Renewal SA

Oakden and Gilles Plains Structure Plan

Technical Studies

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1 Introduction

Arup Australia Pty Ltd (Arup) has been engaged by Holmes Dyer Pty Ltd (Holmes Dyer), on behalf of Urban Renewal Authority (Renewal SA), to prepare a range of technical studies to support a Structure Plan and draft Development Plan Amendment over land at Oakden and Gilles Plains. The scope of the technical studies includes:

- Stormwater
- Utilities and services
- Transport
- Noise & Air quality

This combined technical report documents the analysis undertaken and the relevant recommendations developed under each technical discipline.

1.1 Structure Plan

The proposed project precinct structure plan is shown in Figure 1. Estimated development yields for the structure plan area are shown in Figure 2.

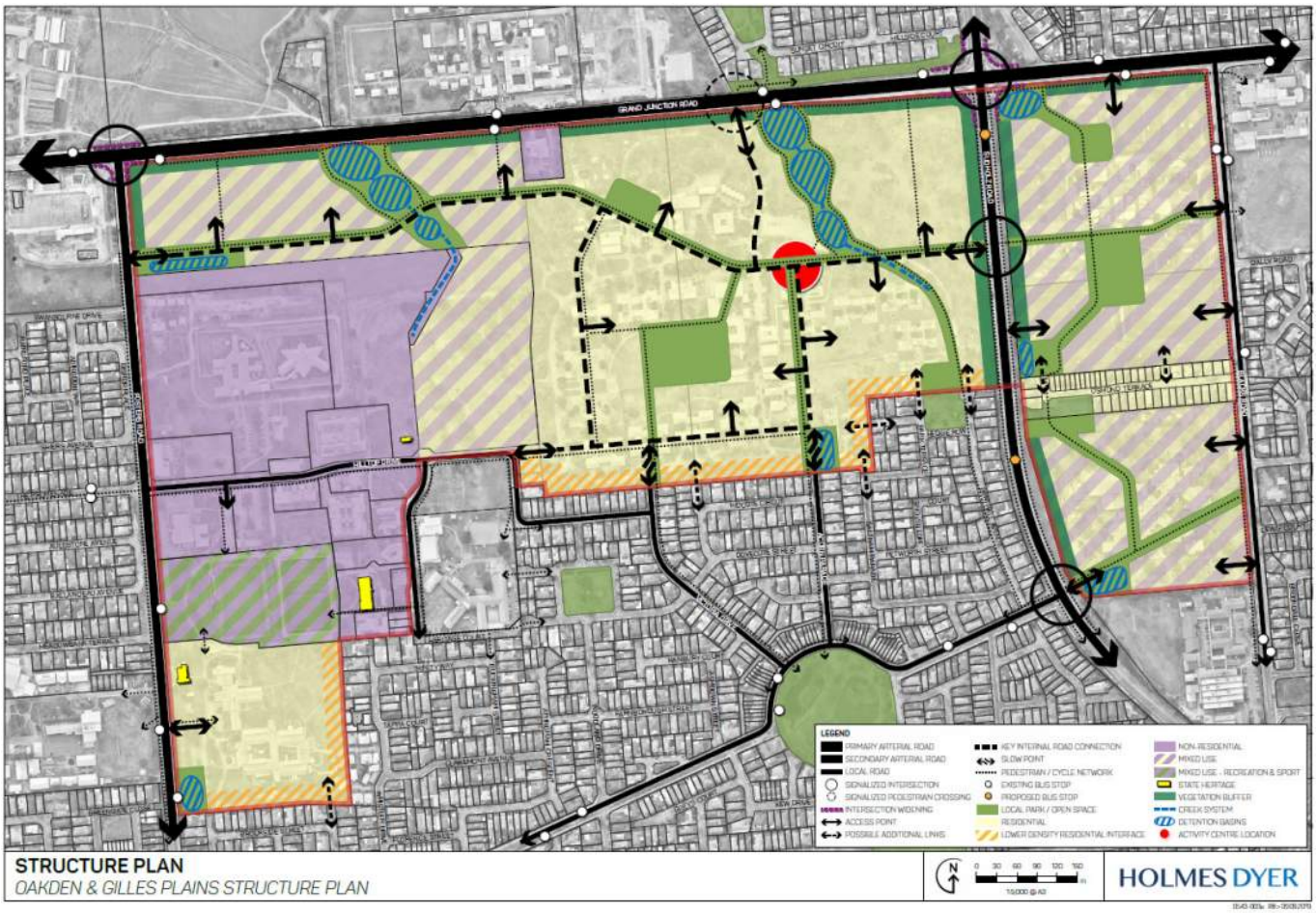


Figure 1: Preliminary Oakden and Gilles Plains Structure Plan

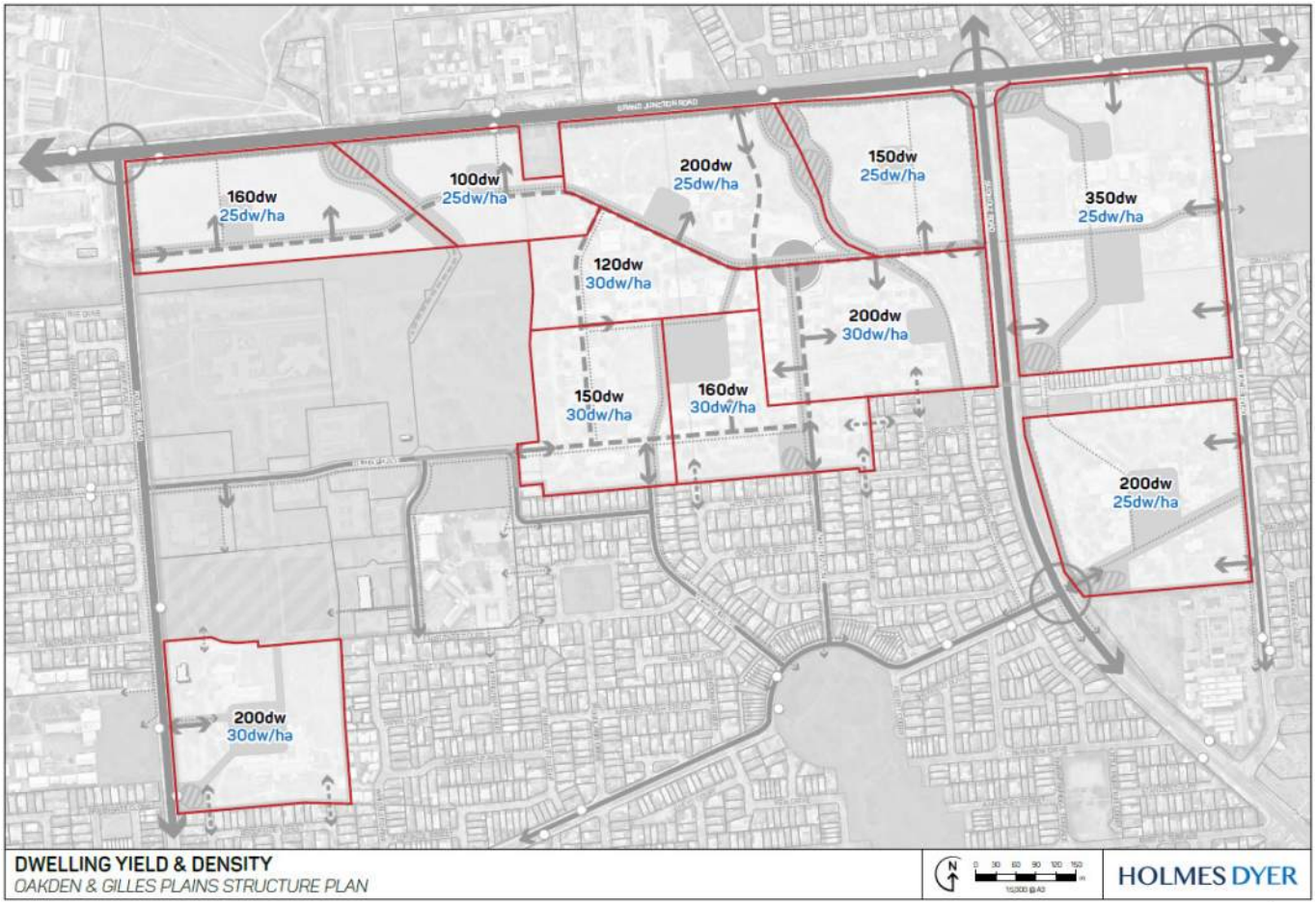


Figure 2: Dwelling and yield density

2 Stormwater

2.1 Site description

The "Structure Plan Area" located at Oakden and Gilles Plains (Figure 1) is defined predominantly by vacant land and mixture of non-residential land use, surrounded residential development. The site is approximately 102.7 ha in area.

The scope of stormwater assessment, management plan and modelling is broadly categorised into the following:

- Review the existing stormwater outflows from the site under a range of design storm events;
- Investigate any capacity constraints within the existing stormwater disposal network to support the Structure Plan area and identify any options for augmentation/upgrade works which might increase downstream capacity.
- Investigate the potential to use land within the Structure Plan area for stormwater treatment in order to meet water quality targets.

2.1.1 Site description

The natural ground contours indicate that a significant portion of the land enclosed by Grand Junction Road, Fosters Road, Hilltop Drive and Sudholz Road falls towards Grand Junction Road, except for the pocket of land, which is separated by a ridge from the north, on the south-east corner near Hidcote Circuit, Park Terrace and Hedge Row which falls towards south.

Half of the land surrounded by Sudholz Road, Black Road, Grand Junction Road and Osmond Terrace (which is the SAHMRI site) grades north towards the Grand Junction Road / Sudholz Road corner and the rest slopes towards the corner of Osmond Terrace and Sudholz Road. The TAFE site naturally falls south. There is no survey available for these areas.

The existing James Nash House land west of the drainage easement falls towards Fosters Road.

The parcel of land occupied by the former mental health facility (survey not available at this stage) at the south-west corner grades towards Fosters Road.

Potential discharge points have been identified at various locations with potential detention basins proposed at the lowest points in each sub-catchment.

2.1.2 Development requirements

The City of Port Adelaide Enfield have provided the following requirements for management of stormwater from the "Structure Plan Area" for the proposed development:

1. Stormwater detention should be provided such that peak post-development discharge rates do not exceed pre-development, or the capacity of downstream infrastructure, for all storm events up to and including a 100 year ARI (1% AEP).
2. The layout and design of roads and stormwater systems should have consideration for any upstream flows which may pass through the development and make allowance for fully developed upstream catchments.

3. Council have identified that if the land to the east of Sudholz Rd is developed, that verge along the eastern side of Sudholz Rd will need to be constructed to a swale to direct flows downstream. This is required as Sudholz Rd is higher than the land to the east and overland flows need to be safely conveyed to the South. The design of Sudholz Rd will need to be to the satisfaction of Council.
4. Stormwater detention should be provided within the public realm and not rely on on-site detention systems.
5. Stormwater quality improvement systems should be incorporated which ensure that 90% GP (greater than 50mm), 80% TSS water quality reduction targets have been achieved.
6. Stormwater detention basins which are proposed in reserves that form part of a Developer's minimum 12.5% public open space contribution should be designed to ensure that no greater than 20% of the reserve is inundated during a 10 year ARI storm event. This will help to ensure the reserve remains useable and comply with Council's open space policy and guidelines.
7. The use of rear of allotment drains should be avoided.
8. The stormwater hydrological design must satisfy the following requirements:
    - Pit inlet capacities shall be sufficient for design flows.
    - The minimum grade of stormwater pipes should be 0.5%. Flatter grades may be accepted where it can be demonstrated that flow velocities will be greater than 0.8 m/s during a 1 EY (1 year ARI) storm event.
    - The piped drainage system shall cater for all flows up to and including a 0.2 EY (5 year ARI) storm event.
    - Overland flow paths via the road network and reserves shall cater for stormwater flows which exceed the capacity of the piped drainage system up to and including a 1% AEP (100 year ARI) storm event.
    - Where there are changes in direction of overland flow paths, the capacity of the flow paths must allow for full energy conversion.
    - There shall be no inundation to any allotment during a 1% AEP (100 year ARI) ARI storm event.
    - 20% blockage factor shall be used for on-grade inlet pits and 50% blockage factor for sag pits.
    - Gutter flow widths shall not exceed 2.5 metres for the 0.2 EY (5 year ARI) storm event.
    - Minimum runoff coefficient shall be as follows unless justification can be provided by the Engineer which confirms why lesser coefficients are considered acceptable:
        - Residential allotments: 75% impervious (paved) / 25% pervious (grassed).
        - Industrial allotments: 90% impervious (paved) / 10% pervious (grassed).
        - Road reserves: 80% impervious (paved) / 20% pervious (grassed).

It is noted that a large portion of the site drains north to Dry Creek which is contained within the Salisbury Council boundary. Salisbury Council have been provided with an opportunity to outline specific requirements relating to Dry Creek, however this has not been provided.

2.2 Hydrological Assessment

The following sections summarise the modelling and calculations performed to maintain the predevelopment flow regime based on the general requirement guidelines stated in Section 2.1.2.

2.2.1 Hydrological and hydraulic modelling

DRAINS, an industry standard hydrological and hydraulic modelling software package has been used for peak flow determination and detention basin sizing purposes. A range of rainfall data were obtained from Bureau of Meteorology website for Oakden and Gilles Plains using ARR 2016 procedures.

The inbuilt ILSAX model was used with the following parameters:

- Paved (impervious) area depression storage = 1 mm
- Supplementary area depression storage = 1 mm
- Grassed (pervious) area depression storage = 5 mm
- Antecedent moisture content (AMC) = 3

An additional IL/CL (initial loss/continuing loss) loss model was set up for comparison purposes using the following parameters for both existing and developed catchments as recommended in ARR 2016:

- Effective Impervious Area (EIA) initial loss (IL) = 1 mm
- Effective Impervious Area (EIA) continuing loss (CL) = 0 mm/hr
- Remaining Area initial loss (IL) = 30 mm
- Remaining Area continuing loss (CL) = 3 mm/hr

IL/CL loss model considers effective impervious areas and remaining area fractions in percentage terms instead of paved (impervious), supplementary and grassed (pervious) areas fractions as considered by conventional ILSAX models. It was found that the ILSAX and IL/CL models produced comparable results.

2.2.2 Sub-catchment areas

The subject site has been subdivided into eight sub-catchments abbreviated as C1 – C8 within Figure 3 below, based on the distribution of proposed detention basins and discharge points shown in Figure 1.

Figure 3: Sub-Catchments

2.2.3 Impervious (paved), supplementary and pervious (grassed) areas

Based on the current land use conditions, for the pre-development scenario the following area sub fractions have been considered for the determination of peak flows.

Table 1: Pre-development sub-catchment conditions

Sub-catchment	Area (Ha)	Land use	Direct Impervious %	Supplementary %	Grassed %
C1	23.7	Vacant	5	-	95
C2	18.7	Non-residential/vacant	10	-	90
C3	8.6	Non-residential/vacant	20	-	80
C4	7.0	Non-residential/vacant	15	-	85
C5	7.0	Vacant	5	-	95
C6	8.0	Non-residential/vacant	30	-	70
C7	6.67	Non-residential/vacant	25	-	75
C8	22.5	Non-residential/vacant	30	-	70

For post-development conditions, the impervious percentage area for the site has been adopted based on PAE Council requirements, however a check was undertaken based on the proposed development strategy as described below. Based on the yield and dwelling density (Figure 2) provided by Holmes Dyer, impervious areas were estimated for residential and non-residential future development for modelling purposes. Roof areas were assumed be on average 250 m^2 for each dwelling. Similarly, road lengths and

other paved areas were estimated (as road layout is not available) to factor into the impervious area fraction. It was found that the proposed Council impervious area guidelines provide a suitable representation of expected impervious coverage. The following table provides a summary of the fractions adopted for DRAINS modelling.

Table 2: Post-development sub-catchment conditions

Sub-catchment	Area (Ha)	Land use	Direct Impervious %	Supplementary %	Grassed %
C1	23.7	Residential & Non-Residential	65	10	25
C2	18.7	Residential	65	10	25
C3	8.6	Residential	65	10	25
C4	7	Residential	65	10	25
C5	7	Residential	65	10	25
C6	8	Residential	65	10	25
C7	6.67	Residential	70	10	20
C8	22.5	Non-residential	50	0	50

2.2.4 Pre and post development peak flows

0.2 EY (approximately a 5 Year ARI) and 1% AEP (100 Year ARI) events have been considered as the minor and major storm events for which IFD data have been sourced for modelling purposes. The DRAINS program automatically stacks ensembles of storms and determines the critical storm for both major and minor events to generate peak flows. The table below provides a summary of peak flows for pre and post development conditions generated by the DRAINS model. It is important to note that Catchments 1 and 2 contain existing detention storages which provide peak flow attenuation.

Table 3: Pre and post development peak flows (prior to throttling)

		Pre- development peak flows (m^3/s)		Post-development peak flows (m^3/s)	
Sub-catchment	Area (Ha)	0.2 EY	1% AEP	0.2 EY	1% AEP
C1	23.7	0.14	0.14	0.14	0.14
C2	18.7	0.18	0.18	0.13	0.18
C3	8.6	0.20	0.92	0.61	1.50
C4	7.0	0.14	0.81	0.58	1.40
C5	7.0	0.05	0.76	0.58	1.40
C6	8.0	0.31	1.10	0.66	1.60
C7	6.67	0.33	1.11	1.06	2.47
C8	22.5	0.60	2.26	0.97	2.80

As the site has been proposed to be developed with predominantly residential use types (as per Table 2), it is evident from the table above that runoff generated from the fully developed site will be increased significantly for both major and minor events. Hence, detention of flows will be required to limit the flows back to predevelopment levels.

2.2.5 Detention basin and minimum storage required

It has been assumed that an underground pit and pipe drainage system and suitable overland flow paths will be designed and constructed by others in future stages within each sub-catchment to capture and convey runoff during both minor and major events to each basin. For detention basin sizing, the basins were assumed to have a piped outlet (with orifice plates as required) for minor flows and a controlled high level overflow for major flows such that pre-development flows are not exceeded in any event up to the 1% AEP. As dictated by City of PAE requirements, detention storage should be provided within the public realm and on-site detention is not recommended. Therefore, on-site detention within individual allotments (e.g. Rain water tanks with dedicated flood storage) has not been considered within the modelling.

As a general rule, proposed detention basin depths were based on site contours where augmentation of existing basins is proposed, while new basins were typically limited to a maximum depth of 1.5 metres. The detailed design of each basin including footprint, depth, batter slopes, lining, maintenance access and outfall configuration will be confirmed by others in future stages of development.

Proposed detention volumes for each catchment and corresponding outflow rates have been tabulated below.

Table 4: Detention basin sizes, outlet diameter & discharge

Sub-catchment	Basin ID	Minimum volume (m^3)	Proposed outlet pipe diameter (mm)	0.2 EY Discharge (m^3/s)	1% AEP Discharge (m^3/s)	0.2 EY Discharge (m^3/s)	1% AEP Discharge (m^3/s)
				Pre-development		**Post-development**	
C1	BASIN 1	12,500	375	0.14	0.14	0.1	0.14
C2	BASIN 2	8,400	375	0.18	0.18	0.13	0.18
C3	BASIN 3	2,000	375	0.20	0.92	0.20	0.89
C4	BASIN 4	1,600	375	0.14	0.81	0.14	0.70
C5	BASIN 5	2,000	225	0.05	0.76	0.04	0.73
C6	BASIN 6	2,000	375	0.31	1.10	0.21	0.80
C7	BASIN 7	1,800	375	0.33	1.11	0.22	0.71
C8	BASIN 8	1,200	450	0.60	2.26	0.41	0.5

Each basin is proposed to have an outfall at the nearest road/street drainage system. Whilst capacity of receiving networks has not been confirmed, the assumption that pre-development flows will not be exceeded means that the proposed development should not compromise the existing capacity of downstream networks.

2.2.6 Impact on Existing Major Catchment Flood Risk

Information on existing flood flow paths within the site does not appear to be available on the Waterconnect site (https://www.waterconnect.sa.gov.au/) , nor has any data been provided by Council. The nearest major catchments are North Arm East which is to the west of Fosters Road and the site is partially within the Dry Creek catchment. Dry Creek Floodplain mapping previously undertaken by others for the City of Salisbury is limited to the Dry Creek channel floodplain and flood contours for the 100 year ARI event do not extend to the upstream boundaries within the subject site.

In general, given the presence of a ridge that divides the site, there are not likely to be existing flood flows generated from external catchments that are likely to be impacted by the proposed development.

The only major flow path obstruction likely to occur is at Sudholz Road which is higher than the land to the east. Therefore management of the major event flooding within the areas bounded by Grand Junction Road, Fosters Road and Sudholz Road will be undertaken by internal measures as described in the proposed major system design in Section 2.4. However, in general, Council requires that:

- Overland flow paths via the road network and reserves shall cater for stormwater flows which exceed the capacity of the piped drainage system up to and including a 1% AEP (100 year ARI) storm event.
- Where there are changes in direction of overland flow paths, the capacity of the flow paths must allow for full energy conversion.
- There shall be no inundation to any allotment during a 1% AEP (100 year ARI) ARI storm event.

2.3 Water quality modelling

2.3.1 MUSIC modelling

A preliminary water quality modelling analysis has been undertaken using MUSIC (Model for Urban Water Improvement Conceptualisation) V6.3.0 program developed by eWater. The aim of this modelling was to determine if the proposed water quality treatment train is effective at reducing pollutants, ranging from debris, suspended solids and heavy metal nutrients, in stormwater discharging onto receiving water bodies and to demonstrate the measures necessary to achieve specific water quality requirements from the City of Port Adelaide Enfield. Council requires that the water quality treatment systems recommended for the "Structure Plan" based on best practice management principles shall achieve the following targets:

- 80% reduction in total suspended solids (TSS)
- 60% reduction in total nitrogen (TP)
- 45% reduction in total phosphorus (TN)
- 90% reduction in gross pollutants (> 50 mm) (GP)

It has been assumed that sub-catchments namely C1, C2, C4 & C8 have ultimate outfall (OUTFALL 1) at Dry Creek whereas sub-catchments C3, C5 and C6 discharge the stormwater to the wetlands adjacent to Sir Ross Smith Boulevard (OUTFALL 2). Sub catchment C7 discharges to Fosters Road which eventually outlets into the River Torrens. The outfall to Fosters Road has been nominated as OUTFALL 3 in the model. As such three different models have been setup to determine if these outfalls will receive treated stormwater meeting the above water quality criteria.

These impervious and pervious area percentages assigned for each sub-catchment are in accordance with Table 5.

Table 5: Catchment data for MUSIC model

Sub-catchment	Area (Ha)	Impervious %
C1	23.7	75
C2	18.7	75
C3	8.6	75
C4	7.0	75
C5	7.0	75

Sub-catchment	Area (Ha)	Impervious %
C6	8.0	75
C7	6.67	80
C8	22.5	50

The models have been developed to simulate water quality treatment trains using the BoM 6-minute rainfall data file for Parafield Airport Station for the period of 7 years (2003 – 2010) and monthly Adelaide Evaporation data which are contained within the software package.

A treatment train combination of bioretention swales, gross pollutant traps and sedimentation/detention basins has been proposed for each sub-catchment using the basin sizes from DRAINS modelling.

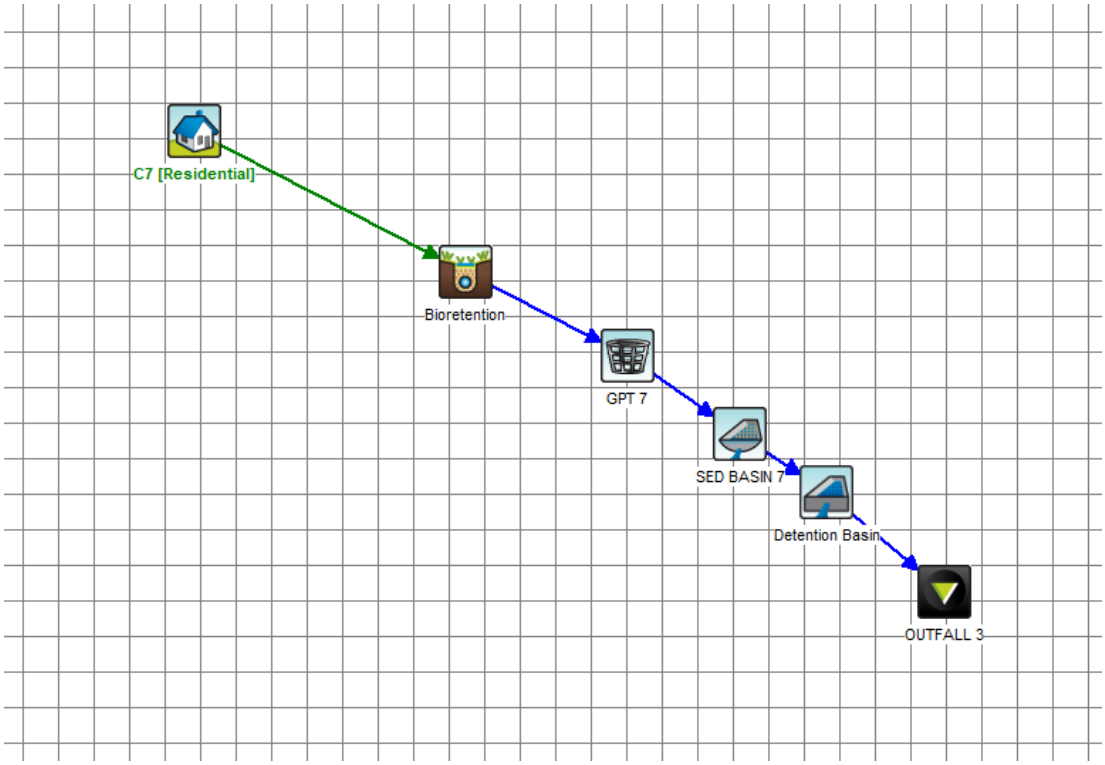


Figure 4: Typical Treatment Train Configuration

Assuming the proposed bioretention swales can be incorporated at a sufficient scale, this treatment train is expected to meet or exceed the water quality treatment targets set by the council. The following table provides a summary of reduction in pollutants in terms of percentage of loading, assuming the proposed strategies recommended in the MUSIC models were implemented:

Table 6: % reduction of pollutant loads (MUSIC Model)

			% Reduction of Pollutants			
Model Name	Outfall ID	Associated Sub-catchments	TSS	TP	TN	GP
OAKDEN MUSIC MODEL 1	OUTFALL 1	C1, C2, C4 & C8	95	73	54	100
OAKDEN MUSIC MODEL 2	OUTFALL 2	C3, C5 & C6	90	62	47	100
OAKDEN MUSIC MODEL 3	OUTFALL 3	C7	91	63	47	100

2.4 Stormwater management plan

2.4.1 Major / Minor system

A general Council requirement is to design and construct minor drainage networks within the internal road networks to capture and convey 0.2 EY flows (5 Year ARI) to the proposed basins within individual catchments.

The internal drainage network design is outside of the scope of works for this Structure Plan SMP as this would be expected in future development planning and staging design once detailed subdivision lots and internal roadway access layout plans are developed. It is envisaged that the future internal (minor) drainage to each basin will comprise side entry pits or grated inlet pits with junction boxes that connect underground pipes or box culverts sized to provide the required design capacity. The major system will require roads to be designed with the capacity to contain the peak 1% AEP gap flows within the road reserves. Finished floor levels for individual dwellings are proposed to satisfy the following as a minimum:

- 150mm freeboard above the predicted 1% AEP peak flood level generated by the proposed detention basin, overland flow path, or 300mm above the top of kerb, whichever is greater.

The catchment split and cut/fill arrangement is proposed to be such that rear of allotment connection and drainage easement be avoided, as far as practicable. It has been assumed that the future lot layout will be designed to drain naturally towards internal roads. This will need to be verified when the lot layout has been drawn and, roads and drainage design are undertaken. It should be noted that assessment at the individual allotment scale including downpipe connections and the impact of rainwater tanks have not been considered in this study.

It is understood that development in sub-catchment C8, which includes James Nash House, is the expansion from the existing non-residential facilities. During the design and construction of internal drainage systems for this area, it is imperative to ensure the existing buildings are adequately protected from flooding. The existing drainage and sewer easement at boundary of sub-catchment C1 & C8, which abuts with the open grassed channel should be retained as the cost associated with decommissioning and relocation of sewer and stormwater drainage may be prohibitive for the perspective developers.

It has been indicated that the land east of Sudholz Road is only likely to be developed in the long term (in 12 to 15 years' time). However, the potential impacts on the drainage systems and flows have been considered as part of this assessment. The City of Port Adelaide Enfield have specifically mentioned that the verge on the eastern side of Sudholz Road be constructed as a swale to the satisfaction of Council requirements when the development is undertaken at this location. This is required as Sudholz Rd is higher than the land to the east and overland flows need to be safely conveyed to the South. Whilst the

proposed swale design is recommended to be agreed with Council, the capacity of the swale will be based on the throttled 1% AEP detention basin overflows from Catchments 4, 5 and 6.

Anticipating that the development will be progressed in various stages, during construction it is recommended to design and implement an appropriate industry standard "Soil Erosion and Sedimentation Control Plan" based on best practice management guidelines.

2.4.2 Stormwater harvesting and reuse

The City of PAE have not outlined any requirements relating to stormwater harvesting and reuse. Furthermore, it is understood that the City of Salisbury typically don't provide stormwater harvesting infrastructure within catchments that are smaller than 200 hectares. This topic was raised at an early workshop with the City of PAE and it was agreed between all stakeholders that stormwater harvesting is not required to be considered.

2.4.3 Water quality considerations

It should be noted that the conceptual water quality treatment models are based on very preliminary information available and on the assumption of several parameters that influence results such as sizing of bioretention swales, depth of filter media and footprint of the proposed basins.

The rationale for the selection of the specific treatment train is that bioretention can be incorporated in road medians or reserves as part of the minor network swale design which often leads to an underground pit and pipe network. Once the flows pass through the underground network, a GPT is proposed to be installed upstream of each basin to collect litter and gross pollutants. Once the flows pass through the GPT they will arrive at a sedimentation basin which then connects to the proposed detention basins.

In general terms, the greater the detention time, area of infiltration and coverage of vegetation species effective at removal of nutrients, the better the water quality outcomes. Therefore, the bioretention swales could be replaced or complemented (whether fully or in part) by other WSUD measures such as raingardens, swales and passive irrigation, whilst the detention basins (especially within the larger sub-catchments) could be made into quasi wetlands with appropriate shaping and planting to further improve water quality treatment performance. The proposed bioretention filter areas used in the modelling are shown in Table 7.

Table 7: Bioretention Filter Areas Adopted in Modelling

Model Name	Outfall ID	Associated Sub-catchments	Bioretention Filter Area (m2)
OAKDEN MUSIC MODEL 1	OUTFALL 1	C1, C2, C4 & C8	(3000+3000+2000+1000) = 9000
OAKDEN MUSIC MODEL 2	OUTFALL 2	C3, C5 & C6	(1000+1000+1000) = 3000
OAKDEN MUSIC MODEL 3	OUTFALL 3	C7	500

Future design of water quality treatment measures will also likely involve other interdisciplinary engineering investigations (eg. geotechnical investigations) to validate the assumed soil parameters or to adopt valid input parameters for developing accurate models. However, the modelling demonstrates that a significant reduction can be achieved within the available area to meet or exceed the target treatment. It is recommended that more detailed water quality modelling is undertaken in future stages once the internal layouts are planned and eventually designed.

Water quality life cycle costing has not been modelled at this stage of the project.

2.4.4 Basins

Based on the results of the DRAINS and MUSIC modelling, the size of proposed basins is based on the detention storage requirement along with some additional capacity to allow for a small sedimentation pond upstream of each basin as well as provide for future design flexibility in the event that the cut and fill requirements of the site don't allow for the nominal depths and configurations of the basin used in this early stage assessment. In general it is recommended that detention basin locations are integrated / amalgamated with open reserves to provide dual use spaces that offer amenity and recreational benefits along with the required detention storage and water quality improvement performance.

In general, the basin footprint is a function of the volume and depth, although considerable flexibility exists in relation to the shape and batter slopes used. Basins with an elongated flow path will provide more optimum water quality treatment whilst typical batter slopes are 1V: 5H or gentler for grassed batters and 1V: 3H or gentler for vegetated batters.

In accordance with the general guidelines, the basins were assumed to have a piped outlet (with orifice plates as required) for minor flows and a controlled high-level overflow for major flows such that pre-development flows are not exceeded in any event up to the 1% AEP. As described in the water quality plan, each basin is also proposed to have a sedimentation basin and GPT upstream to remove gross pollutants and sediment. Table 8 summarises some of the indicative parameters of the proposed detention basins. It is worth noting that basins in Catchments 1 and 2 are proposed to be vegetated and designed as wetlands to reduce the requirements on bioretention.

Table 8: Proposed Basin Paramater Summary.

Basin ID	Indicative Invert Level (m)*	Indicative Total Depth (m)	Minimum Total Volume (m3)	Proposed outlet pipe diameter (mm)	Proposed WQ Treatment
BASIN 1	70.50	2.0	14,000	375	Bioretention swale / GPT / sedimentation basin / wetland
BASIN 2	73.67	1.5	10,000	375	Bioretention swale / GPT / sedimentation basin / wetland
BASIN 3	82.33	1.5	2,500	375	Bioretention swale / GPT / sedimentation basin / detention basin
BASIN 4	88.29	1.5	2,000	375	Bioretention swale / GPT / sedimentation basin / detention basin
BASIN 5	87.00	1.5	2,500	225	Bioretention swale / GPT / sedimentation basin / detention basin
BASIN 6	79.50	1.3	2,500	375	Bioretention swale / GPT / sedimentation basin / detention basin
BASIN 7	84.17	1.5	2,300	375	Bioretention swale / GPT / sedimentation basin / detention basin
BASIN 8	79.5	1.5	1,500	450	Bioretention swale / GPT / sedimentation basin / detention basin

** Invert levels are indicative only based on current survey and pipe inverts where available.*

2.4.5 External stormwater management plan

Based on the preliminary assessment in Section 2.2.6 no external flood management works are recommended as part of this plan other the provision of a swale in the verge of Sudholz Road. However, flood modelling for the affected area is recommended to be undertaken in future planning and design stages to confirm flood afflux and hazard ratings external to the site.

Basins with spillways to downstream roads are recommended to be designed so that overflows can be safely integrated into the existing road corridors that form the major overland system. Any flood risk assessment should also consider placement of dwellings to ensure they do not affect adjacent properties and that the finished floor levels have a minimum freeboard of 300 mm above the peak 1% AEP event.

3 Utilities

A preliminary investigation on the essential services within and near the proposed site development (Structure Plan Study Area) has been undertaken using the Dial Before You Dig (DBYD) service to determine the extent of existing services. Following review of the information of existing services, service authorities have been contacted to detail further information in terms of requirement for the future development, identifying any gaps in the provision of services, develop a preliminary services supply arrangement. A categorised detail of correspondence had with authorities has been presented in **Appendix 3A** of this report.

Based on the availability of the services, the following key services providers have been consulted to lay a clear plan of their potential supply arrangement and any associated augmentation or upgrade works requirement for essential services provision to the proposed development.

- SA Water – for potable water and wastewater (sewer) services
- City of Port Adelaide Enfield and City of Salisbury – for recycled water services
- SA Power Networks (SAPN) – for electricity supply
- National Broadband Network (NBN) – for communication services
- APA Group – for gas supply

3.1 Site description

The natural ground contours indicate that a significant portion of the land enclosed by Grand Junction Road, Fosters Road, Hilltop Drive and Sudholz Road falls towards Grand Junction Road, except for the pocket of land, which is separated by a ridge from the north, on the south-east corner near Hidcote Circuit, Park Terrace and Hedge Row which falls towards south.

A half of the surrounded by Sudholz Road, Black Road, Grand Junction Road and Osmond Terrace, which is the SAHMRI building appears to be grading north towards Grand Junction – Sudholz corner and the rest slopes towards the corner of Osmond Terrace and Sudholz Road. The TAFE site naturally falls south. There is no survey available for these areas.

The parcel of land defined by former mental health facility (survey not available at this stage) at the south-west corner grades towards Fosters Road.

Based on above site topography information, it is important to consider low points in the design of gravity drained sewer and stormwater services. The following figure illustrates the existing site topography.

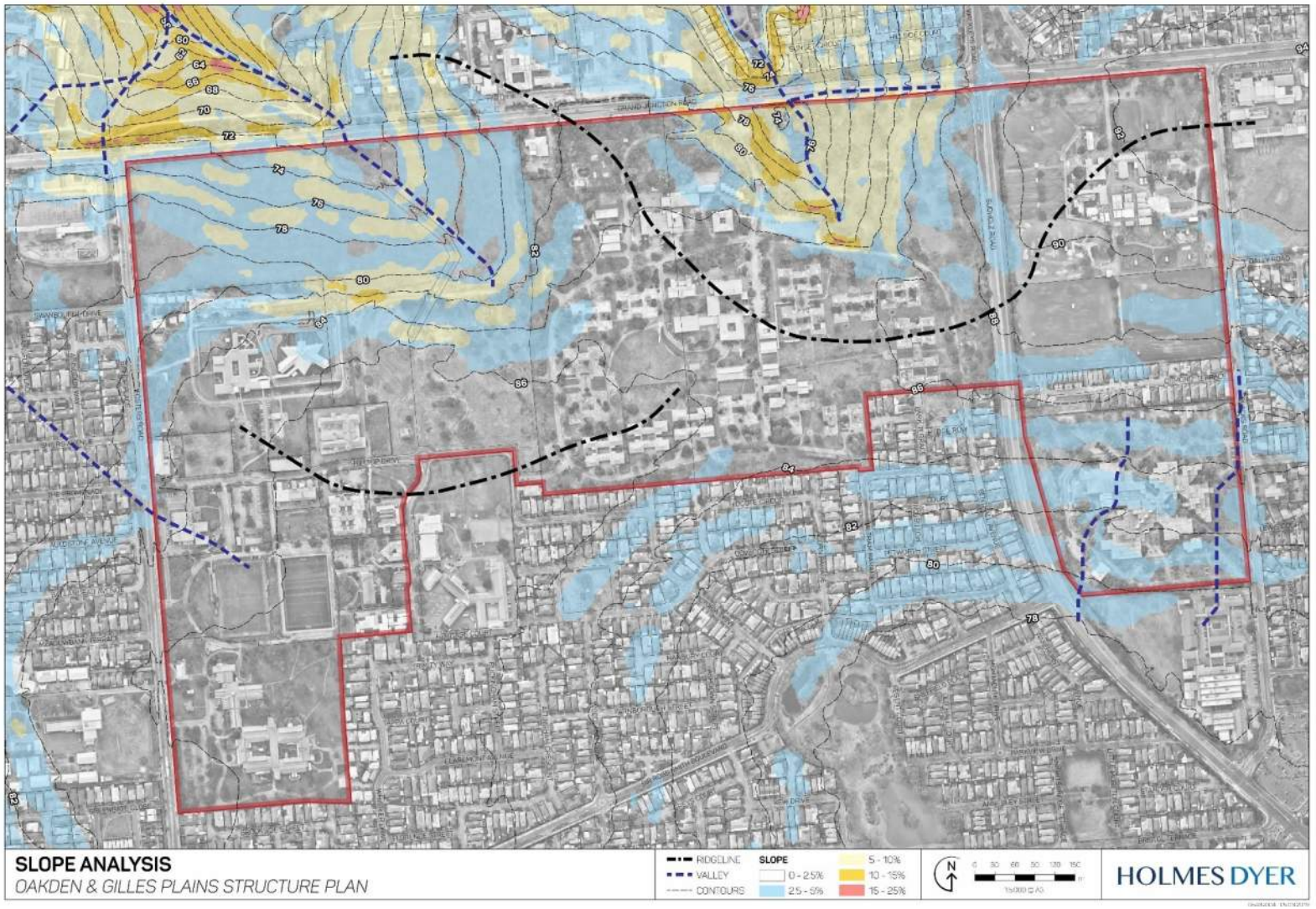


Figure 5: Existing site topography

3.2 Potable water infrastructure

3.2.1 Existing infrastructure

The development site is situated on the proximity of existing potable water network defined by a number of watermains within existing roads. A 150mm PE100 main in Grand Junction Road currently services Oakden Fire Station and Strathmore Centre. 600 mm MSCL trunk main and a 300 mm CICL distribution main run along Grand Junction Road.

There is a 250 mm CICL main in Fosters Road which currently services James Nash House and other existing facilities directly facing this road.

Further, 250 mm DICL reticulation main along Hilltop Dr and 300 mm PVCM along the southern boundary of the site can provide future connection opportunities.

A 250 mm CI main along Blacks Road, which currently services existing SAHMRI and TAFE SA can service the areas on the eastern side of Sudholz Road.

3.2.2 New infrastructure required

SA Water have completed a high-level assessment to provide a servicing information that may be critical to providing future water and wastewater services to the proposed development. The outcome of the assessment conducted by SA Water's System Planning provided on 17 September 2019 (email included in Appendix 3A), outlines the following information.

The assessment has assumed of the following development requirement based on the current details available which was provided to SA Water for assisting their investigation.

- Developer: Renewal SA
- Total proposed allotment yield: 1990
- Type of development: Residential
- Multi-story development: 1-2 storey residential development
- Apartment Buildings: No apartment buildings proposed
- Proposed development start: 2020/2021

The existing network surrounding the 'Structure Plan' area has the capacity to service future development, subject to:

Distribution Main: No external work required at this stage. However, this may change when a revisit occurs when the layout is clearer at time of lodgement of the Land Development application and/or when staging information is provided.

Existing Water Meters: Multiple existing meters may or may not need removing depending on the development layout and staging.

Fire Service: Fire flow analysis to be undertaken separately when and if required.

Inline Pumps: Inline pumps permit application to be undertaken separately when required.

Figure 6 outlines a conceptual water reticulation service layout and existing network connection opportunities.

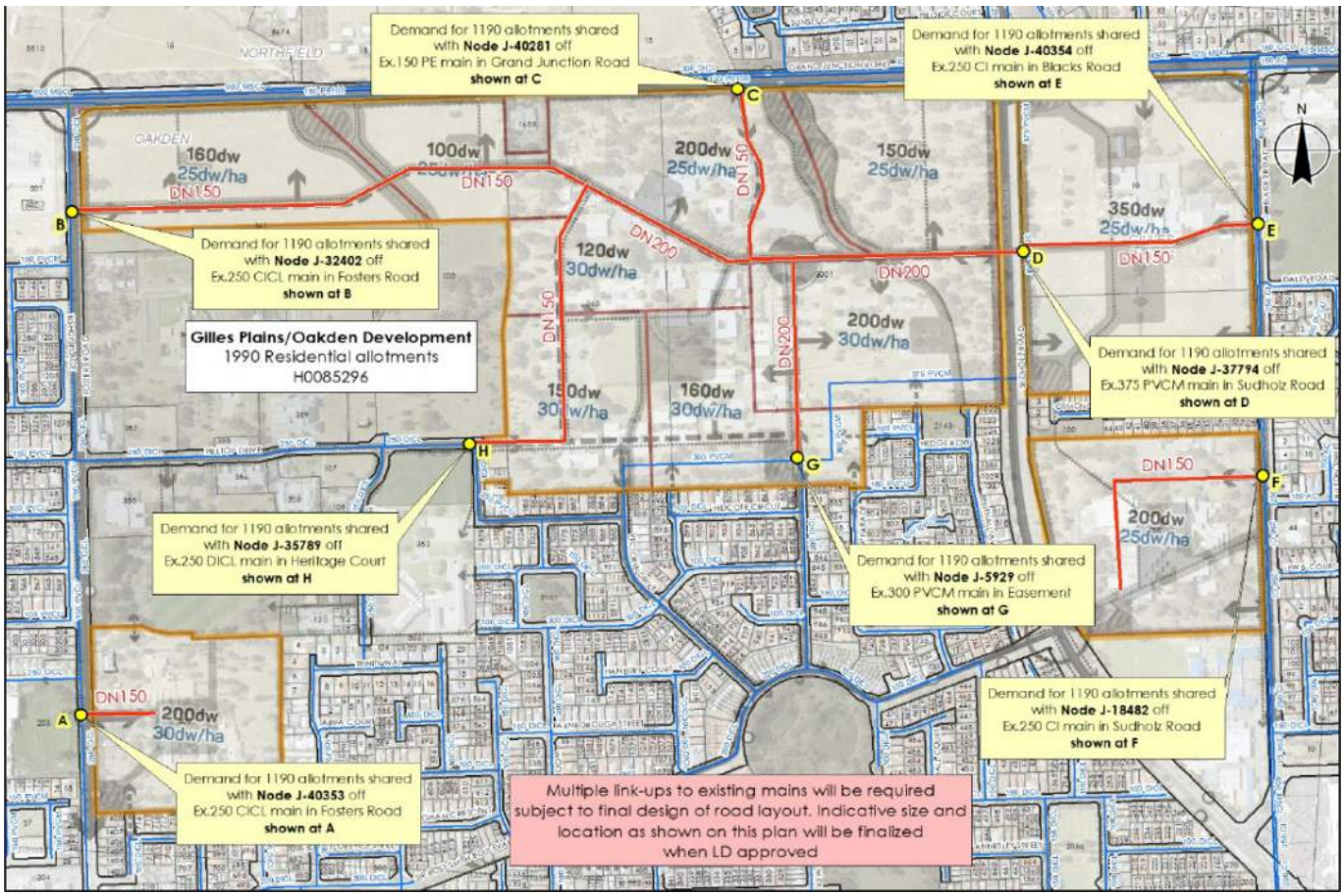


Figure 6: Potable water services connection opportunities (Source: SA Water)

3.3 Wastewater infrastructure

3.3.1 Existing infrastructure

There is an existing 225 mm PVCU gravity sewer main in the middle of the development site which runs along the creek system from Hilltop Drive down to Grand Junction Road on a sewer easement. Oakden Fire Station is serviced by this main whereas Strathmore Centre is connected to another 300 mm VC gravity main across Grand Junction Road.

There is sewer infrastructure in Fosters Road, Hilltop Drive, Victoria Drive, Acorn Parade which can be possible connection points for the southern catchment.

3.3.2 New infrastructure required

SA Water have undertaken a preliminary capacity assessment and advised the following regarding wastewater infrastructure (provided on 17 September 2019, refer Appendix A):

- The DN675 RC gravity main (north of the development site – see Figure 7) which would ultimately convey a large portion of flows from the development site has been identified as requiring future augmentation based on the 2018 Bolivar South master planning.

- Given the size of the development and the large expected flows it is recommended that the system is monitored to determine when the augmentation works, and upgrades are required. Further

assessment and monitoring will need to occur when detailed information is provided on the development layout and staging plans.

- In addition, depending on the development layout and staging plans, it may be necessary for the developer to construct headworks of a new DN225 gravity main in Grand Junction Road of approximately 2.4km. As shown in Figure 8 below.

- A reassessment of the availability of wastewater services and the potential network connection points will be undertaken once additional details (including proposed lot layout and proposed servicing strategies) for the development are determined and submitted to SA Water.

- The construction of the sewer infrastructure must be in accordance with SA Water Network Infrastructure Standards.

Information provided by SA water is based on a high-level assessment and is subject to further assessment when a lodged land development application is received, or further development information is provided. It should be noted that the Wastewater Servicing strategy is subject to further assessment by SA Water's Asset Management Team to determine the delivery of the required augmentation works to service this proposed development.

Figure 7 & 8 provides a high-level overview of potential augmentation works which may be required (Source: SA Water).

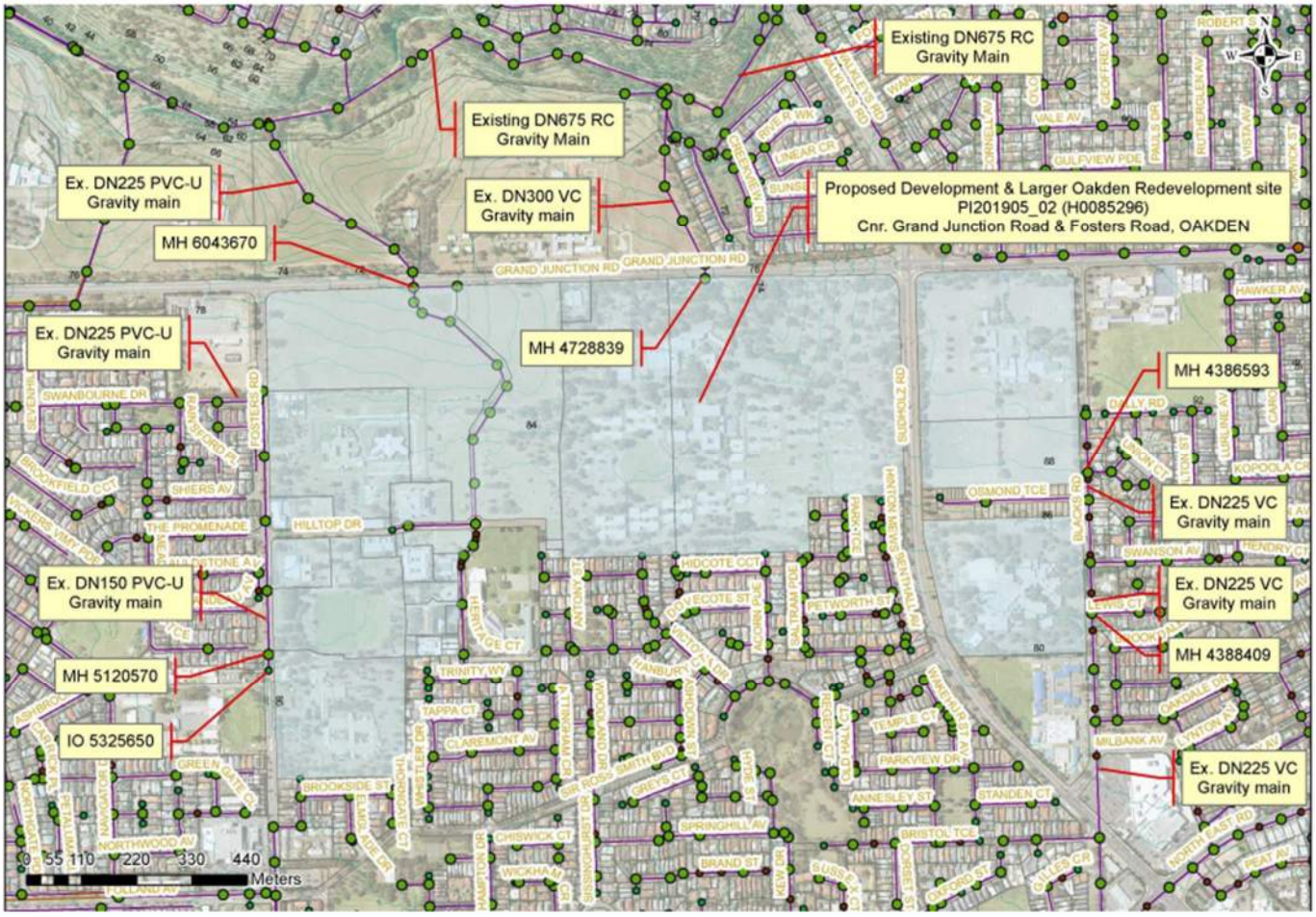


Figure 7: Sewer Services Existing - Option 1

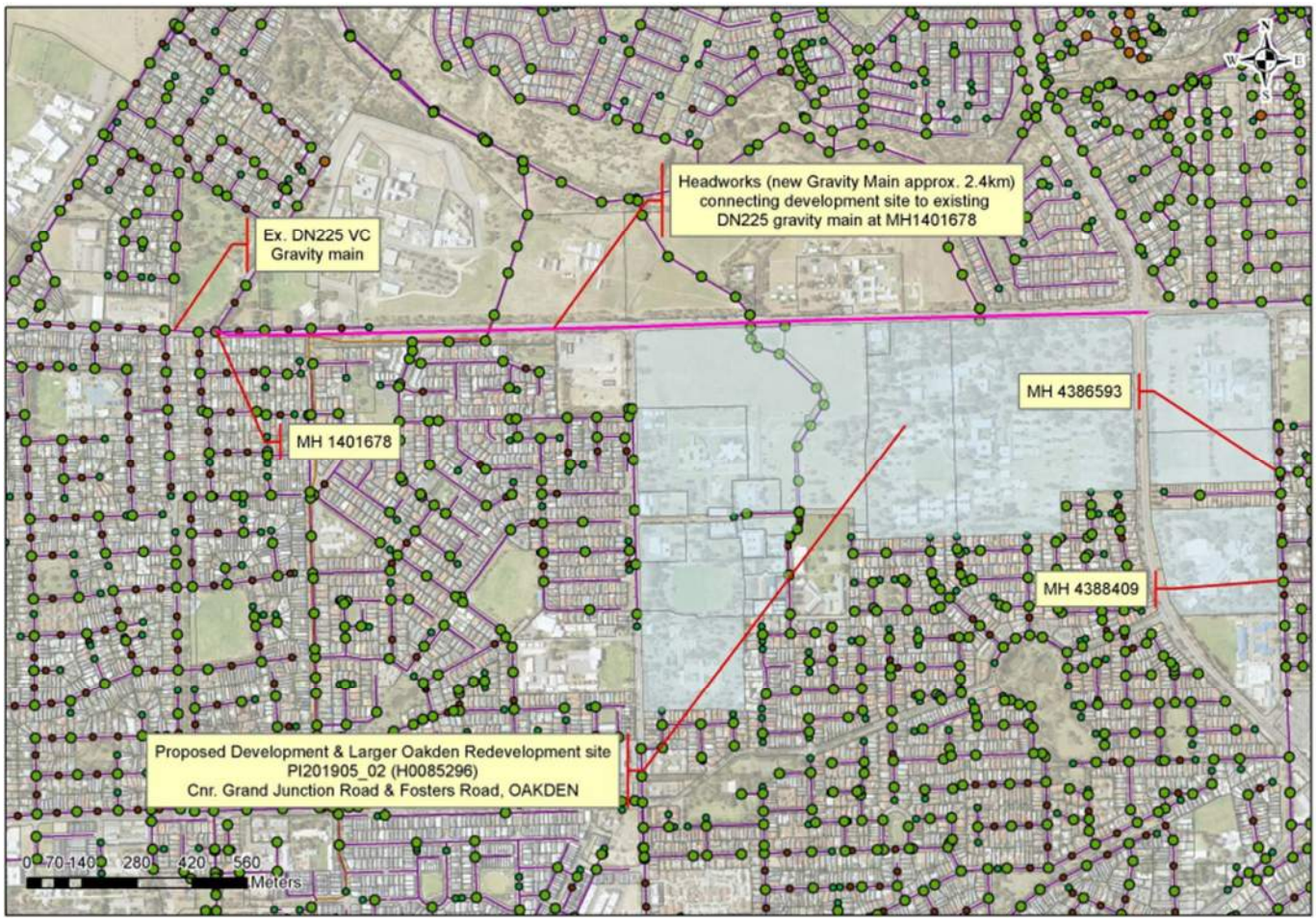


Figure 8: Sewer Services Existing System and Headworks - Option 2

3.4 Recycled Water Infrastructure

There is no existing recycled water infrastructure in vicinity of the site owned and operated by Port Adelaide Enfield or Salisbury Council. However, Water Utilities Australia (WUA) have been contacted to provide an information on the existing recycled water infrastructures servicing adjacent Lightsview development and future augmentation works that might be required to service the proposed development in Oakden and Gillies Plains area from irrigation and household non-potable uses perspective. WUA have advised the following in relation to the above:

- The Lightsview pipeline has a direct supply from from the City of Salisbury's stormwater treatment scheme. The current connection has some capacity however there is potential to make a second connection to the City of Salisbury and augment the existing scheme to service the Oakden/Gillies Plains area.
- It is likely that on-site storage at the development site would be required to balance the peak demands of the Oakden/Gillies Plains area.
- Preliminary discussions with the City of Salisbury have indicated a connection in the Walkley Heights area could supply the additional water necessary to supply the scheme.
- No estimates of capital works required for this infrastructure are currently available.
- If the water was to be used for household connections additional treatment including chlorination and potentially UV disinfection to ensure the water is suitable for household use.

3.5 Electrical infrastructure

3.5.1 Existing infrastructure

As the DBYD information was not readily available due to the large extent of the "Structure Plan Area", SA Power Networks was consulted to provide a brief snapshot of the existing services. The following information was supplied by SAPN:

- There are 4 different feeders coming from 2 different substations which can be used around this development.
- Northfield Sub Station Feeder HH-403B runs overhead from Northfield Substation, East up Grand Junction Road towards the hills. This feeder supplies the Strathmont Rehabilitation Centre with an 11kV Bulk Supply and runs past the SAHMRI site. The SAHMRI site has an existing 500kVA padmount transformer on it.
- Northfield Sub Station Feeder HH-404C runs overhead South along Fosters Road. This feeder runs into Hilltop Drive and past the Oakden Mental Health Facility. The Oakden Mental Health has an existing 500kVA padmount transformer on it.
- Hillcrest Sub Station Feeder HH-428E runs underground through Oakden and across Sudholz Road to the TAFE Site. There are several provisions that have been made to extend the HV through Oakden including Park Terrace, Acorn Parade, Hilltop Drive and Victoria Drive. The TAFE site has an existing 750kVA padmount transformer on the Western side.
- Hillcrest Sub Station Feeder HH-428E runs underground near the northern end of the TAFE site at the corner of Swanson Avenue and Blacks Rd. This feeder supplies an existing 1MVA padmount transformer on the Eastern side of the TAFE site.

In addition to the information on the existing services, SAPN have suggested the following in terms of new infrastructure required to service the developments and augmentation rates which might be applicable.

3.5.2 New infrastructure required

Upon receipt of a preliminary desktop study conducted by SA Power Networks (SAPN), it is understood that an approximate load of 10MVA will be required to service the full development which is proposed to have a large yield of residential properties. The study has recommended that an extensive consultation with SA Power Networks 'Network Planning' department to coordinate the possible upgrade of substations and HV infrastructure. The network planning team will need a projected timeline of the development and programme containing the order of stages to be developed.

The desktop study has pointed out that it will be critical to develop a master plan for the High Voltage works.

The augmentation rate would be at the published rates of $235/kVA if connected to the Feeder HV, or $361/kVA if connected to the existing LV. The Northfield substation is a 20MVA substation, so at 2MVA the additional zone substation augmentation rate will be applicable. The Hillcrest substation is a 50MVA substation, so at 5MVA the additional zone substation augmentation rate will be applicable. If the load connected to the Hillcrest substation exceeded 14.2MVA, then Sub-transmission line augmentation rate would also be applicable. The additional rated would be triggered by a rolling load connected within a five-year period.

3.6 Communications Infrastructure

3.6.1 Existing infrastructure

The current Dial Before You Dig (DYBD) results from the National Broadband Network (NBN) indicate that there are no NBN services available for this site. However, the NBN rollout map (source: NBN Co website) indicates that construction of Fibre to the Curb (FTTC) technology has commenced which will be ready for connection around Jan – Mar 2020.

As Telstra did not release their existing services information for the site without paying an upfront data extraction mandatory fees, DYBD data obtained in 2010 (supplied by Renewal SA), indicate that there are Telstra services currently serving the existing developments including the James Nash House, Strathmore Centre and the surrounding residential areas. However, the existing capacity and the type of services are not known. It is recommended to confirm this by obtaining a current network data from Telstra.

3.6.2 New infrastructure required

Based on the existing services information outlined above, NBN was contacted to provide more detailed information related to the capacity and upgrade required. It has been advised by NBN that a formal 'feasibility study' needs to be lodged through their website, due the size of the proposed development. The 'feasibility study' request form requires specific details including developer's name, ABN, number of development stages, construction commencement and completion time line, which are not available at this stage of the project. Hence, it is difficult to provide details of new infrastructure and network upgrade charges. However, as stated above NBN rollout has started in this area with Fibre to the Curb (FTTC) services forecast to be available from early 2020.

3.7 Gas Infrastructure

3.7.1 Existing infrastructure

From the DBYD inquiry and confirmation from APA Group that there are existing medium pressure mains surrounding the proposed development area with capacities sufficient enough to service the increased gas demand due to this development.

3.7.2 New infrastructure required

It has been advised in a written correspondence that gas mains can be installed by Australian Gas Networks at no cost to the developer, in common services trench which is provided by others. The future developer will need to lodge a formal request to APA once the development has been ready to kick off providing the information including number of dwellings, commencement dates, build rate, length of internal roads.

3.8 Recommendations

The following recommendations have been made for each utility service after assessing the existing services information and requirements outlined by the corresponding service authority:

- **Potable water**: SA Water have advised that the proposed development can be provided with potable water supply from the existing infrastructure in the surrounding areas as per the recent investigation summary discussed in Section 3.2.2. It should be noted that a direct liaison with SA

Water be made by perspective developer or their representative (consulting engineers) during detailed design of water services for the development.

- **Sewer/Wastewater**: Based on the recent advice received from SA Water as discussed in Section 3.3.2, sewer services are available for future development of this land. As per the advice, augmentation works will be required the extent and cost of which are subject to further assessment upon development application lodgement. It is recommended that, a direct liaison with SA Water be made to discuss to details of augmentation layout and any applicable fees once the development has been progressed to next phase.

- **Recycled Water**: From the recycled water service information provided by City of Salisbury and City of Port Adelaide Enfield (PAE), as there is no such service near the subject land which councils own and operate. However, PAE have indicated that Water Utilities Australia have recycled water reticulation network operating in Northfield area and Lightsview residential precinct, for recycled water supplied by City of Salisbury stormwater treatment and reuse scheme. Potential developers have opportunities to explore feasibilities of providing the development with reclaimed/recycled water, if required, for non-potable uses like irrigation and toilet flushing. Based on the advice received from WUA as discussed in Section 3.4, it is recommended to liaise with Water Utilities Australia and the City of Salisbury to identify these opportunities and plan the way forward in terms of infrastructure requirement and associated costs.

- **Communication**: Although NBN services rollout has started and the services are likely to be available from early 2020, NBN Co have advised that a detailed assessment will be required for this development as the residential development yield is very high. Taking this advice from NBN into consideration. it is recommended that a formal ‘feasibility study’ request is lodged with National Broadband Network (NBN Co.) to determine the requirements that may entail any infrastructure upgrade works to service the development.

- **Gas**: Gas supply is available through several existing low to medium pressure mains near the subject land which have the capacity to service the future development. Developer will be required to sign an agreement with Australian Gas Networks (APA Group) for installation of gas supply infrastructure upon a formal lodgement of development application with APA Group once the development is progressed to next phase. APA Group have advised that the new gas reticulation will be designed and installed by them in the service trench provided by developer, free of cost.

- **Electricity**: In accordance with the new infrastructure information outlined by SA Power Networks documented in Section 3.5.2, augmentation works will be required to sustain the load to be generated by the new development. It is recommended that the perspective developer liaise with SAPN to develop a master plan of high voltage augmentation works for the whole development which would be critical provide a detail of effective electrical supply solution to the proposed development.

4 Transport

A multi-modal assessment has been undertaken to document the likely transportation implications related to the scale and form of development identified in the Oakden and Gilles Plains structure plan. This has included evaluation of the existing transportation context and site conditions, likely development traffic generation characteristics and development of preliminary measures to facilitate an acceptable standard of access and movement opportunity across walking, cycling, public transport and private vehicle modes of travel.

4.1 Existing conditions

4.1.1 Locality and site

The structure plan area is located approximately 10 kilometres north east of the Adelaide CBD, adjacent Grand Junction Road and Sudhulz Road. Key nearby destinations of significant useful land use include:

- Ingle Farm Shopping Centre to the north.
- Northgate and Greenacres shopping centres to the south.
- Gilles Plains Shopping Centre to the south east.
- Commercial strip development along North East Road to the south and east.
- Tea Tree Plaza retail precinct to the north east

The closest high frequency, high capacity public transport corridor to the site is the O-Bahn busway, which can be accessed via Paradise Interchange, approximately 3km to the south east.

Figure 9: Structure plan site locality

4.1.2 Infrastructure

Figure 10 provides an overview of the road network infrastructure connecting the structure plan area to its surrounds. Key roadways which will be primarily responsible for providing access to and from development within the structure plan area are:

- *Grand Junction Road*. An important cross suburban divided dual carriageway arterial, providing 2 lanes in each direction, with a signposted speed limit of 70kph.
- *Fosters Road*. A sub-arterial road connecting Grand Junction Road with North East Road, providing 1 lane in each direction with a signposted speed limit of 50kph south of Hilltop Drive and 60kph north. Although reasonably well trafficked, this road does not currently have a signalised intersection with North East Road.
- *Sudholz Road*. A high capacity dual carriageway sub-arterial providing an orbital connection through the north east with 2 lanes in each direction and a signposted speed limit of 60 kph south of Sir Ross Smith Boulevard and 70 kph north.
- *North East Road*. A high capacity dual carriageway arterial providing the primary road connection between the Adelaide CBD and the north eastern suburbs. Adjacent the structure plan area it has 2 lanes in each direction and a posted speed limit of 60 kph.
- *Sir Ross Smith Boulevard*. A collector road linking Fosters Road to Sudholz Road through of Oakden, providing the primary access to local roads within the suburb. It has one lane in each direction and a speed limit of 50kph.
- *Blacks Road*. A collector road linking Grand Junction Road to Sudholz Road through Gilles Plains. It has one lane in each direction and a speed limit of 50kph.

Figure 11 shows existing dedicated cycling infrastructure surrounding the structure plan area. Identified cycling routes which do not provide at least a marked lane have been omitted for clarity. On road bike lanes are provided for all key roads surrounding the site. However, these facilities represent absolute minimum cycling infrastructure and would generally attract only the most confident of cyclists, particularly along large, higher speed arterial roads. Fosters road represents the most broadly accessible route connecting the site to local retail and commercial destinations.

In terms of key cycling connections to useful non-local destinations, the City to Levels bikeway runs approximately 2.5km to the west of the site through Clearview, while the River Torrens Linear Trail is approximately 2km to the south. Relatively low stress access between to the City to Levels bikeway exists via Foster Road and Folland Avenue. Direct low stress cycling access between the site and the River Torrens Linear Trail does not currently exist. However, an indirect and non-signposted route which avoids major arterials through Oakden, Hillcrest and Windsor Gardens is available.

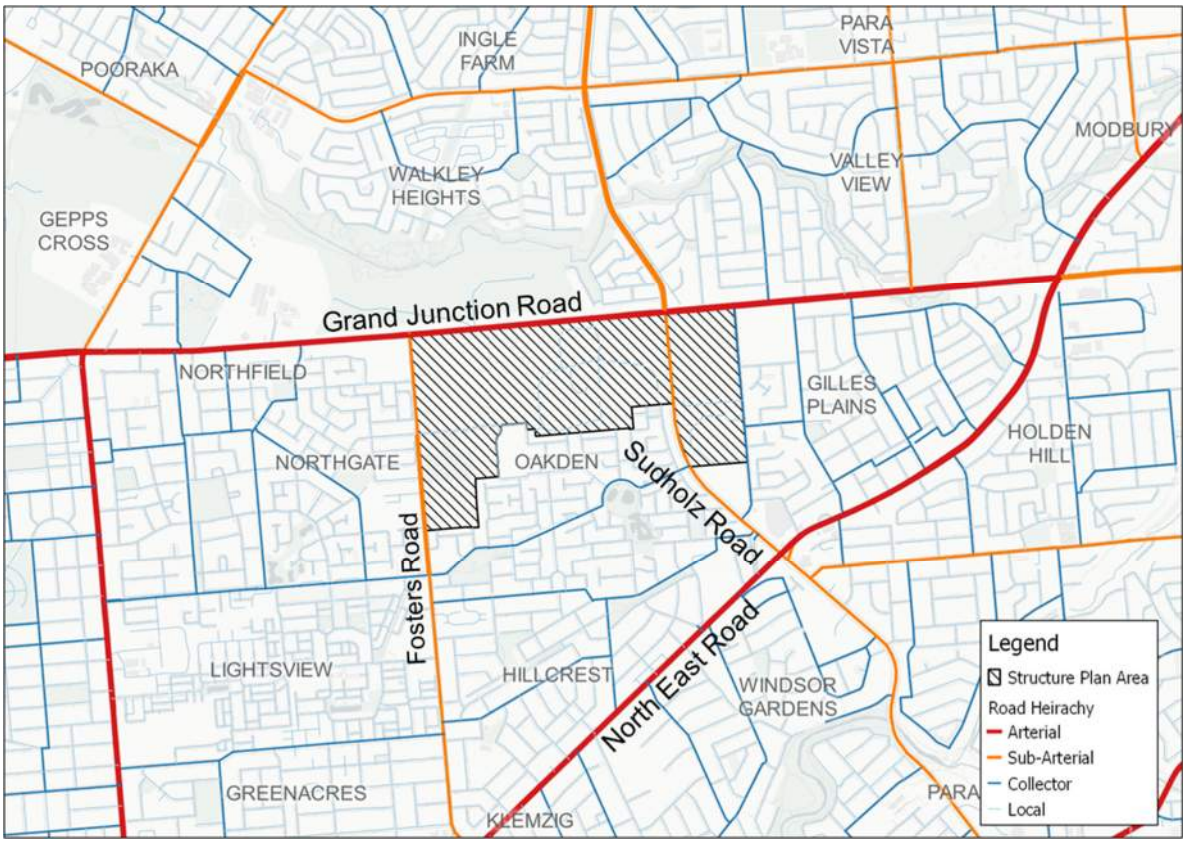


Figure 10: Road network and hierarchy surrounding structure plan area (data source: Data SA)

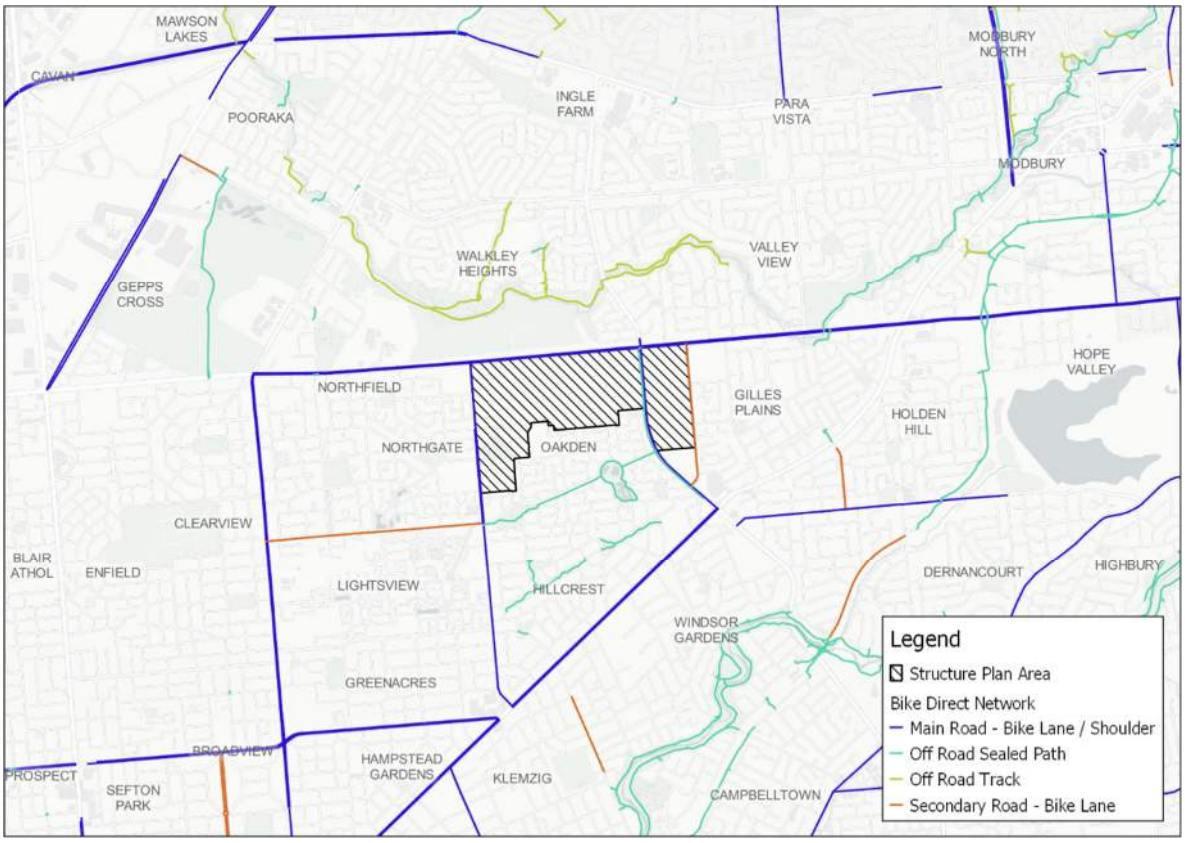


Figure 11: Dedicated cycling infrastructure surrounding the structure plan area (data source: Data SA)

4.1.3 Road traffic volume & typical congestion

Figure 12 provides a visual representation of typical daily traffic volumes on the road network surrounding the structure plan area. Carrying ~45,000 vehicles per day, North East road is one of the busiest in Adelaide and by far the busiest in the immediate site area. Grand Junction Road and Sudholz Road both carry ~25,000 vehicles a day while Fosters Road carries up to ~15,000.

In terms of mid-block carrying capacity, only North East Road is approaching its limit. This is evident from typical weekday congestion data available through google maps, as shown in Figure 13 for the AM period and Figure 14 for the PM. The data shows significant stretches of moderate congestion in the peak direction along North East Road. At an intersection level, North East Road and Sudholz Road is the most significant hot spot, with peak period congestion shown to extend upstream along both roads from the junction.

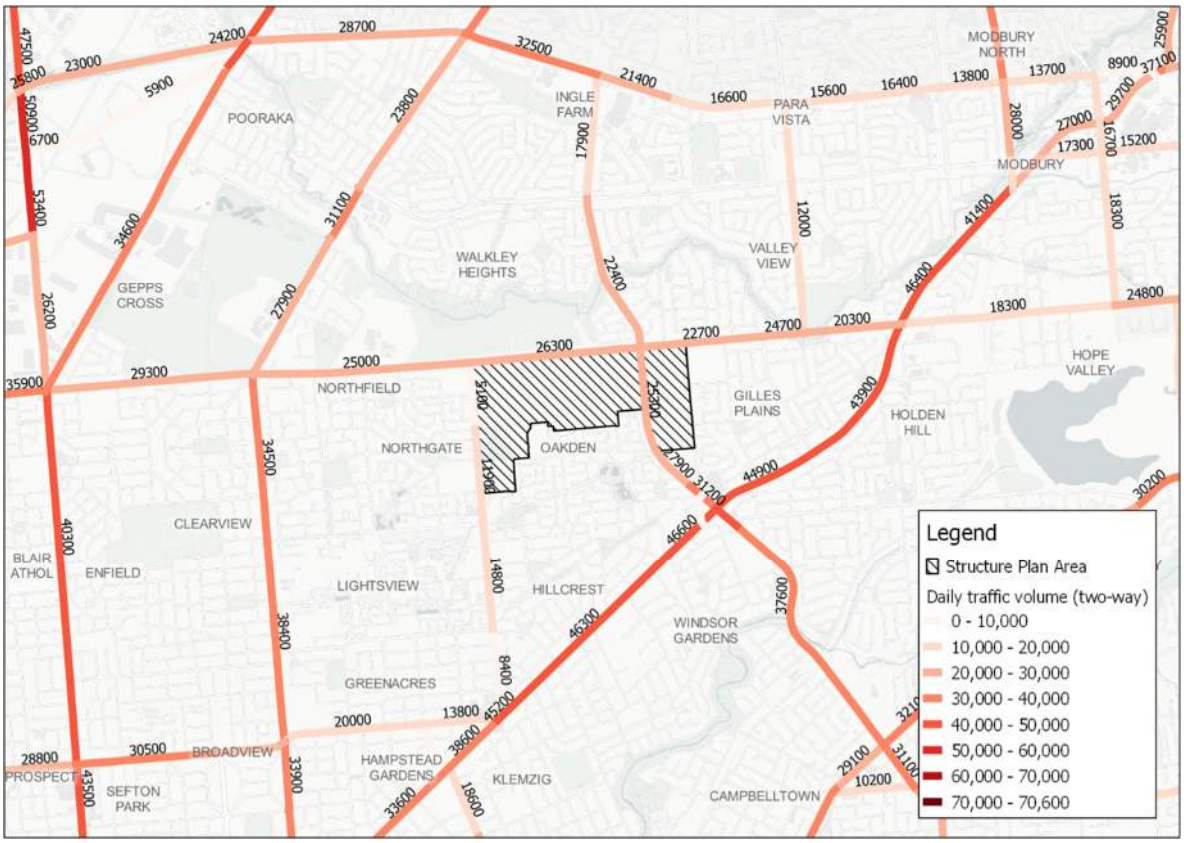


Figure 12: Estimated annual average daily traffic volume for the arterial road network surrounding structure plan area (data source: Data SA)

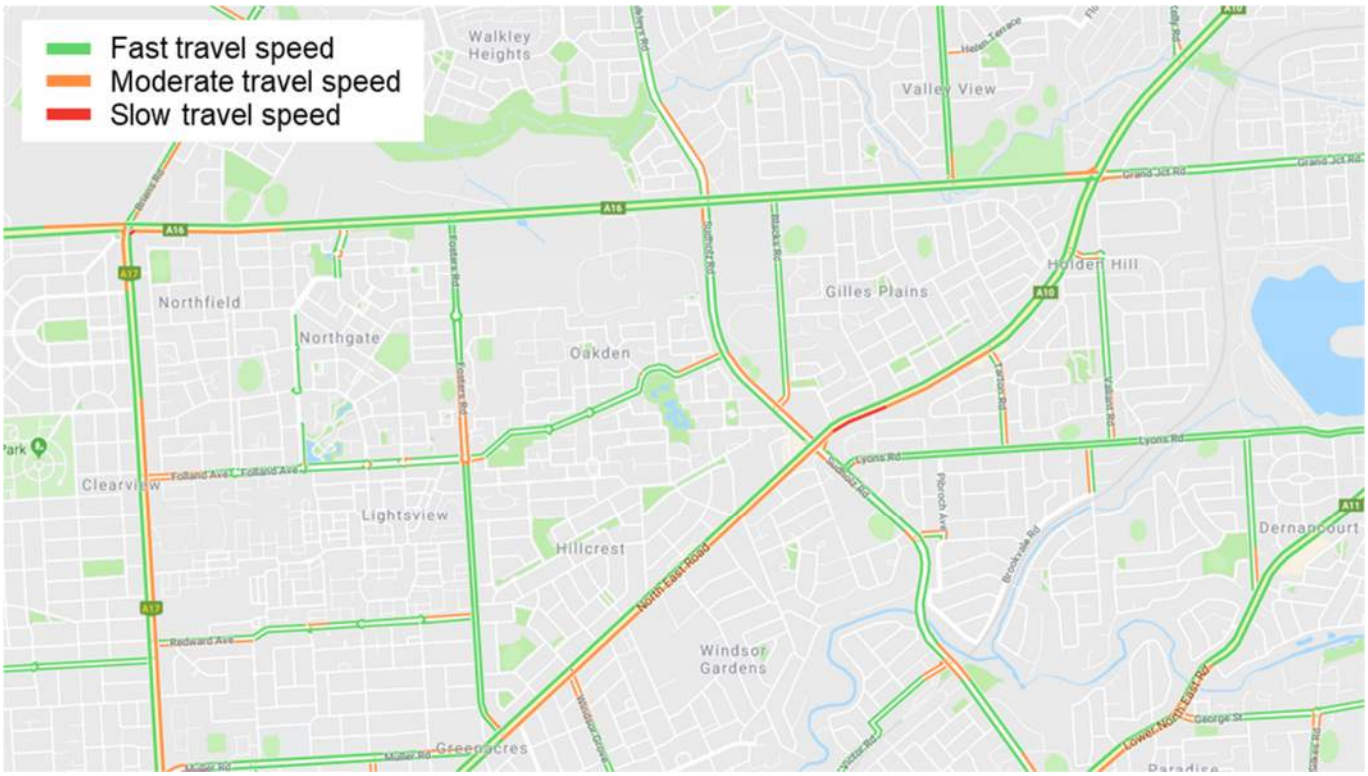


Figure 13: AM peak period road network congestion surrounding structure plan area (Source: Google Maps)

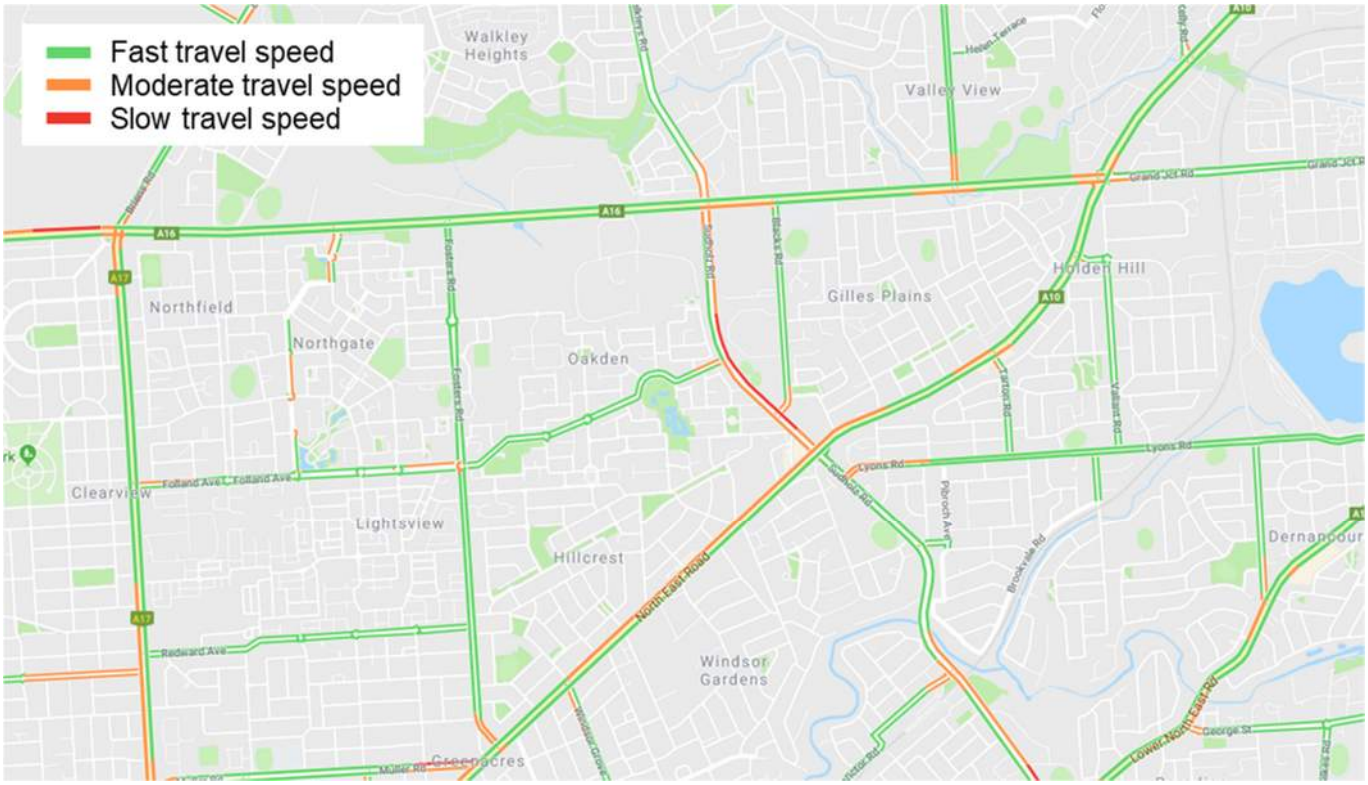


Figure 14: PM peak period road network congestion surrounding structure plan area (Source: Google Maps)

4.1.4 Public transport routes and accessibility

In terms of density of routes, almost all of metropolitan Adelaide is well connected to some form of public transport. As Figure 15 shows, the structure plan area is no different, serviced by the 361 to the north, 500/501/502 to the east and 208/528 to the west and south. However, the simple presence of a route

does not provide a good indication of frequency or how useful of a service it provides in terms of connecting people with the useful destinations they want and need to reach (employment, social interaction, etc…).

To provide better insight into the quality of public transport provided to the structure plan area, analysis has been undertaken to understand the frequency of services, stop walking catchments and accessibility to locations of employment.

The 5-minute walking catchment and the average daytime frequency of service for each bus stop is shown in Figure 16. This shows the following regarding public transport access from the structure plan area:

- As existing, much of the site does not have access to a bus stop within a 5-minute walk. However, this is largely a function of the current lack of walking connectivity.
- Due to the existing lack of development, routes to the east and west of the site do not currently stop adjacent the site, creating a gap in access.
- The bus network surrounding the site is largely low frequency across the day. With the exception being the Sudholz Road corridor providing a high frequency of service connecting directly to the O-Bahn via Paradise interchange.

Taking input from the most recent Adelaide metro GTFS feed[1] and employment data from the 2016 census, the ability for the public transport network to connect residents with locations of employment within a 45-minute journey (including walking time) has been modelled using the Conveyal public transport analytics software platform for the region surrounding the structure plan area. The results of this modelling are presented in Figure 17, with regions shown in red able to access few jobs while regions in green to blue able to access many jobs by public transport.

This modelling shows that although the structure plan site is serviced by a number of routes, they are largely ineffective in connecting residents with areas of employment within a reasonable travel time cut-off. Again, the Sudholz Road corridor is the exception here. By virtue of providing a frequent and direct access to the O-Bahn busway, services along this corridor are highly effective at connecting to locations of employment. As such, providing direct and high quality walking access to these services from development within the structure plan area should be a high priority design objective.

[1] https://data.sa.gov.au/data/dataset/adelaide-metro-general-transit-feed

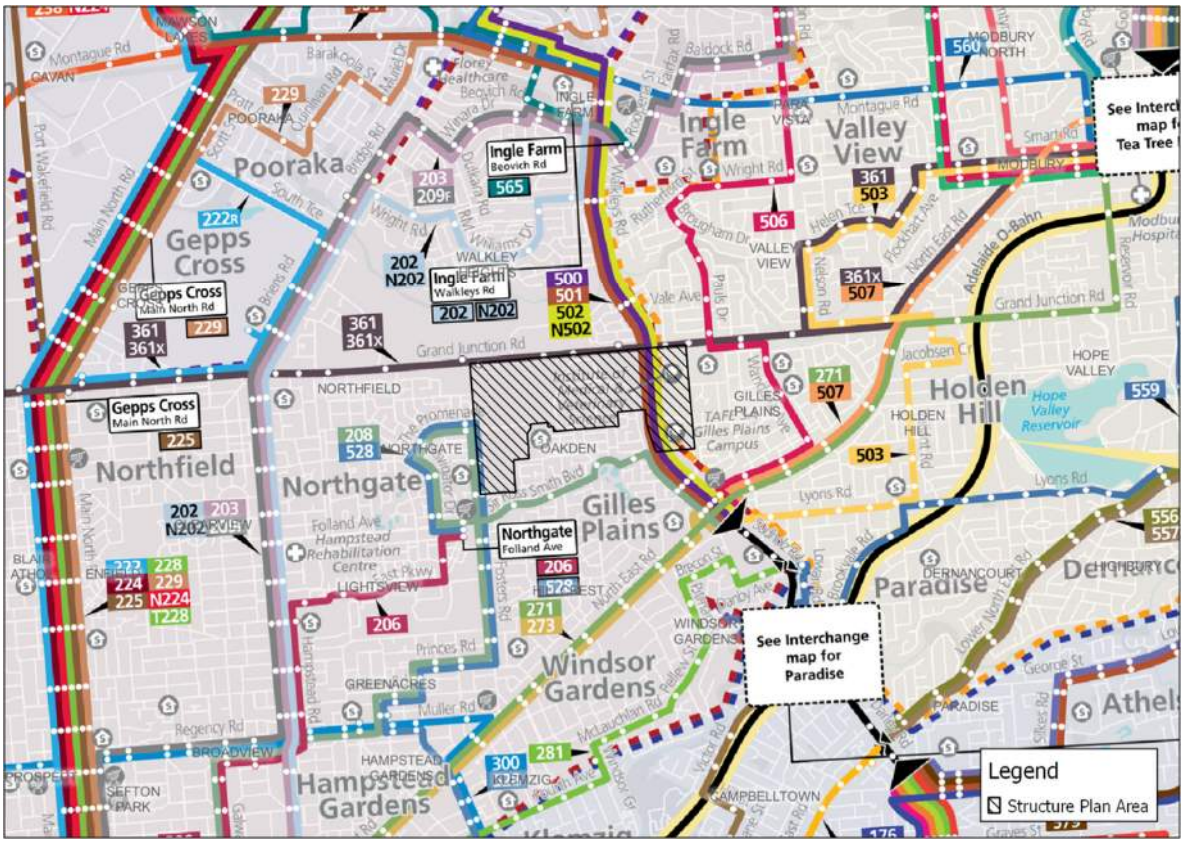


Figure 15: Public transport services nearby structure plan area (source: Adelaide Metro)

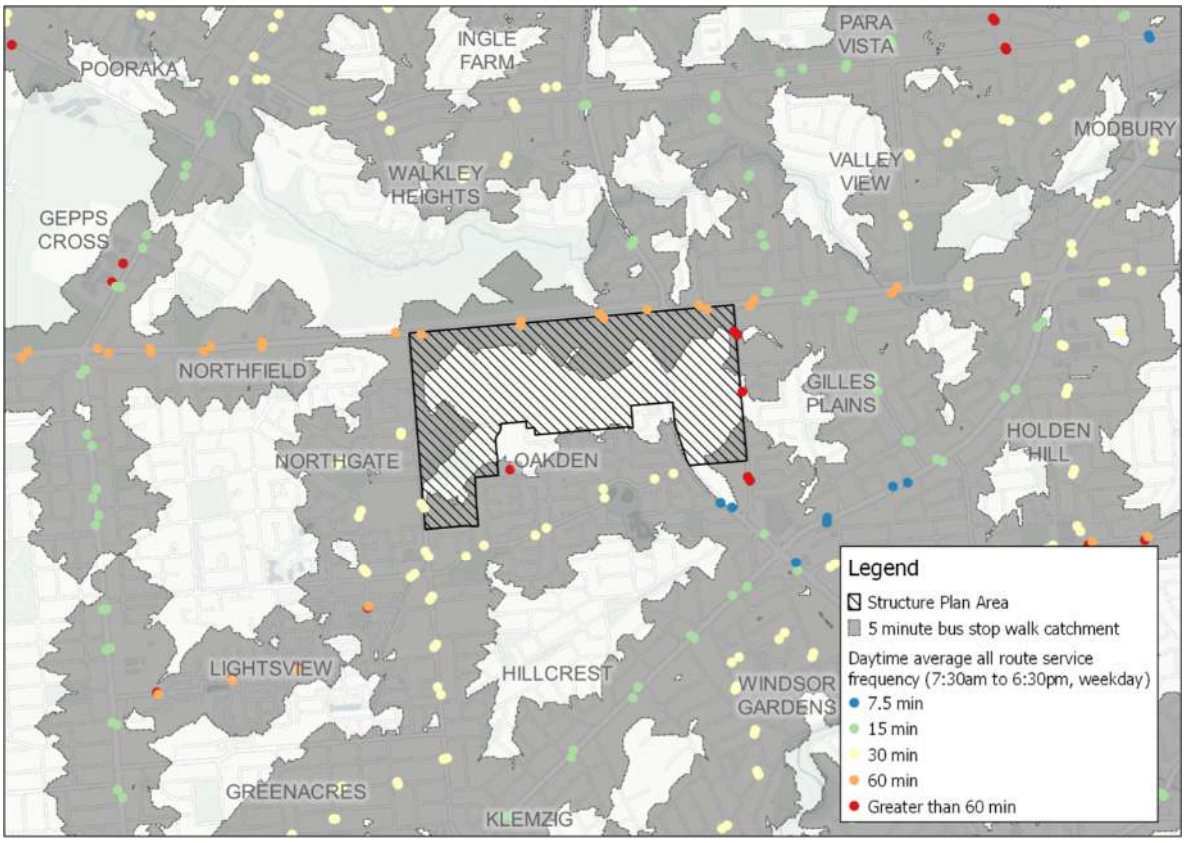


Figure 16: Stop catchments and service frequency for the structure plan area and surrounds (data source: Data SA, Open Street Maps)

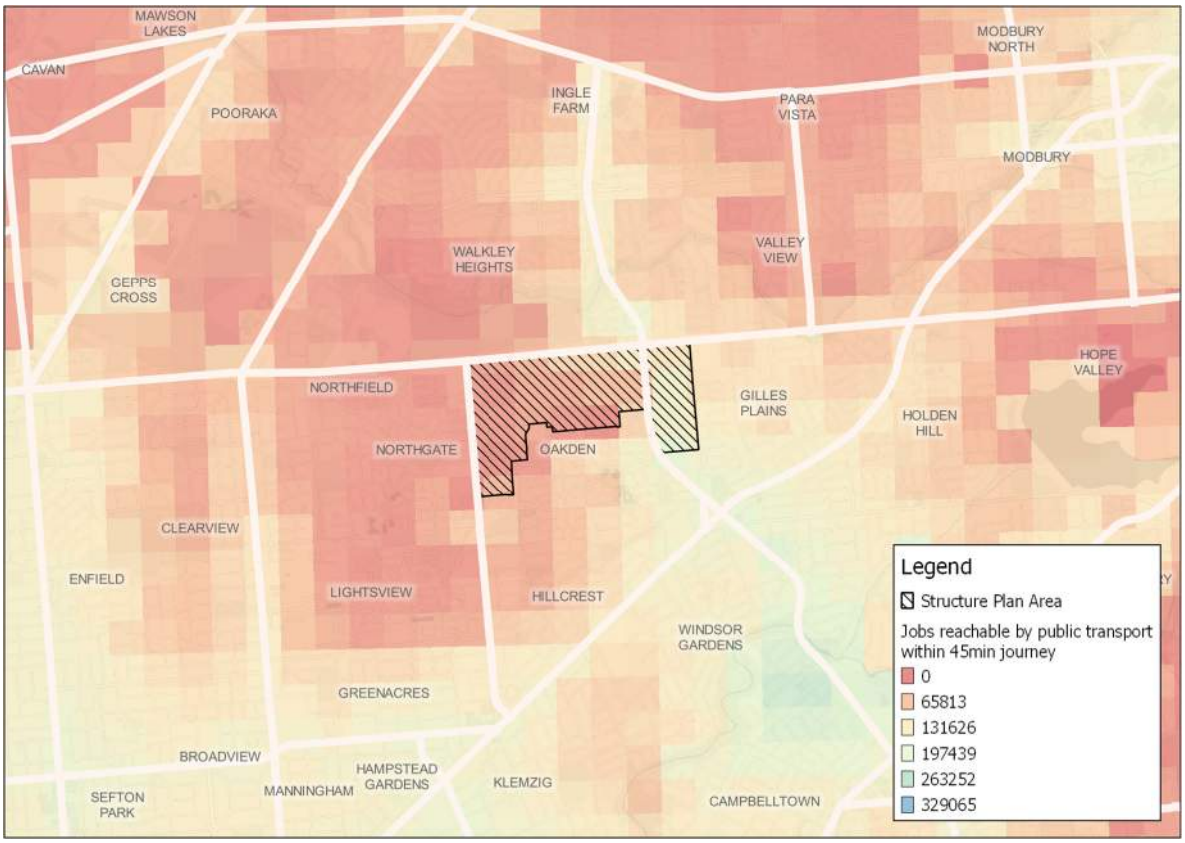


Figure 17: Modelled access to employment by public transport for the structure plan area and surrounds (data source: Data SA)

4.1.5 Walkability

To understand existing the existing walkability in and around the structure plan area, data from the Walk Score API service has been collected and mapped, refer Figure 18. Walk Score provides a metric of walkability from 0 to 100, calculated by measuring the number and type of useful destinations (retail, hospitality, education, etc…) which are within walking distance of the subject location. A score of 0 indicates complete car dependence, requiring travel by car to carry out all daily activities. A score of 100 indicates that all daily activities could be carried out on foot. The measure does not account for factors affecting the quality of the walking environment (i.e. footpath width, frontage type, etc…), rather it is a measure of location accessibility.

As would be expected for an undeveloped area, the structure plan site is currently not functionally walkable. However, the surrounding areas of Walkley Heights, Northgate and Oakden are also not particularly walkable for transportation. This indicates a need for non-residential land uses accessible on foot in the general area.

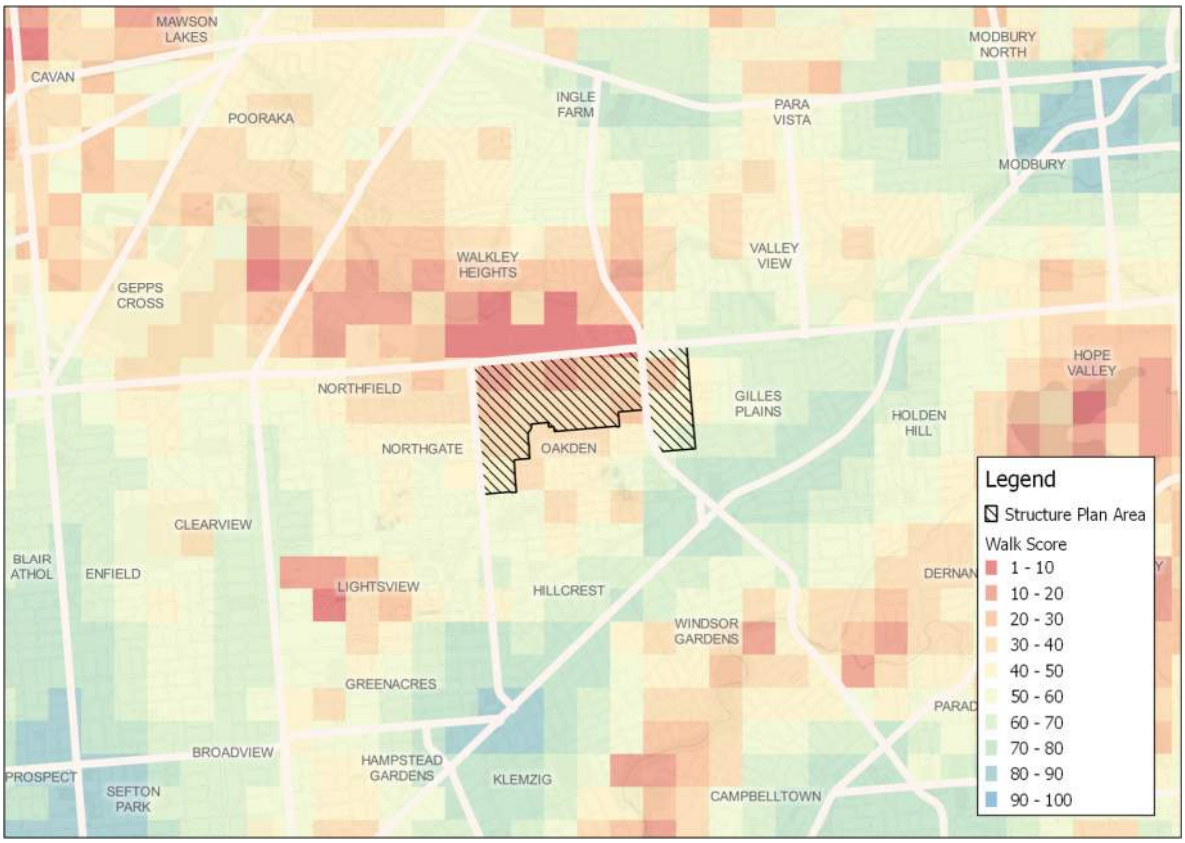


Figure 18: Existing walkability of structure plan area and surrounds (data source: Walkscore)

4.1.6 Crash history

Five years of crash history data for the structure plan area and surrounds has been obtained processed to produce a heatmap of casualty crashes, shown in Figure 19. This provides an understanding of locations where serious traffic incidents resulting in injuries requiring treatment or fatalities are more frequently occurring.

There are a number of key casualty crash hotspots surrounding the structure plan area (noting that higher volume roads will typically see higher numbers of incidents), these are:

- North East Road corridor in general
- Grand Junction Road / Briens Road intersection
- Grand Junction Road / North East Road intersection
- Muller Road / North East Road intersection

In the immediate vicinity of the structure plan area, the largest incident hotspot occurs at the intersection between Sir Ross Smith Boulevard and Sudholz Road.

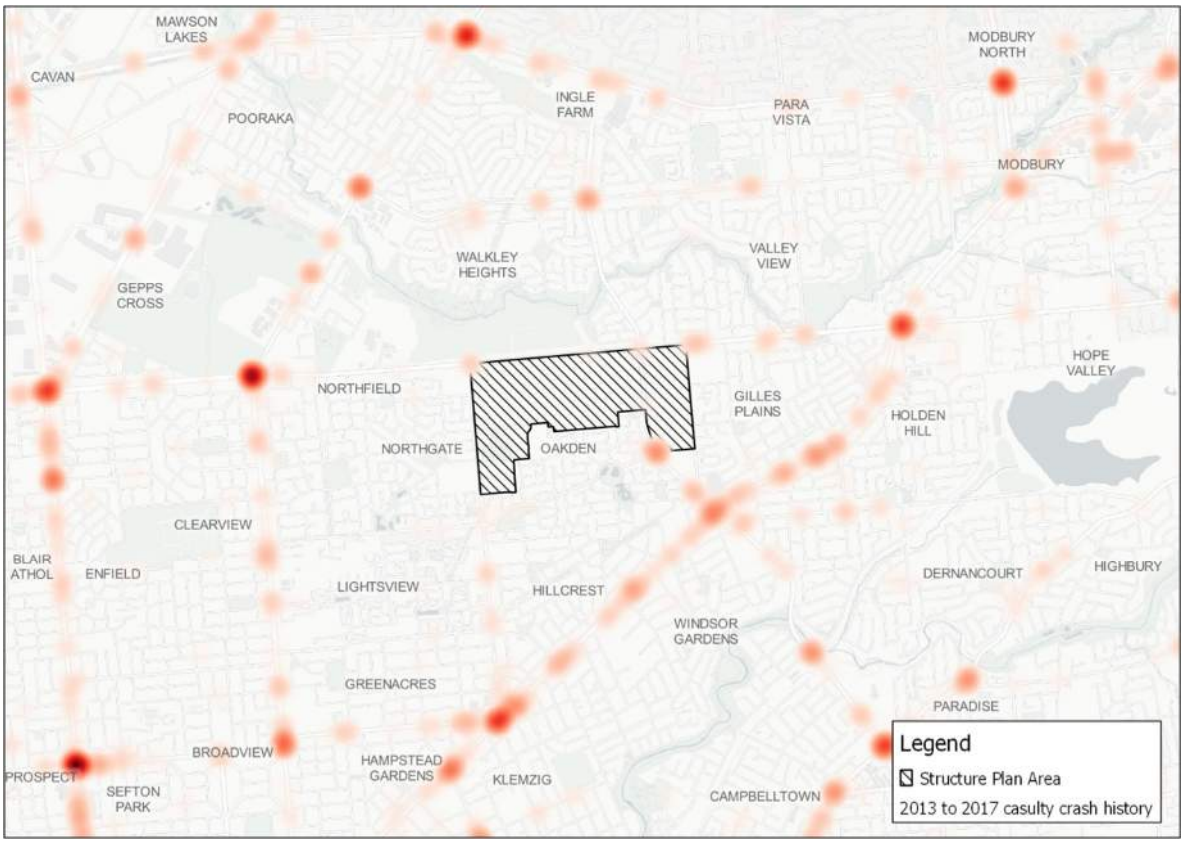


Figure 19: Five year casualty crash history heatmap (data source: Data SA)

4.1.7 Planned works

To identify any significant transportation infrastructure works planned for the short to medium term which may impact the structure plan area, the DPTI forward works plan[2] has been reviewed and advice sought from council. The two most significant projects identified are the Fosters Road Painted Median Scheme[3], scheduled for imminent construction and the Hampstead Road and Grand Junction Road Intersection upgrade[4], which is currently in planning.

The works to be undertaken as part of the Fosters Road project, as stated on the project summary website, are as follows:

- Installation of a painted median scheme, including right turn storage lanes.
- Installation of pedestrian refuges at three locations.
- Pavement rehabilitation between North East Road and Redward Avenue.
- Changing the operating hours of the bike lane on the western side to a full time bike lane (the bike lane on the eastern side will remain a morning peak bike lane). This change will result in parking being removed on the western side, and also on the eastern side where pedestrian refuges are being installed.
- Upgraded lighting at various locations.

[2] https://dpti.sa.gov.au/__data/assets/pdf_file/0004/335533/Forward_Work_Plan_2022.pdf

[3] https://www.dpti.sa.gov.au/infrastructure/road_projects/fosters_road_painted_median_scheme
[4] https://www.dpti.sa.gov.au/infrastructure/road_projects/hampstead_road_and_grand_junction_road_intersection_upgrade

- Modifications to the northern and southern approaches to the two roundabouts to reduce approach speeds, together with upgraded pedestrian facilities.
- Indentation of bus stops where possible.

These works will significantly enhance the amenity of Fosters road, providing walking and cycling benefits to the structure plan area. However, they are not expected to significantly alter the traffic carrying capacity of the road and thus, will have limited bearing on planning for private vehicle access to development within the structure plan.

No design details are currently available regarding the Hampstead Road and Grand Junction Road Intersection upgrade. However, it is expected the works would result in increased traffic capacity through the intersection, potentially improving private vehicle accessibility to the structure plan area from the west and north west.

In addition to these significant state government projects, council have advised of the following projects within the structure plan area:

- Creation of a new bike link across Sudholz Road, adjacent Osmond Terrace. This is currently under construction.
- Upgrade of the shared path along Suholz Road. This project is currently in the planning stage.

4.2 Traffic Impact

To evaluate traffic capacity impact which could arise from the scale and type of development proposed in the structure plan, SIDRA intersection modelling has been carried for the following key intersections:

- Grand Junction Road / Fosters Road
- Fosters Road / Sir Ross Smith Boulevard
- Grand Junction Road / Sudholz Road
- Sudholz Road / Sir Ross Smith Boulevard
- Sulholz Road / North East Road

Development of the intersection models has been carried out based on November 2018 intersection turning count data and SCATS summary data supplied by DPTI, supplemented with on-site observation.

In undertaking the modelling, the following assumptions have been made, recognising that the analysis is in support of early stage planning for development of which the details currently remain necessarily undefined:

- Traffic generation rates are as per the RTA Guide to Traffic Generating Development, 2002, including the 2013 updated traffic surveys technical direction.
- Traffic distribution will largely follow AM and PM tidal patterns present on the surrounding arterial network.
- The proposed activity centre within the structure plan serves a local catchment and attraction of new external traffic or bypass trips will be negligible.
- Intersection models have been developed in accordance with DPTI Traffic Modelling Guidelines for SIDRA Intersection 7, version 1.0.
- Given significant uncertainty at this point in the planning process, no testing of development staging has been carried out. Full development build out has been tested against existing traffic conditions.

- For simplicity, the conservative position on not subtracting traffic associated with existing land uses flagged to be replaced (such as the TAFE SA site) has been adopted for the analysis.

4.2.1 Existing conditions

Existing condition intersection modelling results for each peak period are summarised in Table 9 and Table 10.

The intersection of Sudholz Road and North East Road is currently operating at maximum capacity, with a worst-case degree of saturation over 1.0 during both peaks and lengthy average delays. All other intersections evaluated generally operate within capacity, with a vehicle level of service no worse than D.

Table 9: Intersection capacity summary statistics for AM peak conditions

Intersection	Level of Service (LoS)	Average Delay (seconds)	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
North East Road / Sudholz Road	E	75.0	466	1.02
Sudholz Road / Grand Junction Road	D	46.0	230	0.73
Sudholz Road / Sir Ross Smith Boulevard	C	29.1	320	0.74
Grand Junction Road / Fosters Road	D	45.7	456	0.93
Fosters Rod / Folland Ave	C	30.1	200	1.00

Table 10: Intersection capacity summary statistics for PM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
North East Road / Sudholz Road	F	130.1	922	1.21
Sudholz Road / Grand Junction Road	D	52.1	303	0.93
Sudholz Road / Sir Ross Smith Boulevard	C	21.8	177	0.70
Grand Junction Road / Fosters Road	C	23.9	189	0.70
Fosters Road / Folland Ave	B	13.3	8.7	0.73

4.2.2 Traffic generation

Based on the RTA Guide to Traffic Generating Developments, the following traffic generation rates for residential dwellings have been adopted:

- Daily vehicle trips: 9 / dwelling
- Weekday peak period vehicle trips: 0.85 / dwelling

Based on an estimated yield of 1990 dwellings, full development of the structure plan area could generate ~18,000 daily trips and ~1,700 peak hour trips. For the purposes of peak period capacity analysis, it has been assumed that the directional spit of will be 80% inbound and 20% outbound during the AM and the reverse during the PM.

Generated traffic has been distributed to the external road network based on the existing connectivity, location of intersections, existing observed flow patterns and logical paths between the internal and external street network, as follows:

- The AM outbound traffic would see 60% of traffic heading south, 20% East, 10% North and 10% West
- The PM inbound traffic would see 60% of traffic coming from the south, 20% from the East, 10% from the North and 10% from the West
- Traffic to and from each proposed development area was then assigned based on likely routes and possible access points from the above assumptions

Assignment of peak period development associated traffic to the surrounding road network is shown in Figure 20 and Figure 21.

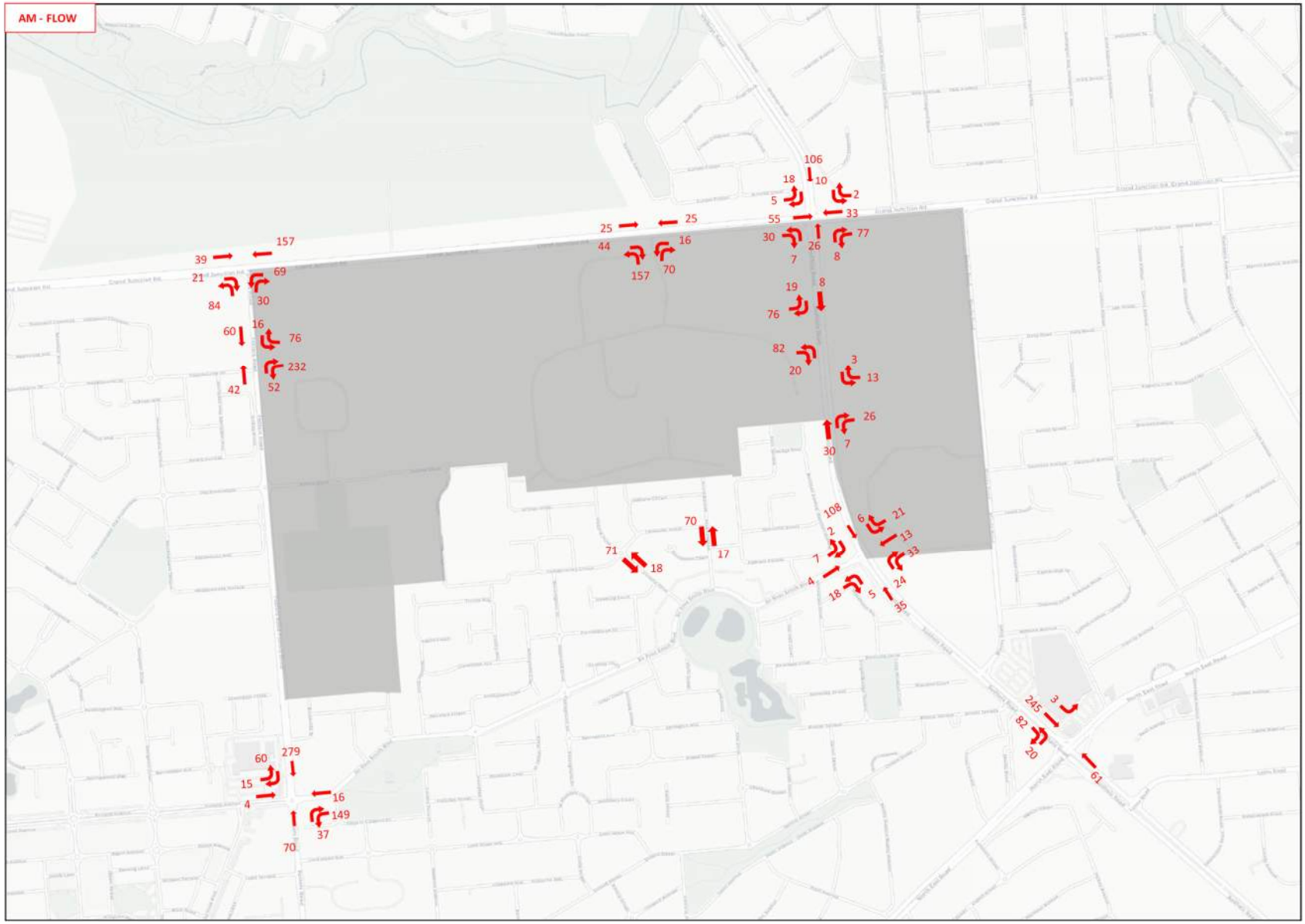


Figure 20: Estimated AM peak development traffic generation (veh/hr)

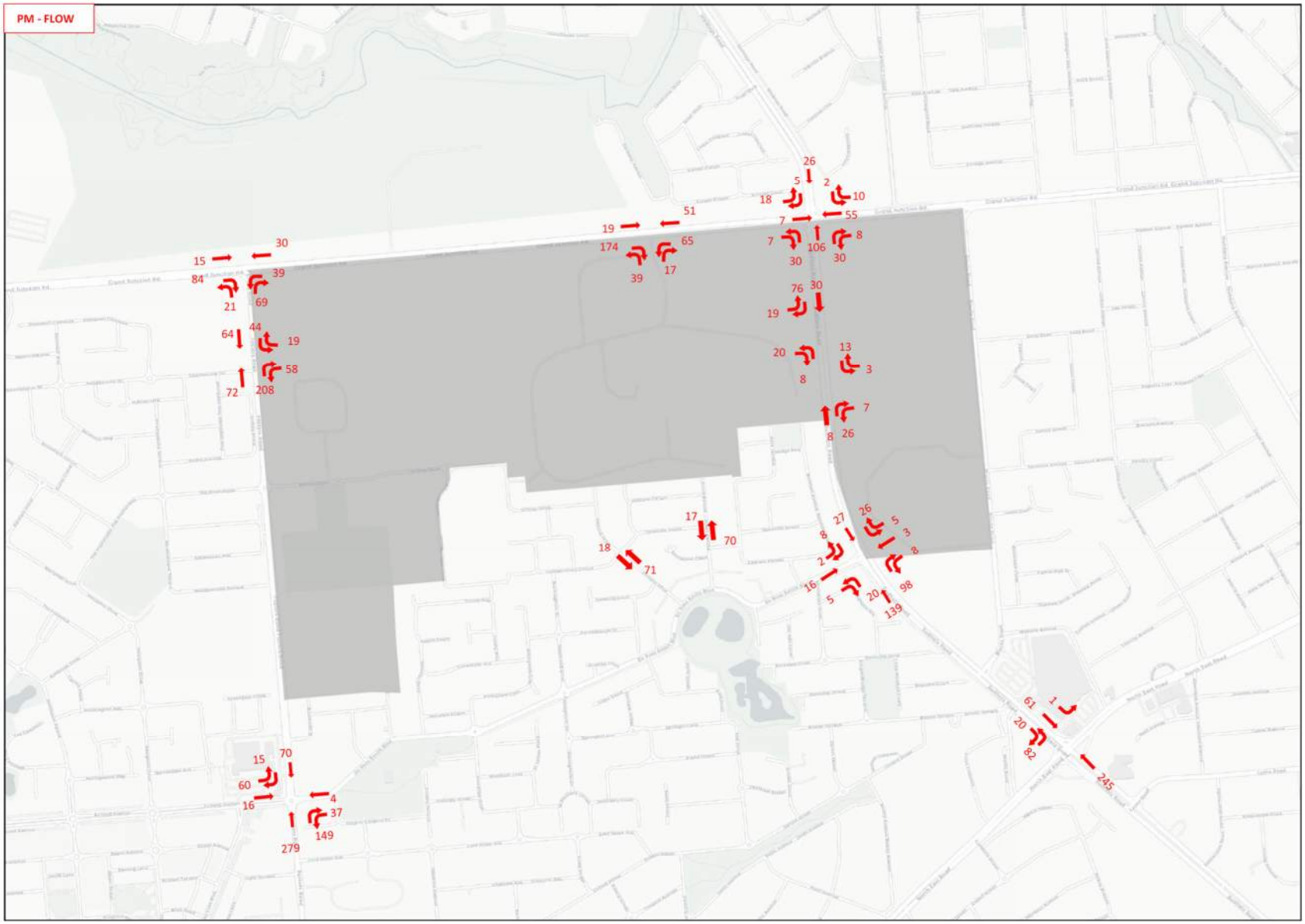


Figure 21: Estimated PM peak development traffic generation (veh/hr)

4.2.3 Potential development impact

Post full yield development scenario intersection modelling results for each peak period are summarised in Table 11 and Table 12. Existing design post development modelling has not been undertaken for the intersection of Sudholz Road / Sir Ross Smith Boulevard, as this intersection has been identified as potentially requiring modification to facilitate development access. Modelling of these modifications is documented in section 4.2.5

The results show that at full build out, development identified within the structure plan could cause the following intersections to exceed available capacity:

- North East Road / Sudholz Road (this intersection is already at capacity)
- Grand Junction Road / Fosters Road
- Fosters Road / Folland Avenue

Table 11: Post development intersection capacity summary statistics for AM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
North East Road / Sudholz Road	F	110.2	626	1.12
Sudholz Road / Grand Junction Road	D	54.2	301	0.97
Grand Junction Road / Fosters Road	F	85.4	789	1.06
Fosters Road / Folland Avenue	F	169	1215	1.63

Table 12: Post development intersection capacity summary statistics for PM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
North East Road / Sudholz Road	F	140.4	965	1.22
Sudholz Road / Grand Junction Road	E	66.6	427	1.00
Grand Junction Road / Fosters Road	C	30.3	241	0.83
Fosters Road / Folland Avenue	F	167.7	863	1.55

4.2.4 Mitigation measures

To address potential capacity impacts associated with the structure plan, the following mitigation measures have been identified at a preliminary level:

- Suhholz Road / Grand Junction Road: Addition of 60m storage lane for left turn slip on west approach, refer Figure 22.

- Grand Junction Road / Fosters Road: Addition of left turn lane on east approach 100m in length, refer Figure 23
- Fosters Road / Folland Avenue: Conversion to two lane roundabout, refer Figure 24

At this stage, development of these measures has considered only traffic carrying capacity in order to provide a planning level understanding of the scale of intervention likely required. Issues including road safety, space proofing and adjacent infrastructure integration would need to be addressed as part of further design development.

Mitigation measures have not been investigated for the intersection of North East Road / Sudholz Road. This intersection has undergone recent upgrades and has likely reached the maximum reasonable footprint and capacity for an at grade intersection in a suburban setting. How critical intersections such as this one should be managed in the broader context of state government policies towards urban infill development and whether or not increasing congestion can be accepted as a reasonable trade-off for all the broader benefits associated with a more compact city is a strategic issue well beyond the scope of this analysis.

Intersection modelling results for each location where mitigation measures have been identified are summarised in Table 13 and Table 14. These results show the mitigation measures sufficiently augment traffic capacity to maintain acceptable average delays.

Table 13: Post mitigation intersection capacity summary statistics for AM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
Sudholz Road / Grand Junction Road	D	52.1	301	0.97
Grand Junction Road / Fosters Road	D	42.9	436	0.94
Fosters Road / Folland Avenue	C	27.7	321	1.01

Table 14: Post mitigation intersection capacity summary statistics for PM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
Sudholz Road / Grand Junction Road	D	54.6	306	0.99
Grand Junction Road / Fosters Road	C	25.8	211	0.74
Fosters Road / Folland Avenue	B	15.6	121	0.90

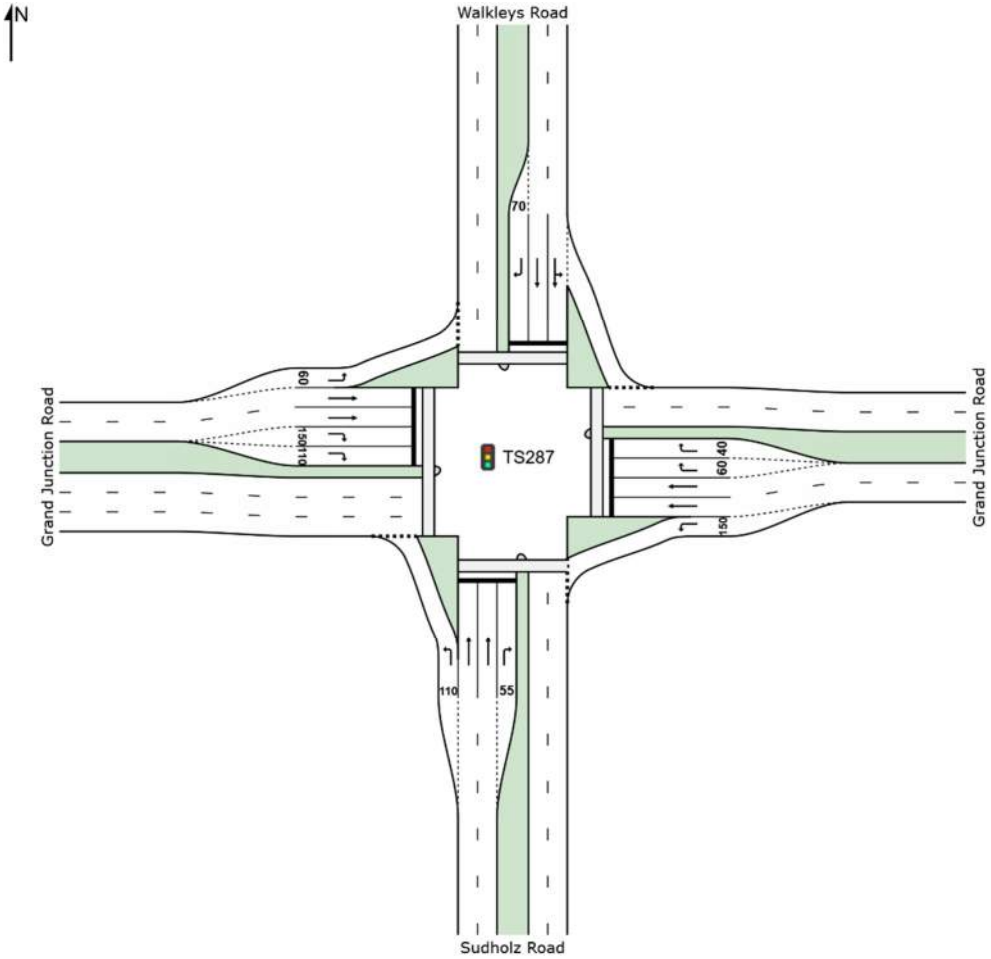


Figure 22: Sudholz Road / Grand Junction Road, suggested modified layout

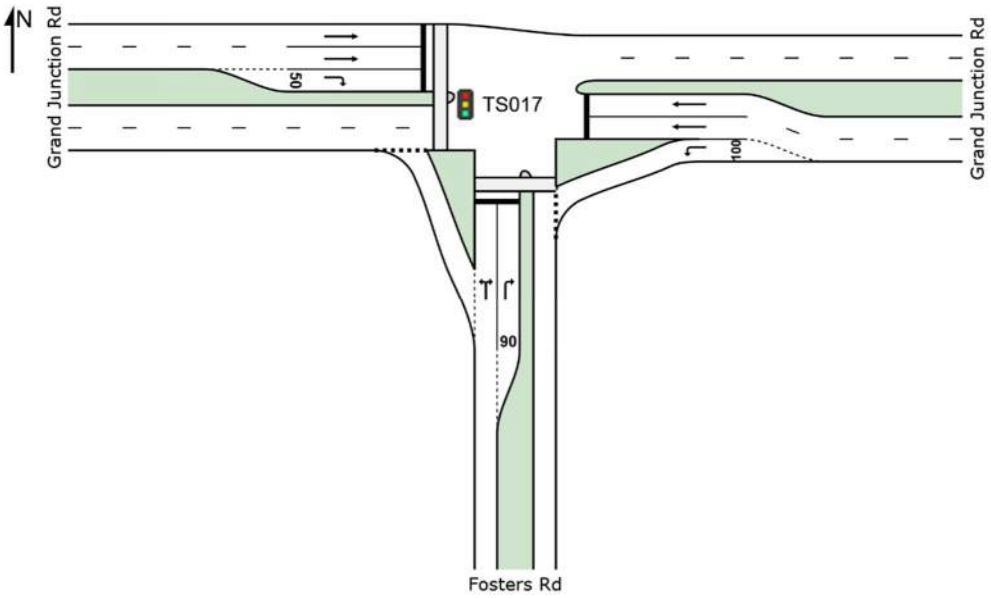


Figure 23: Grand Junction Road / Fosters Road, suggested modified layout

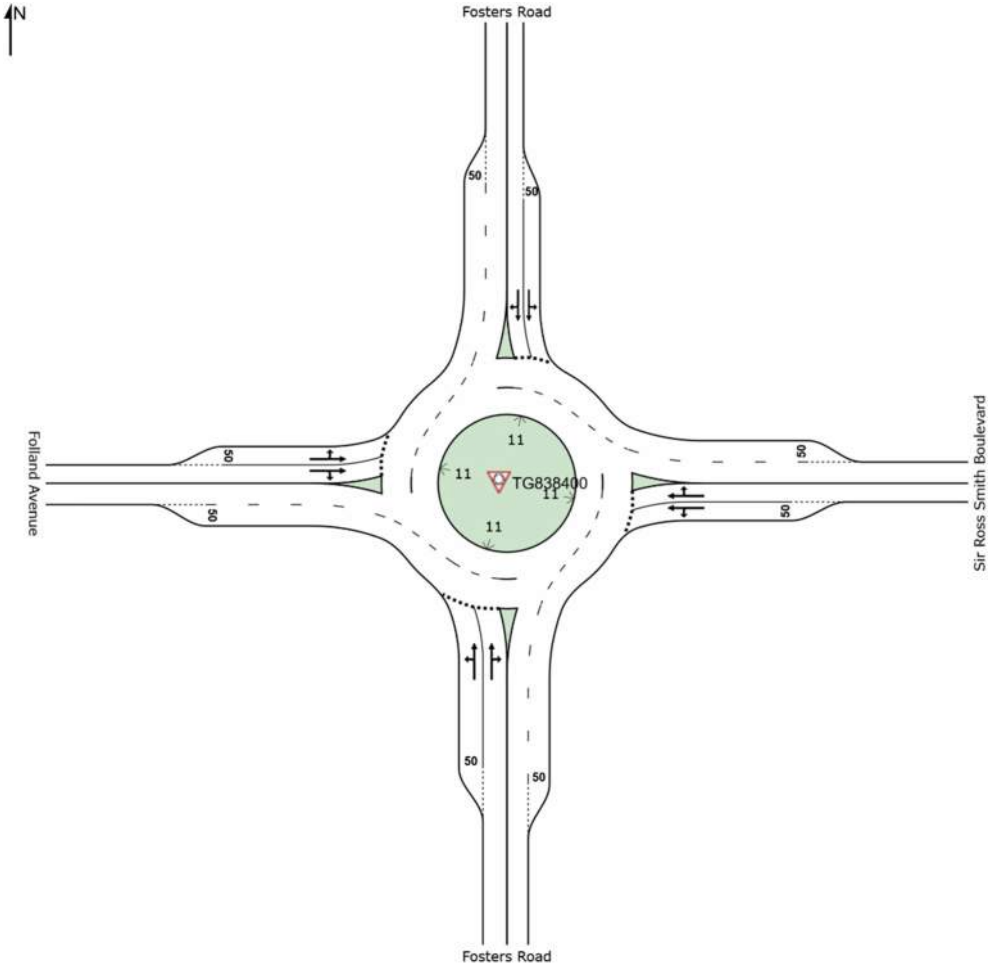


Figure 24: Fosters Road / Folland Avenue, suggested modified layout

4.2.5 Vehicle access

Key private vehicle access points to the structure plan area are identified in Figure 25. The overall design of the development and its associated road network will most likely significantly evolve as the DPA process moves to land sale and development applications, ultimately changing how access may be provided. Potential access intersection treatments have been developed based on the current preliminary structure plan layout to provide an understanding of the size and scale of vehicle access infrastructure likely required to accommodate the identified development yield. These are as follows:

- Access 1, Fosters Road: Unsignalised priority junction
- Access 2, Sudholz Road, signalised junction
- Access 3, Sudholz Road, added western approach to existing signalised junction

Suggested schematic layouts for each access point are illustrated in Table 15. Intersection modelling results are summarised in Table 16 and Table 17. These results show that the suggested layouts are sufficient to accommodate likely development traffic volume. Future design development of these access intersections will need to consider potential road safety issues associated with geometric design and topographic constraints on visibility.

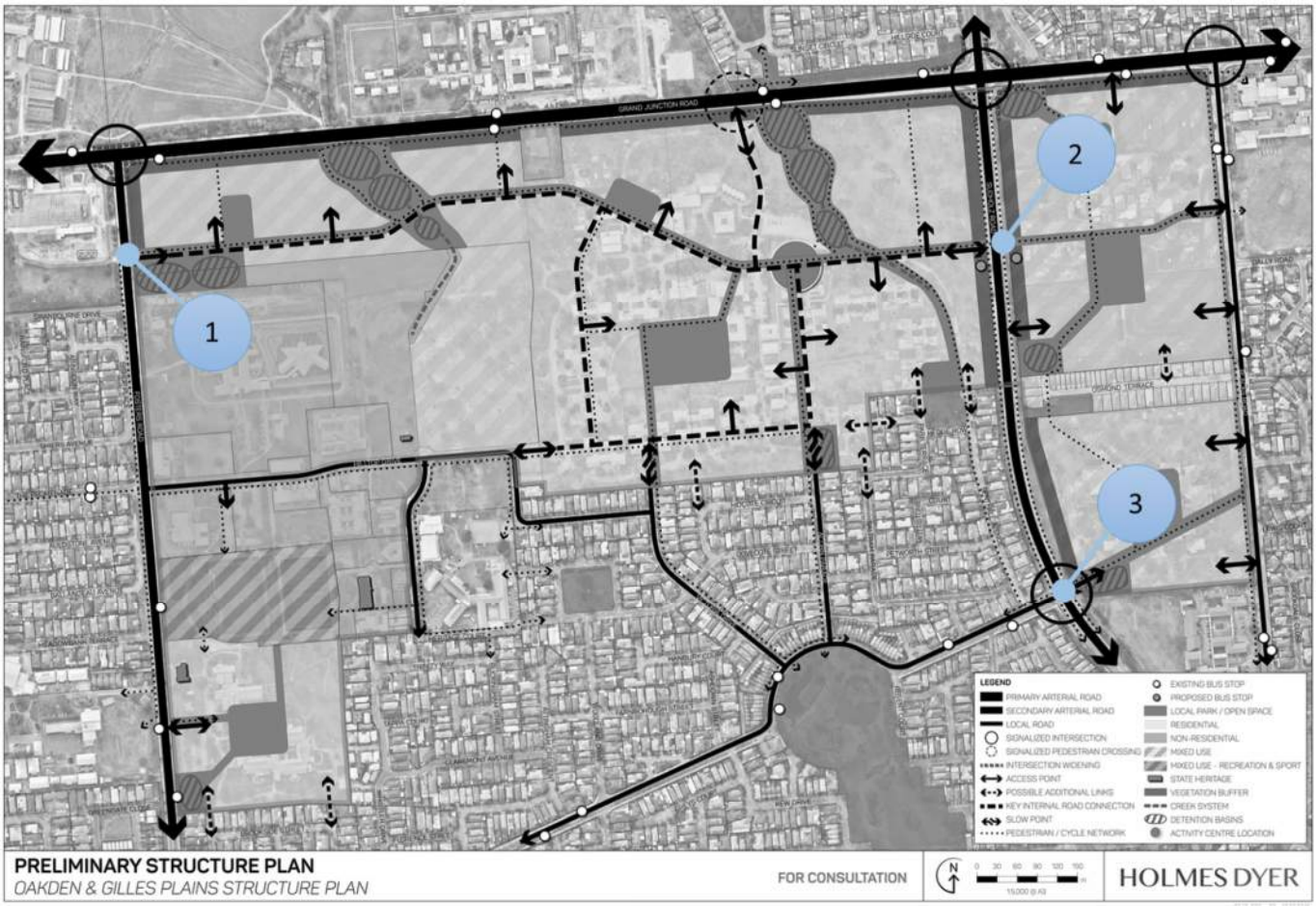
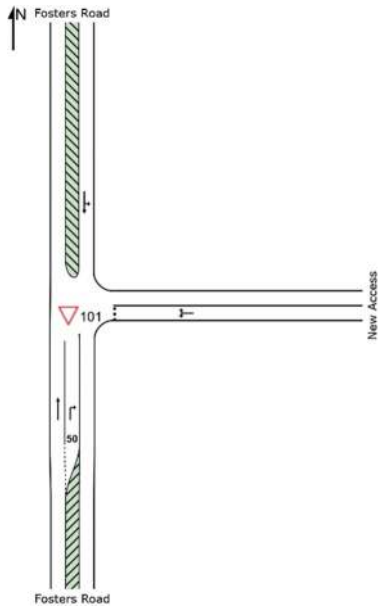
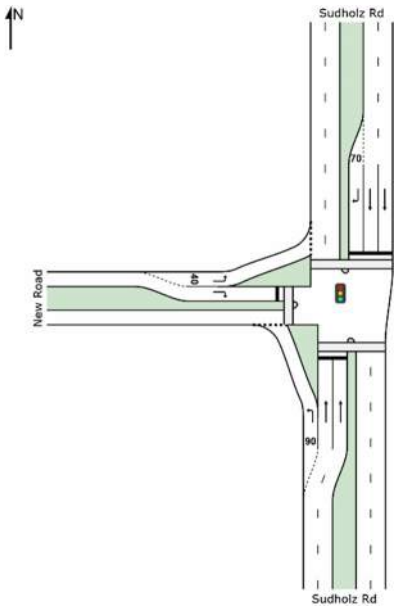


Figure 25: Key vehicle access locations

Table 15: Schematic layouts for vehicle access junctions

Access 1	Access 2
	

Access 3

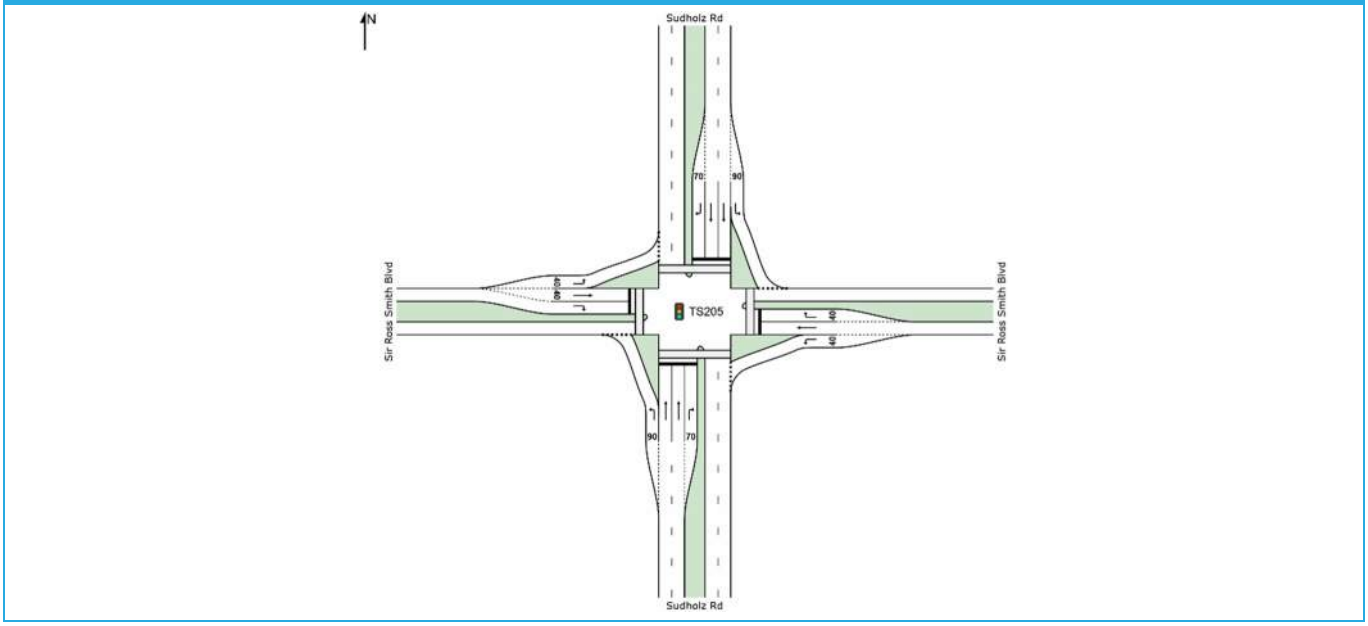


Table 16: Access junction capacity summary statistics for AM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
Access 1	N/A	10.7	87	0.94
Access 2	B	10.6	160	0.57
Access 3	D	46.2	378	0.94

Table 17: Access junction capacity summary statistics for PM peak conditions

Intersection	Level of Service (LoS)	Average Delay	95th percentile queue (metres, worst approach)	Degree of Saturation (worst approach)
Access 1	N/A	2.1	6	0.32
Access 2	B	17.0	121	0.47
Access 3	D	44.9	284	0.90

4.3 Transport opportunity and recommendations

4.3.1 Walking and cycling connectivity

When considering design to facilitate walking and cycling, its useful to distinguish between recreational and transportation activity. Recreational walking and cycling is generally dependant only on the urban design providing an amenable environment and has a limited link to land use, while walking and cycling for transportation is strongly dependant on both land use and urban design.

Most modern residential development caters well to recreational travel by active modes through attractive urban design, comprehensive footpath provision and well distributed allocations of green space. However, for an area to be functionally walkable (or bikeable), useful destinations must be reachable by these modes within a reasonable travel time. The activity centre location proposed in the structure plan will substantially improve the functional walkability and bikeability of the area. Given the existing poor

walkability, refer section 4.1.5, from an active transport local accessibility perspective, the local activity centre is considered well located and necessary inclusion to the structure plan.

To maximise walkability as far as possible within the constraints of a largely homogenous residential suburban area, the following is recommended:

- The internal road network should be as connective as possible, including connectivity to existing Oakden streets, in order to maximise walking catchments and thus maximise accessibility to public transport and useful destinations. Cul-de-sacs and pedestrian dead ends significantly reduce walkability, refer Figure 26. Pedestrian dead ends must absolutely be avoided.
- Avoid an overly rigid road hierarchy resulting in collector streets which have no fronting property and uninteresting, repetitive streetscapes with little to no passive surveillance.
- All streets should provide adequate footpaths on both sides.
- Pedestrian connectivity must be provided between the local street network and external arterials as close as feasible to any location where a bus stop or crossing facility is provided.
- Improved pedestrian connectivity across Grand Junction Road between the southern portion of Walkley Heights and the structure plan area should be considered such that the walkability benefits of the proposed local activity centre are extended to this area.
- Along the main collector street, consider requiring side road junction designs which enhance pedestrian priority and safety. This may include kerb extensions to minimise crossing distance, distinct pavement treatments and/or a raised table. An excellent functional example from the City of Darebin in Victoria is shown in Figure 27.

To enhance the attractiveness of cycling throughout the structure plan area, the following is recommended:

- Provision of a separated bikeway along the main collector street, between Fosters Road and Sudholz Road.
- Implementation of a 40 kph speed limit on all internal streets to enhance safety and encourage cycling beyond just the fit and confident. Given development within the structure plan area will be tightly integrated with existing Oakden built form, consideration should also be given to lowering the speed limit of local streets within Oakden to 40kph.
- Provide wayfinding and a crossing point on Grand Junction Road to connect to the recreational paths in Walkley Heights along Dry Creek.
- Implementation of a side road bicycle boulevard type connection between the structure plan area and the River Torrens Linear Trail through Oakden and Windsor Gardens, avoiding the need to travel along Sudholz Road. A route taking in Kew Drive, Fleet Ave and Pittman Road would likely be feasible.

Figure 26: Impact of road network topology on area reachable within a 5 minute walk. Connective grid type network on the left and disconnected, hierarchical cul-de-sac type network on the right.

Figure 27: Example of side road junction design prioritising walkability

4.3.2 Public transport access and connectivity

Public transport access to the site will primarily be provided by routes along Fosters Road and Sudholz Road. Although route 361 runs along Grand Junction Road, bordering the north of the structure plan area, this route is slow, infrequent and does not represent useful public transport to those with a choice of mode. As such, effort to provide good public transport connectivity should be focussed on the Fosters Road and Sudolz Road corridors.

Based on analysis of the existing network and connectivity, refer section 4.1.4, the following is recommended to maximise public transport accessibility from within the structure plan area:

- Creation of at least one new stop on Sudholz Road for routes 500, 501 and 502. This should be located as close as possible to the main collector road through the site, with a signalised crossing point. This would be provided as part of signalising the vehicle access point.
- Consider extension of the 528 along Fosters road to intersect with the main collector road. This may mean rationalising the existing indirect portion of the route through Northgate and providing facilities for bus turnaround and lay-by within the structure plan area. Further detailed analysis would be required to weigh the trade-off made for increased connectivity to the structure plan area against reduced connectivity within Northgate.
- Ensure the design of the main collector meets DPTIs minimum requirements for a bus route. The location of the structure plan area means this street is unlikely to ever host a high frequency, patronage focused route. However, there may be future opportunity to provide a lower frequency coverage type route through the area and this should not be precluded. Alternatively, dependant on how the final internal road network develops, Hilltop Drive could also be used for a coverage type route.

4.3.3 Street network

Suggested street network cross sections are illustrated in Figure 28 and Figure 29. Design of the internal road network will need to be in accordance with council standards.

The main collector street provides 3.5m travel lanes, indented parking and a separated bikeway. This meets the DPTI minimum requirement of 7.0m clear width for a bus route where indented parking is present.

The local access street cross section provides a roadway width of 7.2m, sufficient to permit on street parking in low traffic locations. This width will force yield flow type behaviour where parked vehicles are present on both sides of the road, a positive outcome when designing for walkability as this will force significantly lower travel speeds and limit opportunity for rat running. As the road network design takes shape, implementation of this cross section will require consideration of the longitudinal form to ensure sufficient passing opportunities are available at regular intervals.

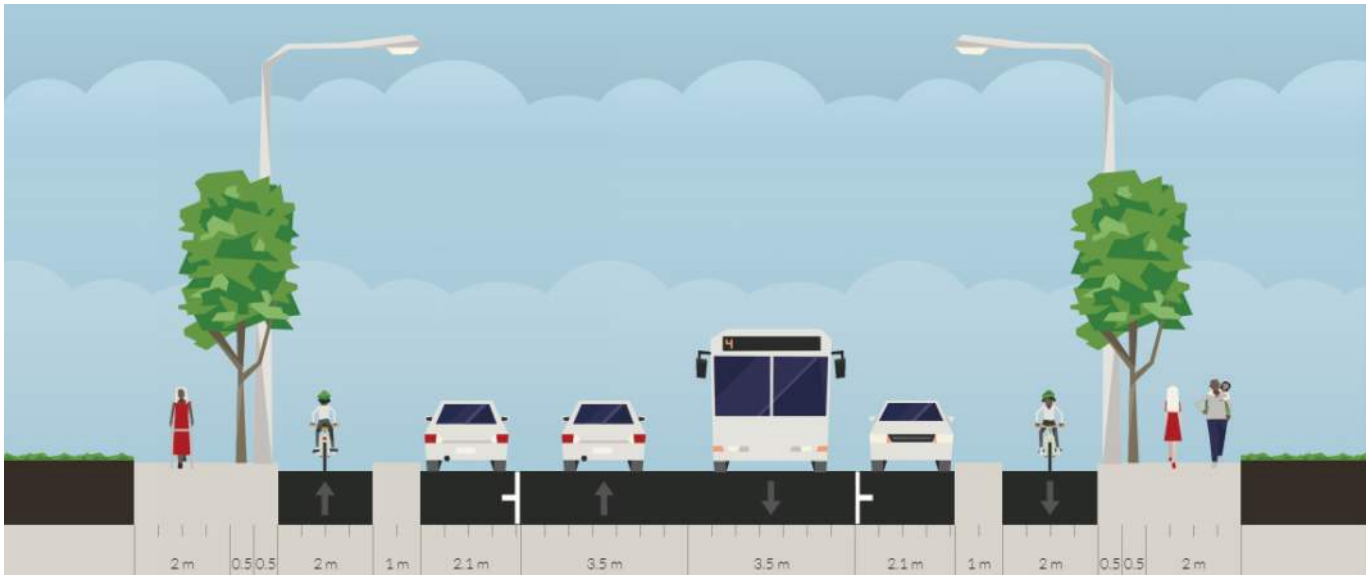


Figure 28: Suggested main collector street cross section

Figure 29: Suggested local access street cross section

4.3.4 Car Parking

During consultation on development of the Oakden and Gilles Plains structure plan, the City of Port Adelaide Enfield advised of resident concerns relating to on-street car parking in the recently developed nearby suburb of Lightsview. These issues appear to stem from reduced parking requirements in parts of Lightsview, relative to the standard residential zone, refer Table 18.

Analysis of household characteristics data from the 2016 census shows that rates car ownership per dwelling bedroom are not substantially different in Lightsview compared with surrounding suburbs which have greater minimum parking requirements. Lightsview is not significantly any more walkable or less car dependant than most middle suburbs in Adelaide and its urban design is effectively an example of "drive-to urbanism". As such, the level of car ownership is not surprising.

Barring large structural change to incentives to drive, public transport infrastructure, land use mix and corridor design, all of which are unlikely over even the long term, it is reasonable to assume that rates of car ownership within the structure plan area will be similar to its surrounds and that measures put in place as part of any subsequent DPA are unlikely to have a significant affect. As such, setting off-street parking requirements for the structure plan area is a decision around what level of on-street parking is acceptable.

High minimum off-street parking requirements have significant externalities, increasing the cost of construction, reducing achievable yields and reducing the area of land which can be put to community use while still meeting commercial realities. On street parking is a legitimate use of an expensive public asset which otherwise does not see much use in low density residential areas. If correctly managed to avoid blockages and ensure sufficient passing opportunities, it can have benefits to walkability and road safety by narrowing the travelled way and lowering average vehicle speeds. Conversely, excessive demand for street parking can significantly impact residential access, create unnecessary congestion and increase traffic volumes through circulation in search of a space.

For the structure plan area, it is recommended that a balance be struck which results in some degree of regular on-street parking not exceeding availability. This may mean a small discount on minimum parking requirements as applied under the standard residential zone.

Table 18: Lightsview car parking requirements (adapted from report supplied by City of Port Adelaide Enfield)

Development	Lightsview (minimum number of spaces)	Residential Zone (minimum number of spaces)
Detached dwelling (2 bedrooms)	1	2
Detached dwelling (3 bedrooms)	2	2
Detached dwelling (4 bedrooms)	2	3
Apartment (visitor parking only)	0.25 per unit	1 per unit
Restaurant	4 per 100m²	1 per 3 seats
Shop	4 spaces per 100m²	7 spaces per 100m²

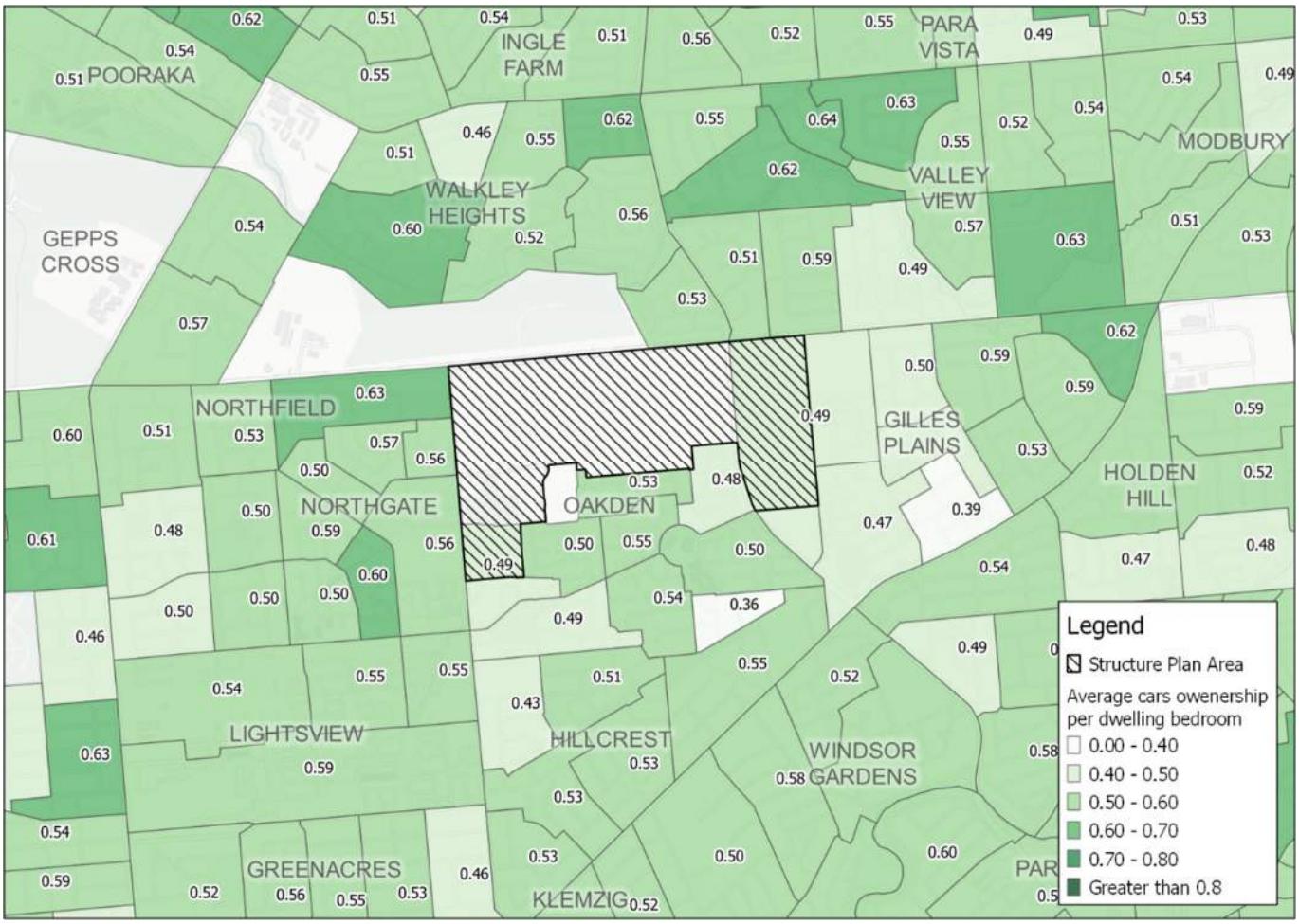


Figure 30: Average car ownership per dwelling bedroom (Data source: 2016 census)

4.3.5 Arterial road speed limits

As previously identified, parts of the arterial road network surrounding the structure plan area have a posted speed limit of 70kph, which is reasonably high for a developed suburban area. Through consultation with the City of Port Adelaide Enfield, reducing the speed limit on Grand Junction Road adjacent the structure plan area has been flagged as an opportunity to facilitate better pedestrian and cyclist connectivity to Walkley Heights. 70 kph represents a significant barrier to permeability across Grand Junction Road. A reduction to 60kph would be beneficial in this regard and should be considered as development in the structure plan area progresses and a need for connectivity to Walkley Heights is created.

Similarly, Sudholz Road is posted at 70kph for its length through the structure plan area between Grand Junction Road and Sir Ross Smith Boulevard. As the nature of abutting land use changes through development, consideration should also be given to lowering the speed limit of this road to 60kph. Walkability and permeability across this road will be particularly important aspect of public transport access, as it hosts the highest quality and most useful public transport connection to the structure plan area.

4.4 Summary

A multi-modal transport analysis of the Oakden and Gilles Plains Structure plan has been carried out to identify potential traffic impacts and transport opportunities associated with development of the site. The following key recommendations have been made as part of this analysis:

- At full build out, identified development within the structure plan area will likely generate approximately ~1700 peak period trips. This traffic generation will have a moderate capacity impact and future measures to augment existing traffic capacity may be required at the intersections of Grand Junction Road / Fosters Road and Fosters Road / Folland Avenue.
- To enhance walkability, it is recommended a fully connective internal road network, footpaths on both sides of all streets and direct pedestrian connectivity to all bus stops on the adjacent arterial road network be provided. Additionally, pedestrian friendly designs should be implemented for side road junctions along the main collector street.
- To enhance the attractiveness of cycling, it is recommended a separated bikeway be provided on the main collector street, along with measures to enhance low stress connectivity to trails along Dry Creek and the River Torrens Linear Trail. It is also recommended that consideration be given to implementation of a 40 kph speed limit for internal roads.
- Useful public transport from the structure plan area is available via Fosters Road and Sudholz Road. To maximise public transport accessibility for future residents, it is recommended that a new stop be placed on Sudholz Road, adjacent the main collector street for routes 500/501/502 and alteration to route 528 is considered in order to provide a connection further north on Fosters Road. Additionally, design of the main collector street should meet DPTI minimum requirements for bus traversal to allow for a potential future coverage type route through the structure plan area.
- It is recommended that off street parking requirements for development are set to strike a balance which results in regular on-street parking to a degree which does not exceed available capacity. This is to avoid the significant externalities associated with requiring excessive off-street parking while maximising value from expensive to build and maintain street network assets.
- To improve pedestrian permeability across the arterial road network, facilitating access to Walkley Heights and public transport stops, consideration should be given to reducing the existing 70 kph speed zones on Grand Junction Road and Sudholz Road to 60 kph.

5 Noise & Air Quality

A noise and air quality study have been undertaken to investigate any potential planning constraints with respect to the project site.

5.1 State Policy and Framework

The *State Planning Policies for South Australia* (31 January 2019) outlines strategies focusing on industrial land use and sensitive land use, to preserve the communities and the environment from exposure to industrial emissions and hazards, altogether creating healthy cities and regions. State Planning Policy 11: Strategic Transport Infrastructure and State Planning Policy 16: Emissions and Hazardous Activities include measures to manage emissions to ambient air. The following clauses are relevant:

- ***Clause 11.4****: Minimise negative transport-related impacts on communities and the environment.*
- ***Clause 16.1****: Protect communities and the environment from risks associated with industrial emissions and hazards (including radiation) while ensuring that industrial and infrastructure development remains strong through:*

  (a) Supporting a compatible land use mix through appropriate zoning controls

  (b) Appropriate separation distances between industrial sites that are incompatible with sensitive land uses.

  (c) Controlling or minimising emissions at the source, or where emissions or impacts are unavoidable, at the receiver.

While the precinct would not include any processes which generate industrial emissions, there is the potential for users of the precinct to be exposed to ambient air quality which is impacted by industrial processes and major transport networks nearby.

This is the over-arching policy statement that applies state-wide when establishing new infrastructure and assessing development applications.

5.2 Local Planning Provisions

The local planning provisions of the project site are currently governed under the *Port Adelaide Enfield Council Development Plan* (6 February 2018). The project site is not currently located within the Noise and Air Emissions Overlay. However, the following review of the relevant provisions to the project site is summarised below:

5.2.1 Interface between Land Uses

The objective of this provision is to protect community health and amenity, to minimise conflict between land uses and ensure that incompatible development is not pursued. The following principles would apply to the project site for both noise and air quality.

Principles of Development Control

1. Development should not detrimentally affect the amenity of the locality or cause unreasonable interface through any of the following:

(a) The emission of effluent, odour, smoke, fumes, dust or other airborne pollutants

(b) Noise

(c) Vibration

2. Development should be sited and designated to minimise negative impacts on existing and potential future land uses desired in the locality.

4. Residential development adjacent to non-residential zones and land uses should be located, designed and/or sited to protect residents from potential adverse impacts from non-residential activities.

5. Sensitive uses likely to conflict with the continuation of lawfully existing developments and land uses desired for the zone should be designed to minimise negative impacts.

6. Non-residential development on land abutting a residential zone should be designed to minimise noise impacts to achieve adequate levels of compatibility between existing and proposed uses.

Noise generating activities

7. Development that emits noise (other than music noise) should include noise attenuation measures that achieve the relevant Environment Protection (Noise) Policy criteria assessed at the nearest existing noise sensitive premises.

9. Outdoor areas (such as beer gardens or dining areas) associated with licensed premises should be designed or sited to minimise adverse noise impacts on adjacent existing or future noise sensitive development.

10. Development proposing music should include noise attenuation measures that achieve the following desired noise levels:

Table 19 – EPA Desired noise levels from music

Noise level assessment location	***Desired noise level***
Adjacent existing noise sensitive development property boundary	*Less than 8 dB above the level background noise ($L_{90,15min}$) in any octave band of the sound spectrum* *And* *Less than 5 dB(A) above the levels of background noise ($L_{A90,15min}$) for the overall (sum of all octave bands) A-weighted level*
Adjacent land property boundary	*Less than 65 dB(Lin) at 63Hz and 70 dB(Lin) in all other octave bands of the sound spectrum* *Or* *Less than 8 dB(A) above the level of background noise ($L_{90,15min}$) in any octave band of the sound spectrum and 5 dB(A) overall (sum of all octave bands) A-weighted level.*

Air quality

11. Development with the potential to emit harmful or nuisance-generating air pollution should incorporate air pollution control measures to prevent harm to human health or unreasonable interference with the amenity of sensitive uses within the locality.

12. Chimneys or exhaust flues associated with commercial development (including cafes, restaurants and fast food outlets) should be designed to ensure they do not cause a nuisance or health concerns to nearby sensitive receivers by:

(a) Incorporating appropriate treatment technology before exhaust emissions are released to the atmosphere.

(b) Ensuring that the location and design of chimneys or exhaust flues maximises dispersion and takes into account the location of nearby sensitive uses.

5.2.2 Open Space and Recreation

17 (g) Landscaping associated with open space and recreation areas should provide an acoustic barrier between any noise generating source and adjacent residential areas.

5.2.3 Residential Development

Objectives

1. Safe, convenient, pleasant and healthy-living environments that meet the full range of needs and preferences of the community.

Noise

42. Noise generated by fixed noise sources such as air conditioning units and pool pumps should be located, designed and attenuated to avoid causing potential noise nuisance to adjoining landowners and occupiers.

43. Residential development close to high noise sources (eg major roads, railway lines, tram lines, industry, and airports) should be designed to locate bedrooms, living rooms, lounge rooms, dining rooms and private open spaces away from those noise sources, or protect these areas with appropriate noise attenuation measures.

45. Residential development on sites abutting established collector or higher order roads should include front fences and walls that will supplement the noise control provided by the building façade.

46. The number of dwellings sharing a common internal pedestrian entry within a residential flat building should be minimised to limit noise generation in internal access ways.

47. External noise and light intrusion to bedrooms should be minimised by separating or shielding these rooms from:

(a) Active communal recreation areas, parking areas and vehicle access ways.

(b) Service equipment areas and fixed noise sources on the same or adjacent sites.

48. Development should be designed and sited to meet ambient and internal noise levels required by the current Environment Protection (Noise) Policy.

58. Residential development on land abutting an arterial road should be constructed in accordance with:

(a) Australian Standard AS 3671 Acoustics – Road Traffic noise intrusion, building siting and construction.

(b) Australian Standard AS 2107 Acoustics – Recommended Design sound levels and reverberation times for building interiors.

5.3 Noise Policy and Standards

The above Council Development Plan (Section 5.2) Clauses 48 and 58 of Residential Development require developments to be designed to meet *Environment Protection (Noise) Policy*, as well as Australian Standards AS 3671 and AS 2107 where abutting an arterial road.

5.3.1 Noise EPP 2007

The Environmental Protection Authority South Australia (EPA SA) provides guidance on environmental noise emissions in South Australia through the use of mandatory policy entitled *Environment Protection (Noise) Policy 2007* (Noise EPP 2007), under the *Environment Protection Act 1993*. The Noise EPP 2007 provides two ways of noise assessment criteria that satisfies general environmental duty at the noise-affected area. They are:

- The source noise level (continuous) does not exceed the background noise level plus 5 dB(A); or
- The source noise level (continuous) does not exceed the indicative noise level for the noise source, determined by reference to the land use categories selected in the Policy.

In accordance with *Guidelines for the use of the Environment Protection (Noise) Policy 2007* (June 2009), the indicative noise level is generally more commonly used approach, because complaints more readily occur when the noise source (continuous) is more than 5 dB(A) above the background noise level of the ambient noise environment.

The indicative noise levels provide the trigger to investigate if further action is to be taken with respect to reducing the noise from the noise source. Exception to the indicative noise levels providing the relevant test is where background noise level is sufficiently high.

Table 1 and table 2 of the Noise EPP 2007 contain indicative noise factors for external noise levels for different land use category. The external noise limits for relevant land use category to the project site are summarised in Table 20.

Table 20 – Indicative noise levels for Project land use category

Land Use Category	**Indicative Noise Factor, dB(A)**	
	Day (07:00 to 22:00 hours)	**Night (22:00 to 07:00 hours)**
Residential	52	45
Commercial	62	55
Mixed Use (Residential and Commercial)	57	50

The Noise EPP 2007 also makes provision for noise source that contains characteristics. The source noise level (continuous) must be further adjusted in the following way (except for the purposes of comparison with the background noise level plus 5 dB(A)):

- If the noise from the noise source contains 1 characteristics, 5 dB must be added to the source noise level (continuous);
- If the noise from the noise source contains 2 characteristics, 8 dB must be added to the source noise level (continuous);
- If the noise from the noise source contains 3 or 4 characteristics, 10 dB must be added to the source noise level (continuous).

Note that Noise EPP 2007 excludes noise principally consisting of music or voice, or both, resulting from an activity at domestic premises. Noise and patron noise emitted from Liquor and licensed premises are governed under the *Office or Liquor and Gambling Commissioner.*

5.3.2 Indoor Sound Levels – AS 2107

The proposed preliminary structure plan contains a mix of ancillary precincts such as residential, local park/open space, mixed use, as well as recreation and sport.

The maximum internal sound levels within indoor sensitive spaces of the buildings within the proposed precinct are recommended to comply with Australian Standards AS/NZS 2107: 2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors* (AS 2107:2016).

AS 2107:2016 provides typical designated indoor areas along with the recommended design sound levels and reverberation times, subject to both external and internal noise sources with steady-state or quasy-steady-state noise characteristics, such as air conditioning system. Internal design sound levels applicable for the development is provided in Table 21.

Table 21 – AS 2107:2016 Recommended design internal sound levels and reverberation times

Designated Area	**Recommended Design Indoor Acoustic Performance**
	Design Sound Level (dBL_{Aeq}) range
Houses and apartments in inner city areas or entertainment districts or near major roads.	
Sleeping areas (night time)	35 to 40
Living areas	35 to 40
Apartment common areas (e.g. foyer, lift lobby)	45 to 50

Note that the AS 2107:2016 specifically states that the standard is not intended for road traffic noise, and refers to AS 3671 *Acoustics – Road Traffic noise intrusion, building siting and construction*. Whilst the AS 3671 does not provide specific internal noise level criteria, instead it addresses the methodology of assessing traffic noise and indicative building envelope acoustic treatment. The Minister has developed Specification SA 78B – *Construction requirements for the control of external sound* (February 2013) to protect sensitive receivers from the impact of existing or future road and rail sound, and from mixed land use area sound sources (refer to Section 5.3.3). The SA 78B is further recommended in the EPA *Evaluation distances for effective air quality and noise management* (August 2016).

5.3.3 Minister's Specification SA 78B

The Minister's Specification SA 78B – *Construction requirements for the control of external sound* (February 2013) specify indoor levels that should be met for occupants of Class 1, 2, 3 and 4 buildings and 9c aged care buildings from the impact of existing or future road and rail sound and from mixed land use area sound sources.

Based on the proposed Oakden and Gilles Plains concept plan, it is assumed that there would be residential premises as part of the precinct development, subject to potential road traffic noise impact.

The following performance requirements apply to the residential precinct:

- The level of attenuation provided by the building envelope and ventilation system against the intrusion of external airborne sound from road, must be sufficient to provide internal sound levels not exceeding the internal sound criteria values stated in Table 22.

Table 22 – SA 78B Internal sound criteria for road traffic noise intrusion

Type of Room	Internal Sound Criteria		Applicable Time Period
	Building design target averaged over the total number of such rooms in the building	Maximum allowable for individual rooms in the building	
Bedroom	30 $dBL_{Aeq, 9hr (transport)}$	35 $dBL_{Aeq, 9hr (transport)}$	Night (22:00 to 07:00)
Other habitable room, other than a bedroom	35 $dBL_{Aeq, 15hr}$	40 $dBL_{Aeq, 15hr}$	Day (07:00 to 22:00)

5.4 Air Quality Standards

Air Quality in South Australia is managed by the *Environment Protection Act 1993*. The relevant state environment protection policy made under Section 28 of the Act is:

- South Australia – *Environment Protection (Air Quality) Policy 2016*

The *Environment Protection (Air Quality) Policy 2016* (Air Quality EPP) provides the legislative basis for air quality regulation and management in the state, including criteria for developing effective conditions to assist commercials and industries to improve their performance in minimising risk of air emissions through a system of licensing.

Air Quality EPP adopts the state-wide air quality requirements of the *National Environment Protection (Ambient Air Quality) Measures 2016* (AAQ NEPM). AAQ NEPM is statutory instrument which outline agreed national objectives for protecting or managing certain aspects of the environment. The South Australian Government has monitoring and reporting responsibilities under the AAQ NEPM on seven common air pollutants – carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2), lead (Pb) and particulate matter (PM_{10} and $PM_{2.5}$).

Air quality standards are set for these seven common air pollutants at ground level for various averaging periods relevant to public exposure. The air quality standards which apply at the project site are shown in Table 23.

Table 23 – AAQ NEPM Ground concentration levels for air quality indicators

Pollutant	Averaging Period	Maximum Concentration Standard	Maximum Allowable Exceedances
Carbon monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen dioxide	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None
Photochemical oxidants (ozone)	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year
Sulphur Dioxide	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None
Lead	1 year	0.50 $\mu g/m^3$	None
PM_{10}	1 day	50 $\mu g/m^3$	None
	1 Year	25 $\mu g/m^3$	None
$PM_{2.5}$	1 day	25 $\mu g/m^3$	None

Pollutant	Averaging Period	Maximum Concentration Standard	Maximum Allowable Exceedances
	1 Year	8 µg/m^3	None

The Air Quality EPP also provides odour level criteria for locations close to odorous processes, these vary based on population level. These are shown in Table 24. These levels would need to be met to ensure amenity is protected

Table 24 – Air Quality EPP odour levels

Number of People	Odour Units (3 minutes average, 99.9% of time)
2000 or more	2
350 – 1999 (inclusive)	4
60 – 349 (inclusive)	6
12 – 59 (inclusive)	9
Single residence (fewer than 12)	10

5.5 Relevant Evaluation Distance Guidelines

The South Australia EPA has issued *Evaluation distances for effective air quality and noise management* (August 2016) to provide separation of sensitive land uses from industrial or commercial premises with the potential for off-site emissions such as noise or air pollutant.

The EPA evaluation distances guidelines provide the recommended minimum separation distances between noise or air pollutant industrial/commercial land use s and sensitive land uses. This is a form of evaluation distance which will apply to those activities where without some minimum separation, the EPA's experience indicates that the residual environmental risk remains unacceptable, even with the best management processes and technologies in place. Among other concerns, this recognises that despite having the best will in the world, plant and equipment can fail at times (upset or malfunction conditions) and atypical emissions may occur which impinge on neighbouring communities. Emissions of consideration are:

- Intense odour.
- Fugitive dust sources.
- Excessive noise from activities.

The inclusion of a minimum distance does not imply EPA's (or relevant planning authority) approval, in the absence of appropriate justification. Proponents will still require to demonstrate in the submissions that potential adverse environmental impacts have been adequately addressed. The following documents are deemed relevant to this project and should be read in conjunction with this evaluation distance guideline.

- *Environment Protection (Air Quality) Policy 2016 (Air EPP)*
- *Environment Protection (Noise) Policy 2007 (Noise EPP)*
- *Ambient air quality assessment*
- *Emission testing methodology for air pollution (Emissions Manual)*
- *Guidelines for the use of the Environment Protection (Noise) Policy 2007 (Noise policy guideline)*

Commercial/industrial premises that are identified as requiring separation from sensitive land uses by this guidance have been reviewed in the vicinity of the project site. Compliance with EPA evaluation distance guideline is addressed in Section 5.7.

5.6 Existing Environment

5.6.1 Identification of Relevant Commercials/Industries

Site inspection of the site and the surrounding area were undertaken by Arup on Thursday 4 April 2019 and Friday 5 April 2019. The site inspection was supplemented by Google Earth and Google Street View aerial photography.

The identified commercial or industrial premises within and surrounding the project site, up to a 500m radius, are shown in Table 25. Refer to Figure 31 for the map locations of the identified nearby commercial/industrial premises.

Table 25 – Identified nearby commercials or industrial premises

Industry	Address	Approximate distance from Project Site Boundary (metres)	Potential Sources	Primary Concern
Substation	Corner of Grand Junction Road and Fosters Road	46	Transformer	Noise
Oakden Central Gaming Lounge	246-256 Fosters Road	Within precinct	Music Patron noise	Noise
Cedar College	215-233 Fosters Road	23	Children/student noise Mechanical plant and equipment School bell	Noise
Northgate shopping centre	Folland Avenue, Northgate	83	Car parking Mechanical plant and equipment	Noise
Nathan Bakes	Light Terrace, Lightsview	426	Production of baked products Mechanical plant and equipment	Odour Noise
TAFE SA	33 Blacks Road, Gilles Plains	Within precinct	Mechanical plant and equipment Car Parking	Noise
St Paul's College	792 Grand Junction Road	20	Children/student noise Mechanical plant and equipment Music School bell	Noise
Submersible pump	Corner of Grand Junction Road and Blacks Road	Within precinct	Pump	Noise
Adelaide Pre-release Centre	Grand Junction Road, Northfield	38	Bell/Alarm Mechanical plant and equipment Car parking	Noise
Adelaide Womens Prison	Grand Junction Road, Northfield	133	N/A	N/A
Oakden Fire Station	700 Grand Junction Road	Within precinct	Alarm Trucks	Noise
Heritage College	2-10 Heritage Court, Oakden	Borders precinct	Children/student noise	Noise
James Nash House	140 Jilltop Drive, Oakden	Within precinct	N/A	N/A
Adelaide City Football Club	Corner of Fosters Road and Hilltop Drive, Oakden	Within precinct	Players voice	Noise
Gilles Plains Shopping Centre	575 North East Road, Gilles Plains	334	N/A	N/A

Figure 31 – Locations of identified nearby commercial/industrial premises

5.6.2 Transport Related Sources

Additional sources of noise and air pollutant emissions that have the potential to impact ambient air quality and noise levels at the project site are summarised in Table 26.

Refer to Figure 31 for the locations of the arterial roads mentioned in Table 26.

Table 26 – Identified transportation noise and air emission sources

Source	Potential Sources	Primary Concern
Grand Junction Road	Cars and occasional heavy vehicles	Air emission, Noise
Sudholz Road	Cars and occasional heavy vehicles	Air emission, Noise
Fosters Road	Cars	Air emission, Noise

5.6.3 On-Site Noise Monitoring

Monitoring Locations

Two unattended noise monitors were installed within the project site for data collection between Friday, 5 April 2019 and Friday, 12 April 2019, to measure traffic noise levels associated with the adjacent arteria roads. One noise monitor was placed at approximately 15 m from the project site's northern boundary, facing Grand Junction Road. Another noise monitor was placed approximately 15 m from the project site's boundary facing Sudholz Road. The 15 m distance from the project site boundary was chosen as it is expected to be representative of the location of the first row residential buildings.

In addition, attended noise measurements were conducted using a handheld Bruel & Kjaer 2270 Sound Level Meter (SLM) at several locations across the site.

The locations of these noise measurements are shown in Figure 32 below.

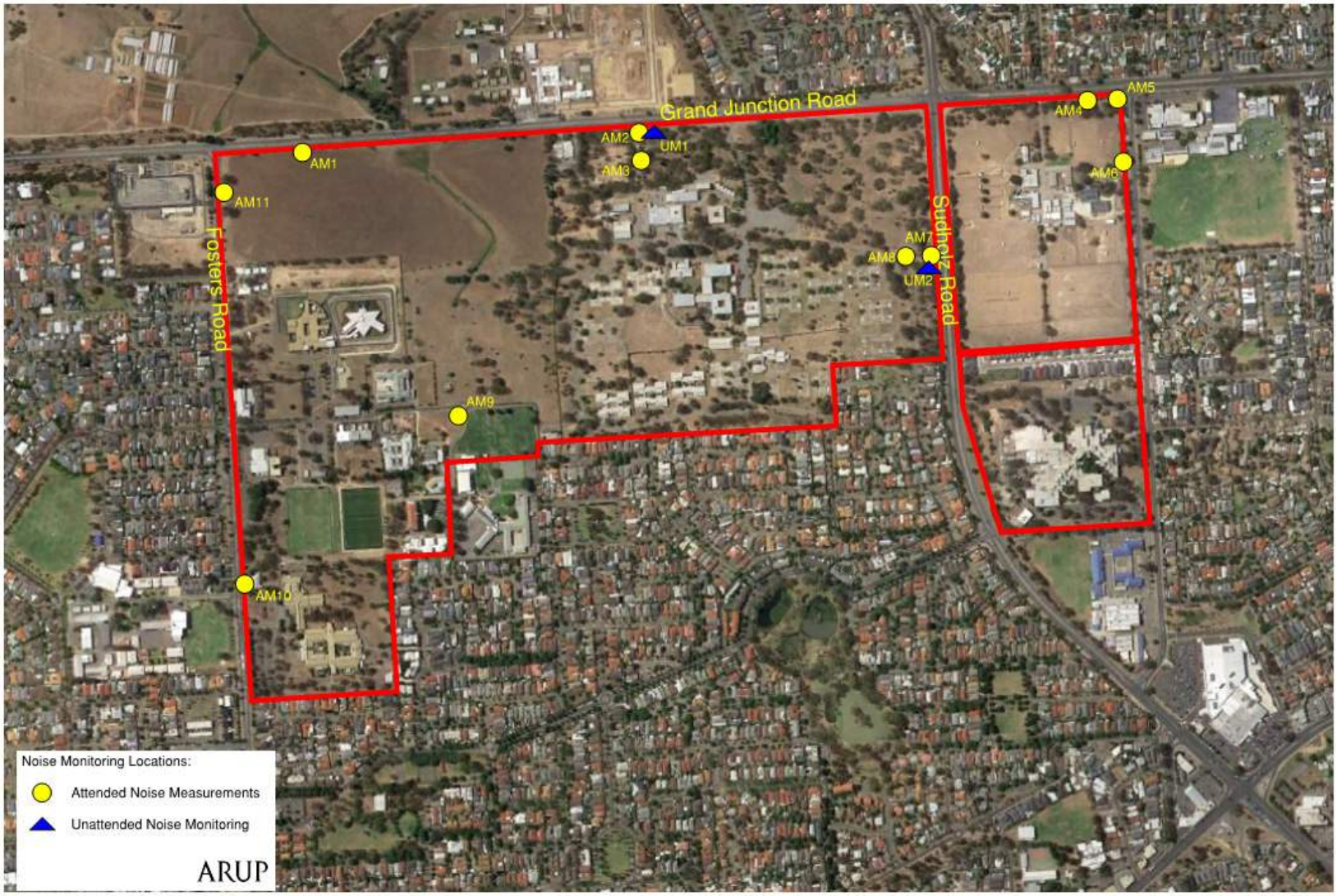


Figure 32 – Site map showing noise logger and attended noise measurement locations

Instrumentation

Unattended noise monitoring was undertaken using the following instruments:

- Two of type 1 Acoustic Research Lab (ARL) Ngara Noise Logging System.

Noise monitoring instrumentation was in current National Association of Testing Authorities (NATA) calibration at the time of use. All instruments were field-checked and calibrated both before and after noise monitoring was undertaken and were found to be conformance with the requirement under Section 5.6 of the Australian Standard AS 1055:1997 *Acoustics – Description and measurement of environmental noise*.

All unattended noise monitoring instruments were calibrated using class 1 Bruel & Kjaer Sound Calibrator type 4231 (Serial 2637409).

Attended noise measurements were undertaken using type 1 Bruel & Kjaer 2270 Sound Level Meter. The instrument was also field-checked for calibration both before and after noise measurements using Bruel & Kjaer Sound Calibrator type 4231 (Serial 2709853) and no significant drift was observed.

Data collected using the unattended noise monitors was downloaded and analysed. Invalid data was removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s at the nearest weather station, when rainfall occurred or when anomalous noise levels occurred.

All noise measuring instruments are capable of measuring continuous sound pressure levels and logging dBL_{A90} and dBL_{Aeq}. Details of the noise measuring instrumentation used are summarised in Table 27 and Table 28.

A summary of the unattended noise monitoring results is presented in the subsequent section.

Table 27 – Unattended noise monitoring equipment details

Description	Measurement Location 1 – Grand Junction Road	Measurement Location 2 – Sudholz Road
Monitor Model	ARL Ngara	ARL Ngara
Monitor Type	Type 1	Type 1
Serial No	878060	8780D0
Start Date	5 April 2019	5 April 2019
Finish Date	12 April 2019	12 April 2019
Pre-Monitoring Calibration (94.0 dBA at 1000 Hz)	93.9	93.9
Post-Monitoring Calibration (94.0 dBA at 1000 Hz)	93.9	93.9
Time Interval	15 minutes	15 minutes
Frequency Weighting	A	A
Time Response	Fast	Fast

Table 28 – Attended noise measurement equipment details

Date	Equipment	Model	Serial	Setting	*Pre-Calibration	*Post-Calibration
4 April 2019 (daytime)	Sound Level Meter (Type 1)	Bruel & Kjaer 2270	3008107	A/Fast	94.1	94.1
	Acoustic Calibrator	Bruel & Kjaer 4231	2709853	-	-	-
4 April 2019 (night time)	Sound Level Meter (Type 1)	Bruel & Kjaer 2270	3008107	A/Fast	94.3	94.2
	Acoustic Calibrator	Bruel & Kjaer 4231	2709853	-	-	-
5 April 2019 (daytime)	Sound Level Meter (Type 1)	Bruel & Kjaer 2270	3008107	A/Fast	94.1	94.1
	Acoustic Calibrator	Bruel & Kjaer 4231	2709853	-	-	-

*94.0 dB at 1000 Hz

Monitoring Results

The unattended traffic noise monitoring results are summarised in Table 29 and Table 30, taking into consideration the day and night traffic noise levels ($dBL_{Aeq,15hr}$ and $dBL_{Aeq,9hr}$).

Attended noise measurement results are summarised in Table 31.

Table 29 – Unattended traffic noise monitoring results – Monitoring Location 1 (Grand Junction Rd)

Monitoring Period	Daytime (07:00 to 22:00) $dBL_{Aeq,15hr}$	Night time (22:00 to 07:00) $dBL_{Aeq,9hr}$
Friday, 5 April 2019	--	54
Saturday 6 April 2019	60	53
Sunday, 7 April 2019	60	54
Monday, 8 April 2019	63	55
Tuesday, 9 April 2019	62	54
Wednesday, 10 April 2019	62	55
Thursday, 11 April 2019	62	56
Friday, 12 April 2019	62	--
Overall Level	**62**	**55**

Table 30 – Unattended traffic noise monitoring results – Monitoring Location 2 (Sudholz Rd)

Monitoring Period	**Daytime (07:00 to 22:00)** **$dBL_{Aeq,15hr}$**	**Night time (22:00 to 07:00)** **$dBL_{Aeq,9hr}$**
Friday, 5 April 2019	--	54
Saturday 6 April 2019	60	53
Sunday, 7 April 2019	59	54
Monday, 8 April 2019	62	55
Tuesday, 9 April 2019	63	54
Wednesday, 10 April 2019	62	55
Thursday, 11 April 2019	62	57
Friday, 12 April 2019	62	--
Overall Level	**62**	**55**

Table 31 – Attended noise monitoring results

Measurement locations (to be read in conjunction with Figure 32)	**Measurement Date (Start time – hh:mm)**	**Measurement Duration (minutes)**	**Ambient noise levels dBL_{Aeq}**	**Background noise levels dBL_{A90}**	**Comments**
AM2 (at 15 m behind UM1 noise logger location)	4 April 2019 (16:25)	15	61	53	Dominant traffic noise associated with Grand Junction Road. Occasional bird, tree rustling noise, as well as plane and emergency siren noise.
AM8 (at approximately 20 m behind UM2 noise logger location)	4 April 2019 (16:48)	5	60	45	Dominant traffic noise associated with Sudholz Road.
AM6 (adjacent to Blacks Road)	4 April 2019 (17:26)	15	62	50	Dominant traffic noise from Grand Junction Road with contribution from Blacks Road. Mechanical noise in distant during traffic lull period. Occasional plane and birds noise.
AM4 (adjacent to Grand Junction Road)	4 April 2019 (17:44)	15	69	57	Dominant traffic noise from Grand Junction Road with occasional truck movements. Occasional plane noise
AM10 (adjacent to Fosters Road)	4 April 2019 (18:12)	15	65	50	Dominant traffic noise associated with Fosters Road traffic noise. Occasional plane, birds, cricket noise.
AM9	4 April 2019 (18:36)	3	40	38	Typical suburban ambient noise with mechanical noise influence in background, occasional birds, local traffic, and patron noise from the ACFC football field.
AM11 (adjacent to Fosters Road substation)	4 April 2019 (23:05)	3	55	46	Transformer noise audible at project site boundary with tonal hum characteristics, dominant at 100Hz and 200Hz. The transformer noise was measured to be 45 dB(A) at the nearest project site boundary during the night time lull period.
AM1 (adjacent to Grand Junction Road)	5 April 2019 (07:21)	15	75	64	Dominant traffic noise from Grand Junction Road with occasional truck movements.

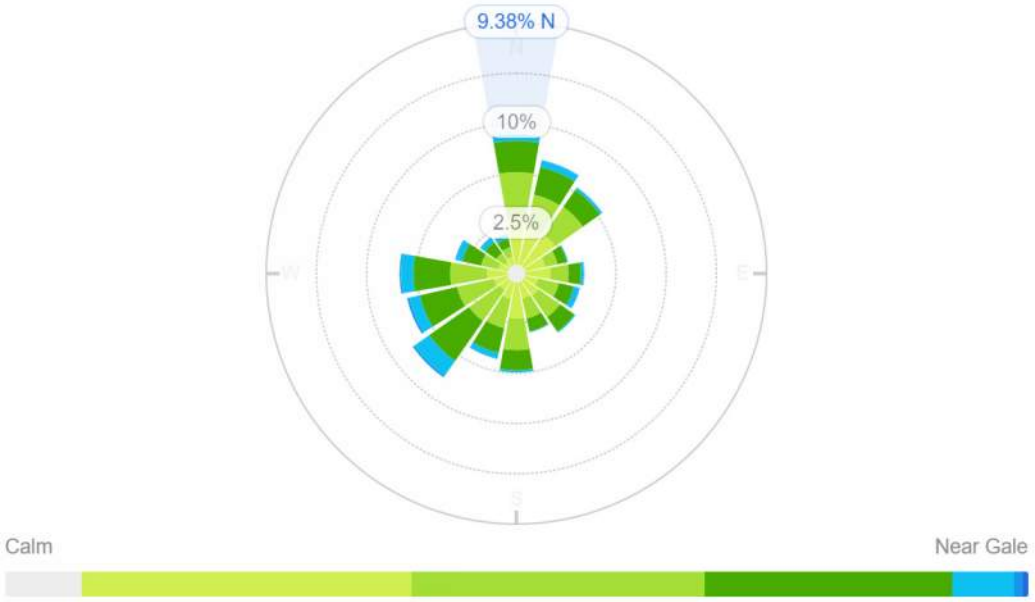
Measurement locations (to be read in conjunction with Figure 32)	Measurement Date (Start time – hh:mm)	Measurement Duration (minutes)	Ambient noise levels dBL_{Aeq}	Background noise levels dBL_{A90}	Comments
AM4 (adjacent to Grand Junction Road)	5 April 2019 (07:53)	15	71	61	Dominant traffic noise from Grand Junction Road with occasional truck movements.
AM5 (Submersible pump measurement at the corner of Grand Junction Road and Blacks Road)	5 April 2019 (08:10)	12 seconds	71	70	Dominant pump noise. Measured pump noise was 71 dB(A) at about 4.5 m away from the pump well opening.
AM7 (at 20 m behind UM2 logger location)	5 April 2019 (08:31)	15	63	57	Dominant traffic noise from Sudholz Road with influence from Grand Junction Road. Occasional birds and dog barking.
AM3 (at 15 m behind UM1 logger location)	5 April 2019 (09:25)	11	64	57	Dominant traffic noise from Grand Junction Road with influence from construction noise associated with the Adelaide Pre-Release Centre.

5.6.4 Site Representative Meteorology

Local meteorology conditions, including wind direction and speed, affect the dispersal of pollutants as well as noise emission in the local area.

Meteorological data for the previous five years (April 2014 to April 2019) was reviewed from the Bureau of Meteorology (BoM) monitoring station at Parafield Airport (-34.80°, 138.63°). This station is located approximately 5.6 km north of Oakden, and that meteorological data are expected to be representative of site conditions due to relatively flat topography.

The annual wind rose in Figure 33 shows that the prevailing wind direction in the area is northerly. Potential pollutants from the Grand Junction Road would be dispersed downwind, therefore it is likely that areas in the north of the project site would be most affected by pollutants based on the dominant prevailing wind direction. Potential impacts are discussed further in Section 5.8.



Source: Willy Weather (using data available from the Bureau of Meteorology)

Figure 33 – Wind Rose for Parafield Airport

5.6.5 Existing Local Air Quality

The current locality of the site is relatively suburban with predominantly residential and community areas; the main contributors to local air pollution in the area currently are traffic on Grand Junction Road, Sudholz Road and Fosters Road, which are the arterial roads surrounding and moving through the project area.

The air quality ambient levels data in the past three years (2016 to 2018) were sourced from publicly available EPA South Australia website for Air Quality Monitoring Reports and Summaries[5].

There is no air quality monitoring undertaken by the EPA within the vicinity of the site. The closest EPA monitoring station for which data is available for the pollutants of concern is North Eastern Adelaide – Northfield (-34.86198°, 138.62289°), approximately 1.5km south west of the site. This location is deemed representative of the project site due to its close proximity to the project site as well as to an arterial road, Hampstead Road. However, it is noted that this station only monitors sulphur dioxide and ozone pollutants.

In the absence of other pollutant data, the PM_{10} and nitrogen dioxide (NO_2) data were sourced from Eastern Adelaide – Kensington Gardens EPA Station (-34.92145°, 138.66506°), approximately 7.7km south south east of the site. Similar to the project site, this location is a typical suburban area with predominant residential premises combined with some open park spaces.

Lastly, the $PM_{2.5}$ monitoring data was sourced from the Adelaide CBD EPA Station (-34.92876°, 138.60094°), located approximately 8.7km south south west of the site, for indicative reference only. It is anticipated that $PM_{2.5}$ concentration levels at the project site would be less than those at the Adelaide CBD, due to lower levels of activity.

Based on the EPA air quality monitoring data years 2016, 2017 and 2018 shown in Table 32, air quality standards are expected to be met at the project site. Exceptions may occur such as shown in the EPA data for the daily mean PM_{10} standard in 2016 and 2018. These exceedances have been attributed by the EPA to smoke from local bushfires and local dust storm. Therefore, the project site is suitable for residential development.

[5] https://www.epa.sa.gov.au/data_and_publications/air_quality_monitoring/reports_and_summaries

Table 32 – Highest monitoring results for Northfield and Adelaide

Pollutant	Standard	Northeastern Adelaide – Northfield (1.5km from site)			Eastern Adelaide – Kensington Park (7.7km from site)			Adelaide CBD (8.7km from site)		
		2016	2017	2018	2016	2017	2018	2016	2017	2018
CO										
Eight-hourly mean	9 ppm	Carbon monoxide for 8-hour ground level concentration is generally quite low,well below the criteria, in a typical suburban area with predominant residential area. This is evidenced by the EPA monitored level at Adelaide CBD area, which would be expected to be higher than those at the project site.								
NO_2										
Maximum hourly mean	0.12 ppm	--	--	--	0.04 ppm	0.038 ppm	0.032 ppm	--	--	--
O_3										
Maximum hourly mean	0.10 ppm	0.07 ppm	0.066 ppm	0.068 ppm	--	--	--	--	--	--
Four-hourly mean	0.08 ppm	0.062 ppm	0.065 ppm	0.063 ppm	--	--	--	--	--	--
SO_2										
Maximum hourly mean	0.20 ppm	The concentration of sulphur dioxide at Northeastern Adelaide is consistently very low below the relevant ground level concentration criteria. Hence, monitored concentration levels have not been reported by EPA.			--	--	--	--	--	--
Daily average	0.08 ppm				--	--	--	--	--	--
Annual average	0.02 ppm				--	--	--	--	--	--
PM_{10}										
Maximum daily mean	50 µg/m^3	--	--	--	91 µg/m^3 (exceedance due to regional dust storm) 36 µg/m^3 (next highest)	28 µg/m^3	73 µg/m^3 (exceedance due to fires and dust storm) 65 µg/m^3 (exceedence due to industrial fire at Wingfield)	--	--	--

Pollutant	Standard	Northeastern Adelaide – Northfield (1.5km from site)			Eastern Adelaide – Kensington Park (7.7km from site)			Adelaide CBD (8.7km from site)		
		2016	2017	2018	2016	2017	2018	2016	2017	2018
							63 µg/m^3 (exceedance due to prescribed burn for Mt Lofty Ranges) 40 µg/m^3 (next highest)			
$PM_{2.5}$										
Maximum daily mean	25 µg/m^3	--	--	--	--	--	--	15 µg/m^3	15 µg/m^3	16 µg/m^3

5.7 Evaluation Distances for Identified Sources

In the case of this study, the EPA recommended evaluation distances guidelines apply to existing facilities located within as well as outside the project site boundary.

There are no facilities identified within the project site that would be subject to the EPA evaluation distances. However, outside the precinct, within 500 m radius, there are facilities that have the potential to cause air emissions, odour or noise impacts, subject to EPA evaluation distances. These activities are summarised in Table 33.

Note that the EPA evaluation distances are guidelines only and cannot be enforced in the absence of planning scheme implementation.

Table 33 – EPA Evaluation distances for activities surrounding the project site

Company	Activity type	Additional activity notes	Evaluation distance (metres)	Description of typical activities and potential air or noise impacts
Nathan Bakes	Bakery	Only if using more than 20 tonnes of ingredients per week	200	Bakeries can cause noise impacts due to their early start times and also emit odour. Despite the pleasant hedonic tone of the odour, continuous odours (even nice food odours) can cause nuisance.
Grand Junction Road	Major Roads	Deemed to be Class 6 or 7 major road under the *Road Classification Guidelines in South Australia*.	100	Emissions from cars, trucks, buses and motor bikes, can have an impact on air quality as well as result in noise impacts. Emissions from motor vehicles include particles, oxides of nitrogen, carbon monoxide and benzene. Design techniques to protect sensitive development from air and noise emissions are contained in *Reducing noise and air impacts from road, rail and mixed land use – A guide for builders, designers and the community* and *Minister's Specification SA 78B Construction requirements for the control of external sound.*
Sudholz Road				
Fosters Road				

The throughput of the Nathan Bakes bakery is unknown at this stage. Site inspection had indicated that there was no odour from the bakery at the Fosters Road project site boundary. Nevertheless, should the 200 m evaluation distance apply to the bakery, this would not cause any constraint to the project site precinct boundary as the bakery is located at a distance greater than 200 m away.

It was observed that there were no other odour sources within or surrounding the project site.

The air emissions and noise impact associated with the nearby transport corridors have been addressed in Sections 5.8 and 5.9 respectively.

5.8 Discussion of Potential Air Quality Impact

A review of the existing air quality conditions in the vicinity of the project site show that air quality standards are met with the exception of occasional exceedances of the daily PM_{10} standard which previously have been associated with sources such as bushfires or dust storms. While the project site is surrounded by arterial roads, vehicle movements are not expected to significantly impact on air quality at the project site.

Notwithstanding the above, in-principle air quality mitigation strategies to are provided in Section 5.10 to minimise air quality impact and optimise amenity as much as practicable at the project site.

Development of the project site for residential and commercial purposes has the potential to generate dust during the construction phase and increase vehicle emissions in the area during the operational phase due to residential traffic travelling to and from the project site. It is unlikely that this would significantly impact local air quality in the surrounding area.

5.9 Discussion of Potential Noise Impact

5.9.1 Road Traffic Noise

The primary background noise environment within the vicinity of the project site was observed to be dominated by traffic noise associated with Grand Junction Road, Sudholz Road and Fosters Road.

Detailed traffic noise intrusion has not been undertaken due to the preliminary nature of the assessment. However, the Minister's Specification SA 78B provides guidance on the deemed to satisfy provisions for building BCA Class 1, 2, 3 and 4 building and 9c aged care building, to preserve the amenity as a result of undue intrusion of external arterial road traffic noise for Type A, Type B or Type R classified roads, stated under the *Port Adelaide Enfield Council Development Plan*. The identified three arterial roads (Table 34) adjacent to the project site are classified as Type B roads.

Traffic noise monitoring has been conducted on-site to determine the $dBL_{Aeq,15hr}$ and $dBL_{Aeq,9hr}$ (refer to Section 5.6.3).

Table 34 below shows the summary of the measured traffic noise levels.

Table 34 – Measured traffic noise levels at 15 m from the project site boundaries

Road	Daytime levels, $dBL_{Aeq,15hr}$	Night time levels, $dBL_{Aeq,9hr}$
Grand Junction Road	62	55

Road	Daytime levels, $dBL_{Aeq,15hr}$	Night time levels, $dBL_{Aeq,9hr}$
Sudholz Road	62	55
Fosters Road	61[1]	56[1]

Note:
1. Predicted level based on traffic volume[6] and measured noise level comparisons with Grand Junction Road and Sudholz Road.

External Amenity

Based on the measured traffic noise levels above, a preliminary traffic noise impact assessment has been undertaken to determine the indicative extent and height of noise barrier which may need to be considered to achieve Noise EPP 2007 compliance for outdoor amenity within the project site. A summary of possible noise barrier locations and heights has been provided in Figure 34, below.

The predicted noise barrier extents and heights may not be practical in some locations due to height constraints or access issues, for example. It is recommended that a detailed traffic noise investigation be undertaken to explore the opportunity of combined noise control strategies such as control in transmission (noise barrier) and land-use control (setback distances with open park area) to optimise the noise barrier heights and extents whilst maintaining the intended outdoor amenity within the residential areas.

Alternatively, noise control at measures at the receiver may be considered to preserve the internal amenity of the sensitive spaces, in accordance with the Minister's Specification SA 78B, addressed in the subsequent section of this report. However, this would also reduce the likely residual noise mitigation benefits to other nearby areas.

The noise mitigation strategies for consideration have been provided in Section 5.10.

[6] Location SA Map Viewer (http://location.sa.gov.au/viewer/?map=hybrid&x=138.84869&y=-34.92469&z=10&uids=138)

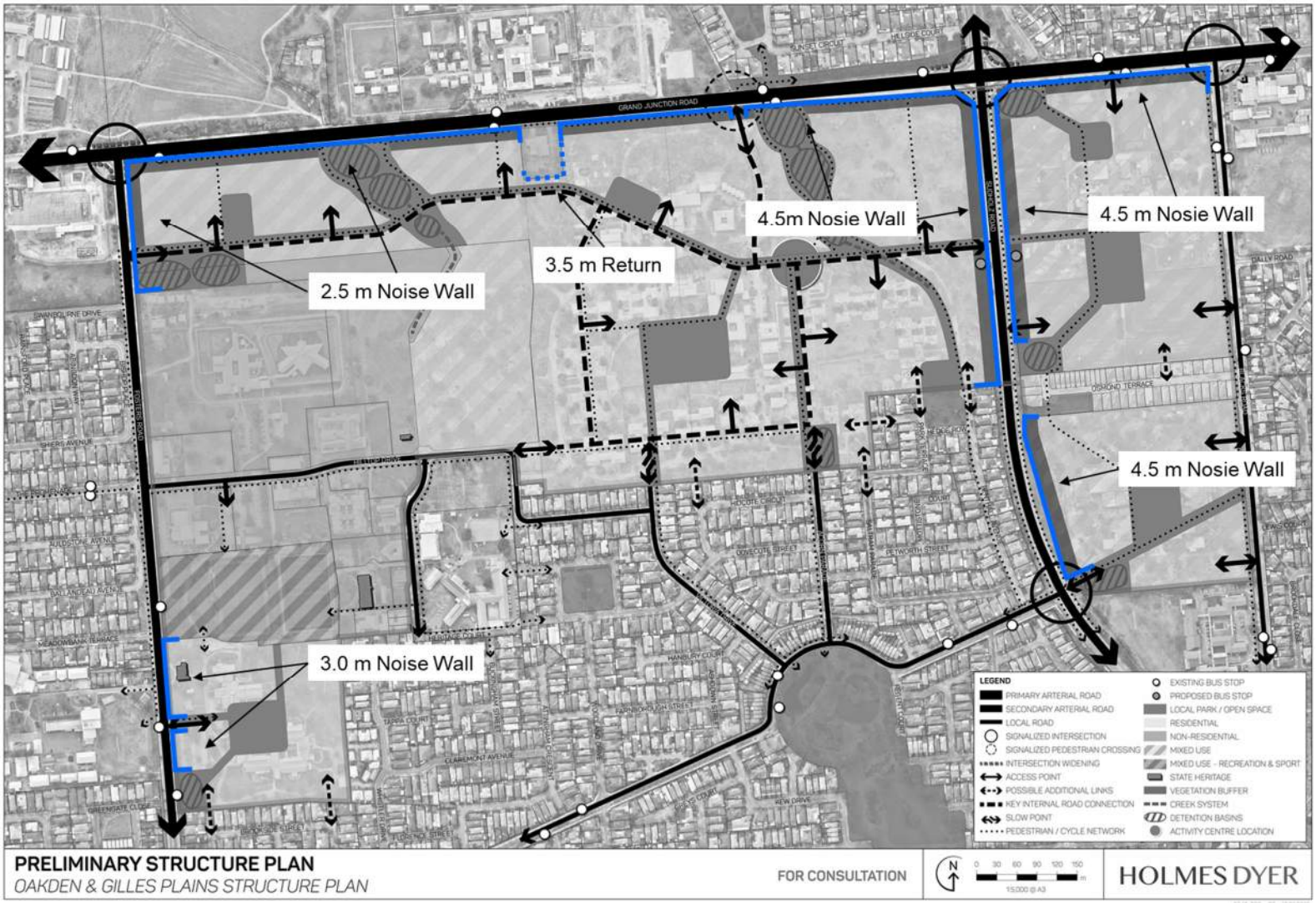


Figure 34 – Indicative noise barrier locations

Internal Amenity

Detailed traffic noise intrusion has not been undertaken due to the preliminary nature of the assessment as well as the absence of building layout and construction information. The Minister's Specification SA 78B provides guidance on the deemed to satisfy provisions for building BCA Class 1, 2, 3 and 4 building and 9c aged care building, to preserve the amenity as a result of undue intrusion of external arterial road traffic noise.

Using the above-mentioned noise barrier in place, based on standard residential building construction with windows closed, the internal noise levels within the dwelling is expected to be less than 40 $dBL_{Aeq,15hr}$ and 35 $dBL_{Aeq,9hr}$ during the day and night respectively.

However, in the absence of noise barriers, the noise mitigation control stipulated in the Minister's Specification SA 78B to be implemented. This is discussed further in Section 5.10.

5.9.2 Substation Noise

Electrical substation located at the corner of Grand Junction Road and Fosters Road was observed to contain transformer with tonal noise emission, just audible at the nearest project site boundary.

Transformer noise level of 45 dB(A) were measured at the nearest project site boundary, along with tonal characteristic dominant at 100 Hz and 200 Hz (refer to Section 5.6.3 and Figure 35).

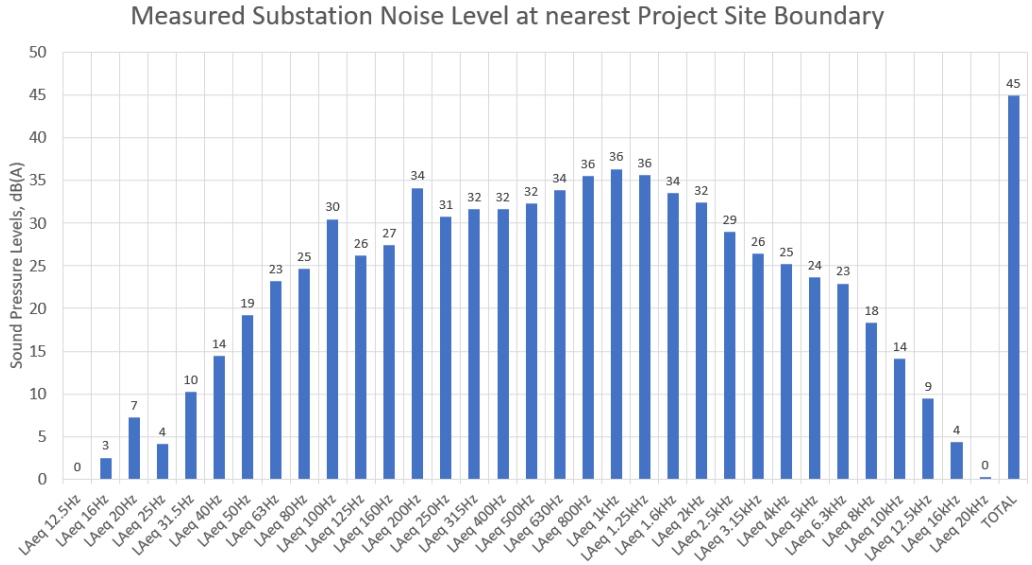


Figure 35 – Measured substation noise levels at nearest project site boundary

The transformer operational noise emission at the project site will need to comply with the Noise EPP 2007 criteria set out in Section 5.3.1.

Due to the tonal noise characteristics, in accordance with the Noise EPP 2007, 5 dB(A) adjustment shall be applied, which equates to 50 dB(A) at the nearest project site boundary. As the nearest project site precinct has been allocated as mixed-use development, the measured transformer noise level complies with the Mixed-Use Noise EPP 2007 day and night time noise criteria of 57 $dBL_{Aeq,15hr}$ and 50 $dBL_{Aeq,9hr}$ respectively.

5.9.3 Submersible Pump Noise

A submersible pump was identified to be located at the corner of Grand Junction Road and Blacks Road, with a measured L_{eq} of 71 dB(A) at approximately 5 m from the well opening. Should the pump be remain in the precinct development, it should be acoustically treated to achieve the daytime and night time Noise EPP 2007 criteria of 52 dB(A) and 45 dB(A) respectively.

Discussion with the pump asset owner may need to be undertaken in providing effective and agreed noise mitigation measures for the pump, which may include solid enclosure in combination with setback distance from the nearest receivers. However, this should not compromise the operational performance of the asset. Alternatively, noise barrier surrounding the pump hole would provide some degree of attenuation, although this would not be effective for elevated receiver locations.

Should control at the source (pump) and control in transmission strategies not be possible, it is not uncommon to acoustically treat the receiver's building envelope via building acoustic treatment, to preserve the internal amenity. However, the limitation with this strategy is that it will not preserve the outdoor amenity of the receiver unless combination of controls be implemented.

In-principle noise mitigation strategies have been provided in Section 5.10.

5.9.4 Oakden Central Gaming Lounge Noise

The Oakden Central Gaming Lounge was observed to be an entertainment venue with restaurant and bar, which may have the potential to cause music or patron noise emission impact to the project site. The Venue is currently under the Liquor Licensing Act 1997 (Licence number 50904725[7]) and has the capacity to accommodate up to approximately 1,600 people with the following relevant conditions:

- ***Condition 1****: Entertainment Consent shall apply during the above trading hours, but only in respect to Areas 1 to 3, and all external doors shall be kept closed whilst entertainment is in progress.*
- ***Condition 4****: The licensee shall erect and maintain a prominent sign at the main entrance to the premises requesting patrons to leave quickly and quietly in the interests of nearby local residents.*
- ***Condition 5****: The licensee shall each day at closing time station an approved Responsible Person at the main entrance to the premises to monitor the orderly and quietly departure of patrons.*
- ***Condition 6****: The licensee shall take and implement advice from a landscaping architect with a view to increasing the density of existing plantings/foliage between the existing palm trees at the front of the property, with a view to reducing car headlight spillage and departing patron noise in the interest of residents living opposite the premises.*
- ***Condition 7****: There shall be no outside speakers placed in Area 6.*

A review of the Minister's Specification SA 78B indicates that music sound from an entertainment venue are only applicable to Class 1, 2, 3, 4 and 9c buildings which are to be located within 65 m of an existing entertainment venue. Based on the proposed project site structure plan, the nearest residential premises are proposed to be located at a distance greater than 65 m from the venue. Hence, the SA 78B specification is not considered applicable in this case.

Notwithstanding the above, the noise from the entertainment venue should meet the criteria stipulated in the council development plan, detailed in Section 5.2, Table 19 of this report. It is recommended that further investigation be undertaken to determine the potential impact of music and patron noise at the nearest residential receivers within the proposed project site precinct, in particular during afterhours venue operation.

[7] https://secure.cbs.sa.gov.au/LGPubReg/LandG_licences_fromDB.php?PDF_ID=5325&stream=L&search_type=get_licence

5.9.5 Adelaide City Football Club

The operational (players) noise of the ACFC football field is not expected to cause significant impact to the project site. The operation of the ACFC is likely to only be daytime period and non-continuous as training or game match is not expected to always occur subsequently.

5.9.6 Adelaide Pre-Release Prison

The operational noise impact associated with the Adelaide Pre-Release Prison situated to the north of the project site is not expected to be significant. The ambient noise environment at the northern side of the project site is dominated by traffic noise from Grand Junction Road, based on the on-site observations. Any noise attenuation measures implemented to minimise traffic noise impact would also provide mitigation against noise emission from the prison facility.

5.9.7 Oakden Fire Station

The Oakden fire station is expected to cause potential significant noise emission to the project site precinct. Potential noise emission sources from a fire could be driving fire/emergency trucks with sirens on, operating water pump, saws, and shouting of civilians and fellow firefighters during fire emergency call.

More detailed investigation of the Oakden fire station noise emissions is recommended to be undertaken to determine the likelihood of impact within the project site.

The noise monitoring data did not capture any fire station operational noise during fire emergency. Although it may have an impact, it may not be strictly required under the policy. Therefore, it should be considered in the design despite it may not be mandatory.

5.9.8 Heritage College

Attended ambient noise measurement (measurement location AM9) was undertaken within the vicinity of the Heritage College. The measured ambient noise level was 40 $dBL_{Aeq,3min}$, with some contributions from mechanical noise, occasional birds, local traffic, and patron noise from the ACFC sport field. Based on this measurement, it is expected that the noise emissions from the college be below the Noise EPP 2007 day and night time noise criteria.

5.9.9 St Paul's College

The operation of the St Paul's College is not expected to cause significant impact to the project site. Ambient noise environment along the eastern boundary of the project site is dominated by traffic noise associated with Blacks Road. It was observed that there was prominent noise emission from the school bell during the daytime, but is not expected to operate during the night-time period, and hence no sleep disturbance impact would be anticipated from the operation of the school.

5.9.10 Miscellaneous Noise

Daytime on-site inspection indicated that there is no mechanical plant noise audible at the south-western most boundary of the project site, closest to the Cedar College, Nathan Bakes and Northgate Shopping Centre. At the nearby location along the project site south-western boundary (AM10-Figure 32), the ambient noise was measured at 65 $dBL_{Aeq,15min}$, dominated by traffic noise associated with Fosters Road – This traffic noise impact is addressed in Section 5.9.1.

5.10 General Mitigation Strategies

5.10.1 Air Quality

The in-principle air quality mitigation strategies below were sourced from South Australian Government – Department of Planning, Transport and Infrastructure (DPTI) guideline entitled; *Reducing noise and air impacts from road, rail and mixed land use – A guide for builders, designers and the community* (DPTI 2012), as per recommended in the EPA evaluation distance guideline (Section 5.7).

Developments located next to busy roads may have challenges in providing an acceptable air quality for residents. However, whilst it is anticipated that the surrounding activities would not have a significant air quality impact on the project site, the following strategies have been provided in-principle for consideration to minimise air quality impacts as much as practicable.

- Consideration should be given to locating air conditioning intakes away from busy roads.
- Locate ground level private and communal open space away from the emission source (Figure 36), introduce a buffer between residential development and roads.
- Avoid the use of confined outdoor spaces oriented towards primary roads that can trap polluted air and restrict air circulation.
- Encourage air dispersal by:
    - Having fewer confined areas to enable winds and breezes to disperse and carry away air pollutants (i.e. carefully consider the orientation and continuity of open spaces, their dimension and shape, topography and the layout of buildings surrounding the area).
    - Stepping back the upper storeys of roadside buildings to increase dispersion of air pollutants.
    - Providing a variety in frontages such as setting upper floors back from the street frontage helps disperse air and noise (Figure 37).
    - Using two-sided balconies to allow more cross breezes (Figure 38).
- Locate air-conditioning air inlets away from high traffic roads.

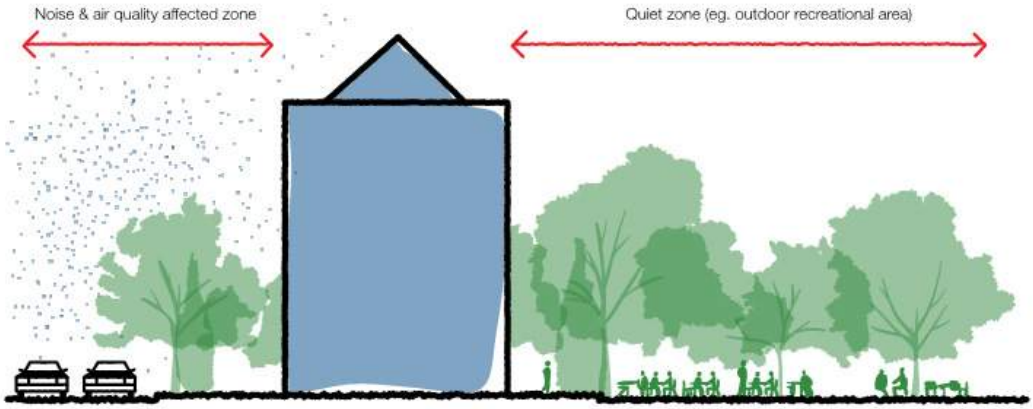


Figure 36 – Outdoor spaces located away from noise and emissions (Source: NSW Department of Planning 2008)

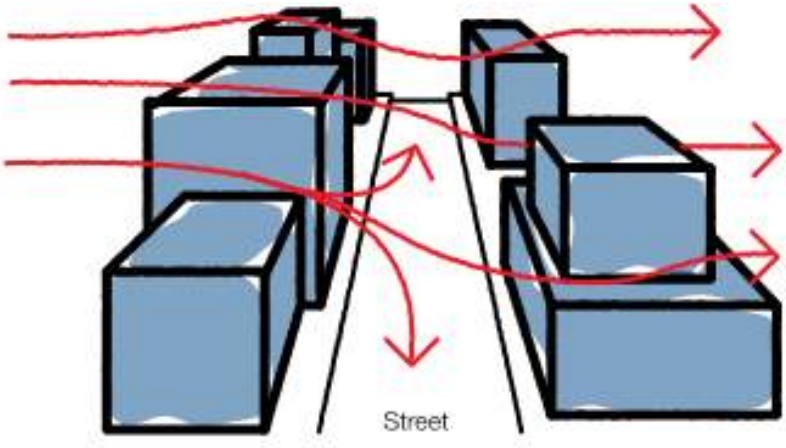


Figure 37 – Variation in building facades increases the dispersion of air pollutants and reduces the effects of canyoning (Source: NSW Department of Planning 2008)

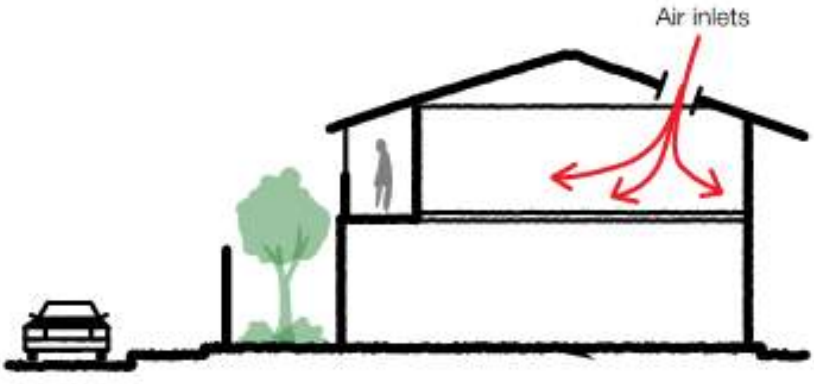


Figure 38 – Locate air intake grills away from the source of pollutes air (Source: DPTI 2012)

5.10.2 Noise

SA 78B Standard Design Treatment

The Minister Specification SA 78B provides sound exposure category to determine the airborne sound insulation ratings for class 1, 2, 3, 4 and 9c building envelopes. Based on the measured traffic noise levels and the SA 78B internal noise criteria, sound exposure Category 1 is deemed to be sufficient to provide external noise intrusion control. The preliminary building envelope construction is summarised in Table 35.

Section C5 of the SA 78B provides the acceptable construction practice to achieve the required acoustic ratings specified in Table 35.

Table 35 – SA 78B Category 1 building acoustic treatment

External building elements	Room type	Acoustic requirements (to be read in conjunction with Section C5 of the SA 78B)
External walls	(i) All habitable rooms	$R_w + C_{tr}$ 45 for all habitable rooms
Windows and external glass doors	(i) Bedroom (ii) A non-habitable room attached to (i)	Area of window and external glass doors as a percentage of the floor area of the room: $R_w + C_{tr}$ 25 for area not more than 20% $R_w + C_{tr}$ 28 for area more than 20% but not more than 40% $R_w + C_{tr}$ 31 for area more than 40% but not more than 60% $R_w + C_{tr}$ 34 for area more than 60% but not more than 80% $R_w + C_{tr}$ 37 for area more than 80%
	(i) Habitable room, other than a bedroom and an enclosed kitchen (ii) A non-habitable room attached to (i)	Area of window and external glass doors as a percentage of the floor area of the room: $R_w + C_{tr}$ 22 for area not more than 20% $R_w + C_{tr}$ 25 for area more than 20% but not more than 40% $R_w + C_{tr}$ r 28 for area more than 40% but not more than 60% $R_w + C_{tr}$ 31 for area more than 60% but not more than 80% $R_w + C_{tr}$ 34 for area more than 80%
Ventilation system – openable windows		Natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the NCC. The window system should be provided as per the windows and external glass doors requirements above. The ventilation system provided in addition to openable windows must have a minimum R_w 40.

General Mitigation Strategies

General noise mitigation and management measures may fall under one or some of the following categories[8] (ranked from the most preferred to the least preferred) where feasible and reasonable:

[8] NSW EPA. Noise Policy for Industry. October 2017.

- *Land-Use Control* (separating the location of noise-producing sources from sensitive areas, which avoids more expensive short-term measures).
- *Control at Source* (Reduce noise output of the source so that the surrounding environment is protected against noise).
- *Control in Transmission* (Controlling noise at the source as it serves to reduce the noise level at specific receivers but not necessarily the broader environment surrounding the source).
- *Receiver Control* (The least preferred option, as it protects only the internal environment of specific receivers and not the external noise environment).

Land-Use Control

The Land-Use Control involves several strategies, such as:

- **Setback distances**. This setback distance strategy aims to reduce noise exposure level at the precinct sensitive receiver via maximisation of distances between the noise source and noise sensitive receiver. Setback distance strategy could also minimise ground-borne vibration exposure from any vibration sources.
- **Setback strategy**. The setback strategy could be considered in minimising the noise exposure level to the sensitive receiver by designing open space area in between the noise sources, such as industries or busy transport corridors, and sensitive receiver.
- **Expansion of pedestrian and cycle areas**. The purpose of such facility is to encourage the use of bicycle or walking, and at the same time discourage the use of motor vehicles. This will minimise the local noise emission within the project precinct.
- **Impose acoustic mitigation control on planning conditions for new developments**. Such mechanism could be done in the form of council's planning permit conditions for development specific acoustic treatment.
- **Building locations and height controls**. High rise building s could be located adjacent to noise sources, such as busy transport corridors, providing noise shielding to the sensitive receivers within the project precinct.

Figure 39 – Example of low density housing adjacent to an expressway with a noise barrier and separation distance to reduce noise emissions (Source: DPTI 2012)

Control at Source

There are several strategies involved in using the control at source measure.

Low-Noise Pavement Surfaces

One of the strategy is to promote the use of low-noise road pavement surfaces on new roads within the project precinct. The type of road surfacing influences the level of noise generated by the contact between tyre and road interface. The Austroads Technical Report entitled: *Guide to the Selection of Road Surfacings* (2000) provides comparison of noise emission correction levels among different conventional road surfacings in Australia, referenced to the Dense Graded Asphalt surface (refer to Table 36). As it can be seen from Table 36 that in general seal and concrete surfacings are not recommended for low noise surfacing due to their higher traffic noise levels compared with asphalt surfacings.

Table 36 – Relative noise emission levels of conventional surfacings in Australia

Surfacing Type	Relative Noise Level, dB(A)
Spray seals, 10 mm or larger	+4
Spray seal, 7 mm	+2
Dense graded asphalt (DGA)	0
Open graded asphalt (SMA)	-3
Stone mastic asphalt (SMA)	-1
Slurry surfacing	+0
Tyned concrete only	+1 to +4
Brommed Concrete	+1 to +4
Hessian dragged concrete (with or without tyning)	+2 to +4
Exposed aggregate concrete	-1 to +1

In addition, Austroads Research Report *entitled: Modelling, Measuring and Mitigating Road Traffic Noise. AP-R277/05*" (2005) has mentioned that "*It should also be noted that the noise generation characteristics of surfacings changes over time in particular as the wear, weathering and roughness of the road changes. In addition, noise generated from open graded asphalt pavement types will also increase as the voids within the surface become clogged over time. As an example,* (Dash, Bryce, Moran, & Samuels, 2001) *indicate that the clogging of surface voids in open-graded asphalt may lead to noise level increases of around 4 dB(A).*" the Austroads Research Report further provides the following table (Table 37) showing the change in road acoustic performance due to aging.

Table 37 – Change in Road Acoustic Performance due to Aging

Road Surface	**Noise Level Variation, dB(A)**		
	When Fresh	**Several Years Old**	**Change**
Spray seals	+4	+2	-2
Dense graded asphalt (DGA)	0	+1	+1
Open graded asphalt (OGA)	-4	-2	+2

Traffic Calming Schemes

The installation of traffic calming schemes below would minimise the traffic noise emission within the development. The Austroads Research Report entitled: *Modelling, Measuring and Mitigating Road Traffic Noise* AP-R277/05 (2005) provides a range of traffic calming schemes to assist in minimise traffic noise impact at the source. The typical traffic calming schemes are summarised in Table 38. Note that the calming schemes in Table 38 may not all be applicable to the project, however they have been provided for information only.

Table 38 – Traffic Calming Schemes (Austroads, 2005)

Factor	**Consideration**
Distance between devices	Distance between traffic calming devices should promote constant speed along the road. Acceleration followed by braking and swerving can increase community annoyance where devices are spaced too far apart.
Height of device	Raised devices, such as mid-block platforms and speed humps have strong traffic calming effects. However, the height of the device can limit its effectiveness. A 3 cm increase in height can provide the equivalent noise increase of moving the device 40 m closer to the noise receiver.
Chicanes	Chicanes can reduce speed annoyance however; they do not reduce the sense of danger that a calming device should achieve. This is mostly a result of noise generated by swerving and acceleration.
Roundabouts	Roundabouts generally provide the greatest benefit in noise reduction. Noise from roundabouts appears to create less community annoyance than other traffic calming devices.
Mid-block platforms	Mid-block platforms are not effective at reducing speed annoyance. Squeaking noise, caused mostly by the vertical displacement of the device, tends to increase noise annoyance at sensitive receivers. This can be reduced by keeping the device height lower than 75 mm.
Speed humps	Speed humps have noticeably lower annoyance levels than mid-block platforms, although device height should be lower than 75 mm to minimise potential annoyance.
Driver behaviour	Implementation of traffic calming devices should be aimed for the minority of drivers who 'challenge' devices, as these drivers create the most noise. Measures that reduce line of sight may be more effective than those that create a vehicle disturbance.
Traffic volume and mix	Traffic volume and mix, particularly at night time (between 10:00 pm – 7:00 am) may affect noise annoyance to sensitive receivers. Unladen heavy vehicles and light trucks crossing these devices can cause sleep disturbance in the early morning hours.
Pavement surface	Contrasting pavement surfaces such as cobblestones or rumbled pavements, often used to highlight devices, can increase the noise at the tyre/road interface.

Factor	Consideration
Emergency vehicle access	It should be noted that emergency vehicle access and response time must be carefully considered when designing and installing calming devices. Emergency vehicles, particularly ambulances, have more difficulty with vertical devices such as speed humps than with horizontal devices such as chicanes.

Control in Transmission

Noise Barrier

Noise control in transmission strategy generally includes the installation of noise barriers. In principle, the noise barrier should be located near to either the source or the receiver, to achieve its maximum noise attenuation performance. However, there is always some compromise to this principle due to aesthetic consideration or physical constraints.

Noise barrier may include the following features:

- Natural slope such as earth mound.
- Purposely designed solid boundary fence.
- Purposely designed building acting as a barrier block.

Figure 40 to Figure 42 below show the different type of noise walls, sourced from NSW DoP: *Development near Rail Corridors and Busy Roads – Interim Guideline* (2008).

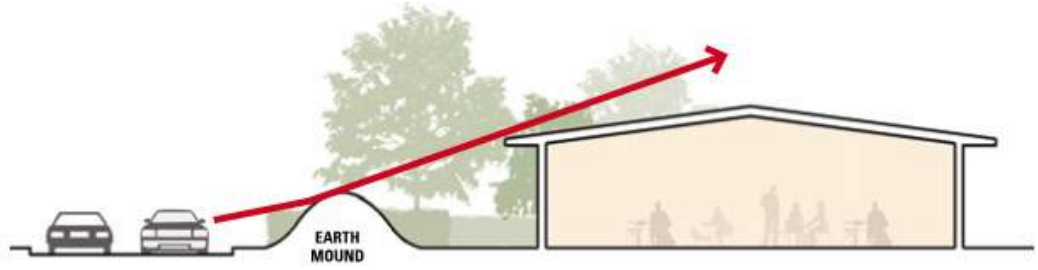


Figure 40 – 'Noise barrier using earth mound (Source: NSW DoP 2008)

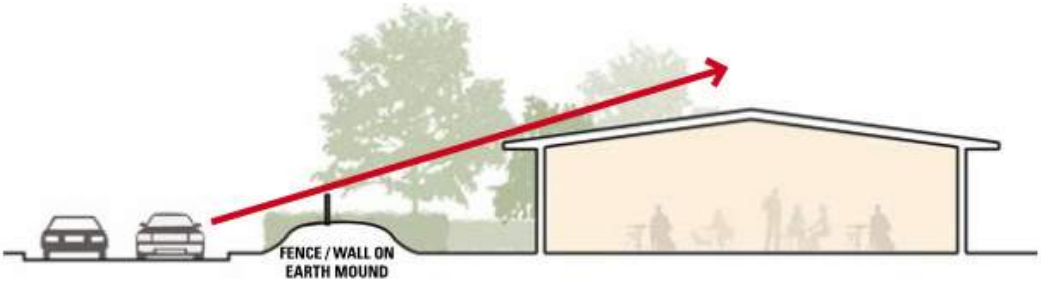


Figure 41 – 'Noise barrier using earth fence/wall (Source: NSW DoP 2008)

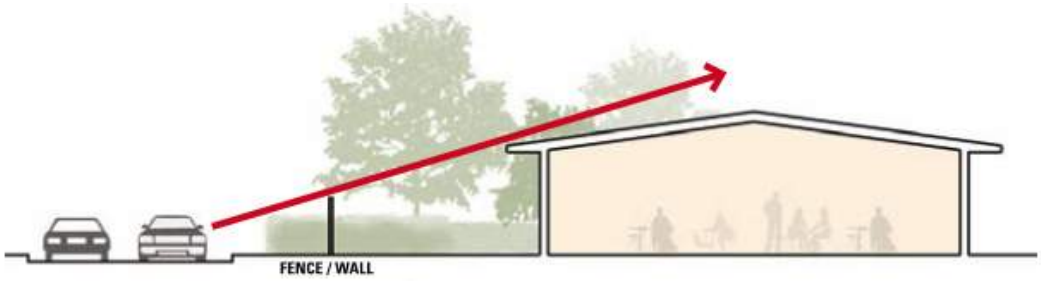


Figure 42 – 'Noise barrier using a fence/wall (Source: NSW DoP 2008)

The effective noise barrier should be made of solid material with continuous arrangement (no gaps). Where continuous noise wall is not possible due to access for pedestrians, cyclists, drainage, maintenance access or emergency access, the design of noise barrier should be overlapped at the opening. The walls should be overlapped with a length of not less than three times of the opening width.

The length of the wall is also an important factor to consider. In general, assuming a level site, the barrier should extend to cover an angle of about 160 degrees from the protected receiver. Alternatively, should space becomes a major constraint, barrier be curved and have returns at ends. This curving of barriers and returning ends could maximise the effectiveness of noise barrier.

The noise barrier vertical and horizontal alignments are recommended to maintain a parallel relationship with the road carriageway, as well as providing sufficient screening to avoid direct line-of-sight between the source and receiver.

VicRoads[9] suggests that noise barrier to have surface density of at least 20 kg/m^2 solid material, such as timber, transparent acrylic, lightweight aerated concrete, and many others, or an overall weighted Sound Reduction Index ($R_w + C_{tr}$) through the noise barrier material of at least 25 dB when tested in accordance with AS 1191:2002 *Acoustics – Method for laboratory measurement of airborne sound transmission insulation of building elements*.

Noise barrier could be installed as part of the traffic noise mitigation strategy to minimise traffic noise impact. The requirement of a noise barrier, as well as its detailed specification, should be confirmed subject to noise modelling assessment, as necessary.

Receiver Control

Development Layout Strategies

There are several development layout strategies that could be considered to minimise noise impact. The following strategies are sourced from DPTI 2012 and NSW Department of Planning (DoP): *Development near Rail Corridors and Busy Roads – Interim Guideline* (December 2008), and are summarised as follow:

- Locating courtyards or balconies away from the noise and emissions source.
- Using buildings in 'U' or 'L' shaped layouts to create sheltered outdoor recreation areas protected from noise (refer to Figure 43).
- Locating noise sensitive rooms such as living rooms and bedrooms away from façade exposed to the noise source (refer to Figure 44).
- Less noise sensitive rooms, such as bathrooms, laundries, corridors can be located facing to the façade exposed to the noise source, where practicable (refer to Figure 44).

[9] VicRoads *Code of Practice – Noise attenuation walls* BTN 007, June 2018.

- Balustrade/balcony design could be used to avoid direct line of sight between source and receiver, providing noise shielding effect (refer to Figure 45).

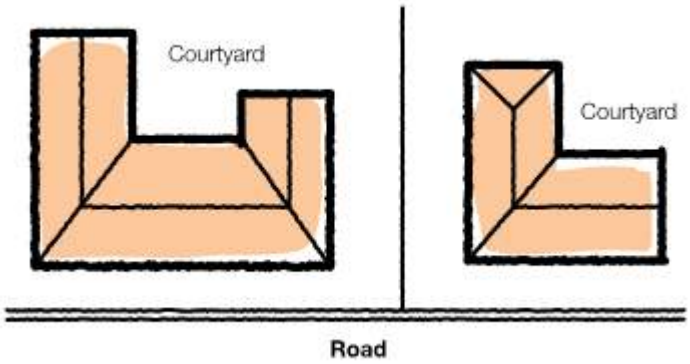


Figure 43 – 'U' or 'L' shaped layouts to protect outdoor space from noise and air emissions (Source: DPTI 2012)

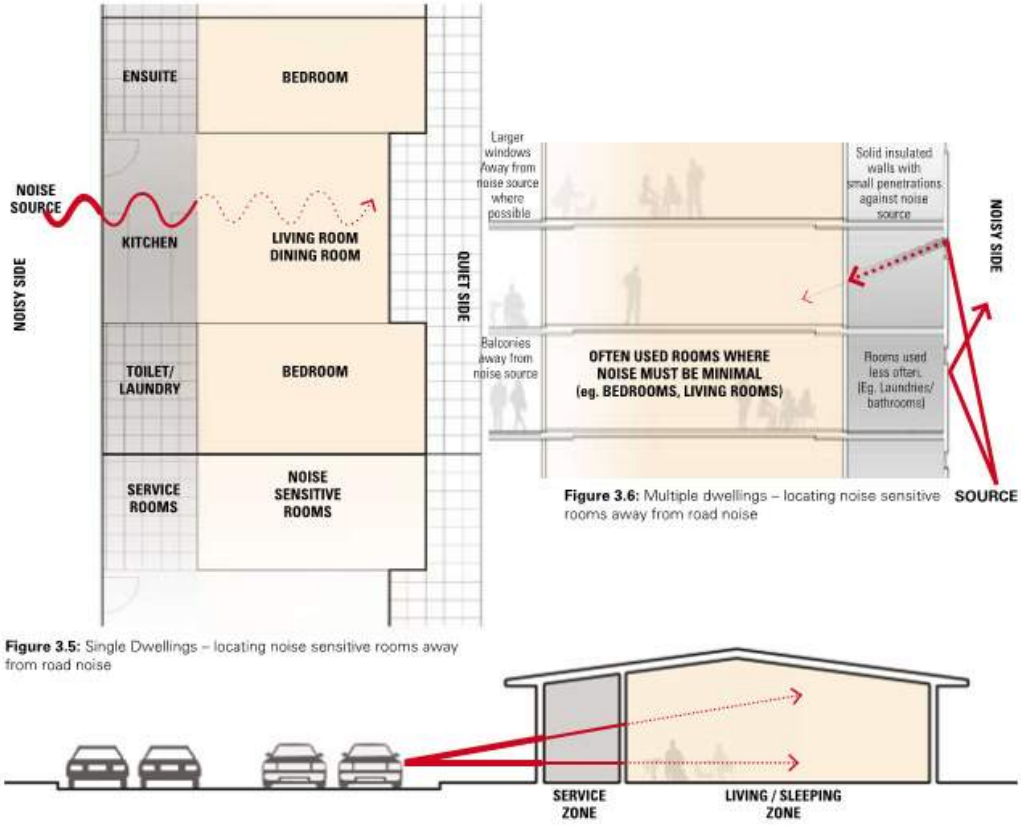


Figure 44 – Building layout treatment – locating noise sensitive rooms away from noise source (Source: NSW DoP 2008)

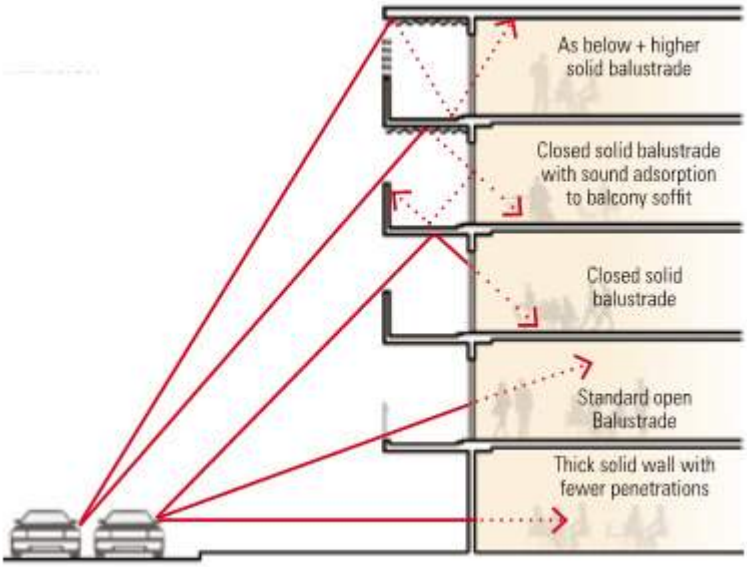


Figure 45 – Balcony treatments which reduce traffic noise intrusion (Source: NSW DoP 2008)

Building Acoustic Treatment

The other option for noise mitigation measures is control at receiver via building acoustic treatment. The relevant standards for this measure are as follow:

- The Australian standard AS3671:1989 – *Acoustics – Road traffic noise intrusion – Building siting and construction*
- Australian Standard AS2107-2016 – *Acoustics - Recommended design sound levels and reverberation times for building interiors*

The AS 3671 provides the traffic noise assessment procedures and determination of appropriate treatments for noise reduction to achieve the desired indoor noise levels. The AS 2107 provides the recommended indoor design noise levels for various types of building within occupied spaces.

The purpose of providing building envelope acoustic treatment is to reduce the internal noise only when the external noise criteria cannot be achieved.

Potential Constraints to the Mitigation Strategies

There are potential key constraints in implementing the above noise mitigation measures within the project site. They are:

- The implementation of land-use control strategy through setback distance could compromise the land utilisation and value.
- The existing established industries or asset with private ownership may pose a challenge in implementing noise mitigation control at source.
- Noise control in transmission via noise barrier may have the following limitations:
  - Noise barriers could create negative perceptions due to view restriction, loss of sunlight, loss of air circulation, loss of lighting.
  - Loss in lighting or sunlight due to the installation of noise barrier may increase in local crime.
  - Noise barrier may be effective for at grade or below grade sensitive receivers, but not as effective for elevated receivers, such as multi-storey dwellings.

- Noise control at receiver via individual building acoustic treatment would involve significant cost implication.

5.11 Recommended Future Works

5.11.1 Noise

Based on the study outcomes in this report, it is recommended that further detailed noise investigation work be undertaken to determine the noise emission impact from the identified sources such as submersible pump, Oakden Central Gaming Lounge, and Oakden fire station, and the required noise mitigation measures to preserve the amenity of the sensitive receivers within the project site. Some of the above measures may require collaboration with the asset owners or stakeholders to seek opportunity for more effective and efficient mitigation strategies.

The traffic noise impact from adjacent arterial roads has been indicatively assessed and indicated exceedances of the Noise EPP 2007 criteria. More detailed traffic noise assessment is recommended to be undertaken to determine more effective noise control strategies to preserve the outdoor as well as indoor amenity within the project site.

Appendix A: Utilities correspondence

Dev Pokhrel

From: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Sent: Wednesday, 8 May 2019 12:04 PM
To: Dev Pokhrel
Cc: Cleere, Kylie
Subject: [External] RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Hi Dev,

Apologies for the delay in getting a response to you.

SA Water has previously assessed this site approximately 5 years ago and I have included our previous response below:

Water:

Water services are available to the proposed development off the existing network surrounding the development area.
Cross connection of water supply through the development site with the existing network is also required.
See plan below:

Dev Pokhrel

From: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Sent: Tuesday, 17 September 2019 12:01 PM
To: Dev Pokhrel
Cc: Cleere, Kylie; Daniel Osborne; David Kon; Joe Haigh
Subject: [External] RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Hi Dev,

Sorry for the delay in getting back to you with servicing information for this proposed development site. I can advise you the following:

The assessment was based on the following development information:

- Developer: Renewal SA
- Total proposed allotment yield: 1990
- Type of development: Residential
- Multi-story development: 1-2 storey residential development
- Apartment Buildings: No apartment buildings proposed
- Proposed development start: 2020/2021

Water:

Based on SA Water's Systems Planning investigation, the network has sufficient capacity to support the proposed development subject to:

Distribution main

- No external work required at this stage. However this may change when a revisit occurs when the layout is clearer at time of lodgement of the Land Development application and/or when staging information is provided

Meters

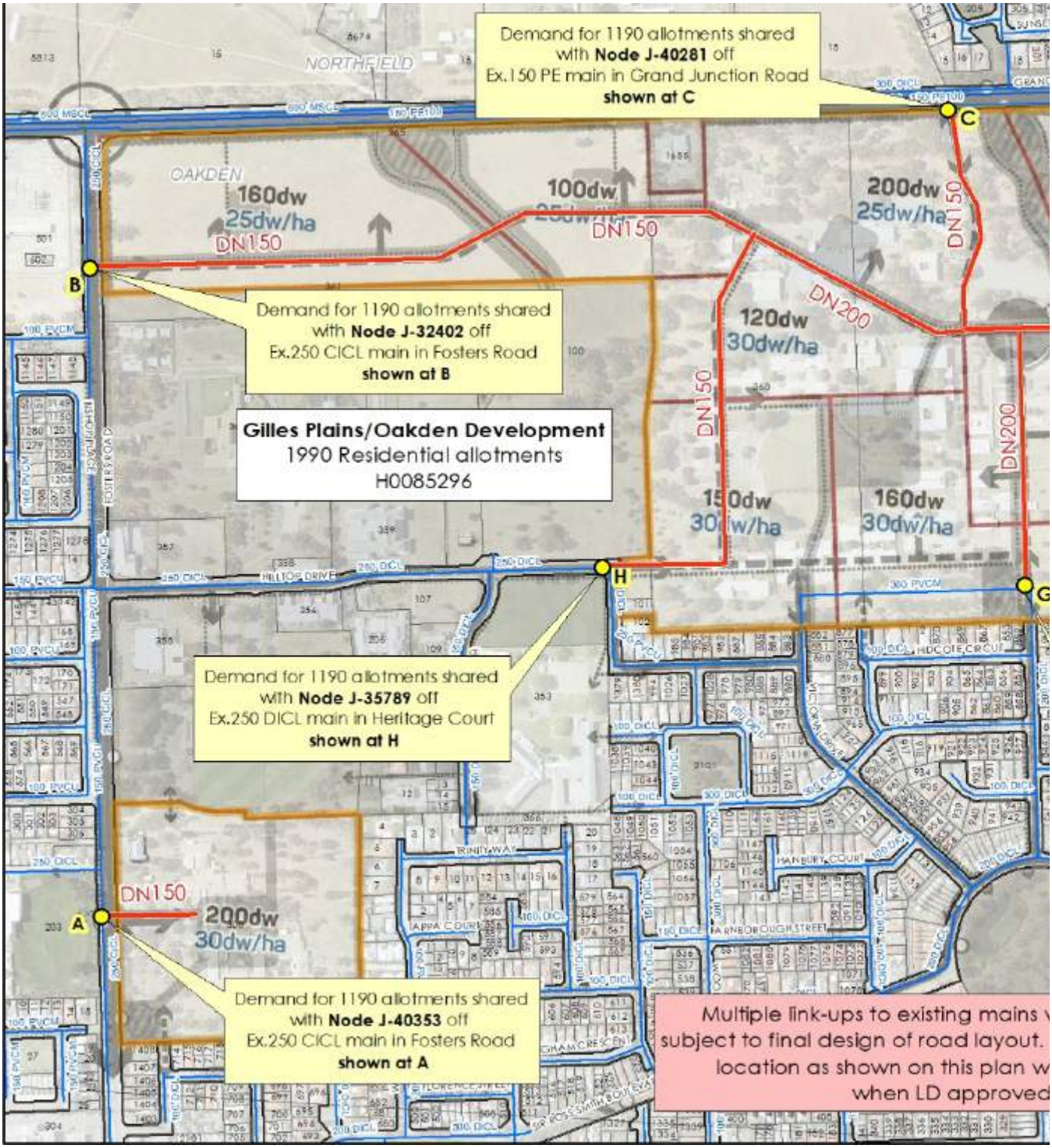
- Multiple existing meters may or may not need removing depending on the development layout and staging

Fire Service

- Fire flow analysis to be undertaken separately when and if required
- No fire service requirements have been provided

Inline Pumps

- Inline pumps permit application to be undertaken separately if and when required
- No details have been provided



Wastewater:

Based on SA Water's Systems Planning investigation sewer services are available to the proposed development subject to:

- The DN675 RC gravity main (north of the development site – see Figure A3) which ultimately conveys a large portion of flows from the development site has been identified as requiring future augmentation based on the 2018 Bolivar South master planning.

- Given the size of the development and the large expected flows it is recommended that the system is monitored to determine when the augmentation

works and upgrades are required. Further assessment and monitoring will need to occur when detailed information is provided on the development layout and staging plans.

- In addition, depending on the development layout and staging plans, it may be necessary for the developer to construct headworks of a new DN225 gravity main in Grand Junction Road of approximately 2.4km. As shown in Figure A4 below.

- A reassessment of the availability of wastewater services and the potential network connection points will be undertaken once additional details (including proposed lot layout and proposed servicing strategies) for the development are determined and submitted to SA Water.

- The construction of the sewer infrastructure must be in accordance with SA Water Network Infrastructure Standards.

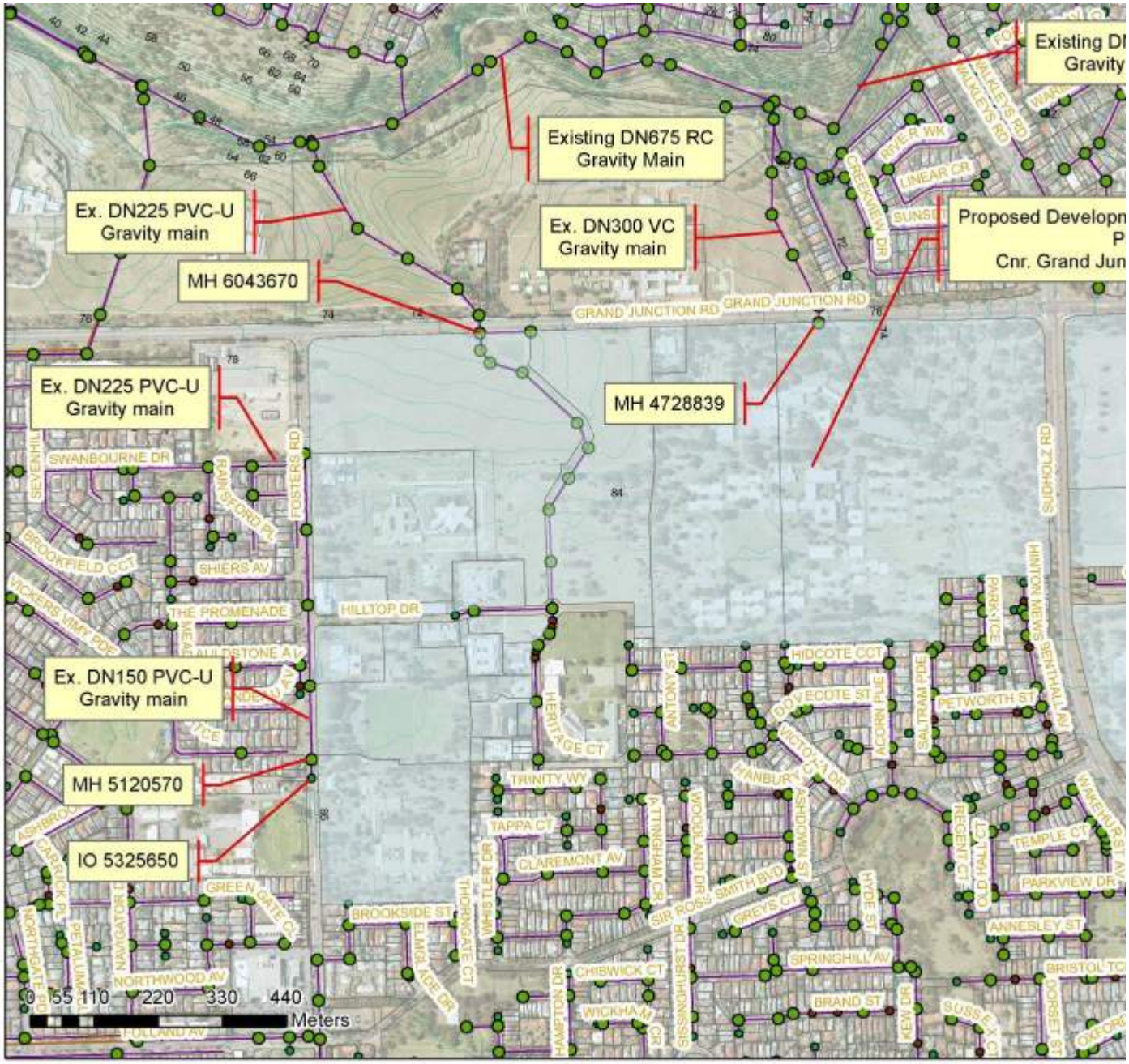


Figure A3 Existing System – Option 1

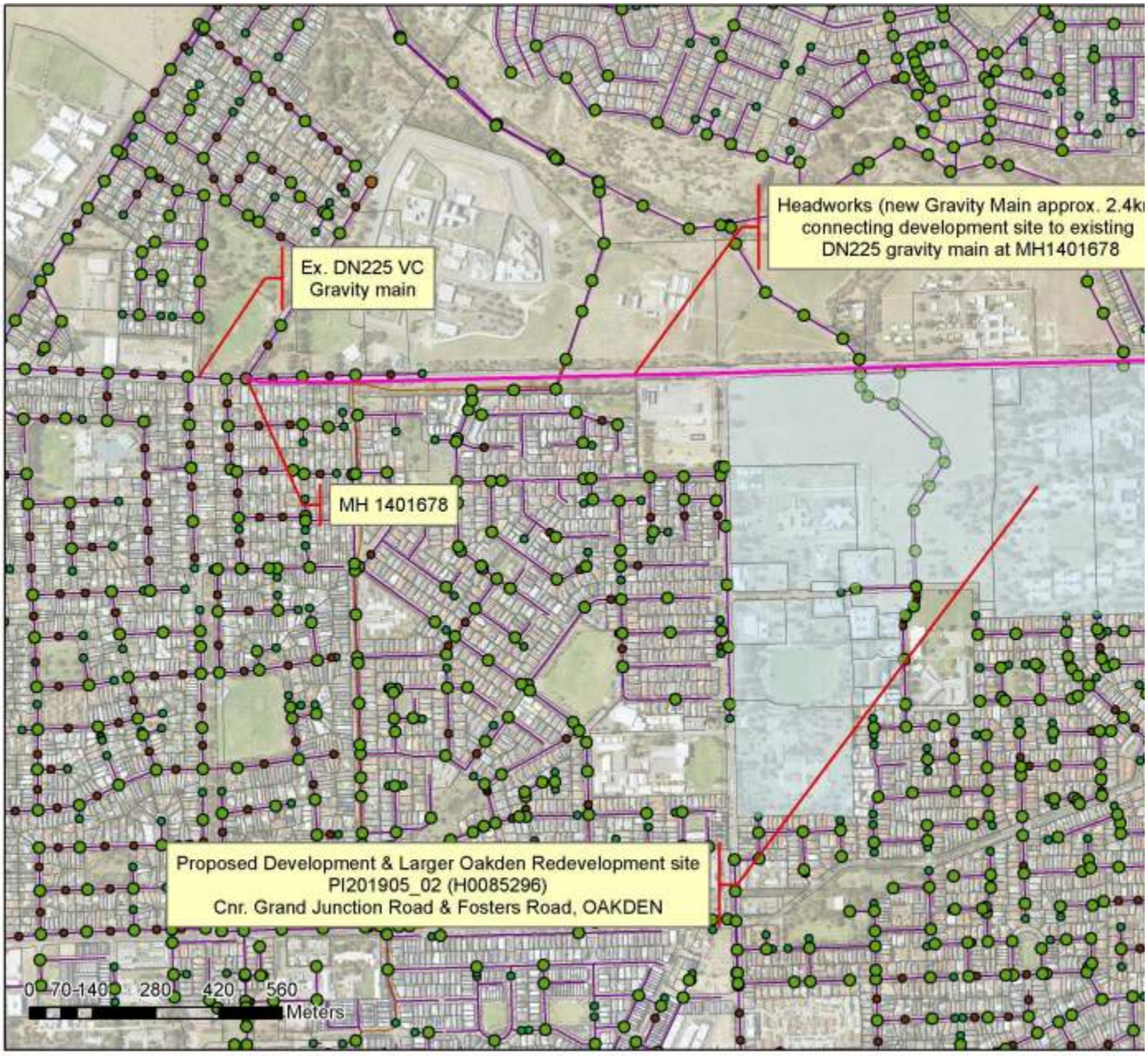


Figure A4 Existing System and Headworks – Option 2

This is a high level assessment and is subject to further assessment when a lodged land development application is received or further development information is provided.

Please also note that the Wastewater Servicing strategy is subject to further assessment by SA Water's Asset Management Team to determine the delivery of the required augmentation works to service this proposed development.

I hope this information assists and if you have any questions or wish to discuss further please do not hesitate to contact me.

Thanks

Kind Regards

Debbie Snoswell
Account Manager, Development Services

Debbie.snoswell@sawater.com.au • 08 7424 1133 • 0416 245 296
250 Victoria Square/Tarntanyangga ADELAIDE SA 5000

sawater.com.au

SA Water respects and acknowledges the deep spiritual connection, knowledge and relationship Aboriginal and Torres Strait Islander people have to land and water.

From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Friday, 13 September 2019 9:38 AM
To: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Cc: Cleere, Kylie <Kylie.Cleere@sawater.com.au>; Daniel Osborne <Daniel.Osborne@arup.com>; David Kon <David.Kon@arup.com>; Joe Haigh <Joe.Haigh@arup.com>
Subject: RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Good Morning Debbie. Hope this email finds you well.

Just following up from the last update about this project – has the assessment been completed in terms of detailing future augmentation/upgrade works required to service this proposed development?
We are looking to issue final report to the client early next week so any updates before then would be really helpful for us to include the details in the final report.

Thanks and warm regards

Dev Pokhrel
Engineer | Transport & Resources VIC/SA
BE (Civil & Water Resources Management, Honours) MIEAust

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From: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Sent: Friday, 17 May 2019 10:30 AM
To: Dev Pokhrel <Dev.Pokhrel@arup.com>
Cc: Cleere, Kylie <Kylie.Cleere@sawater.com.au>
Subject: [External] RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Thanks for the info Dev.

I will be on leave from today for 5 weeks returning to work on 24th June and in my absence Kylie Cleere will be attending to my projects. If you have any queries at all please do not hesitate to contact Kylie (7424 1218).

Kind Regards

Debbie Snoswell
Account Manager, Land Development

Debbie.snoswell@sawater.com.au • 08 7424 1133 • 0416 245 296
250 Victoria Square/Tarntanyangga ADELAIDE SA 5000

sawater.com.au

From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Friday, 17 May 2019 9:00 AM
To: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Cc: Cleere, Kylie <Kylie.Cleere@sawater.com.au>
Subject: RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Good Morning Debbie,
Thanks for your email and it is great to know that this is progressing along well.
As per our understanding, there are no plans for high rise building or apartments – just low density residential buildings.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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From: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Sent: Friday, 17 May 2019 8:33 AM
To: Dev Pokhrel <Dev.Pokhrel@arup.com>
Cc: Cleere, Kylie <Kylie.Cleere@sawater.com.au>
Subject: [External] RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Hi Dev,

We are undertaking the updated assessment and our modelling officer has asked if there are plans for any high rise/apartment buildings and if so what is the maximum height level.

If you can advise as soon as possible that would be great. Thanks

Kind Regards

Debbie Snoswell
Account Manager, Land Development

Debbie.snoswell@sawater.com.au • **08 7424 1133** • **0416 245 296**
250 Victoria Square/Tarntanyangga ADELAIDE SA 5000

sawater.com.au

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From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Thursday, 9 May 2019 9:14 AM
To: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Cc: Cleere, Kylie <Kylie.Cleere@sawater.com.au>
Subject: RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

Thanks Debbie. This information is helpful for this stage of reporting.
Looking forward to receiving the updated assessment as soon it is available.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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From: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Sent: Wednesday, 8 May 2019 12:04 PM
To: Dev Pokhrel <Dev.Pokhrel@arup.com>
Cc: Cleere, Kylie <Kylie.Cleere@sawater.com.au>
Subject: [External] RE: Oakden & Gilles Plains Future Development - SA Water services inquiry - H0085296

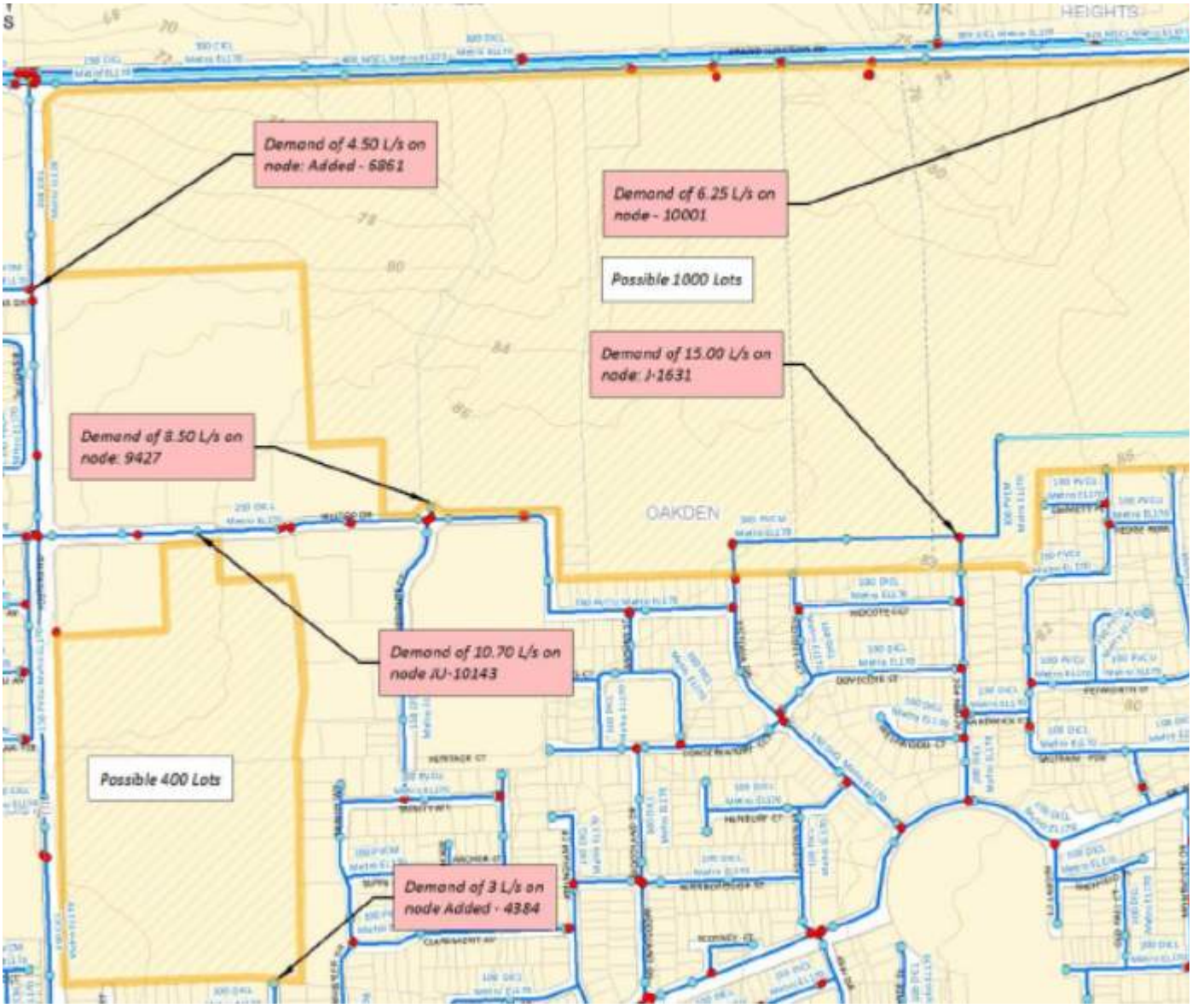
Hi Dev,

Apologies for the delay in getting a response to you.

SA Water has previously assessed this site approximately 5 years ago and I have included our previous response below:

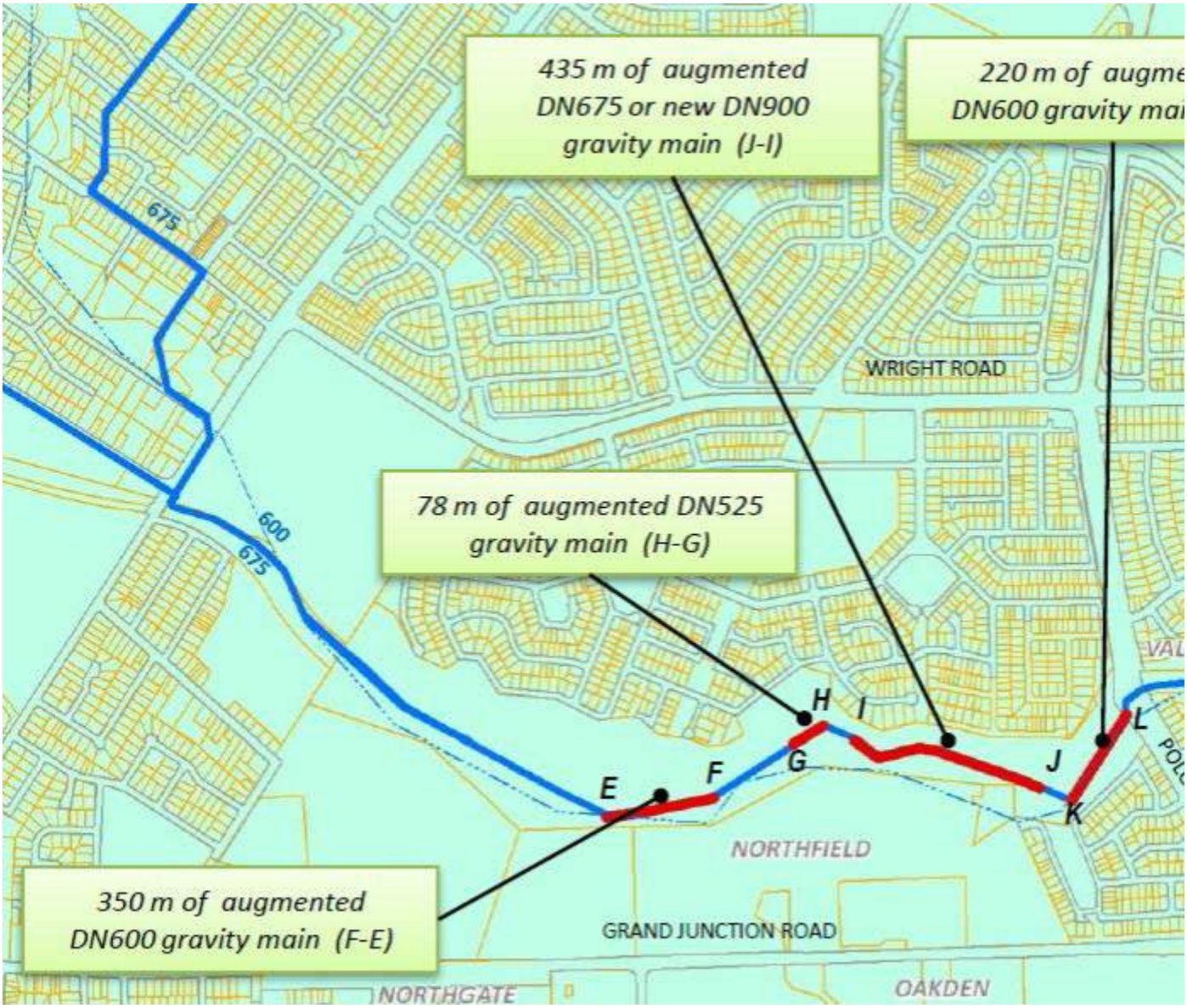
Water:

Water services are available to the proposed development off the existing network surrounding the development area.
Cross connection of water supply through the development site with the existing network is also required.
See plan below:



Wastewater:

Wastewater services are available subject to flow monitoring being undertaken by SA Water's Asset Management group. The results of that monitoring with initiate the need for the works detailed in the figure below to be undertaken as the development progresses.
It is still to be determined how this augmentation works will be funded or if Augmentation costs will apply to the development.



We are currently reinvestigating this assessment to provide you with an updated assessment as soon as possible but this process does take a number of weeks.

I hope that the above information is of assistance to you in the interim until our updated assessment is completed.

Should you have any questions please do not hesitate to contact to me and please quote the following SA Water Ref No H0085296. Also just letting you know that I will be on Annual Leave from 17th May 2019 and returning to work on Monday 24th June. In my absence Kylie Cleere will be attending to my projects and will be able to assist you with any queries. Thanks

Kind Regards

Debbie Snoswell
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From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Wednesday, 8 May 2019 9:01 AM
To: Snoswell, Debbie <Debbie.Snoswell@sawater.com.au>
Subject: RE: Oakden & Gilles Plains Future Development - SA Water services inquiry

Good Morning Debbie,
I hope this email finds you well.
I am following up again regarding the query below – has any progress been made? I would appreciate an update.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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f +61 8 8212 1601 m +61 403 578 910
www.arup.com

From: Dev Pokhrel
Sent: Wednesday, 24 April 2019 9:19 AM
To: 'Debbie.Snoswell@sawater.com.au' <Debbie.Snoswell@sawater.com.au>
Subject: RE: Oakden & Gilles Plains Future Development - SA Water services inquiry

Hi Debbie,
Hope you all had a nice Easter break.

Just following up on the query below to see if there has been any progress made? An update would be appreciated.

Kind regards

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From: Dev Pokhrel
Sent: Tuesday, 9 April 2019 11:13 AM
To: 'Debbie.Snoswell@sawater.com.au' <Debbie.Snoswell@sawater.com.au>
Subject: Oakden & Gilles Plains Future Development - SA Water services inquiry

Hello Debbie,
Hope you are doing good.
It was my pleasure to work with you while I was at Fyfe (as Devi). On a personal news, I have now moved on from Fyfe to Arup (now known as Dev – haha!). Still doing similar stuffs plus more than I used to do at Fyfe.

We have been engaged by Holmes Dyer, who are working for Renewal SA, to assist them with a high level services assessment and reporting for parcels of land in Oakden and Gilles , which is intended to have a development plan amended for future residential development. I have attached preliminary site plans depicting type of land use, approximate yield and the location.

In order to provide our client with a report incorporating detailed existing and future services, can SA Water provide information regarding future connection opportunities for the proposed future development based on existing infrastructure capacity and or any upgrade works, for both sewer and water. We are also attempting to identify if any augmentation charges are applicable, if existing surrounding network need an upgrade or augmented to service this development – it would be great if you provide this information or any other information deemed relevant for this site.

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Thanks heaps in advance.

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Civil Engineer | Transport & Resources

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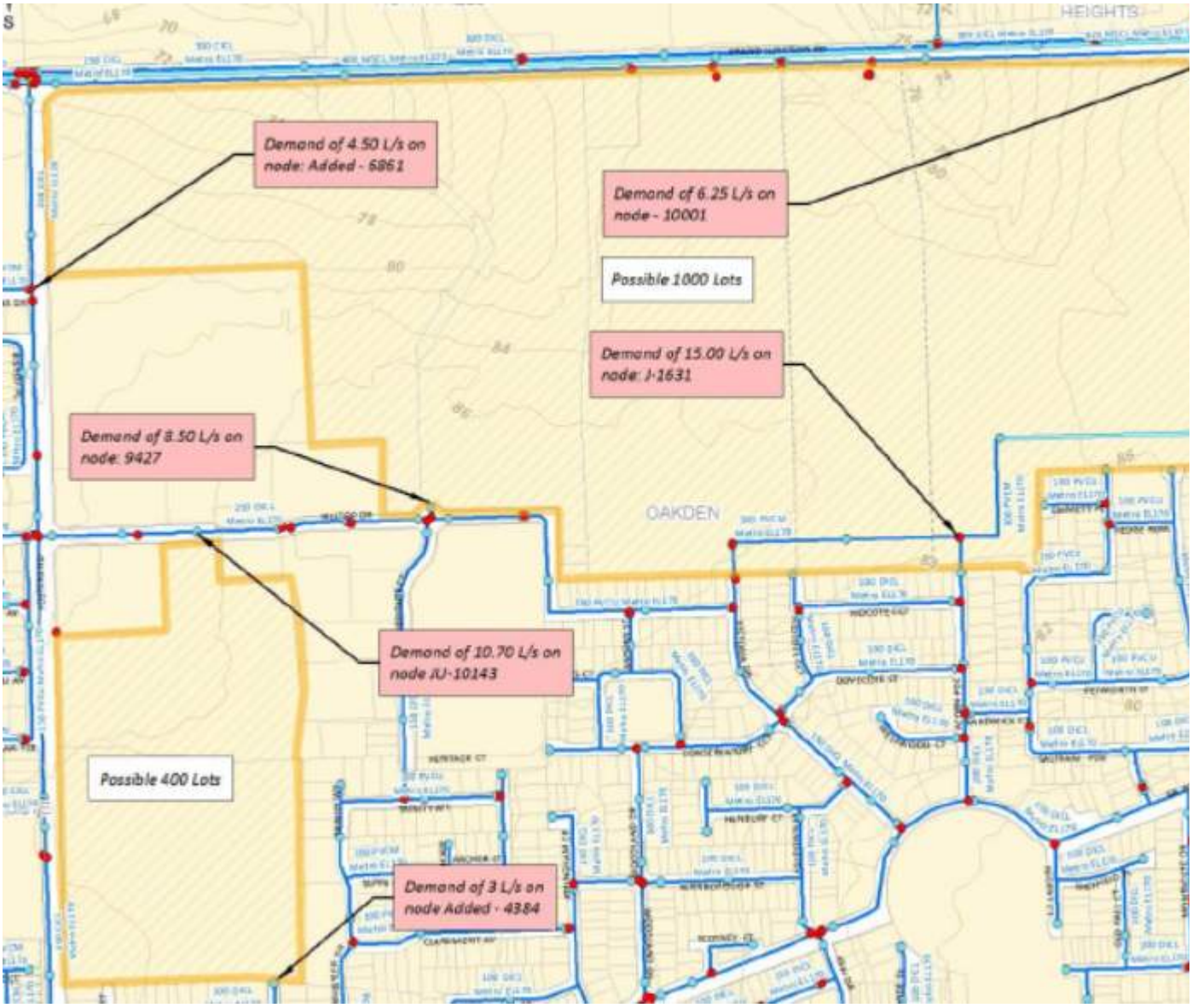

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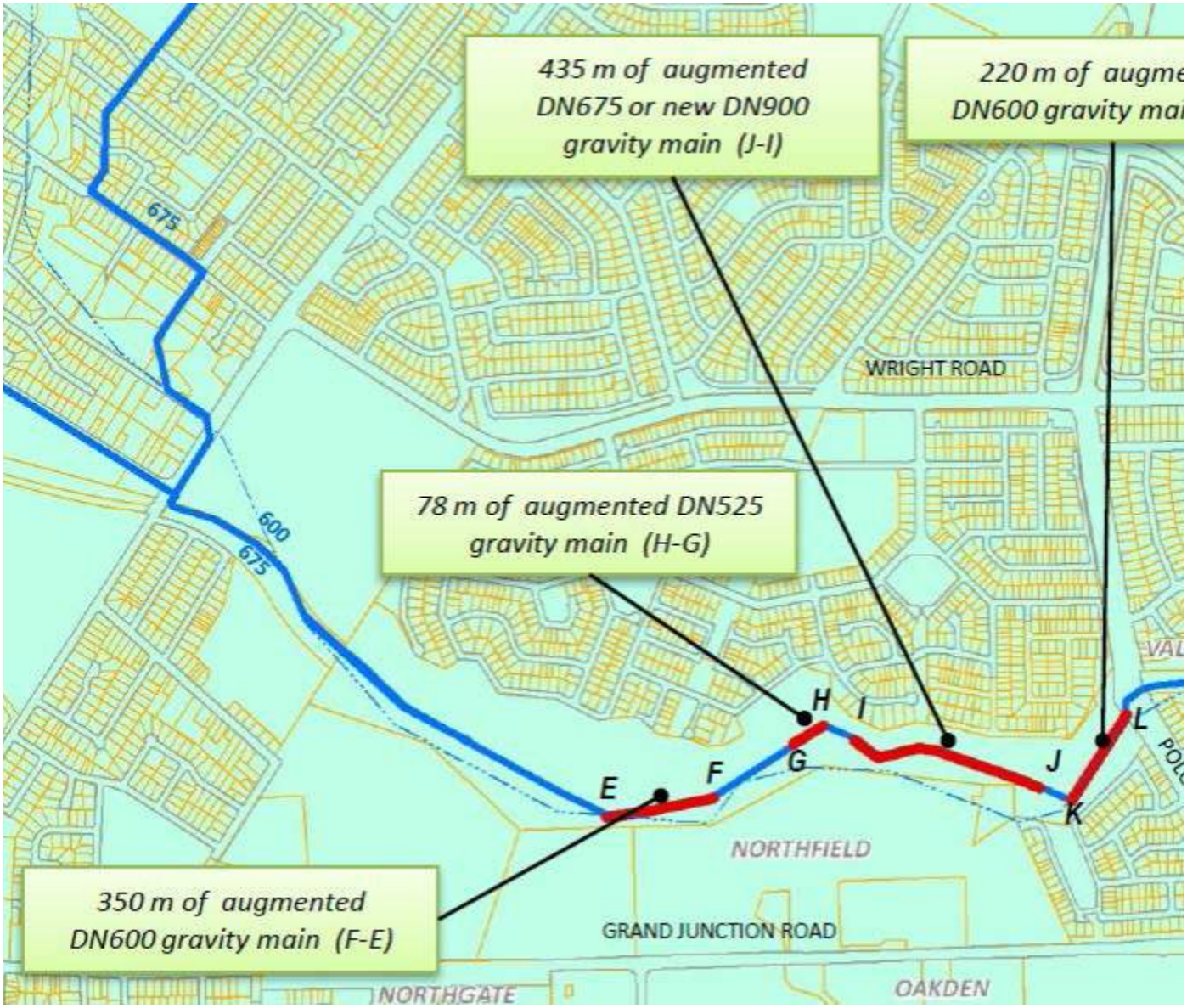

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Sent: Tuesday, 9 April 2019 11:13 AM
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Dev Pokhrel
Civil Engineer | Transport & Resources

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Dev Pokhrel

Subject: FW: [External] RE: Oakden / Gilles Plains - Preliminary stormwater design advice

From: Nathan Wicker <nathan.wicker@cityofpae.sa.gov.au>
Sent: Tuesday, 16 April 2019 4:47 PM
To: Dev Pokhrel <Dev.Pokhrel@arup.com>
Cc: David Kon <David.Kon@arup.com>
Subject: [External] RE: Oakden / Gilles Plains - Preliminary stormwater design advice [Filed 02 May 2019 09:40]

Hi Dev,

Council do not own or operate any recycled water infrastructure.

Water Utilities Australia may have some infrastructure in the Northfield area.

Regards,

Nathan Wicker
Senior Land Development Engineer | City Assets

163 St Vincent Street Port Adelaide SA 5015
PO Box 110 Port Adelaide SA 5015
T: 08 8405 6824
W: www.cityofpae.sa.gov.au

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To send files larger than 20mb (total) which are not related to an existing Development Application, please click here.

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From: Dev Pokhrel [mailto:Dev.Pokhrel@arup.com]
Sent: Tuesday, 9 April 2019 4:45 PM
To: Nathan Wicker
Cc: David Kon
Subject: RE: Oakden / Gilles Plains - Preliminary stormwater design advice

Hi Nathan,
Thanks for the information related to stormwater sent to David. I believe this information is helpful towards preparation of an SMP for the site.
In addition to stormwater plan, we are also preparing an utilities report for the client. In the discourse, I was wondering, if there are any recycled water infrastructures in the vicinity of this site that PAE Council owns and operates?

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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Dev Pokhrel

From: Craig Heidenreich <CHeidenreich@wua.com.au>
Sent: Friday, 13 September 2019 1:17 PM
To: Daniel Osborne
Cc: David Kon; Dev Pokhrel
Subject: [External] RE: Oakden and Gilles Plains - Recycled water network

Hi Daniel,

I have made some comments below, let me know if this is sufficient.

Regards, Craig.

Craig Heidenreich
General Manager | Water Utilities Australia

Water Utilities Australia

Telephone +61 8 7999 8555
Mobile +61 439 399 974
Address Suite 1005, 147 Pirie Street, Adelaide SA 5000
Email cheidenreich@wua.com.au | **Website** waterutilitiesgroup.com.au

---

From: Daniel Osborne <Daniel.Osborne@arup.com>
Sent: Thursday, 12 September 2019 5:33 PM
To: Craig Heidenreich <CHeidenreich@wua.com.au>
Cc: David Kon <David.Kon@arup.com>; Dev Pokhrel <Dev.Pokhrel@arup.com>
Subject: RE: Oakden and Gilles Plains - Recycled water network

Hi Craig,

I am in the process of finalising the technical report which sits behind the Oakden and Gilles Plains structure plan.

You can find the draft online here: https://renewalsa.sa.gov.au/wp-content/uploads/2019/05/DRAFT_Stormwater_Transport_Noise_Utlilities_Assessment_2019.pdf

The draft didn't really address recycled water, other than to note there is no infrastructure in the immediate vicinity. We will include this additional information in the updated report.

However, are you also able to advise on the capacity of the Lightsview pipeline to either:

- Provide irrigation water to new reserves identified in the structure plan

- The Lightsview pipeline has a direct supply to treated stormwater from the City of Salisbury. The current connection has some capacity however there is potential to make a second connect to City of Salisbury and augment the existing scheme to service the Oakden/Gillies Plains area.

- It is likely that on-site storage would be required to balance the peak demands of the Oakden/Gillies Plains area.

- Preliminary discussions with City of Salisbury have indicated a connection in the Walkley Heights area could supply the additional water necessary to supply the scheme.

- No estimates of capital works required for this infrastructure are currently available.

- Provide both irrigation and household connections.

- In addition to the above if the water was to be sued for household connections additional treatment including chlorination and potentially UV disinfection to ensure the water is suitable for household use.

Cheers,

Daniel Osborne
Senior Transport Planner

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m: +61 419 849 655
www.arup.com

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From: Craig Heidenreich [mailto:CHeidenreich@wua.com.au]
Sent: Monday, 15 July 2019 9:02 AM
To: Smith, Stephen (Renewal SA) <Stephen.Smith3@sa.gov.au>
Subject: FW: Oakden and Gilles Plains - Recycled water network

Hi Stephen,

I have just received this data which has been compiled hopefully into a suitable format to assist with the Oakden and Gillies Plains project.

While it is too late for the Structure Plan documents can you pass this on to relevant parties for any further considerations.

Regards, Craig.

Craig Heidenreich
General Manager | Water Utilities Australia

Water Utilities Australia

Telephone +61 8 7999 8555
Mobile +61 439 399 974
Address Suite 1005, 147 Pirie Street, Adelaide SA 5000
Email cheidenreich@wua.com.au | **Website** waterutilitiesgroup.com.au

Dev Pokhrel

From: David Pickard <David.Pickard@sapowernetworks.com.au>
Sent: Wednesday, 1 May 2019 1:35 PM
To: Dev Pokhrel
Subject: [External] FW: Oakden & Gilles Plains Future Development - SAPN services
Attachments: TAFE Blacks Rd.pdf; SAHMRI Grand Junction & Blacks Rd.pdf; Park Tce Oakden.pdf; Acorn Parade, Oakden.pdf; Hilltop & Victoria Drive.pdf; Strathmont Bulk Supply.pdf; HH403B_1.pdf; HH403C_1.pdf; HH428B_1.pdf; HH428E_1.pdf; 200 Fosters Road, Oakden.pdf; TS100 Electrical Design Standard for Underground Distribution Cable Networks (up to and including 33kV).pdf; SA Power Networks Customer Connections..pdf

Afternoon Dev

As this is an extensive development with approximately 2000 homes and a projected load around 10MVA it will require extensive consultation with SA Power Networks 'Network Planning' department to coordinate the possible upgrade of substations and HV infrastructure. Network planning will need a projected timeline of the development and programme containing the order of stages to be developed. I have made them aware of the development, and I will pass on their response as I get it.

It will be critical to get a master plan for the High Voltage works.

I have done a bit of a desktop scope to have a look at the feeders around this area. There are 4 different feeders coming from 2 different substations which can be used around this development.

Northfield Sub Station Feeder HH-403B runs overhead from Northfield Substation, East up Grand Junction Road towards the hills. This feeder supplies the Strathmont Rehabilitation Centre with an 11kV Bulk Supply, and runs past the SAHMRI site. The SAHMRI site has an existing 500kVA padmount transformer on it.

Northfield Sub Station Feeder HH-404C runs overhead South along Fosters Road. This feeder runs into Hilltop Drive and past the Oakden Mental Health Facility. The Oakden Mental Health has an existing 500kVA padmount transformer on it.

Hillcrest Sub Station Feeder HH-428E runs underground through Oakden and across Sudholz Road to the TAFE Site. There are a number of provisions that have been made to extend the HV through Oakden including Park Terrace, Acorn Parade, Hilltop Drive and Victoria Drive. The TAFE site has an existing 750kVA padmount transformer on the Western side.

Hillcrest Sub Station Feeder HH-428E runs underground near the northern end of the TAFE site at the corner of Swanson Avenue and Blacks Rd. This feeder supplies an existing 1MVA padmount transformer on the Eastern side of the TAFE site.

I have attached a couple of feeder diagrams and print outs from our network model for this area to give you a bit more of a picture. Please note that the feeder diagrams are not to scale and are a schematic diagram. I have also attached TS100.

The augmentation rate would be at the published rates of $235/kVA if connected to the Feeder HV, or $361/kVA if connected to the existing LV. The Northfield substation is a 20MVA substation, so at 2MVA the additional zone substation augmentation rate will be applicable. The Hillcrest substation is a 50MVA substation, so at 5MVA the additional zone substation augmentation rate will be applicable. If the load connected to the Hillcrest substation exceeded 14.2MVA, then Sub-transmission line augmentation rate would also be applicable. The additional rated would be triggered by a rolling load connected within a 5 year period.

If you have any more questions, I will be glad to assist. If you would like to meet up, I can catch up with you at some stage to run through the process and explore potential solutions.

Regards,

David Pickard
Network Project Officer

Phone: 08 8404 4550
Mobile: 0447 608 053
David.Pickard@sapowernetworks.com.au
---
12 Senna Road, Wingfield SA 5013
www.sapowernetworks.com.au

SA Power Networks

From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Tuesday, 30 April 2019 11:45 AM
To: David Pickard <David.Pickard@sapowernetworks.com.au>
Subject: RE: Oakden & Gilles Plains Future Development - SAPN services

Hi David,
Attached as requested.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

Arup
Level 7, 182 Victoria Square, Adelaide, SA 5000 Australia
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f +61 8 8212 1601 m +61 403 578 910
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From: David Pickard <David.Pickard@sapowernetworks.com.au>
Sent: Tuesday, 30 April 2019 11:20 AM
To: Dev Pokhrel <Dev.Pokhrel@arup.com>
Subject: [External] Oakden & Gilles Plains Future Development - SAPN services

Morning Dev

I will be your contact for this project.

Unfortunately any attachments that were sent with this email have disappeared along the email trail. Could you please resend everything directly to me.

Regards,

David Pickard
Network Project Officer

Phone: 08 8404 4550
Mobile: 0447 608 053
David.Pickard@sapowernetworks.com.au
---
12 Senna Road, Wingfield SA 5013
www.sapowernetworks.com.au

Dev Pokhrel

From: Scott Matthews <scottmatthews@nbnco.com.au>
Sent: Wednesday, 24 April 2019 9:40 AM
To: Dev Pokhrel
Cc: Jodie Lunn
Subject: [External] RE: Oakden & Gilles Plains Future Development - NBN services inquiry

Hi Dev,

For a development of this size we can investigate via a feasibility study (more than 100 dwellings)

You can lodge all the details, and answer a few questions for us, at the link below:

https://www.nbnco.com.au/new_developments/feasibility_request/terms_and_conditions

Regards,

Scott Matthews
Relationship Manager Enterprise – SA/NT
nbn New Developments | Demand Programs | NPD
M 0407 212 022 | **E** scottmatthews@nbnco.com.au

Remember to **submit all Pre-Construct and As-Built designs for review via the new upload tools*

From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Wednesday, 24 April 2019 9:30 AM
To: Scott Matthews <scottmatthews@nbnco.com.au>
Subject: FW: Oakden & Gilles Plains Future Development - NBN services inquiry

Hi Scott,
Hope you are doing good. It was nice working with you while I was at Fyfe.
I had sent the email below to Jodie on 9th April and, an follow up email this morning only to find she is on Annual Leave and you're the point of contact in her absence.
Could you please look into this and advise in terms of service availability and backhaul etc.? We are approaching the due to submit a report to the client (Holmes Dyer).
If you need any further information, please give me call.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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www.arup.com

From: Dev Pokhrel
Sent: Tuesday, 9 April 2019 10:54 AM
To: 'jodielunn@nbnco.com.au' <jodielunn@nbnco.com.au>
Subject: Oakden & Gilles Plains Future Development - NBN services inquiry

Hello Jodie,
Hope you are doing good.
It was my pleasure to work with you, Scott Matthews and many others from NBN while I was at Fyfe (as Devi). On a personal news, I have now moved on from Fyfe to Arup (now known as Dev – haha!). Still doing similar stuffs plus more than I used to do at Fyfe.

We have been engaged by Holmes Dyer, who are working for Renewal SA, to assist them with a high level services assessment and reporting for parcels of land in Oakden and Gilles , which is intended to have a development plan amended for future residential development. I have attached preliminary site plans depicting type of land use, approximate yield and the location.

In order to provide our client with a report incorporating detailed existing and future services, can NBN provide information regarding future connection opportunities for the proposed future development based on existing infrastructure capacity and or any upgrade works. We are also attempting to identify if any backhaul charges are applicable, if existing surrounding network need an upgrade or augmented – it would be great if you provide this information or any other information deemed relevant for this site.

Should you require further information or wish to discuss further, please do not hesitate to contact me. Thanks heaps in advance.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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www.arup.com

Dev Pokhrel

From: Holden, David <david.holden@apa.com.au>
Sent: Thursday, 11 April 2019 1:31 PM
To: Dev Pokhrel
Cc: Kramer, Zofia
Subject: [External] FW: Oakden & Gilles Plains Future Development - APA Gas services
Attachments: Dwelling Yield & Density.pdf; Opportunities and Constraints Plan.pdf; Preliminary Structure Plan - Study Area.pdf; Smallworld windcplot.pdf

Hi Dev

Thank you for the enquiry below. There are existing medium pressure gas mains surrounding the proposed development sites which have capacity to support the expected gas demand.

Indicatively gas mains could be installed throughout this development in trenching provide by others at no-charged. This would be subject to a formal request including; number of dwellings, commencement date, build rate, length of internal roads and approval by Australian Gas Networks.

Please keep me informed in any progress with this site and contact me if I can be of any assistance.

Regards

David Holden
Gas Development Representative

APA Group
Networks Commercial

d +61 08 8159 1918
m +61 0408 456 684
e david.holden@apa.com.au
w www.apa.com.au

From: Dev Pokhrel <Dev.Pokhrel@arup.com>
Sent: Tuesday, 9 April 2019 11:32 AM
To: Holden, David <david.holden@apa.com.au>
Cc: Kramer, Zofia <Zofia.Kramer@apa.com.au>
Subject: [EXT]: Oakden & Gilles Plains Future Development - APA Gas services

Hi David/Zofia,
Hope you are doing good. I am hoping one of you could assist on the below query.

We have been engaged by Holmes Dyer, who are working for Renewal SA, to assist them with a high level services assessment and reporting for parcels of land in Oakden and Gilles, which is intended to have a development plan amended for future residential development. I have attached preliminary site plans depicting type of land use, approximate yield and the location.

In order to provide our client with a report incorporating detailed existing and future services, can APA provide information regarding future connection opportunities for the proposed future development based on existing infrastructure capacity and or any upgrade works. We are also attempting to identify if any augmentation charges are applicable, if existing surrounding network need an upgrade or augmented – it would be great if you provide this information or any other information deemed relevant for this site.

Should you require further information or wish to discuss further, please do not hesitate to contact me. Thanks heaps in advance.

Kind regards

Dev Pokhrel
Civil Engineer | Transport & Resources

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Appendix B: Sidra modelling results

LANE SUMMARY

Site: TG838400 [AM Fosters Rd / Folland Ave / Sir]

Base Case Flows 2016

By Andrew Olsen
Roundabout

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1[d]	578	5.1	860	0.672	100	10.8	LOS B	6.9	50.7	Full	500	0.0	0.0
Approach	578	5.1		0.672		10.8	LOS B	6.9	50.7				
East: RoadName													
Lane 1[d]	437	1.9	437	1.000	100	84.3	LOS F	28.2	200.5	Full	500	0.0	0.0
Approach	437	1.9		1.000		84.3	LOS F	28.2	200.5				
North: RoadName													
Lane 1[d]	696	4.5	808	0.861	100	22.2	LOS C	18.0	130.6	Full	500	0.0	0.0
Approach	696	4.5		0.861		22.2	LOS C	18.0	130.6				
West: RoadName													
Lane 1[d]	409	2.6	716	0.572	100	12.7	LOS B	5.4	38.7	Full	500	0.0	0.0
Approach	409	2.6		0.572		12.7	LOS B	5.4	38.7				
Intersection	2120	3.8		1.000		30.1	LOS C	28.2	200.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: TG838400 [PM Fosters Rd / Folland Ave / Sir]

Base Case Flows 2016

By Andrew Olsen
Roundabout

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1[d]	775	1.4	1060	0.731	100	9.6	LOS A	8.7	61.7	Full	500	0.0	0.0
Approach	775	1.4		0.731		9.6	LOS A	8.7	61.7				
East: RoadName													
Lane 1[d]	273	2.7	677	0.403	100	10.1	LOS B	2.8	20.4	Full	500	0.0	0.0
Approach	273	2.7		0.403		10.1	LOS B	2.8	20.4				
North: RoadName													
Lane 1[d]	469	2.2	717	0.654	100	14.7	LOS B	7.5	53.2	Full	500	0.0	0.0
Approach	469	2.2		0.654		14.7	LOS B	7.5	53.2				
West: RoadName													
Lane 1[d]	398	1.3	559	0.712	100	21.3	LOS C	8.4	59.4	Full	500	0.0	0.0
Approach	398	1.3		0.712		21.3	LOS C	8.4	59.4				
Intersection	1915	1.8		0.731		13.3	LOS B	8.7	61.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: TG838400 [AM Fosters Rd / Folland Ave / Sir - Post Development]

Post Development Flows

By Andrew Olsen
Roundabout

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1[d]	672	4.4	966	0.696	100	10.0	LOS B	7.6	54.9	Full	500	0.0	0.0
Approach	672	4.4		0.696		10.0	LOS B	7.6	54.9				
East: RoadName													
Lane 1[d]	611	1.4	373	1.637	100	601.4	LOS F	166.1	1176.7	Full	500	0.0	44.3
Approach	611	1.4		1.637		601.4	LOS F	166.1	1176.7				
North: RoadName													
Lane 1[d]	1025	3.1	794	1.291	100	282.1	LOS F	169.2	1215.5	Full	500	0.0	47.5
Approach	1025	3.1		1.291		282.1	LOS F	169.2	1215.5				
West: RoadName													
Lane 1[d]	429	2.5	658	0.653	100	15.9	LOS B	7.1	50.7	Full	500	0.0	0.0
Approach	429	2.5		0.653		15.9	LOS B	7.1	50.7				
Intersection	2737	2.9		1.637		244.8	LOS F	169.2	1215.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: TG838400 [PM Fosters Rd / Folland Ave / Sir - Post Development]

Post Development Flows

By Andrew Olsen
Roundabout

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1[d]	1225	0.9	1085	1.129	100	133.3	LOS F	116.5	821.3	Full	500	0.0	22.4
Approach	1225	0.9		1.129		133.3	LOS F	116.5	821.3				
East: RoadName													
Lane 1[d]	316	2.3	638	0.495	100	11.7	LOS B	4.1	29.4	Full	500	0.0	0.0
Approach	316	2.3		0.495		11.7	LOS B	4.1	29.4				
North: RoadName													
Lane 1[d]	543	1.9	709	0.766	100	19.4	LOS B	11.2	79.7	Full	500	0.0	0.0
Approach	543	1.9		0.766		19.4	LOS B	11.2	79.7				
West: RoadName													
Lane 1[d]	478	1.1	309	1.546	100	527.3	LOS F	122.1	862.8	Full	500	0.0	24.6
Approach	478	1.1		1.546		527.3	LOS F	122.1	862.8				
Intersection	2562	1.3		1.546		167.7	LOS F	122.1	862.8				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: TG838400 [AM Fosters Rd / Folland Ave / Sir - Mitigation]

Post Development Flows

By Andrew Olsen
Roundabout

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1	155	3.4	563	0.275	47[5]	8.8	LOS A	1.2	9.0	Short	50	0.0	NA
Lane 2[d]	517	4.7	878	0.589	100	9.5	LOS A	4.7	33.9	Full	500	0.0	0.0
Approach	672	4.4		0.589		9.4	LOS A	4.7	33.9				
East: RoadName													
Lane 1[d]	312	1.0	430	0.724	96[5]	22.5	LOS C	6.6	46.5	Short	50	0.0	NA
Lane 2	299	1.8	395	0.757	100	26.0	LOS C	7.0	49.4	Full	500	0.0	0.0
Approach	611	1.4		0.757		24.3	LOS C	7.0	49.4				
North: RoadName													
Lane 1	157	3.0	444	0.352	35[6]	11.3	LOS B	2.0	14.0	Short	50	0.0	NA
Lane 2[d]	869	3.1	860	1.010	100	55.5	LOS E	44.7	321.1	Full	500	0.0	0.0
Approach	1025	3.1		1.010		48.7	LOS D	44.7	321.1				
West: RoadName													
Lane 1	115	1.8	488	0.235	54[5]	10.4	LOS B	1.3	8.9	Short	50	0.0	NA
Lane 2[d]	315	2.7	718	0.439	100	10.9	LOS B	3.1	22.2	Full	500	0.0	0.0
Approach	429	2.5		0.439		10.8	LOS B	3.1	22.2				
Intersection	2737	2.9		1.010		27.7	LOS C	44.7	321.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

5 Lane under-utilisation found by the program
6 Lane under-utilisation due to downstream effects
d Dominant lane on roundabout approach

LANE SUMMARY

Site: TG838400 [PM Fosters Rd / Folland Ave / Sir - Mitigation]

Post Development Flows

By Andrew Olsen
Roundabout

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1	199	1.4	627	0.317	35[6]	7.5	LOS A	1.4	10.0	Short	50	0.0	NA
Lane 2[d]	1027	0.7	1144	0.897	100	13.3	LOS B	17.2	121.0	Full	500	0.0	0.0
Approach	1225	0.9		0.897		12.4	LOS B	17.2	121.0				
East: RoadName													
Lane 1	123	2.6	623	0.198	74[5]	8.7	LOS A	1.0	7.5	Short	50	0.0	NA
Lane 2[d]	193	2.2	719	0.268	100	9.1	LOS A	1.5	11.0	Full	500	0.0	0.0
Approach	316	2.3		0.268		8.9	LOS A	1.5	11.0				
North: RoadName													
Lane 1	83	1.7	350	0.238	35[6]	14.0	LOS B	1.2	8.6	Short	50	0.0	NA
Lane 2[d]	460	2.0	673	0.683	100	16.7	LOS B	7.5	53.6	Full	500	0.0	0.0
Approach	543	1.9		0.683		16.3	LOS B	7.5	53.6				
West: RoadName													
Lane 1	155	0.0	308	0.502	64[5]	20.0	LOS B	3.3	23.0	Short	50	0.0	NA
Lane 2[d]	323	1.6	412	0.784	100	30.7	LOS C	8.4	59.9	Full	500	0.0	0.0
Approach	478	1.1		0.784		27.2	LOS C	8.4	59.9				
Intersection	2562	1.3		0.897		15.6	LOS B	17.2	121.0				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

5 Lane under-utilisation found by the program
6 Lane under-utilisation due to downstream effects
d Dominant lane on roundabout approach

LANE SUMMARY

Site: TS017 [AM - Fosters Rd / Grand Junction Rd]

Base Case Existing Intersection AM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Rd													
Lane 1	339	6.5	386	0.879	100	67.9	LOS E	19.9	146.7	Full	500	0.0	0.0
Lane 2	272	2.0	310	0.879	100	68.1	LOS E	17.9	127.6	Short	90	0.0	NA
Approach	612	4.5		0.879		68.0	LOS E	19.9	146.7				
East: Grand Junction Rd													
Lane 1	815	3.2	875	0.932	100	54.3	LOS D	55.7	400.6	Full	500	0.0	0.0
Lane 2	917	5.0	984	0.932	100	46.9	LOS D	62.4	455.5	Full	500	0.0	0.0
Approach	1732	4.2		0.932		50.4	LOS D	62.4	455.5				
West: Grand Junction Rd													
Lane 1	350	12.0	1383	0.253	100	5.8	LOS A	6.7	52.0	Full	500	0.0	0.0
Lane 2	372	12.0	1467	0.253	100	5.8	LOS A	7.1	55.1	Full	500	0.0	0.0
Lane 3	179	12.0	191	0.935	100	85.5	LOS F	13.1	101.3	Short	50	0.0	NA
Approach	901	12.0		0.935		21.7	LOS C	13.1	101.3				
Intersection	3244	6.4		0.935		45.7	LOS D	62.4	455.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: TS017 [PM - Fosters Rd / Grand Junction Rd]

Base Case Existing Intersection PM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Rd													
Lane 1	291	2.0	432	0.673	100	37.6	LOS D	11.6	82.3	Full	500	0.0	0.0
Lane 2	248	2.0	369	0.673	100	52.6	LOS D	13.6	97.1	Short	90	0.0	NA
Approach	539	2.0		0.673		44.5	LOS D	13.6	97.1				
East: Grand Junction Rd													
Lane 1	460	4.3	655	0.702	100	30.2	LOS C	20.6	149.4	Full	500	0.0	0.0
Lane 2	539	6.0	767	0.702	100	30.3	LOS C	25.7	189.1	Full	500	0.0	0.0
Approach	999	5.2		0.702		30.2	LOS C	25.7	189.1				
West: Grand Junction Rd													
Lane 1	731	4.0	1387	0.527	100	9.5	LOS A	20.3	147.0	Full	500	0.0	0.0
Lane 2	578	4.0	1096[1]	0.527	100	8.2	LOS A	14.0	101.2	Full	500	0.0	0.0
Lane 3	176	2.0	256	0.687	100	36.3	LOS D	6.6	47.3	Short	50	0.0	NA
Approach	1484	3.8		0.687		12.2	LOS B	20.3	147.0				
Intersection	3022	3.9		0.702		23.9	LOS C	25.7	189.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS017 [AM - Fosters Rd / Grand Junction Rd - Post Development]

Existing Intersection AM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Rd													
Lane 1	422	6.9	422	1.000	100	67.0	LOS E	31.4	232.4	Full	500	0.0	0.0
Lane 2	310	2.0	310	1.000	100	105.2	LOS F	26.3	187.3	Short	90	0.0	NA
Approach	732	4.8		1.000		83.2	LOS F	31.4	232.4				
East: Grand Junction Rd													
Lane 1	930	3.2	881	1.056	100	104.0	LOS F	79.7	573.5	Full	500	0.0	17.4
Lane 2	1039	5.0	984	1.056	100	118.2	LOS F	108.1	788.9	Full	500	0.0	46.8
Approach	1969	4.2		1.056		111.5	LOS F	108.1	788.9				
West: Grand Junction Rd													
Lane 1	370	12.0	1383	0.268	100	5.9	LOS A	7.2	55.7	Full	500	0.0	0.0
Lane 2	393	12.0	1467	0.268	100	5.9	LOS A	7.6	59.0	Full	500	0.0	0.0
Lane 3	201	12.0	191	1.051	100	139.8	LOS F	19.7	151.8	Short	50	0.0	NA
Approach	964	12.0		1.051		33.8	LOS C	19.7	151.8				
Intersection	3665	6.4		1.056		85.4	LOS F	108.1	788.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: TS017 [PM - Fosters Rd / Grand Junction Rd - Post Development]

Existing Intersection PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Rd													
Lane 1	338	2.0	421	0.802	100	50.2	LOS D	16.8	119.9	Full	500	0.0	0.0
Lane 2	296	2.0	369	0.802	100	58.2	LOS E	17.7	126.3	Short	90	0.0	NA
Approach	634	2.0		0.802		53.9	LOS D	17.7	126.3				
East: Grand Junction Rd													
Lane 1	496	4.2	596	0.832	100	42.9	LOS D	27.4	198.7	Full	500	0.0	0.0
Lane 2	576	6.0	692	0.832	100	40.6	LOS D	32.7	240.9	Full	500	0.0	0.0
Approach	1072	5.2		0.832		41.6	LOS D	32.7	240.9				
West: Grand Junction Rd													
Lane 1	856	4.0	1387	0.617	100	10.5	LOS B	26.4	191.1	Full	500	0.0	0.0
Lane 2	618	4.0	1001[1]	0.617	100	8.4	LOS A	15.3	111.1	Full	500	0.0	0.0
Lane 3	264	2.0	320	0.826	100	42.2	LOS D	10.8	77.2	Short	50	0.0	NA
Approach	1738	3.7		0.826		14.6	LOS B	26.4	191.1				
Intersection	3443	3.8		0.832		30.3	LOS C	32.7	240.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS017 [AM - Fosters Rd / Grand Junction Rd - Mitigation]

Intersection with Mitigation AM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Rd													
Lane 1	416	6.9	467	0.891	100	64.8	LOS E	24.7	183.0	Full	500	0.0	0.0
Lane 2	315	2.0	354	0.891	100	68.1	LOS E	21.1	150.0	Short	90	0.0	NA
Approach	732	4.8		0.891		66.2	LOS E	24.7	183.0				
East: Grand Junction Rd													
Lane 1	548	2.0	1159	0.473	100	10.7	LOS B	7.8	55.6	Short	100	0.0	NA
Lane 2	593	5.0	629[1]	0.943	100	57.2	LOS E	38.9	283.9	Full	500	0.0	0.0
Lane 3	828	5.0	878	0.943	100	55.8	LOS E	59.7	435.9	Full	500	0.0	0.0
Approach	1969	4.2		0.943		43.7	LOS D	59.7	435.9				
West: Grand Junction Rd													
Lane 1	370	12.0	1336	0.277	100	7.0	LOS A	7.9	60.8	Full	500	0.0	0.0
Lane 2	393	12.0	1417	0.277	100	7.0	LOS A	8.3	64.4	Full	500	0.0	0.0
Lane 3	201	12.0	213[1]	0.943	100	86.7	LOS F	15.0	115.5	Short	50	0.0	NA
Approach	964	12.0		0.943		23.6	LOS C	15.0	115.5				
Intersection	3665	6.4		0.943		42.9	LOS D	59.7	435.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS017 [PM - Fosters Rd / Grand Junction Rd - Mitigation]

Intersection with Mitigation PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Rd													
Lane 1	333	2.0	475	0.702	100	38.1	LOS D	14.0	99.8	Full	500	0.0	0.0
Lane 2	300	2.0	428	0.702	100	50.2	LOS D	16.4	116.4	Short	90	0.0	NA
Approach	634	2.0		0.702		43.9	LOS D	16.4	116.4				
East: Grand Junction Rd													
Lane 1	226	2.0	1107	0.204	100	10.1	LOS B	3.2	23.0	Short	100	0.0	NA
Lane 2	423	6.0	587	0.721	100	38.5	LOS D	21.9	160.8	Full	500	0.0	0.0
Lane 3	423	6.0	587	0.721	100	38.5	LOS D	21.9	160.8	Full	500	0.0	0.0
Approach	1072	5.2		0.721		32.5	LOS C	21.9	160.8				
West: Grand Junction Rd													
Lane 1	854	4.0	1320	0.647	100	12.9	LOS B	29.2	211.4	Full	500	0.0	0.0
Lane 2	619	4.0	957[1]	0.647	100	10.4	LOS B	17.1	123.7	Full	500	0.0	0.0
Lane 3	264	2.0	358	0.737	100	32.7	LOS C	8.8	62.4	Short	50	0.0	NA
Approach	1738	3.7		0.737		15.0	LOS B	29.2	211.4				
Intersection	3443	3.8		0.737		25.8	LOS C	29.2	211.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS205 [AM Sir Ross Smith Blvd / Sudholz Rd]

Base Case Existing Intersection AM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Rd													
Lane 1	320	1.0	1225	0.261	100	7.6	LOS A	2.9	20.5	Short	90	0.0	NA
Lane 2	584	4.0	662[1]	0.882	100	41.5	LOS D	33.2	240.1	Full	500	0.0	0.0
Lane 3	731	4.0	829	0.882	100	41.9	LOS D	44.3	320.7	Full	500	0.0	0.0
Approach	1635	3.4		0.882		35.1	LOS D	44.3	320.7				
North: Sudholz Rd													
Lane 1	468	9.0	1121	0.417	100	12.5	LOS B	13.9	104.7	Full	500	0.0	0.0
Lane 2	489	9.0	1172	0.417	100	12.5	LOS B	14.5	109.3	Full	500	0.0	0.0
Lane 3	141	1.0	248	0.569	100	30.5	LOS C	4.4	31.2	Short	70	0.0	NA
Approach	1098	8.0		0.569		14.9	LOS B	14.5	109.3				
West: Sir Ross Smith Blvd													
Lane 1	128	2.0	773	0.166	100	17.7	LOS B	3.8	27.0	Short	40	0.0	NA
Lane 2	269	1.0	319[1]	0.845	100	56.2	LOS E	16.1	113.7	Full	500	0.0	0.0
Approach	398	1.3		0.845		43.8	LOS D	16.1	113.7				
Intersection	3131	4.7		0.882		29.1	LOS C	44.3	320.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS205 [PM Sir Ross Smith Blvd / Sudholz Rd]

Base Case Existing Intersection PM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Rd													
Lane 1	298	1.0	1161	0.257	100	8.2	LOS A	3.0	21.4	Short	90	0.0	NA
Lane 2	503	3.0	759[1]	0.663	100	28.9	LOS C	22.9	164.5	Full	500	0.0	0.0
Lane 3	532	3.0	802	0.663	100	29.5	LOS C	24.7	177.5	Full	500	0.0	0.0
Approach	1333	2.6		0.663		24.5	LOS C	24.7	177.5				
North: Sudholz Rd													
Lane 1	671	2.0	1140	0.589	100	15.7	LOS B	23.9	170.1	Full	500	0.0	0.0
Lane 2	452	2.0	768[1]	0.589	100	13.1	LOS B	13.4	95.7	Full	500	0.0	0.0
Lane 3	174	0.0	304	0.571	100	25.2	LOS C	4.9	34.5	Short	70	0.0	NA
Approach	1297	1.7		0.589		16.1	LOS B	23.9	170.1				
West: Sir Ross Smith Blvd													
Lane 1	112	2.0	864	0.129	100	10.7	LOS B	2.2	15.8	Short	40	0.0	NA
Lane 2	241	2.0	361[1]	0.667	100	42.9	LOS D	12.0	85.1	Full	500	0.0	0.0
Approach	353	2.0		0.667		32.7	LOS C	12.0	85.1				
Intersection	2982	2.1		0.667		21.8	LOS C	24.7	177.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS205 [AM Sir Ross Smith Blvd / Sudholz Rd - Post Development]

New Intersection AM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Rd													
Lane 1	320	1.0	1417	0.226	100	7.1	LOS A	2.9	20.7	Short	90	0.0	NA
Lane 2	622	4.0	660[1]	0.942	100	59.5	LOS E	42.7	309.2	Full	500	0.0	0.0
Lane 3	730	4.0	775[1]	0.942	100	59.3	LOS E	52.2	378.1	Full	500	0.0	0.0
Lane 4	25	0.0	155	0.163	100	62.5	LOS E	1.4	10.0	Short	70	0.0	NA
Approach	1697	3.4		0.942		49.6	LOS D	52.2	378.1				
East: Sir Ross Smith Blvd													
Lane 1	35	0.0	665	0.052	100	20.2	LOS C	1.0	6.8	Short	40	0.0	NA
Lane 2	14	0.0	260	0.053	100	49.1	LOS D	0.7	4.9	Full	500	0.0	0.0
Lane 3	22	0.0	310	0.071	100	51.1	LOS D	1.1	7.7	Short	40	0.0	NA
Approach	71	0.0		0.071		35.5	LOS D	1.1	7.7				
North: Sudholz Rd													
Lane 1	6	0.0	1531	0.004	100	6.0	LOS A	0.0	0.1	Short	90	0.0	NA
Lane 2	576	9.0	765[1]	0.752	100	31.8	LOS C	28.4	214.4	Full	500	0.0	0.0
Lane 3	495	9.0	658[1]	0.752	100	30.2	LOS C	23.1	174.5	Full	500	0.0	0.0
Lane 4	143	1.0	154	0.932	100	82.8	LOS F	10.1	71.2	Short	70	0.0	NA
Approach	1220	8.0		0.932		37.0	LOS D	28.4	214.4				
West: Sir Ross Smith Blvd													
Lane 1	136	2.0	697	0.195	100	17.5	LOS B	3.8	27.0	Short	40	0.0	NA
Lane 2	4	0.0	260	0.016	100	48.5	LOS D	0.2	1.5	Short	40	0.0	NA
Lane 3	288	1.0	306[1]	0.944	100	81.2	LOS F	21.1	148.9	Full	500	0.0	0.0
Approach	428	1.3		0.944		60.7	LOS E	21.1	148.9				
Intersection	3416	4.7		0.944		46.2	LOS D	52.2	378.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS205 [PM Sir Ross Smith Blvd / Sudholz Rd - Post Development - Copy]

New Intersection PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Rd													
Lane 1	319	1.0	1384	0.230	100	7.4	LOS A	3.3	23.3	Short	90	0.0	NA
Lane 2	571	4.0	633[1]	0.901	100	49.4	LOS D	35.5	256.7	Full	500	0.0	0.0
Lane 3	610	4.0	677[1]	0.901	100	49.5	LOS D	38.5	278.8	Full	500	0.0	0.0
Lane 4	103	0.0	217	0.476	100	60.7	LOS E	5.8	40.8	Short	70	0.0	NA
Approach	1603	3.1		0.901		41.8	LOS D	38.5	278.8				
East: Sir Ross Smith Blvd													
Lane 1	8	0.0	686	0.012	100	20.8	LOS C	0.2	1.7	Short	40	0.0	NA
Lane 2	3	0.0	260	0.012	100	48.4	LOS D	0.2	1.1	Full	500	0.0	0.0
Lane 3	5	0.0	294	0.018	100	51.2	LOS D	0.3	1.8	Short	40	0.0	NA
Approach	17	0.0		0.018		35.5	LOS D	0.3	1.8				
North: Sudholz Rd													
Lane 1	27	0.0	1453	0.019	100	6.5	LOS A	0.2	1.2	Short	90	0.0	NA
Lane 2	620	9.0	710[1]	0.873	100	44.9	LOS D	37.7	284.1	Full	500	0.0	0.0
Lane 3	532	9.0	609[1]	0.873	100	44.4	LOS D	31.1	234.2	Full	500	0.0	0.0
Lane 4	182	1.0	215	0.846	100	70.0	LOS E	11.7	82.4	Short	70	0.0	NA
Approach	1361	7.7		0.873		47.3	LOS D	37.7	284.1				
West: Sir Ross Smith Blvd													
Lane 1	114	2.0	796	0.143	100	12.6	LOS B	2.5	17.5	Short	40	0.0	NA
Lane 2	17	0.0	260	0.065	100	49.3	LOS D	0.9	6.1	Short	40	0.0	NA
Lane 3	246	1.0	286[1]	0.860	100	66.8	LOS E	15.8	111.6	Full	500	0.0	0.0
Approach	377	1.3		0.860		49.7	LOS D	15.8	111.6				
Intersection	3358	4.8		0.901		44.9	LOS D	38.5	284.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS206 [AM North East Rd / Sudholz Rd]

Base Case Existing Intersection Am 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
SouthEast: Sudholz Rd													
Lane 1	298	2.0	398[1]	0.750	100	50.5	LOS D	16.7	118.9	Short	64	0.0	NA
Lane 2	284	2.0	379	0.750	100	51.0	LOS D	16.0	114.2	Short	70	0.0	NA
Lane 3	373	5.0	366[1]	1.020	100	113.2	LOS F	35.2	257.1	Full	500	0.0	0.0
Lane 4	522	5.0	512	1.020	100	107.0	LOS F	47.8	349.2	Full	500	0.0	0.0
Lane 5	539	5.0	528	1.020	100	106.4	LOS F	49.2	359.2	Full	500	0.0	0.0
Lane 6	225	4.0	246	0.915	100	77.3	LOS E	15.6	113.2	Full	500	0.0	0.0
Lane 7	207	4.0	226	0.915	100	78.3	LOS E	14.5	104.9	Short	90	0.0	NA
Approach	2447	4.1		1.020		89.3	LOS F	49.2	359.2				
NorthEast: North East Rd													
Lane 1	531	4.0	1154	0.460	100	17.6	LOS B	12.0	86.5	Short	63	0.0	NA
Lane 2	521	1.0	524[1]	0.995	100	90.4	LOS F	43.9	310.3	Full	500	0.0	0.0
Lane 3	754	1.0	757	0.995	100	85.8	LOS F	64.5	455.3	Full	500	0.0	0.0
Lane 4	774	1.0	778	0.995	100	85.2	LOS F	66.0	466.1	Full	500	0.0	0.0
Approach	2580	1.6		0.995		72.5	LOS E	66.0	466.1				
NorthWest: Sudholz Rd													
Lane 1	24	5.0	608	0.040	100	18.3	LOS B	0.6	4.7	Short	20	0.0	NA
Lane 2	398	7.0	399[1]	0.998	100	98.2	LOS F	34.5	255.8	Short	93	0.0	NA
Lane 3	443	7.0	444[1]	0.998	100	95.0	LOS F	37.3	276.9	Full	500	0.0	0.0
Lane 4	522	7.0	523[1]	0.998	100	93.8	LOS F	44.4	329.7	Full	500	0.0	0.0
Lane 5	211	6.0	217	0.973	100	96.0	LOS F	16.7	122.8	Short	120	0.0	NA
Lane 6	187	6.0	193	0.973	100	97.8	LOS F	15.0	110.5	Short	120	0.0	NA
Approach	1785	6.8		0.998		94.8	LOS F	44.4	329.7				
SouthWest: North East Rd													
Lane 1	205	7.0	984	0.209	100	13.7	LOS B	4.6	33.8	Short	20	0.0	NA
Lane 2	101	2.0	647	0.156	22[6]	25.2	LOS C	3.8	27.0	Full	500	0.0	0.0
Lane 3	570	2.0	786	0.724	100	33.1	LOS C	28.1	200.3	Full	500	0.0	0.0
Lane 4	534	2.0	737	0.724	100	33.2	LOS C	26.4	188.0	Full	500	0.0	0.0
Approach	1409	2.7		0.724		29.8	LOS C	28.1	200.3				
Intersection	8222	3.7		1.020		75.0	LOS E	66.0	466.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

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LANE SUMMARY

Site: TS206 [PM North East Rd / Sudholz Rd]

Base Case Existing Intersection PM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
SouthEast: Sudholz Rd													
Lane 1	166	2.0	343	0.483	100	48.4	LOS D	8.5	60.5	Short	64	0.0	NA
Lane 2	156	2.0	323	0.483	100	48.5	LOS D	8.0	57.0	Short	70	0.0	NA
Lane 3	298	2.0	377	0.792	100	50.8	LOS D	17.7	125.9	Full	500	0.0	0.0
Lane 4	352	2.0	445	0.792	100	49.7	LOS D	20.5	146.2	Full	500	0.0	0.0
Lane 5	364	2.0	459	0.792	100	49.5	LOS D	21.1	150.4	Full	500	0.0	0.0
Lane 6	285	2.0	235	1.215	100	264.0	LOS F	40.3	287.2	Full	500	0.0	0.0
Lane 7	262	2.0	216	1.215	100	264.8	LOS F	37.2	264.6	Short	90	0.0	NA
Approach	1884	2.0		1.215		112.0	LOS F	40.3	287.2				
NorthEast: North East Rd													
Lane 1	448	2.0	1249	0.359	100	13.8	LOS B	8.9	63.1	Short	63	0.0	NA
Lane 2	350	0.5	704	0.497	100	25.7	LOS C	14.6	102.6	Full	500	0.0	0.0
Lane 3	426	0.5	857	0.497	100	25.5	LOS C	17.6	124.0	Full	500	0.0	0.0
Lane 4	438	0.5	880	0.497	100	25.5	LOS C	18.1	127.3	Full	500	0.0	0.0
Approach	1662	0.9		0.497		22.4	LOS C	18.1	127.3				
NorthWest: Sudholz Rd													
Lane 1	43	0.0	509	0.085	100	33.5	LOS C	1.7	12.0	Short	20	0.0	NA
Lane 2	420	2.0	355[1]	1.185	100	234.0	LOS F	57.5	409.1	Short	93	0.0	NA
Lane 3	502	2.0	423[1]	1.185	100	231.8	LOS F	68.0	484.3	Full	500	0.0	2.1
Lane 4	565	2.0	477	1.185	100	230.5	LOS F	76.4	543.7	Full	500	0.0	12.6
Lane 5	162	0.4	212	0.762	100	64.7	LOS E	9.9	69.3	Short	120	0.0	NA
Lane 6	144	0.4	188	0.762	100	65.4	LOS E	8.9	62.2	Short	120	0.0	NA
Approach	1836	1.7		1.185		199.5	LOS F	76.4	543.7				
SouthWest: North East Rd													
Lane 1	166	3.0	1096	0.152	100	10.3	LOS B	2.8	20.3	Short	20	0.0	NA
Lane 2	182	0.5	737	0.247	22[6]	22.4	LOS C	6.6	46.5	Full	500	0.0	0.0
Lane 3	1027	0.5	895	1.147	100	192.4	LOS F	131.2	922.1	Full	500	0.0	61.6
Lane 4	962	0.5	839	1.147	100	193.5	LOS F	123.4	867.7	Full	500	0.0	55.8
Approach	2338	0.7		1.147		166.6	LOS F	131.2	922.1				
Intersection	7720	1.3		1.215		130.1	LOS F	131.2	922.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

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LANE SUMMARY

Site: TS206 [AM North East Rd / Sudholz Rd - Post Development]

Existing Intersection Am Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
SouthEast: Sudholz Rd													
Lane 1	300	2.0	438	0.685	100	45.2	LOS D	15.6	111.0	Short	64	0.0	NA
Lane 2	282	2.0	412	0.685	100	45.5	LOS D	14.8	105.1	Short	70	0.0	NA
Lane 3	385	5.0	391[1]	0.984	100	89.5	LOS F	31.5	230.3	Full	500	0.0	0.0
Lane 4	548	5.0	557	0.984	100	85.8	LOS F	45.4	331.2	Full	500	0.0	0.0
Lane 5	565	5.0	575	0.984	100	85.1	LOS F	46.6	340.4	Full	500	0.0	0.0
Lane 6	225	4.0	260	0.864	100	69.4	LOS E	14.6	105.9	Full	500	0.0	0.0
Lane 7	207	4.0	239	0.864	100	70.2	LOS E	13.5	98.1	Short	90	0.0	NA
Approach	2512	4.1		0.984		74.1	LOS E	46.6	340.4				
NorthEast: North East Rd													
Lane 1	531	4.0	1112	0.477	100	19.3	LOS B	12.9	93.1	Short	63	0.0	NA
Lane 2	506	1.0	461[1]	1.099	100	164.6	LOS F	59.1	417.2	Full	500	0.0	0.0
Lane 3	761	1.0	693	1.099	100	157.5	LOS F	86.4	610.0	Full	500	0.0	23.1
Lane 4	782	1.0	712	1.099	100	157.0	LOS F	88.6	625.6	Full	500	0.0	25.4
Approach	2580	1.6		1.099		130.3	LOS F	88.6	625.6				
NorthWest: Sudholz Rd													
Lane 1	27	5.0	646	0.042	100	18.8	LOS B	0.7	5.4	Short	20	0.0	NA
Lane 2	479	7.0	427[1]	1.121	100	182.0	LOS F	58.1	431.4	Short	93	0.0	NA
Lane 3	521	7.0	465[1]	1.121	100	180.4	LOS F	62.8	466.1	Full	500	0.0	0.0
Lane 4	621	7.0	554[1]	1.121	100	177.8	LOS F	74.2	550.5	Full	500	0.0	13.7
Lane 5	256	6.0	229	1.118	100	186.6	LOS F	29.8	219.5	Short	120	0.0	NA
Lane 6	228	6.0	204	1.118	100	188.1	LOS F	26.7	196.5	Short	120	0.0	NA
Approach	2133	6.7		1.121		179.5	LOS F	74.2	550.5				
SouthWest: North East Rd													
Lane 1	226	7.0	946	0.239	100	15.4	LOS B	5.4	40.1	Full	20	0.0	69.7
Lane 2	101	2.0	592	0.171	22[6]	28.1	LOS C	4.0	28.5	Full	500	0.0	0.0
Lane 3	570	2.0	719	0.792	100	38.5	LOS D	30.5	217.4	Full	500	0.0	0.0
Lane 4	534	2.0	674	0.792	100	39.0	LOS D	28.9	205.5	Full	500	0.0	0.0
Approach	1431	2.8		0.792		34.3	LOS C	30.5	217.4				
Intersection	8655	3.8		1.121		110.2	LOS F	88.6	625.6				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

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LANE SUMMARY

Site: TS206 [PM North East Rd / Sudholz Rd - Post Development]

Existing Intersection PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
SouthEast: Sudholz Rd													
Lane 1	166	2.0	355	0.467	100	47.4	LOS D	8.4	59.7	Short	64	0.0	NA
Lane 2	156	2.0	334	0.467	100	47.5	LOS D	7.9	56.3	Short	70	0.0	NA
Lane 3	354	2.0	360[1]	0.983	100	91.1	LOS F	29.2	207.7	Full	500	0.0	0.0
Lane 4	452	2.0	460	0.983	100	87.9	LOS F	37.0	263.4	Full	500	0.0	0.0
Lane 5	467	2.0	475	0.983	100	87.3	LOS F	38.0	270.8	Full	500	0.0	0.0
Lane 6	285	2.0	235	1.215	100	264.0	LOS F	40.3	287.2	Full	500	0.0	0.0
Lane 7	262	2.0	216	1.215	100	264.8	LOS F	37.2	264.6	Short	90	0.0	NA
Approach	2142	2.0		1.215		127.3	LOS F	40.3	287.2				
NorthEast: North East Rd													
Lane 1	448	2.0	1234	0.363	100	14.3	LOS B	9.1	64.8	Short	63	0.0	NA
Lane 2	350	0.5	691	0.507	100	26.5	LOS C	14.8	104.2	Full	500	0.0	0.0
Lane 3	426	0.5	841	0.507	100	26.3	LOS C	17.9	125.9	Full	500	0.0	0.0
Lane 4	438	0.5	864	0.507	100	26.3	LOS C	18.4	129.3	Full	500	0.0	0.0
Approach	1662	0.9		0.507		23.1	LOS C	18.4	129.3				
NorthWest: Sudholz Rd													
Lane 1	44	0.0	521	0.085	100	32.8	LOS C	1.7	12.1	Short	20	0.0	NA
Lane 2	441	2.0	367[1]	1.201	100	247.2	LOS F	62.2	443.1	Short	93	0.0	NA
Lane 3	518	2.0	431[1]	1.201	100	245.2	LOS F	72.5	515.9	Full	500	0.0	7.8
Lane 4	593	2.0	494	1.201	100	243.7	LOS F	82.7	588.5	Full	500	0.0	19.8
Lane 5	173	4.0	207	0.836	100	69.1	LOS E	11.1	80.3	Short	120	0.0	NA
Lane 6	154	4.0	184	0.836	100	70.0	LOS E	10.0	72.2	Short	120	0.0	NA
Approach	1922	2.3		1.201		210.5	LOS F	82.7	588.5				
SouthWest: North East Rd													
Lane 1	253	3.0	1063	0.238	100	12.3	LOS B	5.1	36.5	Short	20	0.0	NA
Lane 2	182	0.5	723	0.252	22[6]	23.0	LOS C	6.7	47.2	Full	500	0.0	0.0
Lane 3	1027	0.5	879	1.169	100	211.0	LOS F	137.2	964.7	Full	500	0.0	65.9
Lane 4	962	0.5	823	1.169	100	212.1	LOS F	129.1	907.4	Full	500	0.0	60.0
Approach	2424	0.8		1.169		176.6	LOS F	137.2	964.7				
Intersection	8151	1.5		1.215		140.4	LOS F	137.2	964.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

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LANE SUMMARY

Site: TS287 [AM - Grand Junction Rd \ Sudholz Rd \ Walkleys Rd]

Base Case Existing Intersection AM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Road													
Lane 1	438	5.0	922	0.475	100	24.1	LOS C	14.7	107.5	Short	110	0.0	NA
Lane 2	455	3.0	539	0.843	100	50.3	LOS D	27.4	196.9	Full	500	0.0	0.0
Lane 3	424	3.0	503[1]	0.843	100	49.1	LOS D	24.8	178.2	Full	500	0.0	0.0
Lane 4	94	3.0	118	0.791	100	73.2	LOS E	6.0	42.9	Short	55	0.0	NA
Approach	1411	3.6		0.843		43.3	LOS D	27.4	196.9				
East: Grand Junction Road													
Lane 1	143	2.0	1169	0.122	100	12.9	LOS B	2.7	19.3	Short	150	0.0	NA
Lane 2	530	3.0	620	0.855	100	47.6	LOS D	32.0	229.7	Full	500	0.0	0.0
Lane 3	475	3.0	556[1]	0.855	100	47.1	LOS D	28.0	201.0	Full	500	0.0	0.0
Lane 4	71	3.0	101	0.701	100	71.1	LOS E	4.5	32.0	Short	60	0.0	NA
Lane 5	71	3.0	102	0.701	100	71.1	LOS E	4.5	32.3	Short	40	0.0	NA
Approach	1291	2.9		0.855		46.1	LOS D	32.0	229.7				
North: Walkleys Road													
Lane 1	470	4.6	601	0.782	100	44.4	LOS D	24.5	178.5	Full	500	0.0	0.0
Lane 2	427	5.0	546[1]	0.782	100	39.4	LOS D	22.1	161.4	Full	500	0.0	0.0
Lane 3	194	1.0	222	0.873	100	73.0	LOS E	12.7	89.5	Short	70	0.0	NA
Approach	1091	4.1		0.873		47.5	LOS D	24.5	178.5				
West: Grand Junction Road													
Lane 1	388	5.5	549	0.708	100	42.6	LOS D	18.6	136.5	Full	500	0.0	0.0
Lane 2	427	7.0	604	0.708	100	37.6	LOS D	21.9	162.2	Full	500	0.0	0.0
Lane 3	109	11.0	126	0.866	100	77.0	LOS E	7.3	55.6	Short	150	0.0	NA
Lane 4	118	11.0	136	0.866	100	76.3	LOS E	7.8	59.8	Short	110	0.0	NA
Approach	1042	7.3		0.866		47.9	LOS D	21.9	162.2				
Intersection	4834	4.3		0.873		46.0	LOS D	32.0	229.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS287 [PM - Grand Junction Rd \ Sudholz Rd \ Walkleys Rd]

Base Case Existing Intersection PM 2018 Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Road													
Lane 1	218	0.0	1228	0.177	100	10.8	LOS B	3.5	24.3	Short	110	0.0	NA
Lane 2	399	3.0	490	0.814	100	49.9	LOS D	23.5	168.7	Full	500	0.0	0.0
Lane 3	349	3.0	430[1]	0.814	100	48.5	LOS D	19.9	142.6	Full	500	0.0	0.0
Lane 4	140	1.0	150	0.933	100	84.3	LOS F	9.9	69.9	Short	55	0.0	NA
Approach	1106	2.2		0.933		46.1	LOS D	23.5	168.7				
East: Grand Junction Road													
Lane 1	86	0.0	1030	0.084	100	15.4	LOS B	1.9	13.3	Short	150	0.0	NA
Lane 2	285	1.0	483	0.590	100	42.8	LOS D	14.8	104.3	Full	500	0.0	0.0
Lane 3	285	1.0	483	0.590	100	42.8	LOS D	14.8	104.3	Full	500	0.0	0.0
Lane 4	58	0.0	103	0.565	100	68.8	LOS E	3.5	24.8	Short	60	0.0	NA
Lane 5	59	0.0	104	0.565	100	68.7	LOS E	3.6	25.1	Short	40	0.0	NA
Approach	774	0.7		0.590		43.7	LOS D	14.8	104.3				
North: Walkleys Road													
Lane 1	433	0.7	471	0.920	100	78.0	LOS E	29.9	210.5	Full	500	0.0	0.0
Lane 2	439	1.0	478[1]	0.920	100	63.2	LOS E	29.6	209.3	Full	500	0.0	0.0
Lane 3	119	1.0	158	0.751	100	69.5	LOS E	7.4	51.9	Short	70	0.0	NA
Approach	992	0.9		0.920		70.4	LOS E	29.9	210.5				
West: Grand Junction Road													
Lane 1	589	1.0	654	0.900	100	57.2	LOS E	38.3	270.5	Full	500	0.0	0.0
Lane 2	664	1.0	737	0.900	100	49.8	LOS D	43.0	303.5	Full	500	0.0	0.0
Lane 3	201	1.0	269	0.748	100	37.2	LOS D	7.4	52.4	Short	150	0.0	NA
Lane 4	218	1.0	291	0.748	100	36.8	LOS D	8.0	56.2	Short	110	0.0	NA
Approach	1672	1.0		0.900		49.2	LOS D	43.0	303.5				
Intersection	4543	1.2		0.933		52.1	LOS D	43.0	303.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS287 [AM - Grand Junction Rd \ Sudholz Rd \ Walkleys Rd - Post Development]

Existing Intersection AM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Road													
Lane 1	469	5.0	921	0.510	100	26.5	LOS C	15.3	111.8	Short	110	0.0	NA
Lane 2	518	3.0	589	0.881	100	53.0	LOS D	32.9	236.1	Full	500	0.0	0.0
Lane 3	472	3.0	536[1]	0.881	100	51.7	LOS D	28.9	207.4	Full	500	0.0	0.0
Lane 4	125	3.0	148	0.846	100	74.1	LOS E	8.1	58.4	Short	55	0.0	NA
Approach	1585	3.6		0.881		46.4	LOS D	32.9	236.1				
East: Grand Junction Road													
Lane 1	152	2.0	1154	0.131	100	13.3	LOS B	3.0	21.2	Short	150	0.0	NA
Lane 2	560	3.0	589	0.951	100	70.5	LOS E	41.9	301.0	Full	500	0.0	0.0
Lane 3	503	3.0	529[1]	0.951	100	70.5	LOS E	37.0	265.3	Full	500	0.0	0.0
Lane 4	76	3.0	90	0.848	100	77.8	LOS E	5.1	36.5	Short	60	0.0	NA
Lane 5	77	3.0	91	0.848	100	77.7	LOS E	5.1	36.9	Short	40	0.0	NA
Approach	1367	2.9		0.951		64.9	LOS E	41.9	301.0				
North: Walkleys Road													
Lane 1	485	4.6	600	0.808	100	47.0	LOS D	26.3	191.4	Full	500	0.0	0.0
Lane 2	442	5.0	547[1]	0.808	100	41.2	LOS D	23.6	172.2	Full	500	0.0	0.0
Lane 3	199	1.0	206	0.966	100	92.0	LOS F	15.0	105.9	Short	70	0.0	NA
Approach	1125	4.1		0.966		52.7	LOS D	26.3	191.4				
West: Grand Junction Road													
Lane 1	436	5.5	536	0.813	100	50.4	LOS D	24.1	176.9	Full	500	0.0	0.0
Lane 2	479	7.0	589	0.813	100	43.9	LOS D	27.3	202.8	Full	500	0.0	0.0
Lane 3	112	11.0	126	0.894	100	79.9	LOS E	7.7	58.9	Short	150	0.0	NA
Lane 4	121	11.0	136	0.894	100	79.2	LOS E	8.3	63.3	Short	110	0.0	NA
Approach	1148	7.3		0.894		53.6	LOS D	27.3	202.8				
Intersection	5226	4.3		0.966		54.2	LOS D	41.9	301.0				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

LANE SUMMARY

Site: TS287 [PM - Grand Junction Rd \ Sudholz Rd \ Walkleys Rd - Post Development]

Existing Intersection PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Sudholz Road													
Lane 1	225	0.0	1185	0.190	100	12.8	LOS B	4.4	30.5	Short	110	0.0	NA
Lane 2	417	3.0	523	0.796	100	47.2	LOS D	23.9	171.5	Full	500	0.0	0.0
Lane 3	359	3.0	451[1]	0.796	100	45.7	LOS D	19.8	142.0	Full	500	0.0	0.0
Lane 4	148	1.0	150	0.989	100	102.2	LOS F	11.8	83.1	Short	55	0.0	NA
Approach	1149	2.2		0.989		47.1	LOS D	23.9	171.5				
East: Grand Junction Road													
Lane 1	121	0.0	982	0.123	100	17.8	LOS B	3.0	21.3	Short	150	0.0	NA
Lane 2	341	1.0	467	0.730	100	46.3	LOS D	18.8	132.7	Full	500	0.0	0.0
Lane 3	311	1.0	425[1]	0.730	100	45.7	LOS D	16.9	119.1	Full	500	0.0	0.0
Lane 4	59	0.0	103	0.575	100	68.9	LOS E	3.6	25.3	Short	60	0.0	NA
Lane 5	60	0.0	104	0.575	100	68.8	LOS E	3.7	25.6	Short	40	0.0	NA
Approach	892	0.7		0.730		45.2	LOS D	18.8	132.7				
North: Walkleys Road													
Lane 1	495	0.7	500	0.991	100	105.8	LOS F	41.4	291.5	Full	500	0.0	0.0
Lane 2	500	1.0	504[1]	0.991	100	89.0	LOS F	40.6	286.5	Full	500	0.0	0.0
Lane 3	138	1.0	158	0.870	100	75.3	LOS E	9.1	63.9	Short	70	0.0	NA
Approach	1133	0.9		0.991		94.7	LOS F	41.4	291.5				
West: Grand Junction Road													
Lane 1	627	1.0	626	1.002	100	70.9	LOS E	41.4	292.0	Full	500	0.0	0.0
Lane 2	689	1.0	688[1]	1.002	100	91.8	LOS F	60.5	427.3	Full	500	0.0	0.0
Lane 3	216	1.0	255	0.847	100	44.4	LOS D	9.0	63.9	Short	150	0.0	NA
Lane 4	234	1.0	276	0.847	100	43.8	LOS D	9.7	68.4	Short	110	0.0	NA
Approach	1766	1.0		1.002		72.2	LOS E	60.5	427.3				
Intersection	4940	1.2		1.002		66.6	LOS E	60.5	427.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the full-length lanes. Some upstream delays at entry to short lanes are not included.

MOVEMENT SUMMARY

Site: TS287 [AM - Grand Junction Rd \ Sudholz Rd \ Walkleys Rd - Post Development - Mitigation]

Existing Intersection AM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

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	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Sudholz Road											
1	L2	469	5.0	0.510	26.5	LOS C	15.3	111.8	0.70	0.87	44.7
2	T1	991	3.0	0.881	52.4	LOS D	32.9	236.1	0.98	0.99	35.2
3	R2	125	3.0	0.846	74.1	LOS E	8.1	58.4	1.00	0.93	28.5
Approach		1585	3.6	0.881	46.4	LOS D	32.9	236.1	0.90	0.95	36.8
East: Grand Junction Road											
4	L2	152	2.0	0.131	13.3	LOS B	3.0	21.2	0.41	0.68	53.9
5	T1	1063	3.0	0.951	70.5	LOS E	41.9	301.0	1.00	1.15	29.9
6	R2	153	3.0	0.753	72.5	LOS E	4.9	35.2	1.00	0.86	28.6
Approach		1367	2.9	0.951	64.4	LOS E	41.9	301.0	0.93	1.06	31.3
North: Walkleys Road											
7	L2	177	4.0	0.808	50.8	LOS D	26.3	191.4	0.97	0.97	36.1
8	T1	749	5.0	0.808	42.4	LOS D	26.3	191.4	0.94	0.90	38.5
9	R2	199	1.0	0.966	92.0	LOS F	15.0	105.9	1.00	1.07	25.1
Approach		1125	4.1	0.966	52.5	LOS D	26.3	191.4	0.96	0.94	34.8
West: Grand Junction Road											
10	L2	160	3.0	0.167	15.0	LOS B	3.6	25.6	0.45	0.69	52.4
11	T1	755	7.0	0.748	40.4	LOS D	22.9	169.8	0.94	0.84	39.6
12	R2	234	11.0	0.894	79.6	LOS E	8.3	63.3	1.00	0.98	26.9
Approach		1148	7.3	0.894	44.8	LOS D	22.9	169.8	0.89	0.85	37.3
All Vehicles		5226	4.3	0.966	52.1	LOS D	41.9	301.0	0.92	0.96	34.9

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P2	East Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P3	North Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		211	54.3	LOS E			0.95	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: TS287 [PM - Grand Junction Rd \ Sudholz Rd \ Walkleys Rd - Post Development - Mitigation]

Existing Intersection PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

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	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Sudholz Road											
1	L2	225	0.0	0.189	12.8	LOS B	4.4	30.5	0.41	0.69	54.7
2	T1	776	3.0	0.753	42.5	LOS D	22.8	163.6	0.95	0.84	38.8
3	R2	148	1.0	0.989	102.2	LOS F	11.8	83.1	1.00	1.11	23.5
Approach		1149	2.2	0.989	44.4	LOS D	22.8	163.6	0.85	0.85	37.8
East: Grand Junction Road											
4	L2	121	0.0	0.122	17.8	LOS B	3.0	21.2	0.51	0.70	51.0
5	T1	652	1.0	0.753	47.8	LOS D	19.2	135.3	0.98	0.87	36.7
6	R2	119	0.0	0.517	67.0	LOS E	3.6	25.1	1.00	0.77	30.1
Approach		892	0.7	0.753	46.3	LOS D	19.2	135.3	0.92	0.83	37.0
North: Walkleys Road											
7	L2	128	0.0	0.938	86.5	LOS F	35.9	252.8	1.00	1.18	27.1
8	T1	866	1.0	0.938	71.8	LOS E	35.9	252.8	1.00	1.14	29.5
9	R2	138	1.0	0.870	75.4	LOS E	9.1	63.9	1.00	0.95	28.4
Approach		1133	0.9	0.938	73.9	LOS E	35.9	252.8	1.00	1.12	29.1
West: Grand Junction Road											
10	L2	204	1.0	0.195	12.8	LOS B	4.0	27.9	0.40	0.69	54.5
11	T1	1112	1.0	0.930	61.9	LOS E	43.3	305.6	1.00	1.10	32.2
12	R2	451	1.0	0.894	49.2	LOS D	10.6	75.0	1.00	0.96	35.5
Approach		1766	1.0	0.930	53.0	LOS D	43.3	305.6	0.93	1.02	34.6
All Vehicles		4940	1.2	0.989	54.6	LOS D	43.3	305.6	0.93	0.97	34.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P2	East Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P3	North Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		211	54.3	LOS E			0.95	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

LANE SUMMARY

Site: [AM Fosters Road Access Point]

Post Development AM FLows
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Road													
Lane 1	656	1.0	1937	0.338	100	0.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	55	0.0	768	0.071	100	9.1	LOS A	0.3	1.9	Short	50	0.0	NA
Approach	711	0.9		0.338		0.7	NA	0.3	1.9				
East: New Access													
Lane 1	324	0.0	344	0.942	100	56.3	LOS F	12.4	86.9	Full	500	0.0	0.0
Approach	324	0.0		0.942		56.3	LOS F	12.4	86.9				
North: Fosters Road													
Lane 1	735	2.0	1923	0.382	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	735	2.0		0.382		0.2	NA	0.0	0.0				
Intersection	1769	1.2		0.942		10.7	NA	12.4	86.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: [PM Fosters Road Access Point]

Post Development PM FLows
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: Fosters Road													
Lane 1	615	1.0	1937	0.317	100	0.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	219	0.0	1097	0.200	100	7.6	LOS A	0.9	6.3	Short	50	0.0	NA
Approach	834	0.7		0.317		2.0	NA	0.9	6.3				
East: New Access													
Lane 1	81	0.0	502	0.162	100	10.7	LOS B	0.6	3.9	Full	500	0.0	0.0
Approach	81	0.0		0.162		10.7	LOS B	0.6	3.9				
North: Fosters Road													
Lane 1	484	1.7	1915	0.253	100	0.8	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	484	1.7		0.253		0.8	NA	0.0	0.0				
Intersection	1399	1.0		0.317		2.1	NA	0.9	6.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: v [Grand Junction Road Access - Conversion]

Post Development AM Flows
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total veh/h	HV %	veh/h	v/c	%	sec		Veh	Dist m		m	%	%
South: RoadName													
Lane 1	165	0.0	465	0.355	100	12.8	LOS B	1.5	10.3	Short	60	0.0	NA
Lane 2	74	0.0	6	12.281	100	10307.7	LOS F	67.4	471.5	Full	500	0.0	3.3
Approach	239	0.0		12.281		3187.4	LOS F	67.4	471.5				
East: Grand Junction Road													
Lane 1	17	0.0	1857	0.009	100	6.4	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	832	0.0	1950	0.426	100	0.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 3	832	0.0	1950	0.426	100	0.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	1680	0.0		0.426		0.1	NA	0.0	0.0				
West: Grand Junction Road													
Lane 1	553	0.0	1950	0.284	100	0.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	553	0.0	1950	0.284	100	0.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 3	46	0.0	63	0.734	100	109.6	LOS F	2.5	17.6	Short	60	0.0	NA
Approach	1153	0.0		0.734		4.4	NA	2.5	17.6				
Intersection	3072	0.0		12.281		249.7	NA	67.4	471.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: [AM New Intersection Sudholz Road]

New Intersection AM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

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: Sudholz Rd											
1	L2	21	0.0	0.013	6.0	LOS A	0.1	0.5	0.11	0.57	50.2
2	T1	1456	2.0	0.567	11.3	LOS B	22.4	159.6	0.58	0.53	50.6
Approach		1477	2.0	0.567	11.2	LOS B	22.4	159.6	0.57	0.53	50.6
North: Sudholz Rd											
8	T1	1100	1.0	0.370	4.8	LOS A	10.2	72.3	0.35	0.32	55.6
9	R2	20	0.0	0.215	68.2	LOS E	1.2	8.4	0.99	0.70	26.9
Approach		1120	1.0	0.370	5.9	LOS A	10.2	72.3	0.36	0.32	54.6
West: New Road											
10	L2	80	0.0	0.137	9.4	LOS A	1.4	9.7	0.36	0.62	47.2
12	R2	86	0.0	0.429	60.3	LOS E	4.9	34.2	0.98	0.77	28.3
Approach		166	0.0	0.429	35.8	LOS D	4.9	34.2	0.68	0.70	35.1
All Vehicles		2763	1.5	0.567	10.6	LOS B	22.4	159.6	0.50	0.46	50.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P3	North Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		158	54.3	LOS E			0.95	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: [PM New Intersection Sudholz Road]

New Intersection PM Post Development Flows

By Andrew Olsen
Signals - Fixed Time Isolated Cycle Time = 120 seconds (User-Given Cycle Time)

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: Sudholz Rd											
1	L2	86	0.0	0.056	6.2	LOS A	0.4	3.1	0.15	0.59	50.1
2	T1	1118	2.0	0.465	12.6	LOS B	17.0	120.8	0.57	0.51	49.7
Approach		1204	1.9	0.465	12.1	LOS B	17.0	120.8	0.54	0.52	49.8
North: Sudholz Rd											
8	T1	1292	1.0	0.435	5.1	LOS A	12.9	91.2	0.38	0.35	55.3
9	R2	80	0.0	0.470	63.6	LOS E	4.6	32.5	0.99	0.77	27.8
Approach		1372	0.9	0.470	8.6	LOS A	12.9	91.2	0.41	0.37	52.3
West: New Road											
10	L2	20	0.0	0.027	7.3	LOS A	0.2	1.7	0.27	0.56	48.5
12	R2	21	0.0	0.105	57.6	LOS E	1.1	7.9	0.93	0.70	29.0
Approach		41	0.0	0.105	33.1	LOS C	1.1	7.9	0.61	0.63	36.1
All Vehicles		2617	1.3	0.470	10.6	LOS B	17.0	120.8	0.48	0.44	50.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P3	North Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		158	54.3	LOS E			0.95	0.95

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.