parameters – Std Dev (log mg/L)
TSS	1.200	0.170	2.150	0.320
Phosphorus	-0.850	0.190	-0.600	0.250
Nitrogen	0.110	0.120	0.300	0.190

Table 11 – Base Flow/Stormflow Concentration Parameters – Pervious Areas

Base Flow/Stormflow Concentration Parameters – Road

Pollutant	Baseflow Concentration Parameter – Mean (log mg/L)	Baseflow Concentration Parameter – Std Dev (log mg/L)	Stormflow Concentration Parameters – Mean (log mg/L)	Stormflow Concentration Parameters – Std Dev (log mg/L)
TSS	0.000	0.00	2.430	0.320
Phosphorus	0.000	0.000	-0.300	0.250
Nitrogen	0.000	0.000	0.340	0.190

Table 12 – Base Flow/Stormflow Concentration Parameters – Road

MUSIC model parameters used for the Bio-retention basin were based off guidelines provided by FAWB – Stormwater Biofiltration Systems – Version 1, 2009, and were modified accordingly. Parameters used to model the bio-retention basin are shown in the table 13 below.

Parameter	Unit	Figure
Extended Detention Depth	m	0.30
Surface Area	m2	2000
Filter Area	m2	1900
Unlined Filter Media Perimeter	M	0.01
Saturated Hydraulic Conductivity	mm/hour	180
Filter Depth	m	0.50
TN Content of Filter Media	mg/kg	900
Orthophosphate Content of Filter Media	mg/kg	30.0
Exfiltration Rate	mm/hour	0.00
Base Lined	-	Yes
Vegetation Properties	-	Effective Nutrient Removal Plants
Overflow Weir Width	m	10.00
Underdrain Present	-	Yes
Submerged Zone	-	No

Table 13 – Bio-Retention Basin Parameters

6.3.7.3 Results

MUSIC modelling results presented as mean annual loads at the receiving node indicate that adopted target reductions are achieved, as shown in Table 8 and 9.

Pollutant	Sources (Kg/yr)	Residual Load (Kg/yr)	Reduction (%)	Target Reduction (%)
Total Suspended Solids	18,000	2,000	88.9	85
Total Phosphorus	35.3	6.53	81.5	60
Total Nitrogen	221	99.7	54.9	45
Gross Pollutants	2,940	0	100	90

Table 14 – Pollutant Loads – Combined Basin A

Pollutant	Sources (Kg/yr)	Residual Load (Kg/yr)	Reduction (%)	Target Reduction (%)
Total Suspended Solids	10,900	1,440	86.8	85
Total Phosphorus	21.1	4.45	78.9	60
Total Nitrogen	128	61.2	52.2	45
Gross Pollutants	1,690	0	100	90

Table 15 – Pollutant Loads – Combined Basin B

Pollutant	Sources (Kg/yr)	Residual Load (Kg/yr)	Reduction (%)	Target Reduction (%)
Total Suspended Solids	39,800	4,980	87.5	85
Total Phosphorus	79.7	16.3	79.6	60
Total Nitrogen	530	247	53.3	45
Gross Pollutants	7,040	0	100	90

Table 16 – Pollutant Loads – Combined Basin C

Pollutant	Sources (Kg/yr)	Residual Load (Kg/yr)	Reduction (%)	Target Reduction (%)
Total Suspended Solids	6,860	744	89.2	85
Total Phosphorus	13.9	2.52	81.9	60
Total Nitrogen	91.3	40.6	55.5	45
Gross Pollutants	1,210	0	100	90

Table 17 – Pollutant Loads – Combined Basin D

6.4 Conclusion

As highlighted in the above section all stormwater drainage within the Oakdale South development has been designed in accordance with the Penrith City Council Engineering Guidelines. This includes design of all pipework, On-Site Detention basins and WSUDs infrastructure. To summarise:

- OSD to be sized to ensure that for all rainwater events up to and including the 1:100 ARI event, new developments do not increase stormwater peak flows in any downstream areas.
- OSD to mitigate post development flows to pre-developed flows for peak Average Reoccurrence Interval (ARI) events.
- WSUD to achieve target reductions:
    - 85% Total Suspended Solids (TSS)
    - 60% Total Phosphorus (TP)
    - 45% Total Nitrogen (TN)
    - 90% Gross Pollutants (GP)
- Finished Floor Levels (FFL) to have minimum 500mm freeboard to 100 year overland flows
- The implementation of OSD to mitigate flows and WSUD systems to treat the water runoff prior to discharging into Ropes Creeks demonstrates a commitment to adhere to the Sydney Regional Environmental Plan (SREP) No 20 – Hawkesbury-Nepean River guidelines.

7 Water Balance

7.1 General

The water balance was simulated using a water cycle management model as part of the MUSIC Model to allow the evaluation of various elements of the water cycle to be assessed at differing stages in the development.

7.2 Water Balance Objective

Potable water supplies in the Sydney area are in recognised short supply with projected population increases, potential climate change and periods of extended drought and any development in sources of the Sydney region places increasing demands on an already scarce water supply. As a result, government bodies, together with Sydney Water have encouraged sustainable development by the implementation of an integrated approach to water cycle management (potable water, sewage, stormwater and rainwater) to minimise demands of potable water supplies.

Whilst opportunities for Water Reuse include such initiatives as regional stormwater harvesting, black water recycling and recycled water, this development is limited to rainwater collection and reuse on an individual lot by lot basis.

As such, we have used MUSIC to establish an estimated tank size for each lot within the development and demonstrated the volume of water reuse possible and provide a more sustainable servicing solution.

7.3 Water Balance End Uses

AT&L has identified the following water demand end uses to be required across the development:

- toilet and urinal flushing, hand basin washing, showering;
- kitchen (food preparation, washing), drinking;
- air conditioning cooling;
- internal cleaning;
- leaking water devices;
- truck/car wash;
- external cleaning; and
- watering (outdoor garden use).

End Use (Water Demand)	Water Demand* (L/day for a total development)	Percentage of Total Water Demand	Assumptions
Toilet and Urinal Flushing	586	12%	Based on '3-star' toilet and urinal fittings. Based on being flushed
Hand Basin Washing	348	7%	Based on 3 uses of the hand basin per person/day for 15 seconds each time using a 3-star tap fitting (8.5 L/min).
Showering	698	14%	20% of staff have showers each day for 8 minutes each time using a 3-star shower head (8L/min)
Kitchen (washing& drinking)	164	3%	3 L / EP/ day
Air Conditioning Cooling	496	10%	10% of total water consumption-of which 88% evaporates.
Leaking Water Devices	Negligible	0%	Traditionally 0.7% of total water consumption in residential dwellings is attributed to leaks (SWC, 2005). However, as the new dwellings will be fitted with efficient, correctly installed and appropriately maintained fittings- the water consumption attributed to leaking water devices was assumed to be negligible.
Unaccounted for Water	499*	10%*	Unaccounted for water accounted for 10% of overall water demand in 2005 (SWC, 2005). *It has been assumed that "unaccounted for water" is equivalent to 10% of pressurised water demands. In reality this will be made up from a portion of both the potable and non-potable demands. This results in an overall "unaccounted for water" demand, except in the case where rainwater tanks are used to supplement end uses. In this case the total "unaccounted for water" demand will be less than 10%.
Truck Wash (Not on all lots)	300	6%	Based on two trucks being washed each day, requiring 150 L per wash.
Internal Cleaning	74	1.5%	Based on the assumption that cleaning involves toilet flushing (8 toilet flushes- 24L) and mopping (5 buckets each 10 L- 50L).

External Cleaning	20	0.4%	Assuming each bucket of water requiring for mopping contains 10 L
Watering (Outdoor Garden use)	1,777	36%	Using subsurface irrigation (and other water efficient watering methods)- the watering required during an 'average' rainfall year was assumed to be 0.88 mm/day (source unavailable).
Total (L/day/ Generic Warehouse (or per 2.04 net hectares)	4,962	100%	
Total (L/day/ net hectare)	2,432	-	

Note * the water demand rates indicated in this table are based on the Oakdale Concept Plan Water Balance Options Report prepared by GHD in December 2007. Refer to Appendix J for Water Demands – End Uses section summarising the proposed water usages.

Table 18 – Summary of Adopted End Use Assumptions within the Development

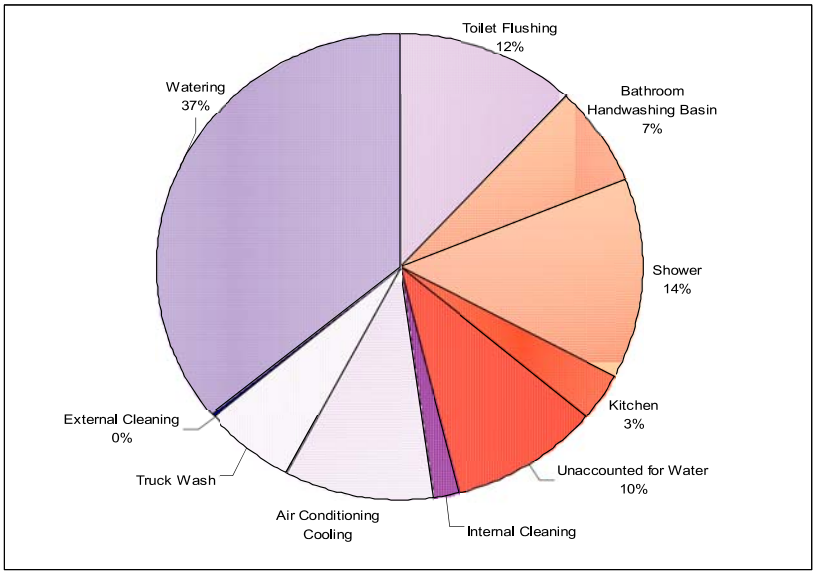

Table 19 – Water Demand Breakdown by End Use within the Development

Figure 3 shows the proportion of total water demands for irrigation and toilet flushing within the development could be as much as 50% of total water

demands across the development that may be potentially substituted for by rainwater reuse.

The remaining 50% of the Development's water demands require a potable water supply.

As such, maximising the substitution of end use demands that do not require a potable water source would result in a maximum achievable potable water saving in the order of 50%

7.4 Total Site Demands

Portion of Proposed Warehouse Facility	**1A Area (m^2)**	**1B Area (m^2)**	**1C Area (m^2)**	**1D Area (m^2)**	**4A Area (m^2)**	**4B Area (m^2)**	**4C Area (m^2)**	**5A Area (m^2)**
Warehouse (including dock office lower level)	20,395	23,675	26,550	28,760	15,775	12,055	17,605	80,100
Office	1,554	1,029	1,368	1,028	806	806	924	3,900
Hardstand (including internal circulation roads, footpaths, car parks)	11,575	13,305	13,129	14,088	9,613	7,290	9,884	37,127
Garden / Landscape Area (including courtyards)	6,938	8,730	10,143	7,201	10,406	3,132	6,227	18,973
Total Area of Proposed Warehouse Facility	40,462	46,739	49,822	51,077	36,600	23,283	34,640	140,100
Total Number of Toilets	37	16	28	16	18	18	19	43
Daily Water Usage (based on 2.432kL/day/ net Hectare) as per Table 4	**5.34kL/day**	**6.0kL/day**	**6.79kL/day**	**7.24kL/day**	**4.03kL/day**	**3.13kL/day**	**4.51kL/day**	**20.43kL/day**

Table 20 – Total Site Demands and Daily Usage

7.5 Rainwater Reuse

The use of rain water collected in rainwater tanks from runoff on the roofs of the warehouse roofs provides a valuable alternative to potable water for a variety of non-potable end uses, such as vehicle washing, air conditioning cooling, and toilet flushing and watering.

We have assumed for this development, irrigation and toilet flushing will be plumbed to the rainwater tanks. Other uses such as truck washing maybe considered at the detailed design stage.

A rainwater tank model was constructed to simulate the rainwater tank operations and select the optimal rainwater tank size, in doing so, the following considerations were made:

- Rainfall received;
- Roof area or runoff area;
- Roof Wetting;
- First Flush; and
- Rainwater demands (by end use).

Refer Appendix E for illustration of reuse.

7.6 Rainwater Tank Model Assumptions

The rainwater tank model assumptions built into the scenarios assumed the following:

Rainfall received

The rainfall runoff that could potentially be captured by the rainfall tank from the roof of each building was simulated individually for the 'dry', 'wet' and 'average' rainfall year within each scenario run.

Roof Wetting, First Flush Diversions and Overflow

While it is assumed that rainfall runoff has the potential to runoff 100% of the area of the roof into the rainwater tank, the proportion of rainfall that actually reaches the rainwater tank is affected by four factors:

- It is assumed that the initial 2mm of rainfall that falls on the roof is considered 'wetting', that is, potential rainfall runoff that is not captured by the rainwater tank, but is rather 'lost runoff' as evaporation or other;
- To prevent sediment and other pollutants entering the rainwater tank, a portion of the initial runoff from the roof is transferred to stormwater, this is known as the 'first flush'. The portion of water diverted as part of the first flush

differs for each facility depending on the amount of pollution each roof is susceptible to.

- As the development is located in a predominantly light industrial area, where there may be potential for some roof pollution, a standard first flush volume of 1mm of runoff from across the roof area has been adopted.
- Any roof runoff that exceeds the rainwater tank capacity is 'overflow', and is directed to the stormwater drainage system.

7.7 Rainwater Tank Modelling

7.7.1 General

For the MUSIC analysis the following parameters are assumed:

- An allowance for 20% loss in rainwater tank size volume to allow for anaerobic zones, mains water top up levels and overflow levels
- Approximately 30% of the total roof area can drain into the rainwater harvest tank
- The daily usage is calculated based on 2.432kL/day/ building area as per the requirements from Table 20.

7.7.2 Rainwater Tank Modelling Results

The use of a rainwater tank was simulated for 'average' rainfall conditions to service three differing combinations of end uses for each Facility being:

Lot Number	Total Roof Area (m^2)	Roof Area draining to tank (m^2)	Size of Tank(kL)	% of total non-potable water used from tank (based on MUSIC modelling)
1A	21,949	6,585	55	**54.8**
1B	24,704	7,411	55	**52.6**
1C	27,918	8,375	60	**52.1**
1D	29,788	8,936	70	**53.9**
4A	16,581	4,974	40	**54.2**
4B	12,861	3,858	30	**53.2**
4C	18,529	5,559	50	**57.3**
5A	84,000	25,200	170	**50.4**

Table 21 – Percentage of Non-Potable Water Used from Tank

7.8 Conclusion

The use of rainwater harvest tanks and the design basis to size the tanks to ensure as a minimum 50% of all non-potable water on each lot can be sourced from the tank, demonstrates a commitment to water recycling and minimising the usage of mains water.

This is in line with the industry best practise and the NSW Stage Government's objective of reducing the amount of potable (drinking) water consumed for non-potable uses.

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8 Flood Modelling

A Flood Impact Assessment of the Proposed Oakdale South Estate was undertaken by Cardno in August 2015. See attached within Appendix U of EIS for flood report

8.1 Purpose of Flood Report

The purpose of this report is determine the flood impact assessment to the surrounding areas and proposed building pads and roads within the Oakdale South site due to the proposed development. For the basis of the proposed development conditions Cardno used the latest Architectural masterplan and AT&L design siteworks plan. *Both the 100 yr ARI and PMF (Probable Maximum Flood) levels have been identified within this report.*

8.2 Flood Modelling Results

Based on the Cardno flood report the following impacts were discovered when comparing the proposed development flood conditions against the existing flood conditions:

- Within the Ropes Creek floodplain there are zones of both minor reductions and minor increases in the 100 year ARI flood levels
- The minor changes in flood levels do not change the flood extents on any adjoining properties
- A zone of significant local increases in 100 yr ARI flood levels extents occurs within the power line easement adjacent to the proposed development
- These local impacts are attributed to the partial filling of an existing flood runner to create the development platform without any compensating earthworks to convey diverted flows
- With regards to the PMF levels across the site a number of flowpaths through the development would be activated by PMF flows discharging into the development along existing drainage lines.

8.3 Conclusion

The Cardno report concludes that the proposed development will have minor impacts on the 100 yr ARI flooding on the Ropes Creek floodplain however this will not adversely impact on any adjoining property. This is subject to the post-developed peak flows being limited to pre-developed flows which has been discussed in Section 6.3.5 of this report.

It is also concluded that whilst a zone of significant local increases in the 100 yr ARI flood levels within the Transgrid easement adjacent the proposed development, these local impacts are confined close to the development and could be mitigated by minor compensating earthworks on the floodplain to convey locally diverted flows. These local earthworks have been included within the civil stormwater drawings with a local swale drain at the western end of the easement draining to the north adjacent the western boundary of Lots 3C and 3A into Ropes Creek adjacent bio-retention basin C.

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9 Creek Realignment

A Watercourse Realignment design and report for Ropes Creek Tributary within the OSE was undertaken by Aecom in August 2015. See attached within Appendix M of EIS for Watercourse Realignment report.

9.1 Purpose of Realignment Report

The purpose of this report is:

- To meet the requirements of the Department of Primary Industries – Office of Water (DPI-OW) as per *the Guidelines for Watercourse Crossings on Waterfront Land* and *the Guidelines for instream works on waterfront land*
- To undertake the detailed design of the waterway
- To protect and enhance stormwater flow, water quality, stream ecology and existing riparian vegetation within the riparian corridor
- To minimise impacts of the development on the hydrologic, hydraulic and geomorphic function of the waterway
- To have limited impact on the 1% AEP peak flood levels as a result of any physical change to the waterway
- To create a visually attractive riparian environment though the coordination of a weed control and revegetation program that is consistent with the existing character of the creek

9.2 Creek Realignment Results

Key elements as identified in the Aecom Creek Realignment report is as follows:

- Ropes Creek Tributary is a watercourse which flows in a westerly direction through the centre of the Oakdale South development.
- The development layout involves the diversion of the Ropes Creek tributary to enable a local perimeter road to be incorporated into the estate as well as providing a location to construct a water quality treatment facility (bio-retention basin).
- The development will divert all stormwater runoff from lots and roads into storage basins that provide two functions;
    - detention of stormwater flow
    - water quality treatment through bio retention
- The section of Ropes Creek tributary upon which development will occur, will be filled and compacted with construction materials suitable for a road embankment.
- The section of Ropes Creek Tributary, downstream of the development will remain untouched and all ecological values retained. This section of the

tributary will still receive local stormwater runoff from the road embankment and its inundation in peak flood events will remain unchanged as it is largely influenced by the flood levels in Ropes Creek.

- A small 44m section of Ropes Creek Tributary (existing) downstream of the Ropes Creek Tributary diversion will be retained to preserve the bank and bench vegetation and maintain as much ecological value as possible. The creek (instream) will be filled and regraded to prevent permanent ponding of stormwater against the road embankment and also limit the potential for problems to occur due to shallow stagnant water (e.g. water quality).
- The waterway diversion itself is 250m long and at the downstream end connects with an existing smaller tributary of Ropes Creek.
- The waterway diversion has been design to incorporate waterway features such as the inclusion of two instream benches and three pools.
- The length of the waterway diversion has been extended through the incorporation of a number of meanders. The diversion length, inclusion of three longitudinal drops (riffles) and increased channel width (compared to the existing tributary) has allowed for improved hydraulic conditions.
- The Ropes Creek Tributary diversion includes bank batters between a 1:6 and 1:8 grade. This feature allows for easier rehabilitation and management for biodiversity gain promoting the eventual return to a mature canopy of trees that form the vegetation community River-flat Eucalypt Forest.
- A single crossing has been included in the waterway design which consists of a single culvert structure under a road. Culvert outlet protection is incorporated into the culvert design.
- Upstream of the Road 01 crossing an existing farm dam will be removed and replaced with a waterway consistent in form to the majority of Ropes Creek Tributary.
- A low level waterway crossing is proposed for the lower reaches of Ropes Creek Tributary. The details of this crossing are yet to be decided.

9.3 Conclusion

The Aecom Creek Realignment report presents a design for the realignment of Ropes Creek Tributary and the associated vegetation management. The report indicates the results of the watercourse re-design, meet the requirements of the NSW Department of Primary Industries Office of Water. This report can be used to satisfy the requirement for obtaining approval for the watercourse works.

10 Services

10.1 Sydney Water

A meeting was held with Sydney Water on 15 July 2015 in order to confirm the infrastructure servicing requirements for Oakdale South and in parallel the future Oakdale West. This report outlines the discussions held and is to be read in conjunction with the submission made to Sydney Water in Appendix E. This report contains the concept servicing master plan for Water and Sewerage services. Refer Appendix E.

10.1.1 Water Supply

An existing 250mm dia potable water main has been previously constructed with Millner Avenue as part of the Oakdale Central Estate. In addition a 450mm dia trunk main has been installed from Horsley Park to the intersection of Old Wallgrove Road and the unformed Burley Road.

It is expected the 450mm dia trunk main be extended along the future SLR route to the roundabout location where a cross connection to the existing 250mm dia main will be made. Trunk reticulations will leave this point to service the OSE. A connection point for the Jacfin site has been nominated within Road 3.

The ultimate servicing strategy for the water supply has not altered substantially from the requirements as determined by GHD in their report titled *"Pressure Asset Management – Pressure Regulation Scheme Requirements"* 2011. The current concept designs and water reticulation master planning has adopted the pipe sizes nominated in this report. This plan has been adopted by Sydney Water for Oakdale Central and it is intended that all water reticulation (internal and external works) is based on this plan.

The changes are relatively minor and relate to road layouts and adjustments. The nett area considered by the report remains the same. Unless directed otherwise by way of a Notice of Requirements from Sydney Water, the proposed pipe sizes recommended in the report will be adopted in future designs.

10.1.2 Sewerage

There is no existing sewer system connected to the site at this stage. The St Clair Trunk sewer system is currently under construction which connects the wider Oakdale Precinct to the existing St Clair Sewer Carrier approximately 1.6km to the north west of the site.

As part of the application for the St Clair carrier (Sydney Water case no. 134866WW), a flow schedule and catchment plan was prepared by the project Water Servicing Coordinator (Qalchek). This flow schedule was used in determining grades, pipe sizes and catchment extents. Based on current approvals from Sydney Water, this catchment has been approved in consultation with Sydney Water's planning department.

Oakdale South forms part of sub-catchment 9. There is a demand of 8201EP across this catchment which caters for parts of the adjoining properties (Jacfin and CSR).

The St Clair carrier under construction has adequate capacity to cater for the Oakdale South development.

10.2 Communications

Existing conduits were installed as part of the Oakdale Central development and are located with both verges of Millner Avenue. To service Oakdale South, the pit and pipe network will be extended and reticulated through the roadways to service the proposed lots.

Staging of the pit and pipe network will coincide with the civil stages.

No NBN is currently installed within the Oakdale Central Precinct.

Refer Appendix E for concept servicing plans

10.3 Gas

Existing Conduits were installed as part of the Oakdale Central development and are located with both verges of Millner Avenue. To service Oakdale South, the conduits will be extended and reticulated through the roadways to service the proposed lots.

Staging of the reticulation will coincide with the civil stages.

Refer Appendix E for concept servicing plans

10.4 Electrical

Over the past 18 months numerous meetings have been held with Endeavour Energy (EE) in relation to servicing the proposed development site. Currently EE have indicated that a new Zone Substation (ZS) will ultimately be required to service the development. The new ZS will potentially have capacity to also service adjacent developments including the Jacfin, CSR and Oakdale West sites. This is subject to detailed design and investigation by EE.

The Services Lot adjacent to Precinct 2 has been identified as the location for the Zone Substation. This has been determined in consultation with EE and they have verbally agreed to the location.

EE will ultimately construct and own and operate the zone substation and is not subject to this application.

EE has indicated that a portion of Stage 1 could be serviced in the interim by connecting to either the existing 11kV reticulation within Millner Avenue or to the existing Eastern Creek Zone Substation located at the corner of Old Wallgrove Road and Roberts road via new 11kV feeders that would be pulled through existing ducts within Millner and Old Wallgrove Road.

EE has indicated that in order to service further Stages of development the new Zone Substation will be required on the site. Stage 1 and all remaining Stages of development would then be serviced by the new Zone Substation upon completion of the ZS.

Whilst a portion of the Stage 1 could be serviced by the existing Eastern Creek ZS, depending on discussion with EE, additional feeders could be pulled to service the entire stage 1 although this would not be economically viable option.

The new zone substation would be supplied via the overhead 132kV feeder 93X located approximately 400m east of Old Wallgrove Road. Additional works associated with supplying power to the new Zone Substation will need to be completed as follows:

- Possible augmentation to feeder 93X; and

Refer Appendix E for concept servicing plans

10.5 Conclusion

This section demonstrates that services including sewer, water, power, telecommunications and gas can be made available to the site.

Internal reticulation will be coordinated at the Construction Certificate (CC) stage of works and applications to the relevant authorities.

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11 Infrastructure Staging

11.1 Staging

It has been assumed that the development will be constructed over three stages in accordance with proposed development layouts.

- Stage 1 - Precinct 1 and 2 including the Services Lot
- Stage 2 – Precinct 3,4 and 5
- Stage 3 – Precinct 6

A summary of the works required for the stages is outlined in the following sections. A copy of the staging plan is provided in **Appendix A.**

11.1.1 Stage 1

Works.	Description
General	Construction of estate roads, bio-retention basins, lead in services, utility reticulation and Services Lot
Earthworks	Bulk and detail earthworks with the following volumes: Cut: -226,000 m3 Fill: +850,000 m3 Import: 624,000 m3
Basin Works	Bio-retention basin A and B
Road network	Road 1 Chainage 0 to 1,000 Road 02 Road 03 Stormwater Pits and Pipes
Services	<u>Water</u> Extension of DN450 water main along Burley Road to Oakdale South (subject to Sydney Water's notice of requirements) Reticulation of D250 watermain along estate road and connection to the existing watermain in Millner Avenue <u>Sewer</u> Construction of East St Clair Sewer Carrier (southern connection) <u>Gas</u> Provision of conduits in the road way <u>Communications</u> Extension of pit and pipe network from Millner Avenue <u>Electrical</u> 11kV feeders are proposed to be installed from the Eastern Creek Zone substation along Old Wallgrove Road, Millner Avenue to service the first stage or portion thereof until the ZS is completed

Table 22 – Stage 1 works

11.1.2 Stage 2

Works.	Description
General	Construction of estate roads, bio-retention basin, lead in services, utility reticulation and creek realignment
Earthworks	Bulk and detail earthworks with the following volumes: Cut: -412,000 m3 Fill: +748,000 m3 Import: 339,000 m3
Basin Works	Bio-retention basin C
Creek works	Realignment of the Ropes Creek tributary, swales, open channels and surface treatment for scour protection
Road network	Road 1 Chainage 1,000 to 1,520 Road 04 Road 05 Stormwater Pits and Pipes
Services	<u>Water</u> Reticulation of D250 watermain along estate road and connection to the existing watermain in Millner Avenue <u>Sewer</u> Construction of East St Clair Sewer Carrier (southern connection), extension through to Jacfin property <u>Gas</u> Provision of conduits in the road way <u>Communications</u> Extension of pit and pipe network along Road 01 <u>Electrical</u> As part of Stage 2, a new Zone Sub Station is proposed to be located on the services lot with 132kV overhead cables installed to service the new Zone Substation. 11kV reticulation would then be installed to service the development The timing of the ZS is subject to EE approval and ongoing negotiations. The ZS may be constructed as part of Stage 1.

Table 23 – Stage 2 works

11.1.3 Stage 3

Works.	Description
General	Construction of final building pad and bio-retention basin
Earthworks	Bulk and detail earthworks with the following volumes: Cut: - -21,000 m3 Fill: +68,000 m3 Import: 47,000 m3
Basin Works	Bio-retention basin D
Services	<u>Sewer</u> Reticulation to remaining building pad Lot 6A and Lot 6B

Table 24 – Stage 3 works

12 Construction

12.1 Clearing and Grubbing

The site is predominantly grassed paddocks with minor pockets of trees. Clearing and Grubbing would generally consist of slashing, tree removal and removal of grass and roots within the top layer of the topsoil where required.

Where trees are to be removed these will be mulched and then reused on site as part of the landscape treatment.

Clearing and grubbing would take place in a staged manner in line with civil and infrastructure works. Where possible existing ground coverings will be left undisturbed until such time it is required to be removed.

All riparian and offset lands would be fenced off and trees to be retained marked to prevent clearing and protected areas.

12.2 Demolition

There are no structures on the site requiring demolition.

12.3 Road works and Services

The roads and services to be constructed will be undertaken once the earthworks for the road corridor and adjacent lots are completed.

The performance of the imported sub grade may ultimately determine whether any modifications are required to the pavement design although at the time of tender, the contractors will be required to determine their source of material and the applicable CBR.

If the cut material from the site is better suited for sub grade, it will be separated and utilised for the final layers.

The general sequence of the road and services is as follows;

- Boxing and construction of base pavement layers
- Excavation for stormwater and laying of pipes and construction of pits
- Excavation for combined services trenches
- Where deep sewer is required to cross roads, this will be finalised
- Services road crossings including water
- Kerb and gutter
- Watermain installation
- Final pavement base layer
- First layer of asphalt

- Light poles stood
- Foot paths constructed
- Topsoil and Landscape completed
- Signage and linemarking

Note, final layer of asphalt will not be installed until 12 months after completion of that stage.

Stormwater basin will be established as a matter of priority to control sediment runoff and once the roads are completed these will be finalised in their final configuration.

12.4 Program

The table below outlines the preliminary construction commencement and completion dates for the various stages.

STAGE No.	COMMENCMENT	COMPLETION	DURATION
1	March 2016	December 2016	10 months
2	March 2017	October 2017	8 months
3	November 2017	April 2018	6 months

Table 25 – Construction Program

12.5 Construction Plant and Equipment

Throughout the various stages of the project, it is expected that the following construction plant and equipment will be required. This list is includes but is not limited to:

- Construction compound
  - Site offices and facilities for staff
  - Car parking
  - Meeting rooms
  - Lay down area for delivery of materials
  - Mechanical bay for plant
- Construction plant
  - Skidsteer loader (Bobcat) 5 of
  - Backhoe (dig depth up to 5 m) 5 of
  - Backhoe + hammer 2 of
  - Dozer 98 to 145 kW (equivalent to Caterpillar D6) 1 of
  - Dozer 145 to 175 kW (equivalent to Caterpillar D7) 1 of
  - Dozer 220 to 305 kW (equivalent to Caterpillar D8) 1 of
  - Dozer 305 to 400 kW (equivalent to Caterpillar D9) 1 of
  - Grader 3 of
  - Loader (up to 90 kW) 5 of
  - Roller, multi-tyred 1 of

- Roller, padfoot (various sizes) 3 of
- Roller, smooth drum 1 of
- Scraper, open bowl, 17 to 28 m3 5 of
- Excavator < 10 t + hammer 1 of
- Excavator 12 t + hammer 1 of
- Excavator 20 t + hammer 1 of
- Excavator 30 t + hammer 1 of
- Watercart 15,000 L 1 of
- Truck 13 t payload 1 of
- Truck and dog 30 t payload 5 of
- Road profiler
- Air compressor (without operator) 41 L/s
- Generator 6.8 kVA (without operator)

12.6 Conclusion

The Construction Staging as demonstrated above is based on the development being split into 3 stages.

This section demonstrates the works required within each of these Stages and the likely construction program and plant and equipment to be used to complete these stages.

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