A7 Water Cycle Management Strategy

Water Cycle Management Strategy Report

Walker Corporation

Appin (Part 2) Precinct

October 2024

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Issue	Author	Reviewer	Approver	Date approved
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C – Minor Amendments	Troy McLeod	Sabina Lohani	Sabina Lohani	25/08/2023
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E – Precinct Boundary Adjustment	Elham Tavakoli	Troy McLeod	Sabina Lohani	5/09/2024
F – Precinct Boundary Adjustment	Troy McLeod	Troy McLeod	Sabina Lohani 	8/10/2024

EXECUTIVE SUMMARY

J. Wyndham Prince have been engaged by Walker Corporation Pty Ltd and Walker Group Holdings Pty Ltd (together the Proponent) to prepare a Water Cycle Management Strategy (WCMS) to support the Appin (Part 2) Precinct Structure Plan.

Appin (Part 2) Precinct directly adjoins the Appin (Part) Precinct and consists of two (2) parcels of land, named Kings Land and Dunbier Land. The Kings Land is located at the head of Ousedale Creek and is bisected by Wilton Road. The Dunbier Land is bisected by a ridgeline and discharges directly to Ousedale Creek in the east and Elladale Creek in the west. The existing sites are occupied by rural residential dwellings and grass pastures.

The WCMS report presents details on the planning proposal for the Appin (Part 2) Precinct. The assessment includes hydrologic analysis, water quality analysis, riparian corridor assessment and consideration of the potential ecological impacts of the development.

Water quality will be managed by a variety of controls in order to deliver the adopted water quality objectives. Devices have been sized indicatively based on a 10-ha typical catchment assumption for both the low-density and commercial areas proposed within the precinct plan. Further discussion on the water quality approach can be found in Section 5 of the report.

The water quantity modelling undertaken to support the Appin (Part) Precinct determined that flows are not detrimentally increased in the major downstream watercourses (Nepean River and Cataract River) as a result of the development. Some local flow increases were observed within the local catchments of the site; however, these increases were generally located within the proposed environmental conservation areas. Once these flows reach the main waterways (Nepean and Cataract River), the localised increases are combined with flows from a significant larger catchment and do not result in overall flow increases.

Given that there is no increase in flows within the major watercourses, it was determined that a merit-based detention approach is considered suitable for further investigation as the staged delivery of the Precinct occurs. Given the locality of the Appin (Part 2) Precinct (near the Appin (Part) Precinct) the same approach is proposed to be applied to detention. Refer to Section 6 of the report for further details on the proposed merit-based approach.

The impacts of the merit-based detention strategy have been carefully considered from an ecology and habitat management perspective. Various factors have been explored including peak flows, regular (frequent) runoff, pollutant reductions, velocity management, geomorphology, and flooding impacts. It is anticipated that while peak flows will be increased locally at the sites discharge points, the impacts on ecology will be manageable given the improvements that will be achieved in regular stormwater runoff and increased management of pollutants together with the resilience of the natural ecosystems that exist downstream of the development.

An illustration of the Water Cycle Management Plan for the Appin (Part 2) Precinct can be seen in Figure 1-1 in Appendix A.

The Water Cycle Management Strategy proposed for the Appin (Part 2) Precinct is therefore functional; it delivers the required technical performance, lessens environmental degradation and pressure on downstream ecosystems and infrastructure and provides for a ‘soft’ sustainable solution for water cycle management. The Proposal can be supported in its current form.

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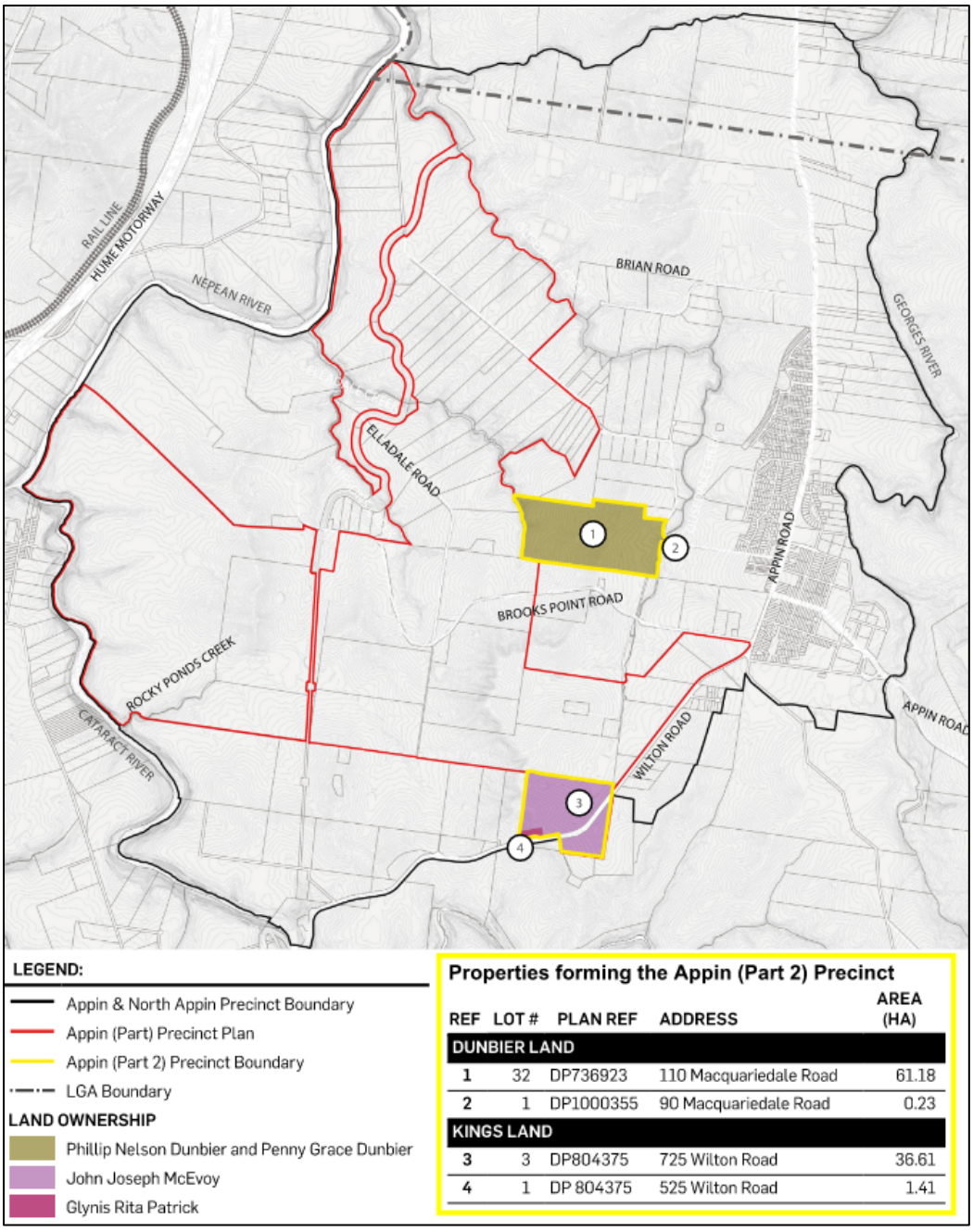
1. INTRODUCTION

1.1. The Proposal

The Proponent has prepared the subject submission to rezone 91.72 hectares of land (the Site) within the Appin Precinct from RU2 Rural Landscape to the following zones:

- Urban Development Zone
  - Zone 1 Urban Development (UD)
- Conservation Zone
  - Zone C2 Environmental Conservation (C2)

The Site is known as the Appin (Part 2) Precinct. The Site directly adjoins the Appin (Part 1) Precinct – refer to Plate 1-1.



Properties forming the Appin (Part 2) Precinct

REF	LOT #	PLAN REF	ADDRESS	AREA (HA)
DUNBIER LAND				
1	32	DP736923	110 Macquariedale Road	61.18
2	1	DP1000355	90 Macquariedale Road	0.23
KINGS LAND				
3	3	DP804375	725 Wilton Road	36.61
4	1	DP 804375	525 Wilton Road	1.41

Plate 1-1 – Boundary of the Appin (Part 2) Precinct

1.2. The Appin (Part 1) Precinct Planning Proposal (PP-2022-3979)

In November 2022, Walker Corporation Pty Ltd and Walker Group Holdings Pty Ltd (the Proponent) lodged a Planning Proposal (PP-2022-3979) to rezone part of the Appin Precinct.

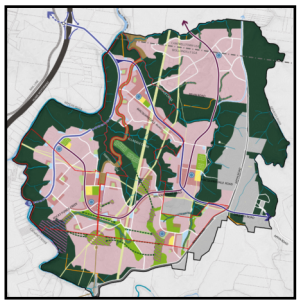
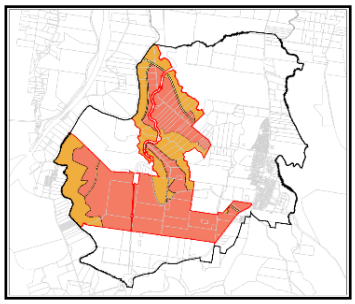
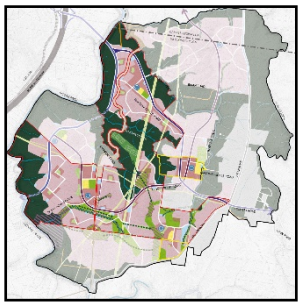
PP-2022-3979 (referred to as the Appin (Part 1) Precinct) proposes to rezone the land from RU2 Rural Landscape to Urban Development Zone (UDZ), C2 Environmental Conservation and SP2 Infrastructure via an amendment to State Environmental Planning Policy (Precincts – Western Parkland City) 2021.

The UDZ will facilitate approximately 12,000 dwellings. The C2 zone will facilitate the conservation of 470ha of endangered ecological community and help implement the Office of the NSW Chief Scientist & Engineer (NSW Chief Scientist) recommendations.

The new zones are accompanied by a structure plan outlining the intended land uses. In addition, the Proponent produced an Appin and North Appin Precincts Indicative Plan to illustrate how the new zones might fit within the broader precinct as land is developed. The Indicative Plan has no statutory weight and will be refined as further planning proposals are prepared.

These plans are summarised in Table 1-1.

Table 1-1 – PP-2022-3979 Title and Purpose of Plans

(1) APPIN & NORTH APPIN PRECINCTS INDICATIVE PLAN	(2) APPIN (PART) PRECINCT PLAN (THE PRECINCT PLAN)	(3) APPIN (PART) PRECINCT STRUCTURE PLAN (THE STRUCTURE PLAN)
Broader context and for information purposes only. It has no statutory weight. It identifies: • Higher-order transport network • Centres hierarchy • School sites • Conservation areas • Residential areas • Cultural sites and connections	It shows the land proposed to be rezoned and incorporated into a new schedule in the Western Parkland City SEPP 2021. The precinct plan contains the development provisions (clauses and maps) applicable to the site and is used in assessing development applications.	Structure plan for the site, showing staging of release areas. Development is to be generally consistent with the structure plan. It illustrates land use components including (but not limited to): • Low and medium-density residential • Retail and employment centres • School • Open space • Drainage network/basins • Transport network
 (21,000+ dwellings)	 (12,000 dwellings)	 (12,000 dwellings)

1.3. Population Growth

Greater Sydney's population is projected to grow to approximately 6.1 million by 2041 – over a million more people than currently live in the Sydney region.

The NSW Government has identified Growth Areas to accommodate the population that will choose to live in greenfield areas (new suburbs). The Greater Macarthur Growth Area (GMGA) is one such growth area and is a logical extension of the urban form of south-west Sydney. The GMGA is divided into precincts. The Appin Precinct and North Appin Precinct are the southernmost land release precincts of the GMGA. The goal is to deliver 21,000 dwellings.

The rezoning and release of land for development will achieve this goal.

1.4. The Appin (Part 2) Precinct Planning Proposal

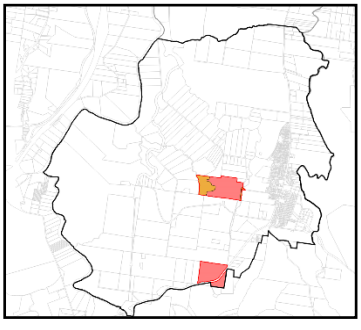
The Appin (Part 2) Precinct Plan (the precinct plan) shows the proposed new zones. 'The precinct plan' will be incorporated into the State Environmental Planning Policy (Precincts – Western Parkland City) 2021 and contain the provisions (clauses and maps) that will apply to 'the Site.' 'The precinct plan' envisages the delivery of the following:

- 1,312 dwellings (as a mix of low-density, medium density and apartments)
- 30,312 m² of gross lettable retail/commercial floor area
- 16.91 ha conservation land

The planning proposal submission is aligned with strategic land use planning, State and local government policies, infrastructure delivery and PP-2022-3979. The development potential is tempered by a landscape-based approach that protects the environment and landscape values, shaping the character of new communities. A series of residential neighbourhoods are to be delivered within the landscape corridors of the Nepean and Cataract Rivers, supported by local amenities, transit corridors and community infrastructure.

The submission includes a hierarchy of plans. The plans and their purpose are summarised in Table 1-2.

Table 1-2 – The subject Planning Proposal's Plans and Proposal

(1) APPIN & NORTH APPIN PRECINCTS INDICATIVE PLAN	(2) APPIN (PART 2) PRECINCT PLAN (THE PRECINCT PLAN)	(3) APPIN (PART 2) PRECINCT STRUCTURE PLAN (THE STRUCTURE PLAN)
Broader context and for information purposes only. It has no statutory weight. It identifies: • Higher-order transport network • Centres hierarchy • School sites • Conservation areas • Residential areas • Cultural sites and connections	It shows the land proposed to be rezoned and incorporated into a new schedule in the Western Parkland City SEPP 2021. The precinct plan contains the development provisions (clauses and maps) applicable to the site and is used in assessing development applications.	Structure plan for the site, showing staging of release areas. Development is to be generally consistent with the structure plan. It illustrates land use components including (but not limited to): • Low and medium-density residential • Retail and employment centres • School • Open space • Drainage network/basins • Transport network
 (21,000+ dwellings)	 (1,312 dwellings)	 (1,312 dwellings)

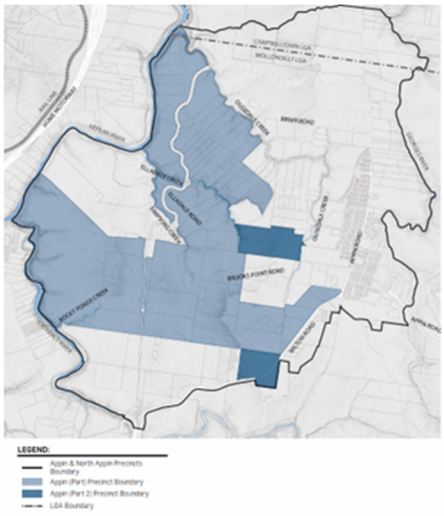
2. PURPOSE OF THIS REPORT

J. Wyndham Prince has been engaged by the Proponent to prepare a Water Cycle Management Strategy to support the Appin (Part 2) Precinct Plan (the precinct plan) and Appin (Part 2) Precinct Structure Plan (the structure plan).

Refer to Figure 1 and Table 3 for key attributes of the precinct plan and structure plan area.

The Appin (Part 2) Precinct Plan zones land for conservation and urban development. It establishes the statutory planning framework permitting the delivery of a range of residential typologies, retail, education, business premises, recreation areas, and infrastructure services and provides development standards that development must fulfil. Within the proposed urban development zone, 1,312 dwellings and more than 30,000 sqm of gross lettable floor area for retail and commercial space can be delivered.

Table 2-1 – Appin (Part 2) Precinct – summary of key attributes

Location		Key Attributes	
Appin (Part 2) Precinct		**Area**	Total – 100.1 ha Private Ownership – 100.1 ha
		LGA	Wholly Wollondilly LGA
		Proposed Dwellings	1,312
		Proposed retail & commercial floor space	30,000+
		Proposed Population	3,709

2.1. Objectives

This report summarises the site-specific assessment of stormwater quantity and quality management to ensure that there are manageable local impacts and no impacts external to the Appin (Part 2) Precinct. The objectives of the report are:

- To ensure that flows discharging to sensitive downstream waterways are not increased as a result of the development,
- To ensure that the water quality targets set out in Wollondilly Shire Council's Integrated Water Management Strategy and Policy (IWMS) are achieved,
- To maximise the reuse of non potable water,
- To ensure that the downstream environment and ecology is not degraded by the urbanisation of the catchment, and
- To provide a framework which will inform the future development applications (DA) for Appin (Part 2) Precinct.

The Proposal can be supported in its current form.

3. PREVIOUS STUDIES AND RELEVANT GUIDELINES

The following previous studies and control documents have been considered in the development of the Water Cycle Management Strategy for Appin (Part 2) Precinct:

- WSC Integrated Water Management Policy and Strategy (Wollondilly Shire Council, 2020);
- NSW MUSIC Modelling Guidelines (BMT WBM, 2015).
- Appin (Part) Precinct Water Cycle Management Strategy (JWP, 2022)

Details of the stormwater related objectives pertaining to this site are provided below.

3.1. Integrated Water Management Policy (2020)

Wollondilly Shire Council's Integrated Water Management Policy (IWMP) provides an overview of the objectives of the integrated water management strategy, outlining the overarching principles to be applied to new developments in the Wollondilly Local Government Area (LGA). The policy aims to deliver an integrated water solution for Wollondilly that protects the pristine waterways, endangered species, maintains and improves the condition of waterways, in the context of a growing population and changing land use. The policy lists the following objectives:

- Ensure stormwater and wastewater from urban development has a zero impact on local waterways;
- Decrease the use of potable water;
- Increase the amount of public and private water reuse and recycling;
- Use all sources of water to support sustainable development including community liveability, biodiversity, local economies including agriculture and climate resilience;
- Ensure water sensitive urban design elements are incorporated within public infrastructure and private development;
- Improve the condition of natural waterways, to remain swimmable, all year round;
- Ensure that residential, industrial, commercial and agricultural development doesn't affect the tributaries of the Georges and Nepean River within Wollondilly Local Government Area and downstream; and
- To support the water quality targets and associated treatment methods of urban water that are located in the Integrated Water Management Strategy.

3.2. Integrated Water Management Strategy (2020)

Wollondilly Shire Council's Integrated Water Management Strategy (IWMS) provides details of the proposed water management strategy to be implemented for new developments within the Wollondilly LGA. An alternate management approach is described in the IWMS which is aimed at achieving "zero impact" on the water cycle as a result of urban development. This approach is described in further detail in the IWMS and is also supported by a Water Sensitive Urban Design (WSUD) Guidelines which are newly adopted.

Importantly, the new Integrated Water Management Strategy outlines the new water quality and flow targets to be achieved by new developments (applied per hectare of new urban development area) in the Wollondilly LGA. They are listed as follows:

- Have between 2.5 and 3 ML of runoff on average, per year
- Reduce TN, TP and TSS by the ideal stormwater outcomes (85%, 95%, 95%) respectively
- Have either:
  - Five hundred square metres of green infrastructure to filter and infiltrate runoff
  - Two (2) megalitres of reuse of water per year
  - A combination of the above two (2) criteria

- Require zero downstream water quality assets, as all runoff and stormwater treatment are managed within development lots and precincts.

3.1. Wilton Growth Area Development Control Plan (2021)

In 2021, the NSW Department of Planning, Industry and Environment (DPIE) released the Wilton Growth Area Development Control Plan (DCP) which outlines the aims and objectives for new developments in the Wilton Growth Area which neighbours the Greater Macarthur Growth Area (GMGA). It is expected that similar controls and objectives will be adopted for the Appin (Part) Precinct (within the GMGA). Therefore, the objectives relating to flooding and water cycle management that have been considered in this strategy and are as follows:

- To manage the flow of stormwater from urban parts of the Precinct to replicate, as closely as possible, pre-development flows.
- To promote, at Precinct and Growth Area scale, an integrated approach to the provision of potable water, and the management of wastewater and stormwater.
- To ensure an integrated approach to drinking water, wastewater and stormwater services is considered to drive more sustainable water management outcomes
- To ensure that water management measures for development incorporate key principles of water sensitive urban design to help protect, maintain or restore waterway health of identified high value waterways with a minimum requirement of maintaining current health. This involves:
  - protecting existing hydrological and ecological processes of natural features and systems including watercourses, wetlands, lagoons and aquatic, riparian and groundwater dependant ecosystems
  - maintaining the natural hydrological behaviour of the catchment
  - where applicable, protecting the water quality of surface and groundwaters
  - minimising demand on reticulated water supply system
  - integrating water into the landscape to enhance ecological, visual, social, economic and cultural values.

Furthermore, this document outlines the water quality targets for the Wilton Growth Area which can be seen in Table 3-1 below.

Table 3-1 – Water Quality and Environmental Flow Targets

Element	Water quality % reduction in pollutant loads Gross Pollutants (>5mm)	Water quality % reduction in pollutant loads Total suspended solids; Total phosphorous; Total nitrogen	ENVIRONMENTAL FLOWS Stream erosion control ratio
Stormwater Management Objective	90	Neutral or Beneficial Effect on Water Quality - meaning loads of pollutants from future development must be equivalent to or less than that from the existing rural land use prior to development'	1:1

3.2. Appin (Part) Precinct Water Cycle Management Strategy (JWP, 2022)

The Appin (Part) Precinct Water Cycle Management Strategy (WCMS) report was prepared by J. Wyndham Prince in 2022 to support the rezoning of a portion of land within the Appin and North Appin Precinct. The WCMS report presents details on the planning proposal for the rezoning of 1,378 ha of land within the Appin and North Appin Precinct and is known as the Appin (Part) Precinct.

Water quality modelling was undertaken to determine the WSUD controls required to deliver the adopted water quality objectives. Devices were sized indicatively based on a 10-ha typical catchment assumption for both the low-density and commercial areas proposed within Appin (Part) Precinct. The modelling concluded that bioretention raingardens sized at 1.6% of the contributing catchments will be required for the proposed development at each discharge point to the downstream environment. The treatment train also consists of 5 kL rainwater tanks on each residential lot and a gross pollutant trap prior to discharge to each raingarden.

The hydrologic modelling assessment demonstrated that the proposed development of Appin (Part) Precinct will result in peak post-development discharges being restricted to less than the pre-development levels within the major receiving waterways (i.e. Nepean River and Cataract River). Preliminary modelling of detention basins within the site shows that introducing detention across the development will increase flows in Nepean and Cataract Rivers. Conversely, the urbanisation of the local sub-catchments within Appin (Part) Precinct means that local creeks and tributaries experience some localised increases in peak flows. Majority of the local increases in peak flows occur within the proposed environmental conservation zones which border the development edge (within the rezoning assessment area). As such, a detention strategy is proposed that focuses on providing strategic detention for areas of Appin (Part) Precinct that discharge to sensitive or higher order watercourses.

The impacts of the no detention strategy were carefully considered from an ecology and habitat management perspective. Various factors were explored including peak flows, regular (frequent) runoff, pollutant reductions, velocity management, geomorphology and flooding impacts. It is anticipated that while peak flows will be increased locally at the sites discharge points, the impacts on ecology will be manageable given the improvements that will be achieved in regular stormwater runoff and increased management of pollutants together with the resilience of the natural ecosystems that exist downstream of the development.

4. RIPARIAN CORRIDOR ASSESSMENT

The proposed rezoning area of the Appin (Part 2) Precinct is intersected by a series of existing watercourses. In accordance with the Guidelines for controlled activities on waterfront land (NRAR, 2018), the watercourses have each been identified to range between 1st to 3rd order riparian corridors based on the Strahler classification system using available 1:25,000 topographic maps. The guidelines state that where a watercourse does not exhibit the features of a defined channel with bed and banks, the NRAR may determine that the watercourse is not waterfront land for the purposes of the Water Management Act (2000) (WM Act).

Refer to Plate 4-1 and 4-2 for context of the watercourses that traverse the existing sites.

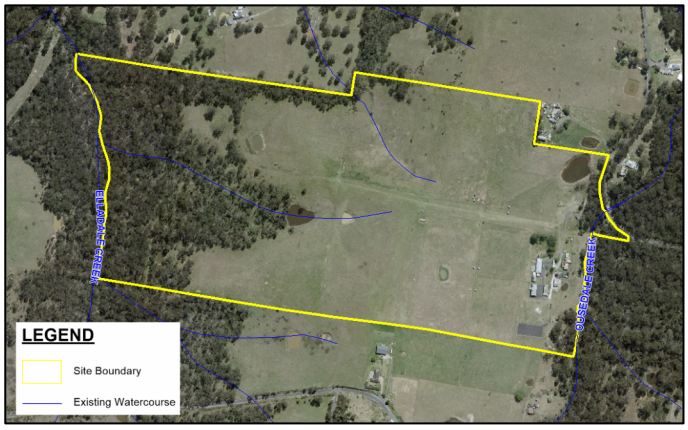


Plate 4-1 – Dunbier Land Existing Watercourses

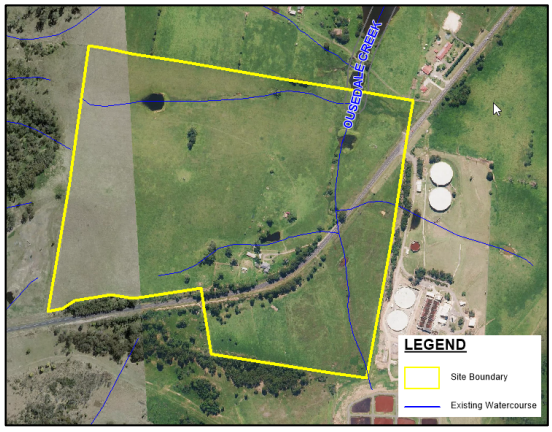


Plate 4-2 – Kings Land Existing Watercourses

A desktop review has been undertaken for the watercourses within the Appin (Part 2) Precinct to determine whether riparian features are present. Any watercourses that don't show signs of defined bed and banks or ecological value have been proposed to be removed. To support the proposed reclassification of these watercourses as waterfront land, a map has been prepared to show the Strahler classifications and watercourses proposed to be reclassified. Refer to Figure 4-1 in Appendix A.

The outcomes of the riparian mapping have been reached with consideration of the Waterfront land tool (NRAR, 2020) which has been developed to aid in the classification of "waterfront land" in accordance with the WM Act.

The 'Guidelines for controlled activities on waterfront land - Riparian corridors' (NRAR, 2018) outline that 1st order watercourses can be realigned/reengineered. Refer to Table 4-1 below. The 1st order watercourses that are located on urban capable land in the Appin (Part) Precinct development are proposed to be removed and replaced by street drainage networks (pit and pipe networks). In addition, any watercourse within 50m of the urban capable land of Appin (Part) Precinct is also proposed to be replaced by street drainage networks where suitable. Importantly, online detention basins are permitted on 1st and 2nd order watercourses.

Table 4-1 – Riparian Corridor Matrix (NRAR, 2018)

Stream order	Vegetated riparian zone(VRZ)	RC offsetting for non-RC users	Cycleways andpaths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10 m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
2nd	20 m	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
3rd	30 m	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes
4th	40 m	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes

5. WATER QUALITY ASSESSMENT

The stormwater quality analysis for this study was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology which is based at Monash University and was first released in July 2002. Version 6.3 was adopted for this study.

MUSIC modelling provides the following features which are relevant to this assessment:

- Determines the source pollutant loads which are generated from a variety of land uses (i.e. commercial, roads, residential, rural residential, etc.)
- Ability to model the potential nutrient reduction benefits associated with Water Quality devices such as gross pollutant traps, constructed wetlands, grass swales, bio-retention systems, sedimentation basins, infiltration systems and ponds. MUSIC includes mechanisms which enable stormwater re-use to be used as a treatment technique
- Provides a mechanism to evaluate the attainment of mean annual runoff volume (MARV), pollutant load/concentration reductions and Stream Erosion Index (SEI) assessment.

The proposed WCMS assessed in MUSIC includes a “treatment train” of Water Quality Control devices to treat runoff from the proposed residential development areas prior to discharge to the downstream environment. This indicative “treatment train” includes proprietary vortex style gross pollutant traps and bio-retention raingardens to be located at each development discharge point.

While we note that “end of pipe” solutions are inconsistent with Wollondilly Shire Councils IWMS, the strategy provides limited details on how the new approaches (i.e. centralised road swales with increased infiltration) can be implemented on steep sites (>5%) together with the challenges with delivering the elevated pollutant removal targets using the available treatment approaches. The Appin (Part 2) Precinct development has used traditional treatment measures to strive toward the elevated water management targets in the IWMS, consistent with the Appin (Part) Precinct approach.

The adopted water quality objectives for this development are consistent with the Integrated Water Management Strategy (2020). In addition to this, we have also assessed stream erosion index (SEI) and neutral or beneficial effect (NorBE) which are included in the Wilton Growth Area DCP (2021) which provides an indication of the possible (future) Appin (Part 2) Precinct DCP. These objectives and targets are detailed in Section 3.

5.1. Modelling Inputs and Assumptions

The MUSIC model setup has been undertaken consistent with Councils ‘MUSIC Template’ (2020), ‘Integrated Water Management Strategy (2020) and ‘WSUD Guidelines’ (2020) as well as the ‘NSW MUSIC Modelling Guidelines’ (BMT WBM, 2015). For further detail about the modelling inputs and assumptions that have informed the modelling process, please refer to Appendix B.

As the development grading within Appin (Part 2) Precinct is unknown at this stage, a typical 10 ha low density residential catchment has been modelled to inform the anticipated size of the water sensitive urban design (WSUD) devices. These areas were then split to reflect the anticipated lot, road and open space areas within the typical urban development catchments.

In accordance with the NSW MUSIC Modelling Guidelines (2015), each of these areas has been further defined based on land uses including “Roof”, “Roads,” “Open Space,” “General Urban Impervious” and “General Urban Pervious” which constitute the different source node types in the model. The overall fraction impervious for the typical catchments aligns with those specified in Appendix A of Council’s IWMS (2020).

The existing conditions have been represented in a single 10 ha “agricultural” source node for the purpose of comparing pollutant loads and flows between existing and developed conditions. This catchment has been assigned a conservative fraction impervious value of 0% for the purpose of assessing stream erosion index (SEI) and neutral or beneficial effect (NorBE).

Further details on land use areas, modelling assumptions and parameters are summarised in Appendix B.

An overview of the model layout for low density development is shown in Plate 5-1.

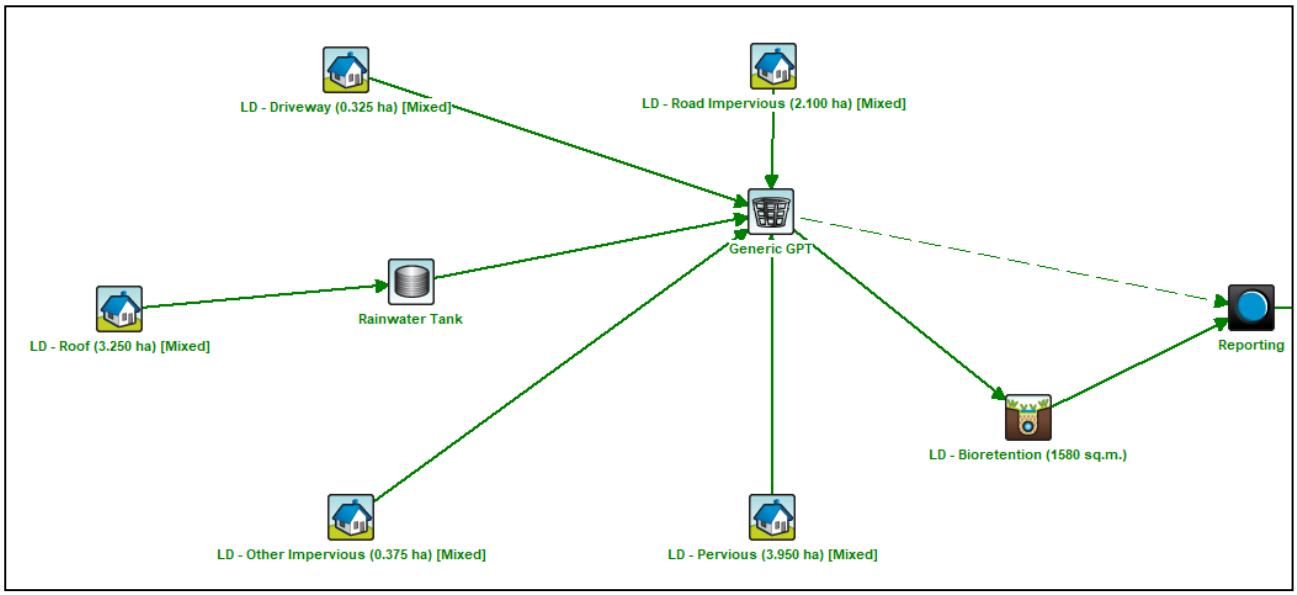


Plate 5-1 – MUSIC Model Layout
(Model Ref: 110628-02 MU02 IWMS.sqz)

5.2. Water Quality Management Measures

It is proposed that stormwater quality in Appin (Part 2) Precinct be managed using a treatment train approach. The treatment train of water quality devices that has been identified to achieve the water quality targets is as follows:

Residential land uses

- 5 kL rainwater tanks on each residential lot;
- Generic Gross Pollutant Traps (GPT) to pre-treat runoff prior to discharge into a tertiary treatment device; and
- The tertiary treatment consists of bioretention raingardens which will receive flows from the GPTs.

Commercial land uses

- For all commercial areas within Appin (Part 2) Precinct there will be a need for each development lot to deliver water quality management within the lot prior to discharge to the adjoining public road. Each commercial lot will need to account for their portion of the road reserves will need to be compensated for with their treatment measures. Alternatively, the developer can provide an end of line water quality treatment solution for the commercial areas which can be utilised by individual developments.

Further details regarding the adopted parameters for Gross Pollutant Trap(s) and Bioretention Raingarden(s) are provided in Appendix B.

It is important to note that this treatment train is only indicative and series of alternate arrangements such as open water bodies/wetlands, swales or proprietary devices for commercial areas, can deliver a similar water quality outcome and would form part of future consideration as the development process continues.

5.3. Modelling Results

Appin (Part 2) Precinct aims to achieve mean annual runoff volume (MARV) and pollutant load reduction requirements outlined in the WSC IWMS. The MUSIC Model was run using the stochastically generated estimated pollution loads from the source catchments.

5.3.1 MARV and Pollutant Loads

A comparison of the pollutant loads being generated on the site has been made between existing and developed conditions. Total annual pollutant loads being generated by the developed site have been derived from the MUSIC modelling and the pollutant load reductions and mean annual runoff results are presented in Table 5-1 below.

Table 5-1 - Summary of Pollutant Load Reductions for a Typical 10 ha Low-Density Residential Catchment

Pollutant	Total Developed Source Nodes	Total Residual Load from Site	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
Total Suspended Solids	9200	949	95.0%	89.7%
Total Phosphorus	18.1	4	95.0%	78.5%
Total Nitrogen	129	39	85.0%	69.8%
Gross Pollutants	1240	3	90.0%	99.8%
MARV Results				
Flow (ML/yr)	32.3			
Flow Target (ML/yr/ha)	2.5 to 3.0			
Flow (ML/yr/ha)	3.23			
Raingarden Sizing				
Filter Area (m²)	1,580			
Pipe Flow (ML/yr)	21.96			
Hydraulic Loading Rate (m³/m²/yr)	13.90			

The results show that the pollutant reduction targets outlined in the IWMS are not achieved, however, it is noted that the results far exceed the typical statutory pollutant reductions which are widely accepted across the state. Many iterations of the water quality modelling have been undertaken with increasing treatment train sizes and it has shown that the target reductions from the IWMS cannot be achieved. The mean annual runoff volume (MARV) which has been achieved is 3.23 ML/yr/ha which is slightly greater than the IWMS targets of 2.5 to 3.0, however, is considered to be a suitable outcome, especially considering that neutral or beneficial effect (NorBE) targets are being achieved for the site. The resulting raingarden sizing for a typical 10 ha catchment is 1,580 m² or 1.58% of the contributing catchment.

Table 5-2 below details the indicative raingarden filter media areas for the various raingardens located across Appin (Part 2) Precinct.

Table 5-2 – Indicative Raingarden Areas

Raingarden ID	Catchment Area (ha)	Filter Area (m²)
R1	23.9	3,780
R2	1.6	260
R3	21.2	3,360
R4	4.8	760
R5	6.8	1,080
R6	4.6	740
R7	8.0	1,270

5.3.2 NorBE

Neutral or beneficial effect (NorBE) forms part of the water quality targets in the Wilton Growth Area DCP (2021). An assessment of the NorBE outcomes achieved by the proposed Appin (Part 2) Precinct treatment train has been undertaken.

Pollutant Loads

A comparison of the pollutant loads being generated on the typical catchment has been made between existing and developed conditions. A summary of the mean annual pollutant load for existing and developed conditions are shown below in Table 5-3 for a typical 10 ha Low Density Residential catchment.

Table 5-3 – NorBE Pollutant Load Comparison

Pollutant	Mean Existing Source Loads	Mean Developed Source Loads	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
Total Suspended Solids	4540	949	≥10%	79.1%
Total Phosphorus	17.9	4	≥10%	78.2%
Total Nitrogen	87.8	39	≥10%	55.7%

Pollutant Concentrations

A comparison of the pollutant concentrations has also been undertaken in accordance with the requirements of a NorBE assessment. A NorBE assessment requires pollutant concentrations for TP and TN in the post-development case to be equal to or less than the pollutant concentrations for the pre-development case within the 50th to 98th percentile range when runoff occurs.

The pollutant concentration reductions are shown in Plate 5-3 for total phosphorus and Plate 5-4 for total nitrogen. The graphs show that reductions are achieved for both nutrients.

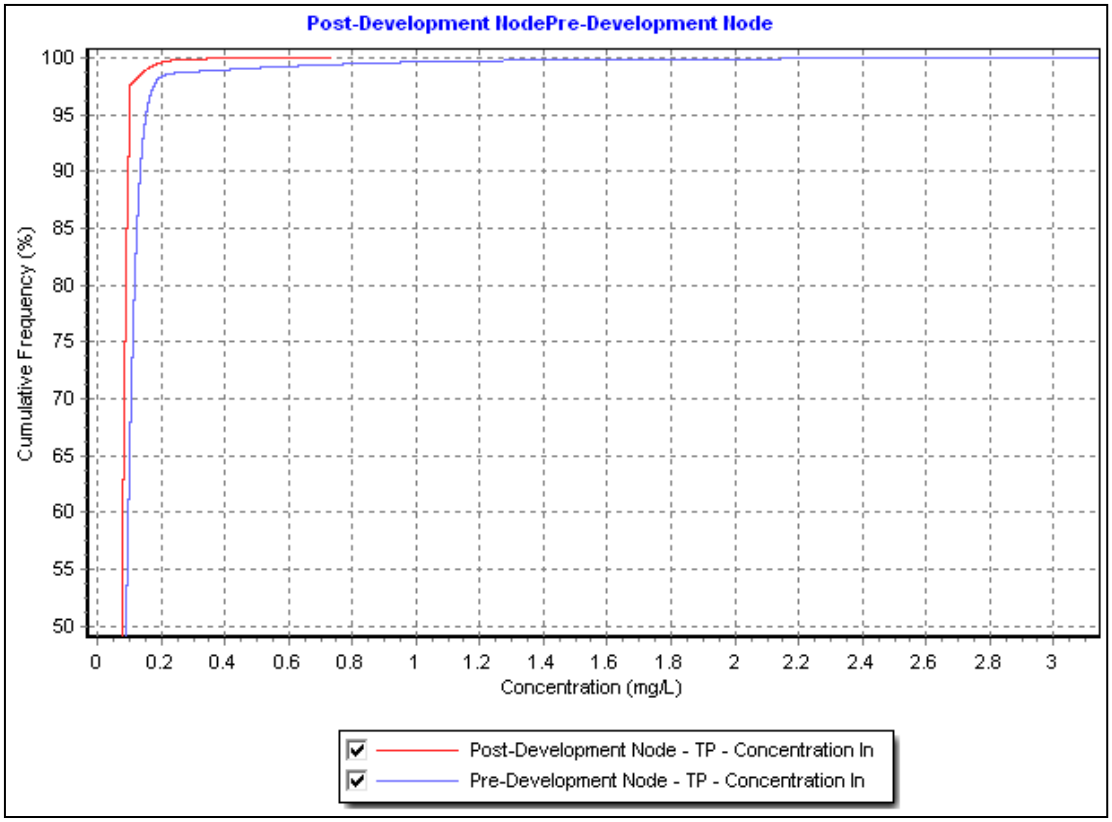


Plate 5-2 – Total Phosphorus – Pollutant Concentration Reduction

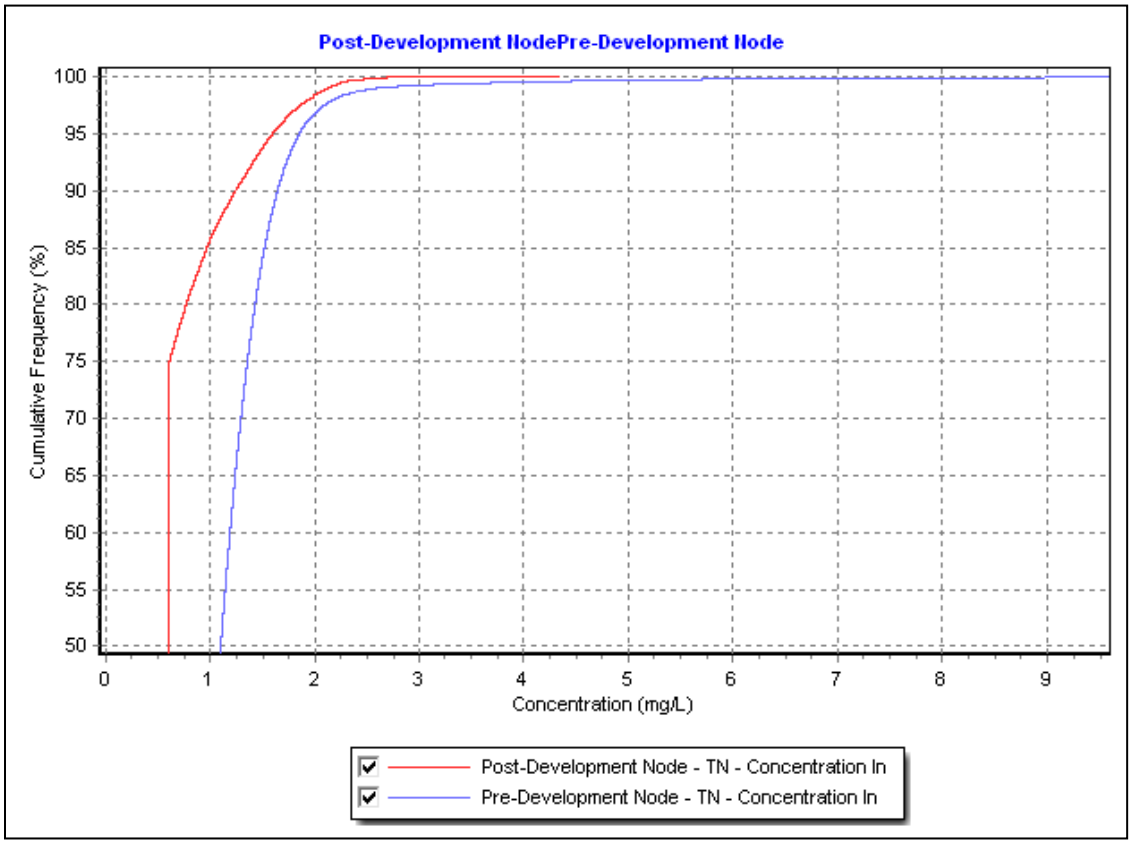


Plate 5-3 – Total Nitrogen – Pollutant Concentration Reduction

5.3.3 Results Discussion

An important part of this WCM Strategy involves the design of stormwater treatment systems that ensures the runoff from the urban development does not result in the pollution of the natural watercourse downstream. Nutrients such as Nitrogen and Phosphorus are potentially harmful pollutants to flora and fauna in natural ecosystems.

Significant reductions will be seen in the pollutants that are discharged to the natural streams due to the stringent water quality targets that have been adopted in this WCMS. The results of the water quality assessment shows that while the targets outlined in Council's Integrated Water Management Strategy (IWMS) have not been achieved, a solution has been provided that protects the pristine waterways by ensuring a significant reduction in the existing pollutants discharging to the downstream environment. This outcome is highlighted by the neutral or beneficial effect that has been achieved in the water quality solution which aligns with the objectives of Councils Integrated Water Management Policy (IWMP).

It is important to note that the NorBE targets which will also be achieved at Appin (Part 2) Precinct are normally applied to catchments discharging to the Sydney Drinking Water Catchment. NorBE targets are more stringent than the typical objectives of other growth areas in NSW (such as the North West and South West Growth Centres) and current standard industry practice. The typical targets for water quality in these areas generally involve achieving a pollutant load reduction (TN 45%, TP 65% and TSS 85%) from the developed catchment (without consideration of the existing loads). Therefore, the pollutant load removal and pollutant concentration reduction that will be achieved in Appin (Part 2) Precinct exceeds the standards of most developments across NSW and will result in a net reduction in pollutant impacts to the natural systems downstream of the site compared to the current land uses. This is aligned with the objectives outlined in Councils Integrated Water Management Policy.

5.3.4 Rainwater Tank Demand

It is understood that the water servicing strategy for Appin (Part 2) Precinct may include a recycled water scheme (purple pipe) to residential dwellings. It is anticipated purple pipes can be delivered in conjunction with the rainwater tanks and fill the reuse demand not met by the rainwater tanks alone.

The rainwater tank supply and demand for the residential catchment modelled in the MUSIC model is summarised in Table 5-4.

Table 5-4 – Rainwater Tanks Supply and Demand

	ML/yr	L/day/dwelling
Reuse Supplied	17.7	224
Reuse Requested	70.9	896
Shortfall (potable demand)	53.2	672
% Reuse Demand Met	25.0%	
% Reuse Demand Not Met	75.0%	

Table 5-4 shows that there is a 75% (53.2 ML/yr) shortfall of the available stormwater that could be reused for a typical 10 ha residential catchment. This means that there is an opportunity for Sydney Water's recycled water scheme to supply residential dwellings with an alternate water supply in order to meet the demands of households across the precinct and achieve a combined use system.

5.4. Stream Erosion Index

A Stream Erosion Index (SEI) assessment has been undertaken to ensure that the indicative treatment reduces the duration of post-development stream forming flows to no greater than the duration of pre-development stream forming flows. This is another requirement set out in the Wilton Growth Area DCP (2021) which gives a potential indication of the future development controls which may pertain to this site. The target specified in the Wilton Growth Area DCP is 1.0.

The modelling setup to assess the SEI has remained consistent with the assumptions and parameters that are outlined in Section 5.1.

The MUSIC modelling guidelines require the stream forming flow for the site to be determined using either the Probabilistic Rational Method (PRM) or Flood Frequency Analysis. As there are no stream gauge records available for Appin (Part 2) Precinct, the PRM method has been adopted. We note that the Rational method is no longer considered valid under the Australian Rainfall and Runoff (ARR 2019) guideline, however, we have utilised this method in accordance with Council's Design Specifications (2016) as the modelled catchments are classified as 'relatively small (approximately 10 ha)'.

The SEI for the typical catchment has been assessed against a range of downstream environment conditions. Specifically, the impacts of urbanisation on different soil types in the receiving creeks have been assessed. Given that the downstream conditions of all the receiving creeks are unknown at this stage, the SEI has considered the various soil conditions and the stream forming flow magnitudes (critical flows) for each soil type. The critical flows have been adopted in accordance with the NSW MUSIC Modelling Guidelines (2015). At the future DA stage, the receiving environments will be subject to separate and detailed environmental/ecological investigations to determine the sensitivity of the creek systems that the development will discharge to.

A summary table of the SEI assessment and results is provided in Table 5-5 and Table 5-6, respectively.

Table 5-5 – SEI Calculations

			Determination of Critical Flow					
Catchment	**Soil Type**	**Critical Flow**	**Area (km^2)**	**t_c (minutes)**	**I_2 (mm/hr)**	**C_2**	**Q_2 (m^3/s)**	**Q_{crit} (m^3/s)**
Low Density	Silty clays	25% of 2 year ARI flow	0.10	15	76.1	0.444	0.94	0.23
Low Density	Medium-heavy clays	50% of 2 year ARI flow	0.10	15	76.1	0.444	0.94	0.47
Low Density	Bedrock (assumed)	100% of 2 year ARI flow	0.10	15	76.1	0.444	0.94	0.94

Table 5-6 – SEI Results

			Stream Erosion Index		
Catchment	**Soil Type**	**Critical Flow**	**Pre Dev Outflow (ML/yr)**	**Post Dev Outflow (ML/yr)**	**SEI**
Low Density	Silty clays	25% of 2 year ARI flow	7.11	4.41	0.62
Low Density	Medium-heavy clays	50% of 2 year ARI flow	3.28	1.76	0.54
Low Density	Bedrock (assumed)	100% of 2 year ARI flow	0.82	0.36	0.44

The SEI results indicate that the proposed stormwater quality treatment train will ensure that the duration of post development stream forming flows would be no greater than the duration of existing conditions stream forming flows which is a requirement specified in the Wilton Growth Area DCP (2021). This is true for the various soil types that are likely to be present across the site. Notwithstanding this assessment, all development applications should undertake an SEI assessment at the design stage to confirm that the statutory SEI requirements are achieved for the specific site conditions.

5.5. Construction Stage

Erosion and sediment control measures across the site are an essential component that must be implemented during the construction phase in accordance with the requirements of Council and the guidelines set out in the "Blue Book" (2004).

The indicative treatment train for Appin (Part 2) Precinct includes 'bio-retention' (raingarden) water quality treatment systems which are sensitive to the impact of sedimentation. Thus, it is recommended that construction phase controls should generally be maintained until the majority of site building works (approximately 80% of the stormwater catchment) are complete to ensure the longevity of the devices.

5.6. Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish and monitor plant establishment and health (for raingardens). Some sediment build-up may occur on the surface of the raingardens and may require removal to maintain the high standard of stormwater treatment. Regular management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. It is strongly recommended that a site-specific Operation and Maintenance (O & M) Manual is prepared for the system as part of future Development Applications. The O & M manual will provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual will provide site-specific management procedures for:

- Maintenance of the GPT structures including rubbish and sediment removal;
- Management of the raingarden including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal); and
- Indicative costing of maintenance over the life of the device.

6. WATER QUANTITY ASSESSMENT

The water quantity assessment for Appin (Part 2) Precinct has been undertaken using modelling previously undertaken in the Appin (Part) Precinct Water Cycle Management Strategy. This modelling was undertaken using AR&R 2019 methodologies within XP-RAFTS hydrologic modelling software. For full details of the modelling assumptions and outcomes, refer to the Appin (Part) Precinct Water Cycle Management Strategy Report (JWP, 2022).

The water quantity modelling undertaken to support the Appin (Part) Precinct determined that flows are not detrimentally increased in the major downstream watercourses (Nepean River and Cataract River) as a result of the development. Some local flow increases were observed within the local catchments of the site; however, these increases were generally located within the proposed environmental conservation areas. Once these flows reach the main waterways (Nepean and Cataract River), the localised increases are combined with flows from a significant larger catchment and do not result in overall flow increases.

Given that there is no increase in flows within the major watercourses, it was determined that a merit-based detention approach is considered suitable for further investigation as the staged delivery of the Precinct occurs. Given the locality of the Appin (Part 2) Precinct (near the Appin (Part) Precinct) the same approach is proposed to be applied to detention.

The following section describes how the merit-based approach would be applied for the precinct.

6.1. Merit Based Detention Approach

The detention basin approach for the Appin (Part 2) Precinct will involve a merit-based approach in applying detention to the urbanised catchments of the site. The hydrologic assessment that was undertaken in the Appin (Part) Precinct Water Cycle Management Strategy (JWP, 2022) for the ultimate site demonstrated that the urbanisation of the precinct does not have a reportable flow impact in the receiving rivers. It is expected that the extension of this development area to include Appin (Part 2) Precinct would also demonstrate the same outcome. However, due to the localised increases that will occur within the rezoning site (mostly within the environmental conservation areas) it is proposed that a considered investigation is undertaken in conjunction with the delivery of future neighbourhood plans to determine the level of sensitivity in the receiving environments. Table 6-1 outlines the different detention approaches that are intended to be applied to each stage of the Appin (Part) Precinct and also now the Appin (Part 2) Precinct.

Table 6-1 – Detention Management Approach Matrix

Watercourse Order (Strahler)	Sensitive Habitat / Vegetation Downstream	Existing Stream Condition	Management Approach
1st order	Yes	Stable, bedrock foundation	No detention
		Unstable	Detention required (BAU)
	No	Stable, bedrock foundation	No detention
		Unstable	Further assessment required. Partial Detention Likely
2nd order	Yes	Stable, bedrock foundation	Further assessment required. Partial Detention Likely
		Unstable	Detention required (BAU)
	No	Stable, bedrock foundation	No detention
		Unstable	Further assessment required. Partial Detention Likely
3rd order	Yes	Stable, bedrock foundation	Further assessment required. Partial Detention Likely
		Unstable	Detention required (BAU)
	No	Stable, bedrock foundation	No detention
		Unstable	Further assessment required. Partial Detention Likely

As shown in Plate 1-1, the Appin (Part 2) Precinct comprises of two (2) portions of land, “Dunbier Land” and “Kings Land”. The Dunbier Land is bisected by a ridgeline and discharges to both Elladale Creek to the west and Ousedale Creek to the east. Kings Land discharges wholly to Ousedale Creek. Ousedale Creek is a perennial 3rd order watercourse that is considered to be a well-established riparian corridor. Preliminary investigation of the watercourse indicates that the bed and banks are likely to be susceptible to erosion caused by substantial stormwater runoff. Based on these details and the matrix shown in Table 6-1, the detention management approach for the catchments draining to Ousedale Creek includes full detention management via the provision of strategically located online and offline basins.

The western portion of the Dunbier Land discharges to environmental conservation areas which contain large gorges, and which consist of predominantly hard rock stream beds and banks. These areas are proposed to remain undetained due to this resilient environment existing downstream of the development edge. These undetained catchments will still require water quality management devices (bioretention raingardens) which will provide frequent/regular flow management in accordance with stream erosion index and mean annual runoff volume targets.

6.2. Proposed Detention

The detention requirements for the proposed site has been determined with consideration of the detention outcomes of the Appin (Part) Precinct strategy. In the Appin (Part) Precinct strategy it was determined that six (6) detention basins would be required to manage catchments in Release Area 1 which discharge to Ousedale Creek. The six (6) detention basins were sized at an average of 350 m³/ha which has been adopted for the indicative detention basins for Appin (Part 2) Precinct. Refer to Plate 6-1 for an illustration of the indicative basin locations and Table 6-2 for indicative basin sizes.

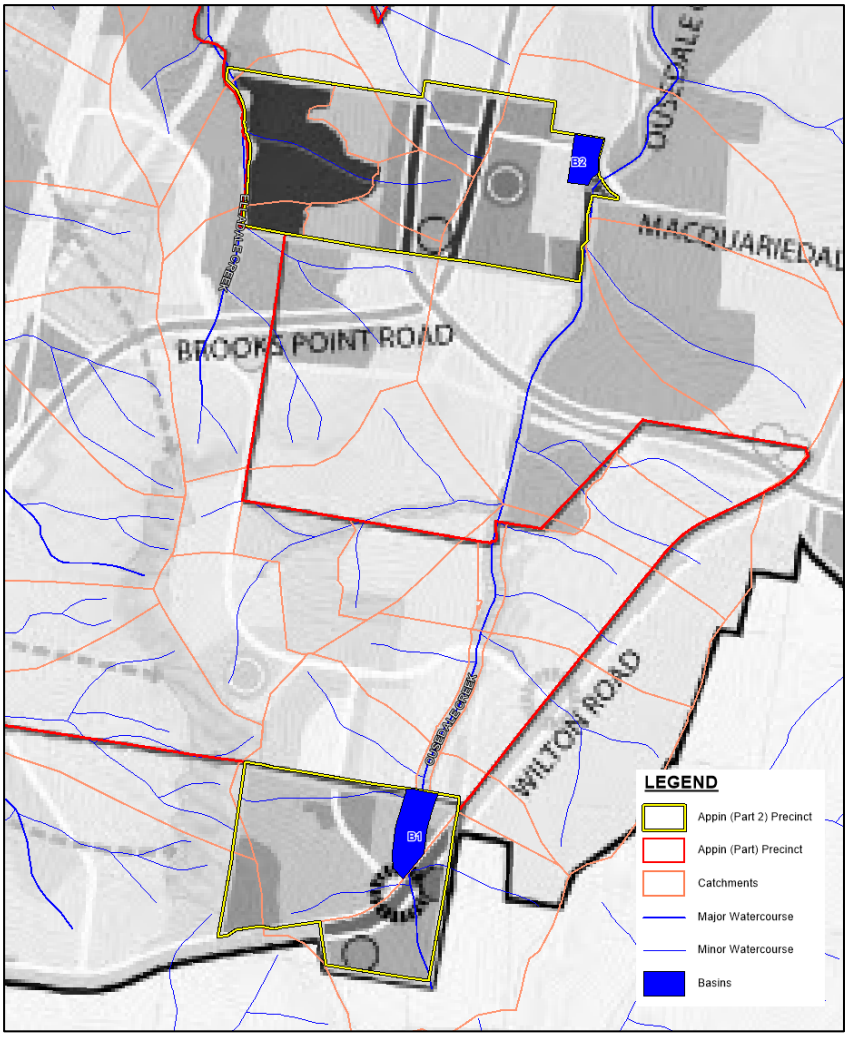


Plate 6-1 – Indicative Basin Locations

Table 6-2 – Indicative Basin Sizes

Basin	Storage Required (m^3)	Approx Footprint (m^2)
B1	19,300	34,470
B2	7,500	13,400

It is noted that as the development of the Appin (Part) Precinct Release Area 1 immediately downstream is progressed, alternative detention strategies will be explored which will aim to consolidate and reduce the number of basins required in Ousedale Creek. This will increase the efficiencies of the proposed basins while reducing future maintenance burdens for Council. It is expected that a consolidated basin approach can be achieved which removes the need for the basin “B1” which is currently situated on Kings Land. Detailed modelling will be undertaken as part of future development applications to demonstrate that a consolidated approach is achievable for the Ousedale Creek catchments.

7. FLOODING

The “Wollondilly Shire Flood Study – Broad Scale Assessment” (the Flood Study) was prepared by Advisian on behalf of Wollondilly Shire Council in October 2021 to provide understanding of the existing flood risk across the LGA. The Flood Study provides a basis from which flood planning controls can be applied to the proposed Appin (Part 2) Precinct.

The Flood Study assesses a range of flood events including the 10% AEP, 1% AEP, 1 in 500 AEP and PMF. In the vicinity of the Appin (Part 2) Precinct the flood mapping shows that the flood extents are contained in the well-defined creeks that traverse and are adjacent to the site. Wollondilly Shire Council’s flood mapping portal has been used to produce flood mapping in the vicinity of the Appin (Part 2) Precinct. The 1% AEP flood depths are shown in Plate 8-1 and the PMF flood depths are shown in Plate 8-2.

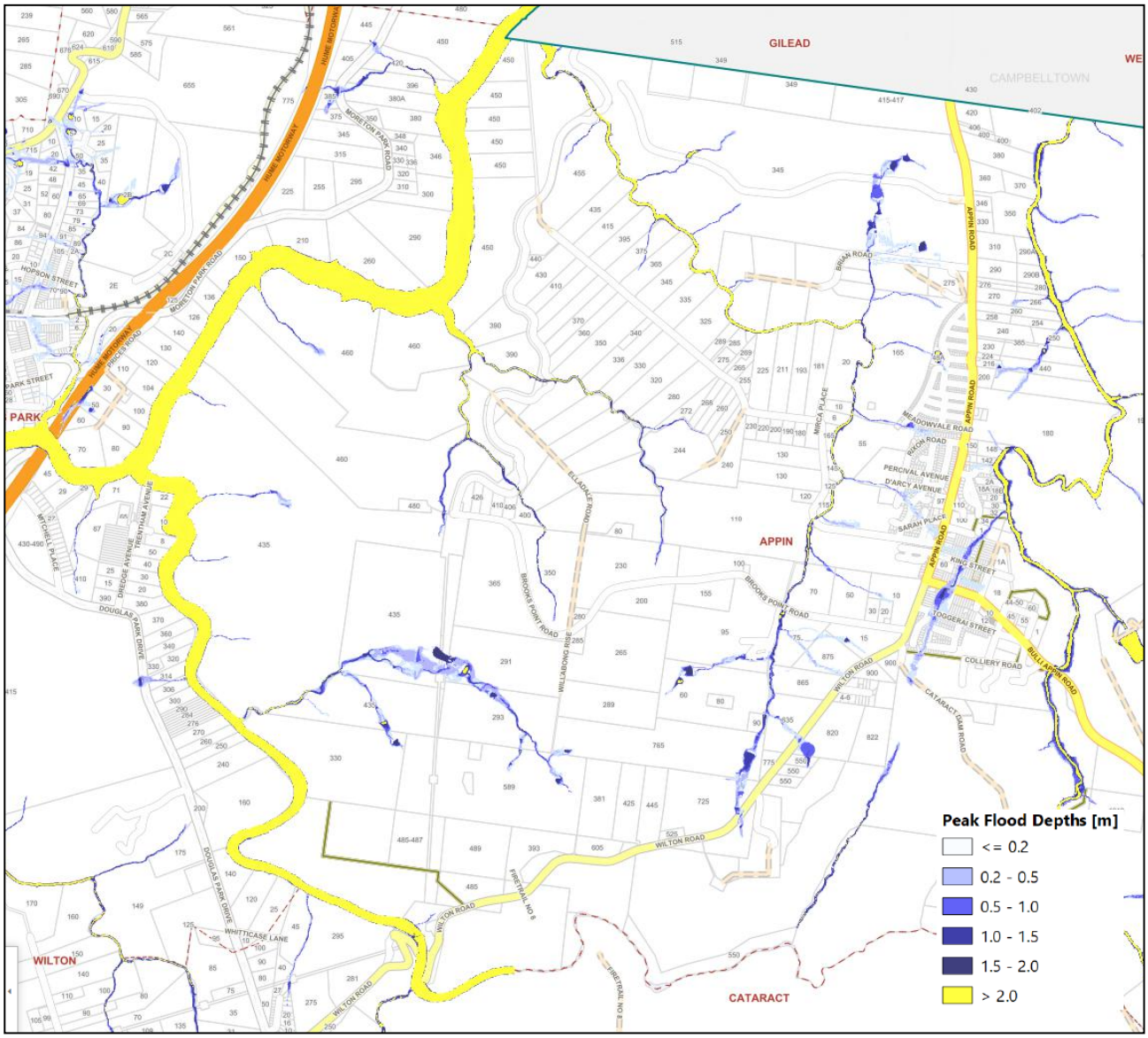


Plate 7-1 – 1% AEP Flood Depth Mapping (Wollondilly Online Mapping System)

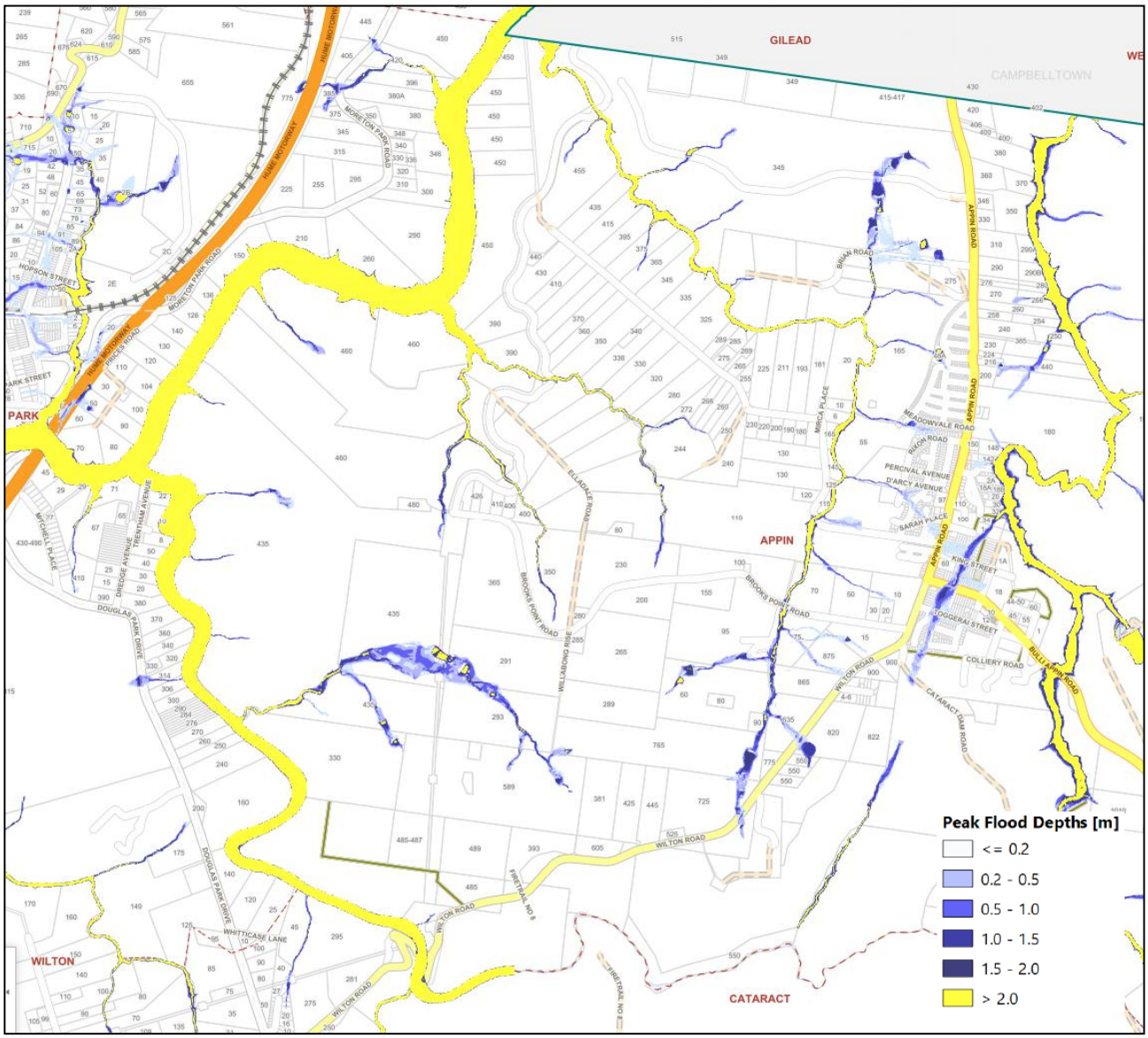


Plate 7-2 – PMF Flood Depth Mapping (Wollondilly Online Mapping System)

The nature of the site is such that the development catchments will drain directly to Elladale Creek and Ousedale Creek. The Flood Study mapping shows that flooding within these creeks is well contained within the riparian corridors suggesting that the development of Appin (Part 2) Precinct will not be impacted during a major flooding event. As such, it was considered that detailed post development hydraulic flood assessment is not required at this stage.

8. REFERENCES

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9. Wollondilly Shire Council (2020), Integrated Water Management Strategy, prepared by Wave Consulting

10. Wollondilly Shire Council (2020), Memo: MUSIC Template, prepared by Wave Consulting

11. Wollondilly Shire Council (2020), Integrated Water Management Policy

12. J. Wyndham Prince (2021), Appin (Part) Precinct Water Cycle Management Strategy

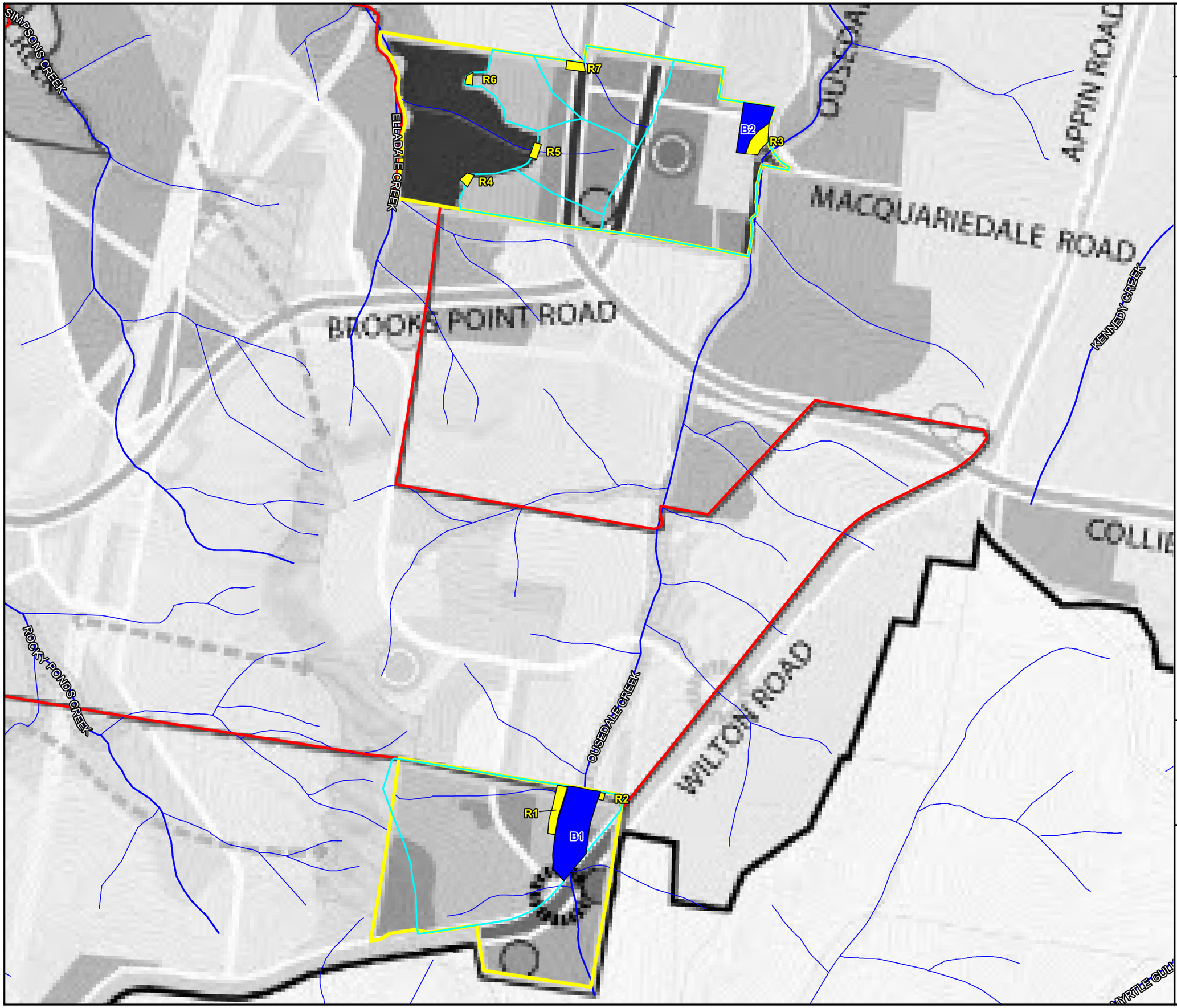
13. Natural Resources Access Regulator (2018), Guidelines for controlled activities on waterfront land - Riparian corridors

9. GLOSSARY

Term	Definition
Annual Exceedance Probability (AEP)	The chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually. Normally expressed as a percentage.
Australian Rainfall and Runoff (AR&R)	Refers to the current edition of Australian Rainfall and Runoff published by the Institution of Engineers, Australia.
Exceedances per Year (EY)	The number of times a year that statistically a storm flow is exceeded.
Floodplain Planning Level (FPL)	The FPL is a height used to set floor levels for property development in flood-prone areas. It is generally defined as the 1% AEP flood level plus 0.5m freeboard.
Floodplain Development Manual (FDM) and Guidelines (April 2005)	The FDM is a document issued by the Department of Environment Climate Change and Water (DECCW) that provides a strategic approach to floodplain management. The guidelines have been issued by the NSW Department of Planning (DoP) to clarify issues regarding the setting of FPL's. This document is also the framework for the development of Floodplain Risk Management Studies and Plans.
Hydrograph	Is a graph that shows how the stormwater discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
J. Wyndham Prince Pty Ltd (JWP)	Consulting Civil Infrastructure Engineers and Project Managers undertaking these investigations
MUSIC	A modelling package designed to help urban stormwater professionals visualise possible strategies to tackle urban stormwater hydrology and pollution impacts. MUSIC stands for Model for Urban Stormwater Improvement Conceptualisation and has been developed by the Cooperative Research Centre (CRC),
Peak Discharge	Is the maximum stormwater runoff that occurs during a flood event
Probable Maximum Flood (PMF)	The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.

Term	Definition
TUFLOW	A computer program that provides two-dimensional (2D) and one dimensional (1D) solutions of the free surface flow equations to simulate flood and tidal wave propagation. It is specifically beneficial where the hydrodynamic behaviour, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.
XP-RAFTS	Is a runoff routing model that uses the Laurenson non-linear runoff routing procedure to develop a sub catchment stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns as well as standard AR&R 1987 data.

APPENDIX A – FIGURES



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LEGEND

- Appin (Part 2) Precinct
- Appin (Part) Precinct
- Appin & North Appin Precinct
- Catchments
- Major Watercourse
- Minor Watercourse
- Raingardens
- Basins

Note:
Device footprints are indicative and subj to future detailed design

N

0 440
metres
Scale 1:11,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 1-1

Appin (Part 2) Precinct: Water Cycle Management Strategy

Water Cycle Management Plan

Date: 8/10/2024 Issue: C

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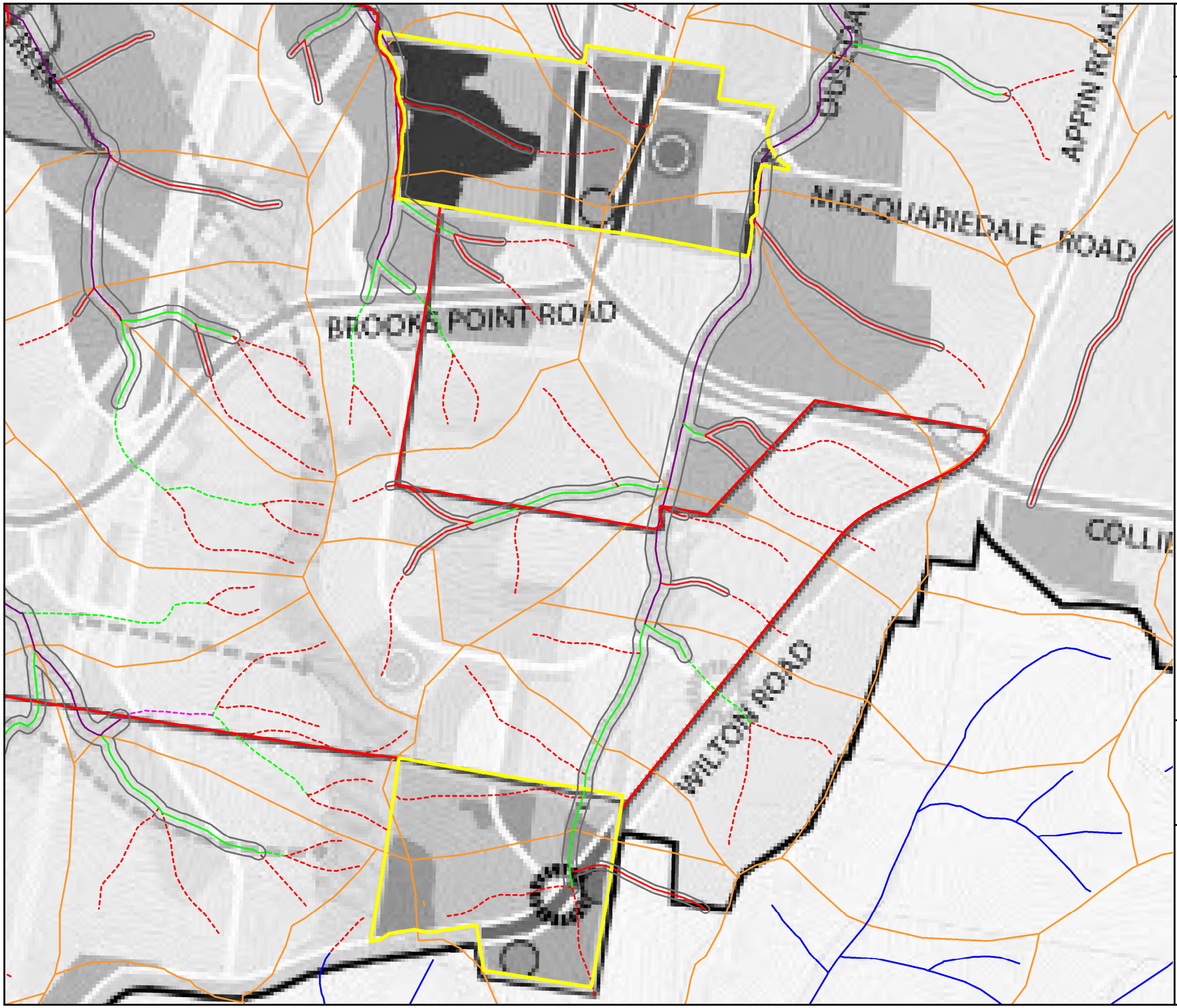

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LEGEND

- Appin (Part 2) Precinct
- Appin (Part) Precinct
- Appin & North Appin Precinct
- External Watercourse
- Existing Catchments
- Vegetated Riparian Zone (VRZ)

STRAHLER STREAM ORDER

- 1st Order Watercourse (10m VRZ Buffer)
- 2nd Order Watercourse (20m VRZ Buffer)
- 3rd Order Watercourse (30m VRZ Buffer)
- 4th Order Watercourse (40m VRZ Buffer)

PROPOSED FOR REMOVAL

- 1st Order Watercourse (10m VRZ Buffer)
- 2nd Order Watercourse (20m VRZ Buffer)
- 3rd Order Watercourse (30m VRZ Buffer)

NOTES

- Creek beds assumed to be 5 metres in width for the purpose of VRZ buffer calculations

N

0 440
metres
Scale 1:11,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 4-1

Appin (Part 2) Precinct: Water Cycle Management Strategy

Riparian Assessment Plan

Date: 8/10/2024 Issue: C

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APPENDIX B - MUSIC MODEL DATA

Modelling Inputs and Assumptions

The proposed rezoning area of the West Appin Precinct is intersected by a series of existing watercourses, many of which are located within environmental conservation areas within the site. In accordance with the Guidelines for controlled activities on waterfront land (NRAR, 2018), the watercourses have each been identified to range between 1st to 4th order riparian corridors based on the Strahler classification system using available 1:25,000 topographic maps. The guidelines state that where a watercourse does not exhibit the features of a defined channel with bed and banks, the NRAR may determine that the watercourse is not waterfront land for the purposes of the Water Management Act (2000) (WM Act).

The MUSIC Modelling has used a series of default assumptions and parameters consistent with NSW MUSIC Modelling Guidelines (WBM BMT, 2015). Details are provided below.

- Commercial areas are assumed to provide on-lot stormwater quality treatment measures that achieve statutory pollutant removal targets prior to discharge to the regional system;
- The MUSIC model catchments have been split into the roof, driveways, road, urban previous and urban impervious;
- The soil / groundwater parameters and pollutant loading rates adopted for all “source nodes” in the modelling are based on the recommended parameters in the NSW MUSIC Modelling Guidelines (2015). 'Light Clay' parameters have been adopted from the guidelines which is consistent with the desktop geotechnical study undertaken by Douglas Partners for the wider Wilton Junction site which is adjacent to the West Appin Precinct.

Rainfall & Evapotranspiration Data

The MUSIC model is able to utilise rainfall data based on 6 minute, hourly, 6 hourly and daily time steps. In accordance with the recommendations from the Memo: MUSIC Template prepared by Wave Consulting on behalf of Wollondilly Shire Council (2020), a 6 minute rainfall data set has been selected from the Rookwood Station (no. 066164).

The 6 minute data obtained for Rookwood Station between the years 1975 – 1984 was analysed and found to be a fair representation of the long term statistical data for the mean annual rainfall within Wollondilly Shire and was therefore adopted in this study.

The evapotranspiration data used in the mode was also source from those suggested in Councils MUSIC Template. The evapotranspiration data used in the modelling is summarised in Table C-1 below.

The rainfall and evapo-transpiration data for the period analysed is shown on the graph which is provided in Plate C-1 below.

Table C-1 – Daily mean PET data

Month	Daily Mean PET (mm)
January	5.35
February	4.63
March	3.85
April	2.55
May	1.58
June	1.27
July	1.28
August	1.83
September	2.68
October	4.00
November	4.78
December	5.18

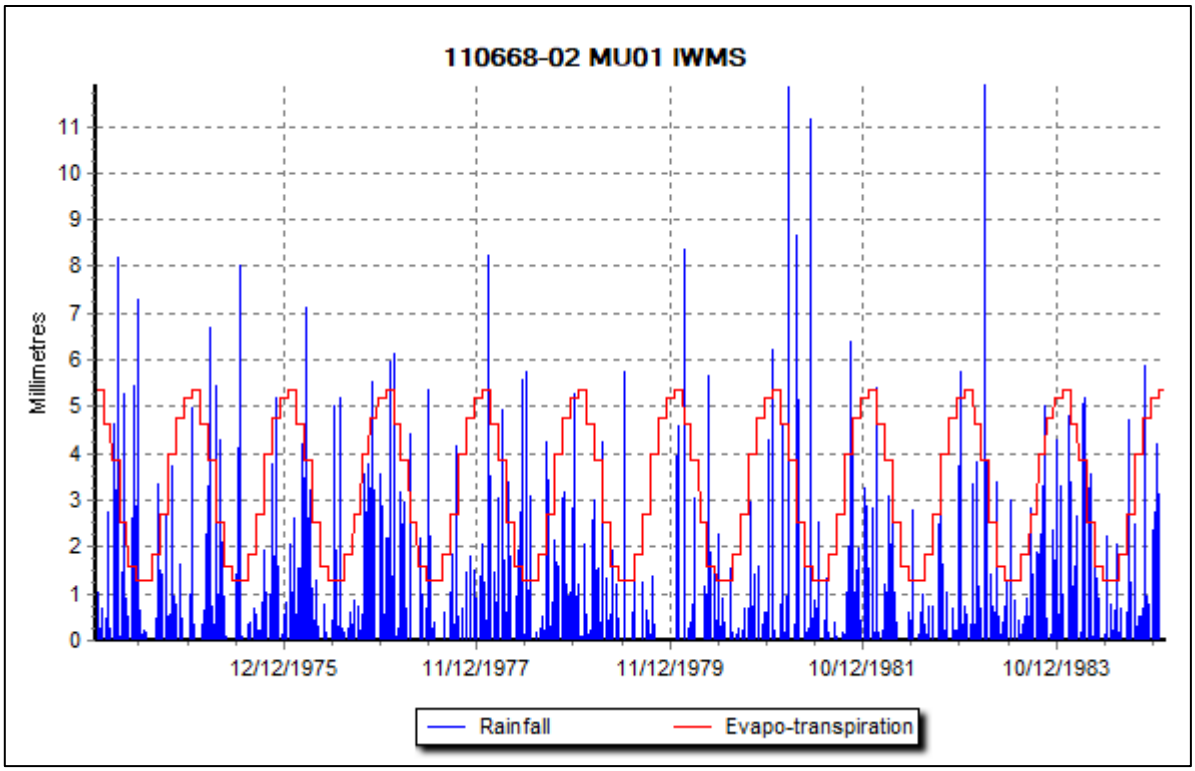


Plate C-1 – Rainfall and Evapo-transpiration Data for Rookwood Station

MUSIC MODELLING WORKSHEET Input
West Appin - IWMS WQ Assessment MUSIC Input
110668-02 MU02 IWMS.sqz

	Catchment Division						Node Inputs Catchment Split for MUSIC							
Catchment	**Total Catchment Area (ha)**	**Lot Area (ha)**	**R2 No. of Lots**	**Avg Lot Size (m²)**	**Road Reserve Area (ha)**	**Active Open Space**	**Road Impervious (ha)**	**Driveways (ha)**	**Roof to Tank (ha)**	**Roof bypass (ha)**	**Other Impervious (ha)**	**Pervious (ha)**	**Road Pervious (ha)**	**Effective % Impervious**
Typical 10 ha Low-Density	10.000	6.500	217	300	3.000	0.500	2.100	0.325	3.250		0.375	3.950	--	61%

	Node Inputs Rainwater Tanks					
Catchment	**Hi Flow Bypass**	**Equivalent Pipe dia (mm)**	**Daily Demand (kL)**	**Annual Demand (kL/yr)**	**Total Tank Volume (m^3)**	**Tank Surface Area (m^2)**
Low Density Residential	1.679	737	195.3	0	868.0	368.9

	Cat. Area (ha)	**Treatable Flow Calculation**				
		Flow Path Length (m)	**Tc* (min)**	**%Imperv.**	**1yr Flow (m^3/s)**	**3mth Flow (m^3/s)**
GPT Treatable flow (low density)	10.000	300	6	61%	1.231	0.640

*Tc calculated based on Kinematic wave equation for a typical lot plus flowpath travel time @ 2 m/s

	RWT	
Overflow Pipe Diameter	50	mm
PET - Rain for landscape area		L/m²/day
Assumed daily demand	900	L/day
Adopted tank size	5	kL
Assumed 80% is usable (w/o topups)	80	%
Useable tank	4	kL
Tank surface area per dwelling	1.7	m2
I5min/10yr	186	mm/hr

%Impervious	
R2 Lots	60%
Commercial	90%
Road Reserve	70%
Active Open Space	10%

% Breakdown Low Density		**% Breakdown Commercial**	
Roof	50%	Roof	60%
Driveways	5%	Driveways	20%
Other Impervious	5%	Other Impervious	10%
Pervious Areas	40%	Pervious Areas	10%

Water Quality Management Measures

Details as to the Gross Pollutant Traps and Bioretention Raingarden are provided below.

Gross Pollutant Traps

Gross Pollutant Traps (GPTs) have been provided to filter stormwater prior to discharge into the bioretention raingardens. A generic GPT has been adopted with the pollutant removal rates as specified in Table C-2.

Table C-2 – GPT Input Parameters

Pollutant	Input	Output
TSS (mg/L)	0	0
	100	100
TP (mg/L)	0	0
	100	100
TN (mg/L)	0	0
	50	50
GP (kg/ML)	0	0
	100	2

A 4 EY (3-month ARI) treatable flow rate has been adopted. A high flow bypass link within the MUSIC model reflects flows in excess of the treatable flow bypassing both the bio-retention raingarden and GPT. The final hydraulic arrangement for each device will be subject to a detailed design process to support the future development application.

Bioretention Raingarden

The design parameters adopted for the bioretention raingarden are shown in Table C-3. The filter media receives flow having firstly being treated by the GPT at each outlet.

Table C-3 – Raingarden Input Parameters

Raingarden Parameter	10 ha Residential Catchment
High Flow Bypass (m^3/s)	100
Extended Detention Basin (m)	0.3
Surface Area (m^2)	1580
Filter Area (m^2)	1580
Filter Depth	0.5
Unlined Filter Media Perimeter (m)	0.01
Saturated Hydraulic Conductivity (mm/h)	100
TN Content of Filter Media (mg/kg)	400
Orthophosphate Content of Filter Media (mg/kg)	40
Exfiltration Rate (mm/hr)	0.36
Overflow Weir Width (m)	6.50
Base Lined	No
Vegetated with effective Nutrient removal Plants	Yes
Underdrain Present	Yes
Submerged Zone with Carbon Present	No

A8 Air Quality Opportunities & Constraints

Letter

Northstar Air Quality Pty Ltd | Suite 1504 | 275 Alfred Street | North Sydney | NSW 2060
Web: northstar-env.com | Tel: 1300 708 590
air quality | environment | sustainability

Date: Thursday, 3 October 2024

Walker Corporation
Level 21, Governor Macquarie Tower, 1 Farrer Place, Sydney NSW

FAO: Ahmad Ali

Project Name:	**Air Quality Opportunities and Constraints – Appin (Part 2)**
Reference:	**22.1101.FR2V4**
Status	**Final**

The following letter has been prepared by Northstar Air Quality Pty Ltd on behalf of Walker Corporation and provides an addendum to Northstar's Air Quality Opportunities and Constraints Review[1] following the addition of two new zones to the Proposal, known as Appin (Part 2).

If you require any further information or clarification, please do not hesitate to contact the undersigned at your convenience.

For and on behalf of

Northstar Air Quality Pty Ltd

Martin Doyle

Director & Air Quality Scientist

Reviewed by: Nicholas Phillips-Glyde

[1] Northstar Air Quality 2022 *Air Quality Opportunities and Constraints Review, Appin (Part) Precinct Plan reference 22.1101.FR1V4, dated 7 October 2022*

1. INTRODUCTION

This letter provides an addendum to the Air Quality Opportunities and Constraints Review prepared by Northstar (22.1101.FR1V4, dated 7 October 2022, see Attachment A) to support the Appin (Part) Precinct Plan (the Precinct Plan) and Appin (Part) Precinct Structure Plan (the Structure Plan).

This addendum has been prepared to assess any additional or revised opportunities or constraints relating to the addition of two new zones (known as Appin [Part 2]) to the Appin (Part 1) Boundary. A location of the Appin (Part 2) boundary is shown in Figure 1, along with the Appin (Part) boundary.

1.1. The Proposal

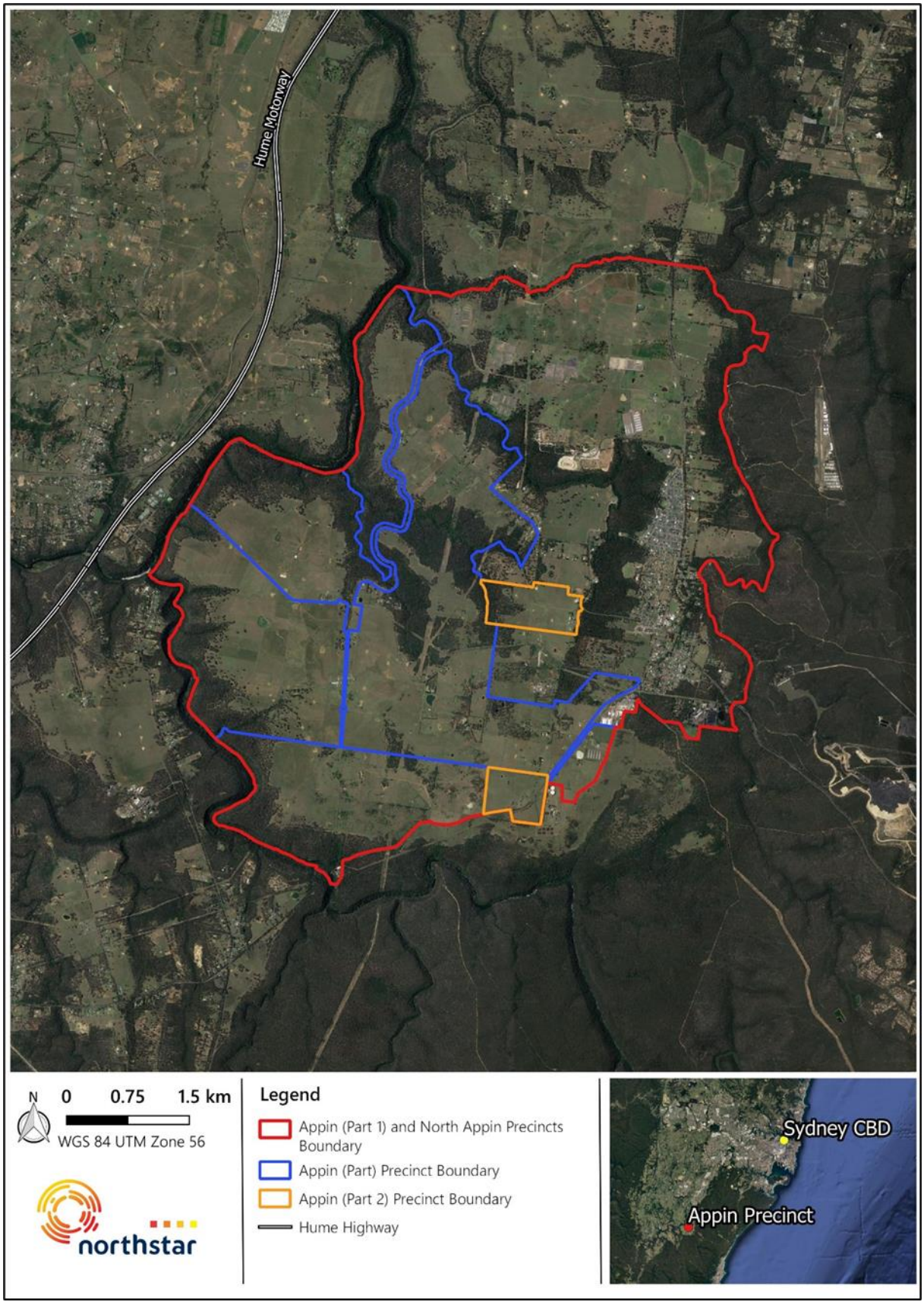
The Appin (Part 2) Precinct Plan shows the proposed new zones. The Appin (Part 2) Precinct Plan will be incorporated into the *State Environmental Planning Policy* (Precincts – Western Parkland City) 2021 and contain the provisions (clauses and maps) that will apply to the Site. The Appin (Part 2) Precinct Plan envisages the delivery of the following:

- 1 312 dwellings (as a mix of low-density, medium density and apartments);
- 30 312 square meters (m^2) of gross lettable retail/commercial floor area; and
- 16.91 hectares (ha) conservation land.

The planning proposal submission is aligned with strategic land use planning, State and local government policies, infrastructure delivery and PP-2022-3979. The development potential is tempered by a landscape-based approach that protects the environment and landscape values, shaping the character of new communities. A series of residential neighbourhoods are to be delivered within the landscape corridors of the Nepean and Cataract Rivers, supported by local amenities, transit corridors and community infrastructure.

The Appin (Part 2) Precinct Plan zones land for conservation and urban development. It establishes the statutory planning framework permitting the delivery of a range of residential typologies, retail, education, business premises, recreation areas, and infrastructure services and provides development standards that development must fulfil. Within the proposed urban development zone, 1 312 dwellings and more than 30 000 m^2 of gross lettable floor area for retail and commercial space can be delivered.

Figure 1 Site location



Source: Northstar

2. BACKGROUND

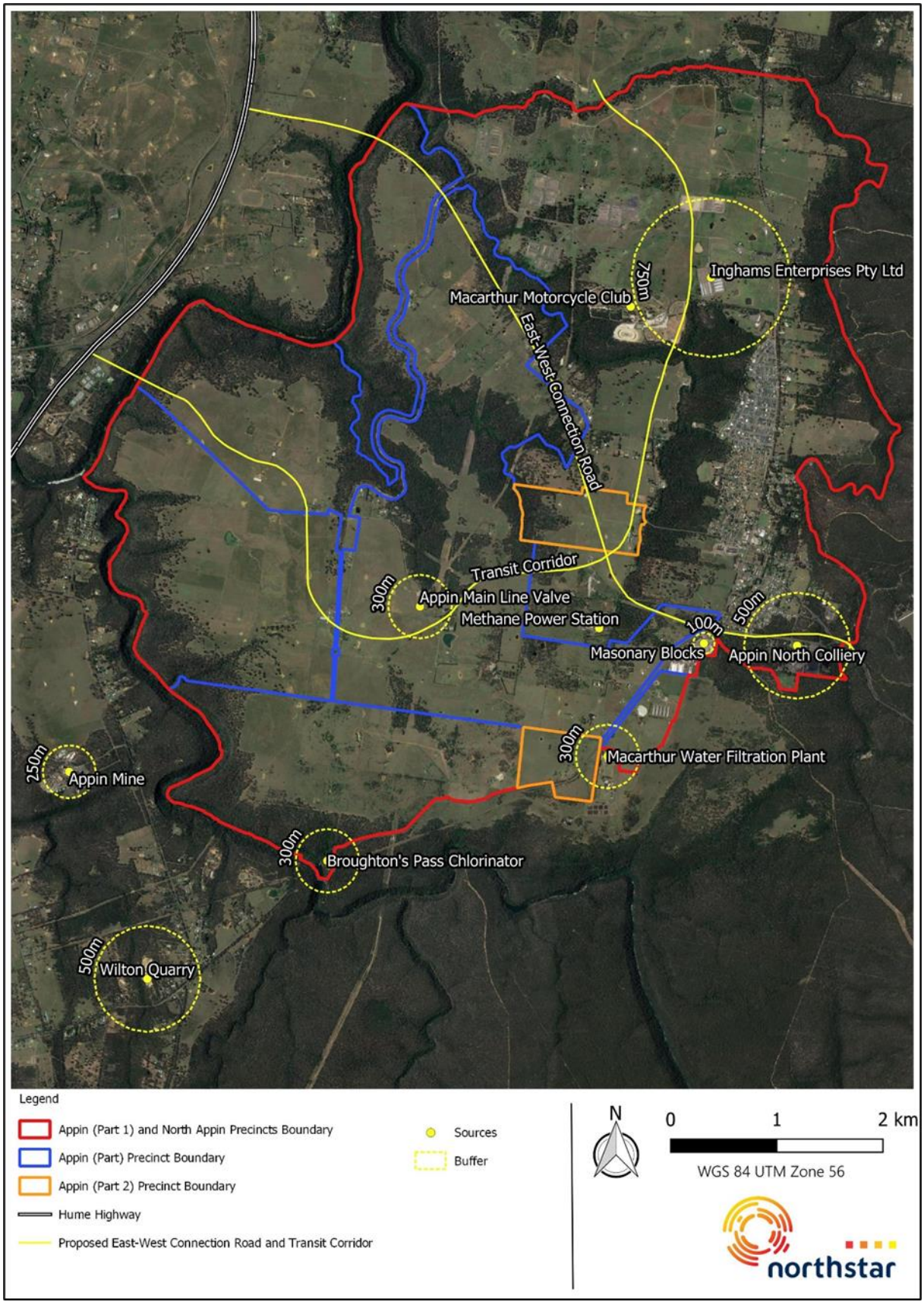
An assessment of published separation distances from existing or potential future sources to existing or future locations for sensitive land uses was undertaken in the Air Quality Opportunities and Constraints Review to determine potential air quality impacts or risks of the Proposal. A review of the land uses and activities in the vicinity of the Proposal site was undertaken through a desktop mapping survey, online review of the relevant EPA Environment Protection Licence (EPL) register for facilities within proximity to the Proposal site and a search of relevant sources from the National Pollution Inventory (NPI) to determine potential sources of air (and odour) emissions within the vicinity of the Proposal site.

Through review of identified sources of air and odour emissions sources as outlined in Figure 2, those which had the potential to impact upon air quality at the Proposal site were identified.

Based on the assessment of separation distances, a number of facilities (main line gas valve, methane power station, water filtration plant and Hume Highway) were located within the adopted separation distances, having the potential to adversely impact on air quality and/or odour at the Proposal site. These facilities were subject to a risk assessment in order to understand the level of risk.

The high-level risk review demonstrated that medium (i.e. manageable) air quality risks were associated with identified sources located within the relevant recommended separation distances, and it was anticipated that with appropriate land use planning and design and consideration of the appropriate regulatory standards and guidelines, these risks would be further reduced.

Figure 2 Air quality sources and buffer distance



Source: Northstar

2.1. Assessment of Appin (Part 2)

Assessment of the additional new sites as part of Appin (Part 2) indicates the Macarthur water filtration plant to be within the recommended separation distance to the southern Part 2 zone, and the proposed East-West Connection Road and Transit Corridor running through a portion of the Appin (Part 2) northern zone (as shown in Figure 2).

Potential air quality impacts as a result of the operation of the water filtration plant relate to potential odour impacts resulting from the filtration process and water storage systems. A risk assessment for this facility has been undertaken as part of the Air Quality Opportunities and Constraints review, which determined that as that the plant treats raw fresh water from the nearby weir and does not treat sewage or associated wastewater, the potential risk is considered manageable. Furthermore, the wind direction taken from the nearby Campbelltown weather station indicates a predominant south westerly wind which is less likely to affect the Appin (Part 2) Precinct zone.

Potential air quality impacts as a result of the connection road and transit corridor relate to particulate matter and oxides of nitrogen resulting from vehicle movements on the road surface. While the neighbouring land uses adjacent to the proposed connection road and transit corridor are yet to be defined in detail, appropriate separation from the roadway would be expected within the planning and design stages. Appropriate setback distances from the roadway would be expected, in addition to a consideration of design measures to further ameliorate any potential air quality impacts, which would also be relevant for any identified acoustic issues. Based on the above, the proposed rezoning design and appropriate urban planning is considered adequate to manage identified potential hazards and manage potential risk associated with air quality and odour impacts.

3. CONCLUSION

A review using assessment of published separation distances from existing or potential future sources to existing or future locations for sensitive land uses was undertaken for the Appin (Part 2) precinct, which identified the Macarthur water filtration plant and the proposed East West Connection Road and Transit Corridor to be located within the recommended distance guidelines for the Part 2 sites.

Based on the high-level assessment undertaken for the Appin (Part 2) Precinct, it has been determined that the existing and proposed identified sources of air quality and odour will not alter the outcomes of the Air Quality Opportunities and Constraints review and correspondingly, will not form a significant constraint on the rezoning and proposed development of the Appin (Part 2) Precinct zones.

ATTACHMENT A

Air Quality Opportunities and Constraints Review

This document has been prepared for Walker Corporation by:

Northstar Air Quality Pty Ltd,
Suite 1504, 275 Alfred Street, North Sydney, NSW 2060

northstar-env.com | Tel: 1300 708 590

Air Quality Opportunities and Constraints Review

Appin (Part) Precinct Plan

Addressee(s):	Walker Corporation
Site Address:	Appin
Report Reference:	22.1101.FR1V4
Date:	7 October 2022
Status:	Revised Final

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	MD, LS	MD
THE PROPOSAL	Final	Northstar Air Quality	MD, LS	MD
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar Air Quality	MD, LS	MD
EXISTING ENVIRONMENT	Final	Northstar Air Quality	MD, LS	MD
METHODOLOGY	Final	Northstar Air Quality	MD, LS	MD
AIR POLLUTION EMISSION SOURCES	Final	Northstar Air Quality	MD, LS	MD
RISK ASSESSMENT	Final	Northstar Air Quality	MD, LS	MD
CONCLUSION	Final	Northstar Air Quality	MD, LS	MD

Report Status

Northstar References		Report Status	Report Reference	Version
22	1101	Revised Final	R1	V4
Based upon the above, the specific reference for this version of the report is:				22.1101.FR1V4

Final Authority

This report must by regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below.

Martin Doyle 7 October 2022

Non-Technical Summary

Northstar Air Quality Pty Ltd was engaged by Walker Corporation, to prepare an air quality constraints and opportunities assessment report for the proposed rezoning of Appin (Part) Precinct for urban development.

Appin (Part) Precinct occupies an area of approximately 1 300 hectares of land within the Appin Precinct. The Appin Precinct is the southernmost precinct of the Greater Macarthur Growth Area (GMGA).

A review was performed using assessment of published separation distances from existing or potential future sources of air emissions to existing or future locations of sensitive land uses.

The review and risk assessment identified a number of sources of air emissions located within the recommended separation distance guidelines. However, it is anticipated that with appropriate land use planning, the proposed rezoning design and consideration of appropriate regulatory standards and guidelines, identified potential hazards would be adequately managed and sufficiently reduced.

Based on the assessment undertaken, it has been determined that the existing and proposed identified sources of air emissions will not form a significant constraint on the rezoning and proposed development of the Proposal site.

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1. INTRODUCTION

Northstar Air Quality Pty Ltd (Northstar) have been engaged by the Proponent to prepare an air quality opportunities and constraints review to support the Appin (Part) Precinct Plan (the Precinct Plan) and Appin (Part) Precinct Structure Plan (the Structure Plan).

The precinct and structure plan boundaries are Wilton Road to the east, the Nepean River to the west and Ousedale Creek to the north, the boundaries of which are shown in Figure 1.

The Appin (Part) Precinct Plan zones land for conservation, urban development and infrastructure and establishes the statutory planning framework permitting the delivery of a range of residential typologies, retail, education, business premises, recreation areas, and infrastructure services and provide development standards that development must fulfil. Within the proposed urban development zone, 12 000+ dwellings can be delivered.

1.1. Purpose of the Report

The purpose of this high-level review is to review and identify potential constraints and potential opportunities associated with the proposed urban land use rezoning with respect to air quality and identify constraints from existing and proposed sources of emissions to air proximate to the proposed Appin (Part) Precinct site.

This report has been prepared to accompany a rezoning application for the Proposal site to be developed into a new urban community as outlined in Section 2.1.

1.2. Scope of Assessment

This report presents information and data that summarises and characterises the existing environmental conditions and identified potential air quality pollutants associated with both the existing and proposed nature of the Proposal. It examines the potential risk of both of these scenarios and provides commentary on the suitability (or otherwise) for the land to be rezoned for urban development land uses.

2. THE PROPOSAL

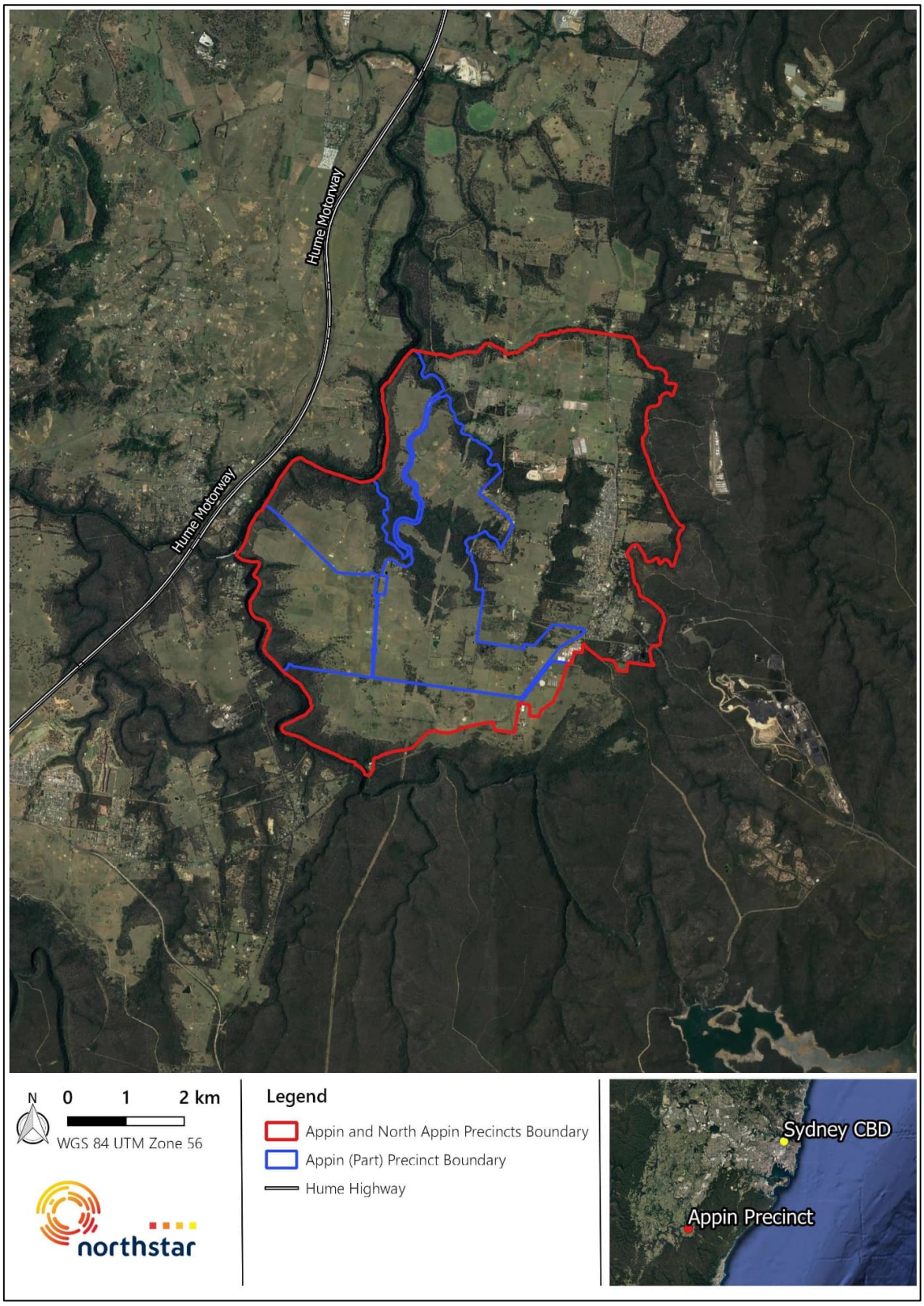
2.1. Environmental Setting

The Proponent is the landowner of approximately 1 400 ha of land located along Macquariedale Road, Appin in Southwestern Sydney. The Proposal site is located approximately 12 kilometres (km) south of Campbelltown and is predominantly bound by waterways, with Mallaty Creek to the north, Georges River to the east, Nepean River to the west and Cataract River to the south (see Figure 1) and is located predominantly within the Wollondilly Shire Council area. A portion at the northern end of the Proposal site lies within the Campbelltown Local Government Area (LGA).

The site is undulating in character and lies at an elevation of between 70 and 250 meters (m). The site is currently highly vegetated and features a number of steep secondary ridge lines. Vehicle access is currently limited with only a small number of existing roads. Along Appin Road is the existing Appin township with low density housing and a range of local community facilities, services and amenities. The remainder of the site is mostly largely grazing holdings.

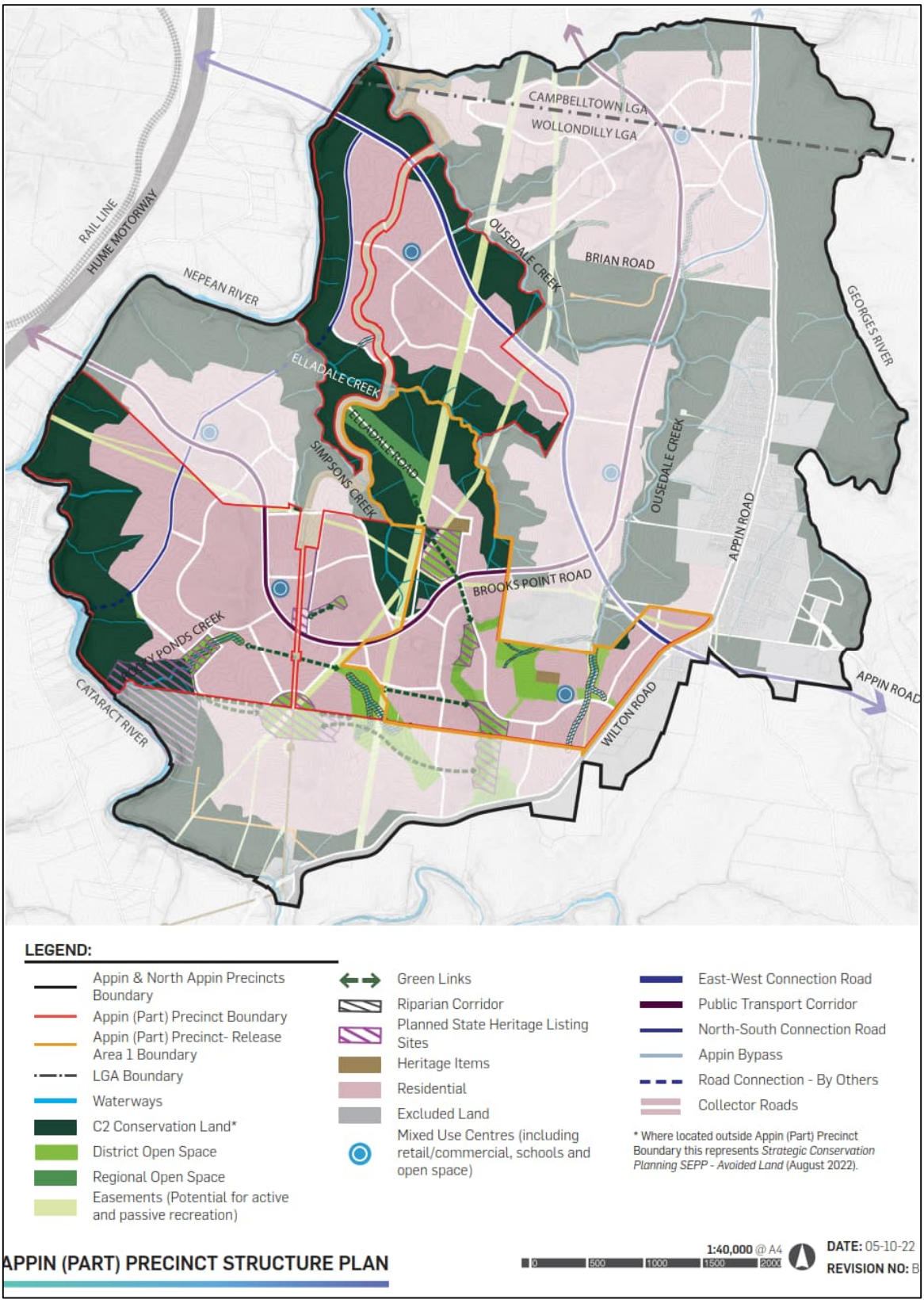
A proposed masterplan layout indicating the proposed land use types is presented in the structure plan in Figure 2.

Figure 1 Proposal Site Location



Source: Northstar Air Quality

Figure 2 Proposed structure plan



Source: Provided by Walker Corporation October 2022

2.2. Project Overview

The NSW Government has identified Growth Areas as major development areas that will assist in accommodating this growth. The Greater Macarthur Growth Area (GMGA) is one such growth area and is a logical extension of the urban form of south-west Sydney. The GMGA is divided into precincts. The Appin Precinct and North Appin Precincts are the southernmost land release precincts of the GMGA. The goal is to deliver 21 000+ dwellings.

The land is to be rezoned and released for development to achieve this goal. A submission has been prepared the Proponent to rezone 1 378 hectares of land within the Appin Precinct from RU2 Rural Landscape to the following zones:

- Urban Development Zone - Zone 1 Urban Development (UD)
- Special Purposes Zone - Zone SP2 Infrastructure (SP2)
- Conservation Zone - Zone C2 Environmental Conservation (C2)

The submission is aligned with strategic land use planning, State and local government policies and infrastructure delivery. The development potential is tempered by a landscape-based approach that protects the environment and landscape values, shaping the character of new communities. A series of residential neighbourhoods are to be delivered within the landscape corridors of the Nepean and Cataract Rivers, supported by local amenities, transit corridors and community infrastructure.

3. LEGISLATION, REGULATION AND GUIDANCE

3.1. NSW Government Air Quality Planning

NSW Environment Protection Authority (EPA) has formed a comprehensive strategy with the objective of driving improvements in air quality across the State. This comprises several drivers, including:

- Legislation: formed principally through the implementation of the Protection of the Environment Operations Act 1997, and the Protection of the Environment Operations (Clean Air) Regulations 2021. The overall objective of this legislative instruments is to achieve the requirements of the National Environment Protection (Ambient Air Quality) Measure;
- Clean Air for NSW: The 10-year plan for the improvement in air quality;
- Inter-agency Taskforce on Air Quality in NSW: a vehicle to co-ordinate cross-government incentives and action on air quality;
- Managing particles and improving air quality in NSW; and
- Diesel and marine emission management strategy.

In regard to the relevance of the NSW Government's drive to improve air quality across the State and this air quality assessment, it is imperative that this Proposal demonstrates leadership in the development of the NSW economy (in terms of activity and employment) and concomitantly not cause a detriment in achieving its objectives.

3.2. Air Quality Criteria – Criteria Air Pollutants

The NSW EPA document 'Approved Methods for the Modelling and Assessment of Air Quality in NSW' (NSW EPA, 2016) (the Approved Methods) lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Proposal. The criteria listed in the Approved Methods are derived from a range of sources (including National Health and Medical Research Council (NHMRC), National Environment Protection Council (NEPC), Department of Environment (DoE), World Health Organisation (WHO), and Australian and New Zealand Environment and Conservation Council (ANZECC)). The following criteria as set out in Section 7.1 of NSW EPA (2016) is outlined in Table 1 below for reference within this report.

Table 1 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units	Criterion	Notes
Nitrogen dioxide (NO_2)	1 hour	$\mu g \cdot m^{-3}$	246	Numerically equint to the AAQ NEPM[(b)] standards and goals.
	Annual	$\mu g \cdot m^{-3}$	62	
Particulates (as PM_{10})	24 hours	$\mu g \cdot m^{-3}$	50	

Pollutant	Averaging period	Units	Criterion	Notes
Particulates (as $PM_{2.5}$)	1 year	$\mu g \cdot m^{-3}$	25	
	24 hours	$\mu g \cdot m^{-3}$	25	
	1 year	$\mu g \cdot m^{-3}$	8	
Particulates (as Total Suspended Particulate)	1 year	$\mu g \cdot m^{-3}$	90	
Particulates (as dust deposition)	1-year[c]	$g \cdot m^{-2} \cdot month^{-1}$	2	Assessed as insoluble solids as defined by AS 3580.10.1
	1-year[d]	$g \cdot m^{-2} \cdot month^{-1}$	4	
Ozone (O_3)	1 hour	$\mu g \cdot m^{-3}$	214	
	4 hours	$\mu g \cdot m^{-3}$	171	

Notes: (a): micrograms per cubic metre of air
(b): National Environment Protection (Ambient Air Quality) Measure
(c): Maximum increase in deposited dust level
(d): Maximum total deposited dust level

Air quality criteria are not specifically adopted within this assessment but are presented for context.

3.3. Air Quality Criteria - Odour

Experience gained through odour assessments from proposed and existing facilities in NSW indicates that an odour performance goal of 7 OU is likely to represent the level below which "offensive" odours should not occur (for an individual with a 'standard sensitivity' to odours). Therefore, the Odour Technical Framework (DECC, 2006) recommends that, as a design goal, no individual be exposed to ambient odour levels of greater than 7 OU. In modelling and assessment terms, this is expressed as the 99th percentile value, as a nose response time average (approximately one second).

Odour assessment criteria need to consider the range in sensitivities to odours within the community to provide additional protection for individuals with a heightened response to odours. This is addressed in the Technical Framework (DECC, 2006) by setting a population dependant odour assessment criterion, and in this way, the odour assessment criterion allows for population size, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity. A summary of odour performance goals for various population sizes, as referenced in the Odour Technical Notes (DECC, 2006) is shown in Table 2. This table shows that in situations where the population of the affected community lies between 125 and 500 people, an odour assessment criterion of 4 OU at the nearest residence (existing or any likely future residences) is to be used. For isolated residences, an odour assessment criterion of 7 OU is appropriate.

Table 2 NSW EPA odour impact criterion

Population of affected community	Complex mixture of odours (OU)
Urban area (≥2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10 – 30	6.0
Single residence (≤2)	7.0

Source: The Odour Technical Notes, DECC 2006

3.3.1. Odour Control under the POEO Act

The *Protection of the Environment and Operations Act* 1997 (POEO Act) is applicable to scheduled activities in NSW and emphasises the importance of preventing 'offensive odour'. Although the operations at the Proposal site are non-scheduled activities under the POEO Regulations, they are regulated by Council and the principles contained within the POEO framework are applicable.

For reference, 'offensive odour' is defined within the POEO Act as:

> *an odour:*
> *(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:*
> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
> *(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.*

3.4. Greater Macarthur 2040

The Greater Macarthur 2040 plan (DPE, 2018) was developed as a land use and infrastructure implementation plan (LUIIP) to help set the vision for the planned Greater Macarthur Growth Area as it develops and changes. The plan is based on five themes that collectively encompass an area, as experienced by people: place; land use; movement; landscape and built form. Matters relating to air quality are found within the 'landscape' theme, which outlines relevant planning principles to consider as part of the development, relating to air quality.

The planning principles relevant to this review include:

- Set back residential and other sensitive uses, such as childcare centres and schools away from existing and likely future sources of air pollution, such as busy roads, with Annual Average Daily Traffic (AADT) flows, or likely AADT of above 20 000 movements, and rail corridors;
- Incorporate setbacks to minimise exposure and odours from agricultural uses; and
- Utilise best practice emissions controls to minimise air pollution from industrial and commercial uses.

The above have been considered within this review and how they may present limitations or otherwise on development types and locations within the Proposal site.

3.5. Child Care Centre Planning Guideline

The NSW Child Care Centre Planning Guideline (DP&E, 2017) is generally used to reference and inform appropriate design to maximise the safety, health and overall care of young children. Clause 28 of the Child Care Guidelines outlines the requirements for an air quality assessment to ensure that air quality is acceptable where childcare facilities are proposed close to external sources of air pollution such as major roads and industrial development. While there is no specific guidance on design of childcare centres within the ACT guidelines, other than prohibiting development within certain areas of the Proposal site, the NSW Guidelines may be referenced as a guide for the appropriate planning from an air quality perspective.

Clause 28 of the Child Care Guideline outlines the requirement for an air quality assessment to ensure that air quality is acceptable where childcare facilities are proposed close to external sources of air pollution such as major roads and industrial development:

> *A suitably qualified air quality professional should prepare an air quality assessment report to demonstrate that proposed child care facilities close to major roads or industrial developments can meet air quality standards in accordance with relevant legislation and guidelines. The air quality assessment report should evaluate design considerations to minimise air pollution such as:*

- *creating an appropriate separation distance between the facility and the pollution source. The location of play areas, sleeping areas and outdoor areas should be as far as practicable from the major source of air pollution*
- *using landscaping to act as a filter for air pollution generated by traffic and industry. Landscaping has the added benefit of improving aesthetics and minimising visual intrusion from an adjacent roadway*
- *incorporating ventilation design into the design of the facility.*

Reference is also made to the NSW Department of Planning document "*Development Near Rail Corridors and Busy Roads – Interim Guideline*" (NSW DoP, 2008) (the Roads Guideline) which supports the specific rail and road provisions of the NSW State Environmental Planning Policy (Infrastructure) 2007. An aim of the

Roads Guideline is to assist in reducing the health impacts of adverse air quality from road traffic on sensitive adjacent development and assists in the planning, design and assessment of development in, or adjacent to busy roads (NSW DoP, 2008). The Roads Guideline also provides those situations in which air quality should be a design consideration:

- Within 10 m of a congested collector road (traffic speeds of less than 40 km·hr^{-1} at peak hour) or a road grade > 4 %, or heavy vehicle percentage flows > 5 %;
- Within 20 m of a freeway or main road (with more than 2 500 vehicles per hour, moderate congestions levels of less than 5 % idle time and average speeds of greater than 40 km·hr^{-1});
- Within 60 m of an area significantly impacted by existing sources of air pollution (road tunnel portals, major intersection / roundabouts, overpasses or adjacent major industrial sources); or
- As considered necessary by the approval authority based on consideration of site constraints, and associated air quality issues.

While specific development types within the Proposal are not yet known, it is envisaged the masterplan will include childcare facilities within the proposed neighbourhoods. Appropriate location of these with due consideration of orientation, placement of outdoor areas and incorporation of appropriate ventilation design and landscaped areas as recommended in the above would minimise any potential air quality impacts as a result of emission sources.

3.6. Separation Distance Guidance

Separation distance guidelines provide recommended separation distances between various pollution emitters and sensitive land uses. They aim to ensure incompatible land uses are located in a way that minimises the impacts of odour and polluting air emissions when applied in the assessment of new development applications. While guidelines assist in the siting of new developments, they may also be used to ensure industrial activities in appropriate zones are protected from encroachment by residential and other sensitive land uses that would have a negative effect on the viability of industry (ACT EPSDD, 2018). Separation distance guidelines consider impacts of air pollutants including odour.

Based on the industry type and scale, separation distances from activities have been determined through review of guidelines presented in:

- Separation distance guidelines for air emissions (ACT EPSDD, 2018); and
- Evaluation distances for effective air quality and noise management (EPA South Australia, 2016).

The NSW EPA or Department of Planning and Environment (DPE) do not publish separation distance guidelines. It is noted that the ACT Environment, Planning and Sustainable Development Directorate have released a separation distance guideline for air emissions in November 2018, which consequently provides the most contemporary reference in regard to separation distances (ACT EPSDD, 2018). Those separation distances relevant to relevant activities are outlined in Table 4.

3.7. Wollondilly Shire Council Development Control Plan 2016

The Wollondilly Shire Council Development Control Plan (DCP) outlines the specific controls and objectives for development undertaken with the Wollondilly Shire area. The purpose of the DCP is to provide guidance for future development within the Proposal site.

While the specific conditions relating to air quality management require air quality impact assessments for development or activities which are likely to emit odour or hazardous chemicals, Section 3.3 of the DCP outlines a minimum separation distance of 500 m setback for poultry farms from all residential zones which is applicable for the Proposal. No other setback requirements for activities applicable to this Proposal are identified in the DCP.

3.8. Campbelltown City Council Development Control Plan 2015

Section 7.7.2 of the Campbelltown City Council Development Control Plan (DCP) outlines design requirements relating to air quality. Any development that is likely to generate levels of air emissions exceeding the POEO requirements are to demonstrate appropriate measures to mitigate against air pollution. No other specific requirements relating to air quality or separation distances are outlined the Campbelltown DCP.

Section 6.4.5 of the DCP relates to residential interface and requires that all commercial buildings designed to accommodate the preparation of food from a commercial tenancy shall provide ventilation facilities to ensure that no odour is emitted in a matter that adversely impacts upon any residential premises. Any facilities within the future masterplan which have potential odour generating activities would be required to provide adequate ventilation facilities in line with the DCP requirements.

4. EXISTING ENVIRONMENT

4.1. Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

The Proposal site is located proximate to an air quality monitoring station (AQMS) operated by NSW DPE. The closest active representative AQMS is noted to be located at Campbelltown West which has been operating since 2012 when the station was commissioned. This AQMS is considered to be reflective of the conditions at the Proposal site. Data over the period 2017 to 2021 has been assessed, representing the last 5-years of data.

A summary of the air quality monitoring data is presented in Table 3 (mean, 99th percentile value and maximum for each year shown only). The measured values are compared to the air quality standards as outlined in Section 3.2. Where there are measured exceedances of those criteria this is highlighted in red in Table 3.

The summary shows periodic exceedance (non-attainment) of the 24-hour average PM_{10} and $PM_{2.5}$ criteria in most years 2017 to 2021. This is not unexpected and is typical of most monitoring stations across NSW. The exceedances are typically associated with sporadic regional pollutant events, such as bushfires and dust storms.

Figure 3 indicates that periodic exceedance of 1-hour ozone (O_3) and 4-hour (rolling) O_3 were experienced at Campbelltown West AQMS, predominantly in summer months. High temperatures can accelerate the formation of O_3 following the generation of precursor pollutants including NO_2 and VOCs. O_3 exceedances measured at Campbelltown AQMS for the period 2017-2021 generally coincided with days of high temperatures.

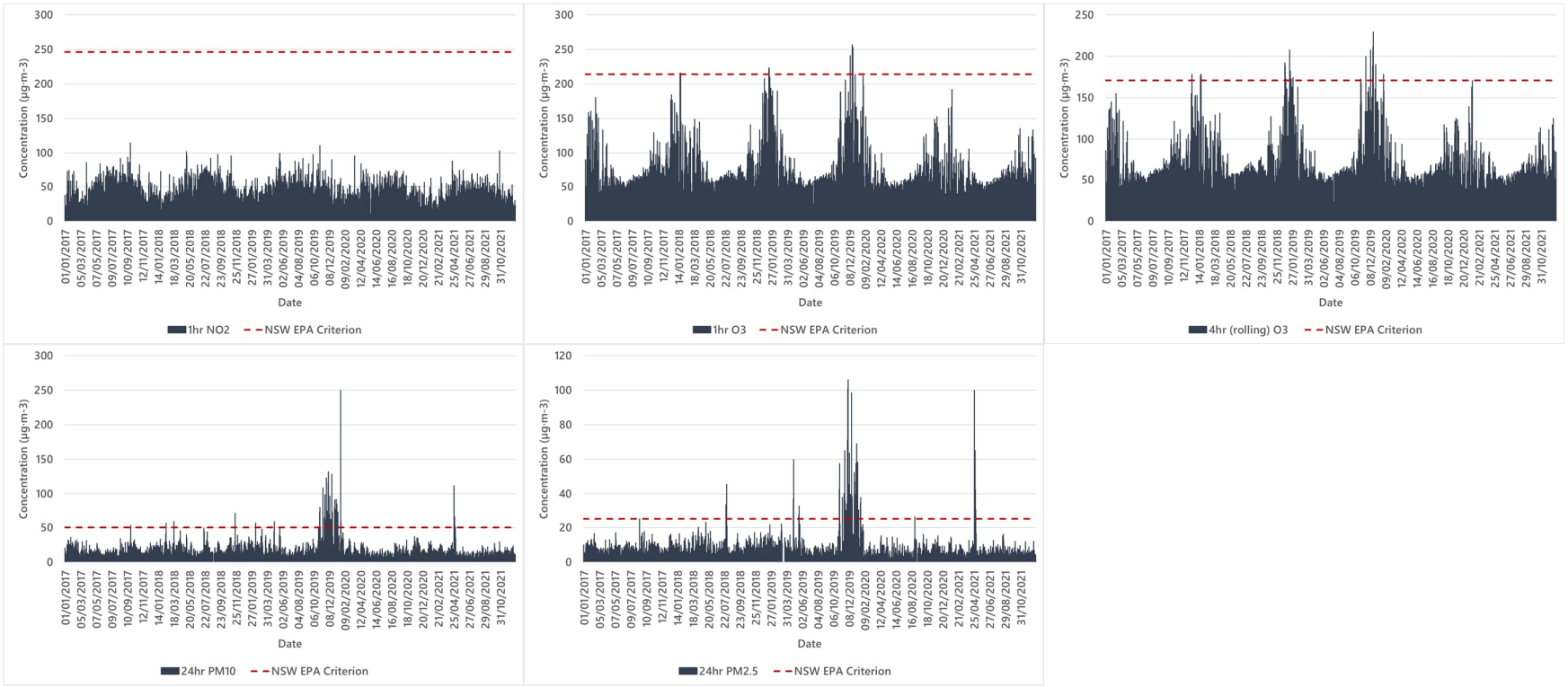
The time-series plots of measured concentrations of 1-hour NO_2, 1-hour O_3, 4-hour (rolling) O_3, 24-hour PM_{10} and 24-hour $PM_{2.5}$ are provided in Figure 3.

Odour is not measured at the Campbelltown West AQMS, and is not measured routinely at any AQMS in NSW or Australia. Impacts associated with odour are required to be considered individually.

Table 3 Summary of background air quality monitoring data

Year	AQMS	Campbelltown West AQMS				
	Pollutant	NO2	O3	O3	PM10	PM2.5
	Ave Period	1h	1h	4h rolling	24h	24h
	Units	µg·m-3	µg·m-3	µg·m-3	µg·m-3	µg·m-3
All	Mean	18.5	32.7	32.1	17.3	8.2
	99%ile	65.8	121.5	115.6	73.5	45.4
	Max	114.7	256.8	229.3	249.7	106.0
2017	Mean	19.8	32.5	31.8	15.7	7.4
	99%ile	67.9	115.6	107.8	32.2	16.8
	Max	114.7	184.2	178.4	53.1	25.0
2018	Mean	20.1	33.9	33.2	17.9	8.4
	99%ile	69.6	123.4	113.7	47.0	20.7
	Max	101.5	215.6	192.1	72.3	45.4
2019	Mean	20.1	34.8	34.0	22.3	11.8
	99%ile	69.6	152.9	145.0	111.8	69.8
	Max	110.9	256.8	229.3	132.0	106.0
2020	Mean	17.2	32.3	31.7	17.0	7.5
	99%ile	62.0	115.6	111.7	80.3	42.8
	Max	95.9	211.7	178.4	249.7	69.0
2021	Mean	15.2	30.2	29.6	13.8	6.3
	99%ile	56.4	100.0	95.9	34.5	30.1
	Max	103.4	192.1	170.5	111.9	99.9

Figure 3 Time series plots of measured 1-hour NO_2, 1-hour O_3, 4-hour (rolling) O_3, 24-hour PM_{10} and 24-hour $PM_{2.5}$

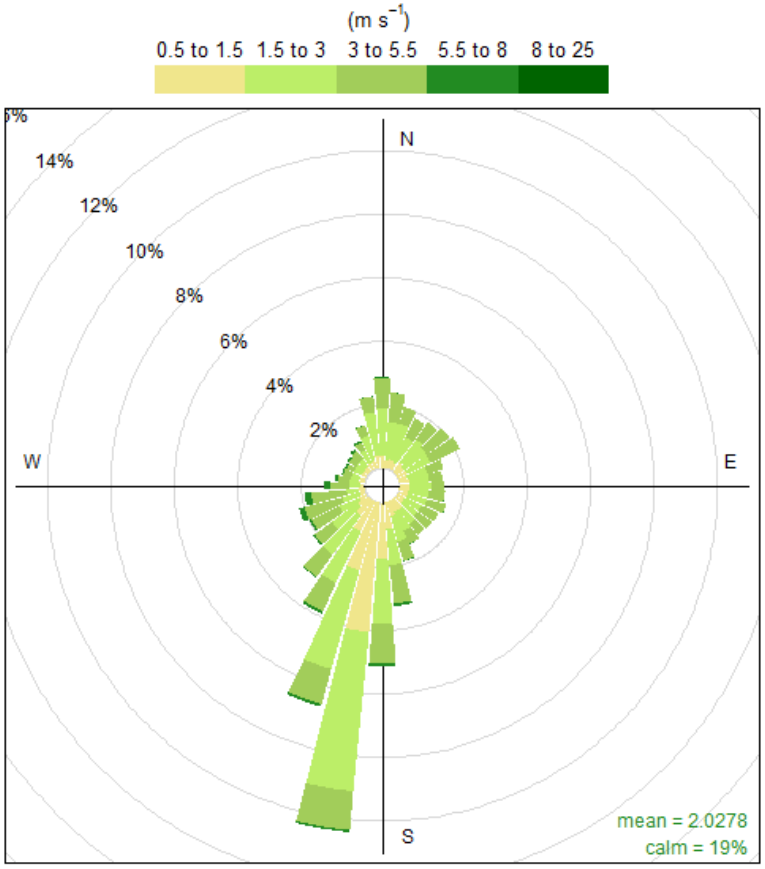


4.2. Meteorology

The meteorology experienced within an area can govern the generation (in the case of wind-dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the Proposal site have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at a number of surrounding Automatic Weather Stations (AWS).

To adequately describe the prevailing meteorological conditions surrounding the Proposal site, measurements taken at the Campbelltown (Mount Annan) AWS, a 5-year (2017-2021) analysis of observed meteorology is provided as a wind rose in Figure 4. The wind rose presented in Figure 4 indicates that from 2017 to 2021, winds at Campbelltown (Mount Annan) AWS shows a predominant south south-westerly wind direction.

Figure 4 Wind rose 2017-2021, Campbelltown (Mount Annan) AWS



The majority of wind speeds experienced at Campbell (Mount Annan) AWS over the 5-year period 2017 to 2021 are generally in the range < 0.5 metres per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from westerly directions. Winds of this speed occur during less than 0.02 % of the observed hours over the 6-year period. Calm winds are more frequent, occurring more than 19 % of observed hours.

5. METHODOLOGY

5.1. Overview

This assessment has been prepared to identify the potential risks or constraints associated with air quality impacts relevant for the development of the Proposal.

The assessment of potential operational air quality risks is based on information provided at the time of the assessment for proposed future land uses on the Proposal site.

5.2. Construction Phase

Construction phase activities have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and are typically experienced by neighbours as amenity impacts, such as dust deposition and visible dust plumes, rather than associated with health-related impacts. Localised engine-exhaust emissions from construction machinery and vehicles may also be experienced, but given the scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts.

Modelling of dust from construction Proposals is generally not considered appropriate, as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly, depending upon local conditions.

Given that construction activities have not yet been determined, further assessment of the construction phase activities has not been undertaken for the Proposal. It is considered that any relevant mitigation measures to manage potential construction phase impacts would be outlined in a site-specific Construction Environmental Management Plan (CEMP) developed for the Proposal.

5.3. Operational Phase

This assessment has been prepared to address the potential air quality impacts / risks of the Proposal. The assessment of operational phase impacts / risks needs to account for:

- Air emissions from existing external sources (i.e. those not contained within the Proposal site) affecting sensitive land uses within the Proposal site;
- Air emissions from future (unknown) internal sources (i.e. those which may be contained within the Proposal site in the future) affecting sensitive land uses inside and outside of the Proposal site.

This has been performed using an assessment of published separation distances from existing or potential future sources to existing or future locations for sensitive land uses.

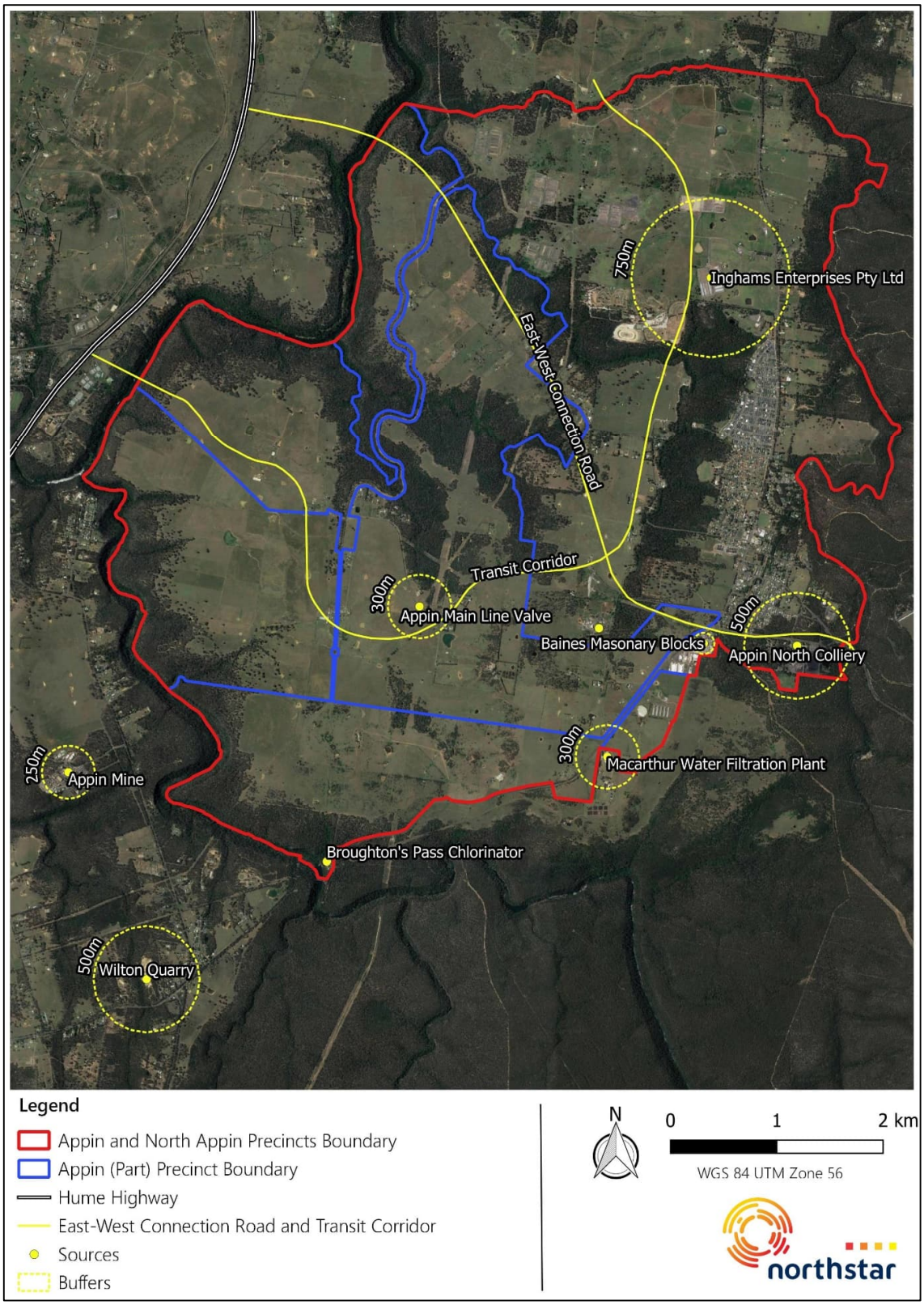
A review of the land uses and activities in the vicinity of the Proposal site was undertaken through a desktop mapping survey, online review of the relevant EPA Environmental Protection Licence (EPL) register for facilities within proximity to the Proposal site and a search of relevant sources from the National Pollution Inventory (NPI) to determine potential sources of air (and odour) emissions within the vicinity of the Proposal site.

Through a review of identified sources of air and odour emission sources, those which may have the potential to impact upon air quality at the Proposal site have been identified as shown in Figure 5.

While the development types within the Proposal site are yet to be confirmed, it is assumed these would be typical of a populated suburban centre. As such, potential air emission sources from the future development would be expected to include kitchen exhaust outlets from cooking processes and emissions associated with road traffic, in line with a typical urban environment. Major sources of potential air pollutants, such as those resulting from industrial or manufacturing processes which may impact on receptors both within and outside of the Proposal site are considered unlikely.

As such, appropriate design in accordance with the relevant guidelines and Australian Standards would be appropriate to manage any potential impacts of these future sources of air emissions resulting from within the Proposal site.

Figure 5 Air quality sources and buffer distance



Source: Northstar Air Quality

6. AIR POLLUTION EMISSION SOURCES

As outlined in Section 5.3, a desktop survey review, a search of the EPA EPL register and review of the NPI database has been performed to identify potential industrial sources within the immediate vicinity or located within the Proposal site.

The following potential local air quality influences (see Table 4) have been identified around an approximate 5 km radius of the Proposal site, through either desktop mapping of the site and surrounds, and/or search results of the NPI database. The relevant buffer distances have been presented in Figure 5.

Table 4 Identified local air quality influences

Facility Name	Location	Category	Separation distance guidelines (m)	Approximate distance (m) from Proposal boundary	Main Pollutant of Concern
Appin Main Line Valve	Brooks Point Road, Appin	Gas distribution works	300[a]	Within Proposal site	Odour
Appin Coal Seam Methane Power Station	Northampton Dale Road	Electricity generation	-	155 north	VOCs, NO_X, CO
Broughton's Pass Chlorinator	Broughton's Pass	Water chlorination	300[c]	1 500 south	Odour
Inghams Enterprises Pty Ltd	345 Appin Road	Poultry farm	750[a]	1 430 north east	Odour
Appin West Colliery	Douglas Park Drive	Coal mining	250[b]	1 200 south east	Particulate matter
Baines Masonry Blocks	900 Wilton Road, Appin	Concrete works	100[a]	118 m east	Particulate matter
Macarthur Water Filtration Plant	550 Wilton Road, Wilton	Water filtration	300[c]	70 south east	Odour
Wilton Quarry	155 Wilton Road, Wilton	Mining and extractive industry	500[b]	2 700 south	Particulate matter
Appin North Colliery	Appin Road, Appin	Mining and extractive industry	500	780 east	Particulate matter
East-West Connection Road & Transit Corridor (Proposed)	Appin Road to proposed Hume Motorway interchange	Road traffic	100[d]	Within Proposal site	Particulate matter, NO_X

Facility Name	Location	Category	Separation distance guidelines (m)	Approximate distance (m) from Proposal boundary	Main Pollutant of Concern
Hume Highway	Existing Hume Highway	Road traffic	100	700 m west	

Notes: a) taken from Separation distance guidelines for air emissions, ACT Government

b) taken from Recommended separation distances for industrial residual air emissions, EPA Victoria

c) No specific distance provided for water filtration, therefore separation distance for sewage treatment works has been applied

d) South Australian EPA 2019 *Evaluation distances for effective air quality and noise management*

Based on the separation distances outlined in Table 4, a number of facilities are located within the recommended separation distance guidelines (highlighted) and have the potential to adversely impact on the air quality and/or odour of the Proposal site. Further assessment to guide the reduction of potential impacts has been undertaken and outlined in Section 7. Identified sources which are located within the recommended separation distance have been subject to a risk assessment in order to understand the level of risk, as outlined in Table 5 overleaf.

7. RISK ASSESSMENT

Where a risk assessment is undertaken for the purposes of assessing potential impacts of proposed emissions sources, the aim of the assessment is generally to determine the level of control required (if applicable) for that source. Given that this this assessment is largely focused on existing emissions sources, over which the Proponent has little control, this high-level risk assessment has therefore been performed in order to understand the level of risk associated with those sources and further describe how the emission source may present any constraints if applicable, for the Proposal.

A full explanation of definitions describing the metrics of *sensitivity* and *magnitude* that are used to derive *risk* as outlined in this process is provide in Appendix A, to help understand potential air quality constraints on the Proposal.

Using the methodology outlined in Appendix A derives an assessment of risk (as expressed on a scale: *high – medium – low*), as summarised in Table 5, for those facilities identified as having the potential to result in air quality impacts within the Proposal site. Each of these risks are detailed further below.

Table 5 Risk assessment

Facility	Air Quality Impact	Sensitivity	Pre-Mitigation		
			Magnitude	Risk	Outcome
Appin Main Line Valve	Odour	Very High	Slight	Medium	Manage risk
Appin Methane Power Station	VOCs, NO_x, CO		Slight	Medium	Manage risk
Macarthur Water Filtration Plant	Odour		Slight	Medium	Manage risk
East-West Connection Road & Transit Corridor (Proposed)	PM, NOx		Slight	Medium	Manage risk

Appin Main Line Valve

The Appin Main Line Valve is located within the Proposal site and according to the indicative structure plan, is located on the fringe of an area which is proposed as urban capable land. Based on the separation distance guidelines, the recommended distance between gas distribution works and sensitive land uses i.e. schools, residential dwellings, child care centres etc, is 300 m. However, given that the activities are limited to one valve only (and not the full suite of infrastructure associated with gas distribution works), potential air quality impacts as a result of the gas line valve relate to potential leakages and/or emergency maintenance scenarios which may require dispersion of gas into the atmosphere.

It is noted that there is an existing dwelling within approximately 100 m of the Appin Main Line Valve, which further indicates that the separation distance of 300 m may be conservative. Any development of land within

300 m of the Appin Main Line Valve would be performed with full consultation with the relevant gas distribution authority/company to ensure that any risks are minimised.

Given the scale of the source and existing land uses surrounding this, the potential magnitude is considered to be *slight* and the corresponding risk is *medium.*

Appin Methane Power Station

The Appin methane power station is located within the Proposal site and according to the indicative structure plan, is located at distance approximately 800 m from the nearest proposed future town centre. While there is no recommended separation distance guideline for an operating methane power station, review of air quality impact data for the site indicates compliance with air quality standards at the nearest sensitive receptors.

Given the above, the potential magnitude is considered to be *slight* and the corresponding risk is *medium.*

Macarthur Water Filtration Plant

The Macarthur Water Filtration Plant is located across Wilton Road, approximately 70 m to the south east of the Proposal site boundary. Potential air quality impacts as a result of the operation of the water filtration plant relate to potential odour impacts resulting from the filtration process and water storage systems.

Given that this plant treats raw fresh water from the nearby weir and does not treat sewage or associated wastewater, the potential impact magnitude is considered to be *slight* and the corresponding risk is *medium.* Furthermore, the wind direction taken from the nearby Campbelltown weather station indicates a predominant south westerly which is less likely to affect the Proposal site.

East-West Connection Road and Transit Corridor

According to the SA EPA (SA, 2019), the recommended separation distance for sensitive receptors to a major road is 100 m, and (NSW DoP, 2008) refer to air quality being a design consideration when development is to occur within 10 m to 20 m of a collector or main road. While the neighbourhood land uses adjacent to the proposed East West Connection Road and Transit Corridor are not yet defined, appropriate separation from the roadway would be expected within the planning and design phase. Appropriate setback distances from the East-West Connection Road and Transit Corridor would be included, in addition to a consideration of design measures to further ameliorate any potential air quality impacts, which would also be relevant for any identified acoustic issues. The requirements of the Child Care Centre Planning Guideline (see Section 3.5) would be required to be addressed during the selection of appropriate sites for that use. Given the above, the potential impact magnitude is considered to be *slight* and the corresponding risk is *medium.*

Based upon the above, the proposed rezoning design is adequate to manage identified potential hazards and determined to represent medium risks. The objective associated with medium risks is management to reduce that risk as low as possible

8. CONCLUSION

Northstar has been commissioned by Walker Corporation to prepare an air quality constraints and opportunities report for the proposed rezoning of a portion of land within the Appin Precinct, known as Appin (Part) Precinct, for the development of a new urban community.

This high-level review has been performed to review and identify potential constraints and opportunities associated with the proposed urban land use with respect to air quality, and identify constraints from existing and proposed sources of emissions to air proximate to the proposed Appin (Part) Precinct site.

A review was performed using assessment of published separation distances from existing or potential future sources to existing or future locations for sensitive land uses. Identified sources located within the recommended distance guidelines include:

- Main line gas valve;
- Methane power station;
- Water filtration plant; and
- Major roadways, proposed.

While a high-level risk review demonstrated that medium (i.e. manageable) air quality risks were associated with identified sources located within the relevant recommended separation distances, it is anticipated that with appropriate land use planning and design and consideration of appropriate regulatory standards and guidelines, these would be further reduced. Review of historic air quality data for the local region indicates instances of exceedances of ozone and particulate matter which also coincide with periods of high temperature. It is anticipated that these conditions would prevail during development of the Proposal, and not present any further adverse effects for the rezoning application.

Based on the high-level assessment undertaken, it has been determined that the existing and proposed identified sources of air quality and odour will not form a significant constraint on the rezoning and proposed development of the Proposal site.

9. REFERENCES

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ACT Government. (2018). *Separation distance guidelines for air emissions .*

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NSW DPIE. (2020). *New South Wales Annual Compliance Report 2018.*

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APPENDIX A

Risk Assessment

Provided below is an outlined of the risk assessment methodology used for a typical air quality impact assessment. It is based upon the definitions provided under ISO 31000.

The risk assessment presented in below is generally performed in two stages:

- Step 1: Pre-mitigated risk: This is used to identify any significant risks and identify the need to control;
- Step 2: Control and mitigation: An examination of what constitutes best available technology (BAT) for emissions control for that process. Note for this assessment, this Step is not undertaken as the risk assessment is not being used to inform an air quality impact assessment.

The risk assessment procedure adopted uses the determinations of:

- sensitivity of receptors; and
- impact magnitude; to derive
- risk.

These terms are defined and discussed in the following subsections.

Sensitivity of Receptors

Sensitivity terminology may vary depending upon the environmental effect, but generally this may be described in accordance with a scale from 'very high' to 'low', as defined in Table A1.

Table A1 Methodology - sensitivity of receptors

Sensitivity		Descriptions
4	Very high	Receptors are highly sensitive to changes in the air quality / odour environment. Areas may be typified by extended (day-long) exposure times and/or an expectation of high amenity values. Typical examples may include residential areas, health care facilities, retirement homes
3	High	Receptors have a high sensitivity to changes in the air quality / odour environment. Areas may be typified by working-day exposure times and/or an expectation of high amenity values. Typical examples may include commercial zones, recreation facilities, schools, high-end office space (banking etc).
2	Medium	Receptors have a medium sensitivity to changes in the air quality / odour environment. Areas may be typified by up to working-day exposure times and an expectation of reasonable amenity values commensurate with the land-uses. Typical examples may include agricultural and environmental conservation spaces, industrial zones.
1	Low	Receptors have a low sensitivity to changes in the air quality / odour environment. Areas may be typified by short-term exposure times and a low expectation of amenity values. Typical examples may include infrastructure land uses, open and undeveloped land.

Impact Magnitude

Impact magnitude is a descriptor for the predicted scale of change to the air quality environment that may be attributed to the operation of the Proposal and is evaluated on a scale from 'major' to 'negligible' as defined in Table A2.

Table A2 Methodology - impact magnitude

Magnitude		Descriptions
4	Major	Potential impact magnitude may cause statutory objectives / standards to be exceeded. Potential major magnitude of impacts may generate nuisance complaints, resulting in regulatory action.
3	Moderate	Potential impact may give rise to a perceivable health and/or amenity impact. Potential moderate magnitude of impacts may generate nuisance complaints, likely to require management but not result in regulatory action.
2	Slight	Potential impact may be tolerated. Potential slight magnitude of impacts is not likely to generate nuisance complaints.
1	Negligible	Potential impact magnitude is unlikely to cause significant consequences. Potential negligible magnitude of impacts is unlikely to generate nuisance complaints and is likely to only be perceptible within the site boundary.

Risk

The risk matrix provided in Table A3 illustrates how the definition of the impact magnitude and sensitivity of receptors interact to produce impact risk (composite risk index). For example, an impact of *slight* magnitude at a *medium* sensitive receptor location would be determined to be of *medium* risk (significance).

Table A3 Methodology -risk matrix

Magnitude Sensitivity	Negligible (1)	Slight (2)	Moderate (3)	Major (4)
Very High (4)	Medium (4)	Medium (8)	High (12)	High (16)
High (3)	Medium (3)	Medium (6)	Medium (9)	High (12)
Medium (2)	Low (2)	Medium (4)	Medium (6)	Medium (8)
Low (1)	Low (1)	Low (2)	Medium (3)	Medium (4)

The 'risk' derived through this methodology is presented on a simplified three-point scale:

High	A high risk that requires management, through changes to impact magnitude and/or sensitivity
Medium	An intermediate risk, and recommendations are to reduce risk as low as practicable through changes to impact magnitude and/or sensitivity
Low	No further management required, although risks should be managed

The relative risk is provided as a dimensionless product of the defined values attributed to receptor sensitivity and impact magnitude.

The determined risk (significance) may be used to highlight the relative environmental risk and to highlight the general requirement for the application of controls and mitigation. It is noted that the above approach is designed to provide an overall impact risk and is not intended to represent the defining determination for the requirement for mitigation and control. The determined risk methodology is not designed to exclude impacts with a lower determined significance from receiving mitigation and control treatments, in accordance with the principle of reducing environmental impacts to maximum extent practicable.

The following represents the risk assessment that is used to identify the risks associated with operation without any supplementary mitigation and identify the type and nature of controls that are required to be applied to avoid unreasonable emissions to air.

Pre-Mitigated Sensitivity of Receptors

Rezoning of the Proposal site is anticipated to include residential neighbourhoods, including ancillary support infrastructure such as schools, dayacares and health care facilities. Given the nature of the proposed landuses, the sensitivity of receptors is determined to be *very high*.

Pre-Mitigated Impact Magnitude

In the context of the risk assessment methodology, the impact magnitude relates to the definitions presented in Table A2, and is described on a scale from *substantial* to *negligible*. The key considerations in the assessment of potential impact magnitude are:

- Assessing the potential emissions from the processes to give rise to off-site impacts; and,
- Assessing the scale, frequency and duration of those process emissions.

The sources identified may demonstrate potential risk of emissions to air are briefly described in Section 6. These processes can be generally categorised as follows:

- Appin Main Line Valve
- Appin Methane Power Station
- Macarthur Water Filtration plant
- East West Connection Road & Transit Corridor (proposed).

Table A4 Impact magnitude (pre-mitigated)

Process	Comments and application	Pre-mitigated magnitude
Appin Main Line Valve	Pre-mitigated	Slight
Appin Methane Power Station	Pre-mitigated	Slight
Macarthur Water Filtration Plant	Pre-mitigated	Slight
East-West Connection Road & Transit Corridor (Proposed)	Pre-mitigated	Slight

Pre-Mitigated Risk

Based upon the above, the pre-mitigated risk may be determined as presented in Table A5.

Table A5 Risk (pre-mitigated)

Hazard	Sensitivity	Pre-Mitigation		
		Magnitude	Risk	Outcome
Appin Main Line Valve	Very high	Slight	Medium	Manage risk
Appin Methane Power Station		Slight	Medium	
Macarthur Water Filtration Plant		Slight	Medium	
East-West Connection Road & Transit Corridor (Proposed)		Slight	Medium	

Based upon the above, the proposed rezoning design is adequate to manage all identified potential hazards and determined to represent medium risks. The objective associated with medium risks is management to reduce that risk as low as possible.

A9 Noise Impact Assessment

Noise Impact Assessment
Proposed Land Rezoning
Appin, NSW

Prepared for:

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Project Code: 212214R

Reference: 212214R_29780_Rpt_Final_5Sep23

This version: Final

Date: 5 September 2023

CONTENTS

EXECUTIVE SUMMARY

An acoustic assessment has been undertaken into the potential for noise emanating from various existing and proposed significant noises sources to impact on the Appin (Part 2) Precinct that is proposed for rezoning for residential purposes.

Appropriate noise criteria were developed for the overall Appin Precinct in our report 212214R-29780 dated September 2022 (denoted SA1 and attached to this report for reference) based on procedures in the applicable Australian Standards and Government guidelines and policies.

The SA1 assessment considered theoretical noise emissions from a number of existing industrial noise sources and also from existing and proposed roads in the area and those findings have been reviewed for application to the Appin (Part 2) Precinct.

Noise control options and noise management techniques were advised, as required, to enable compliance with the relevant noise criteria at future residential, and other, receivers.

The assessment concludes that the proposed Part 2 development may be supported provided the appropriate noise attenuation measures are incorporated at key existing noise generating sites and proposed infrastructure deliverables for the project.

1.0 THE APPIN (PART 2) PROJECT

Walker Corporation Pty Ltd and Walker Group Holdings Pty Ltd (together the **Proponent**) has prepared the subject submission to rezone 100.30 hectares of land (the **Site**) within the Appin Precinct from *RU2 Rural Landscape* to the following zones:

Urban Development Zone

Zone 1 Urban Development (UDZ)

Special Purposes Zone

Zone SP2 Infrastructure (SP2)

Conservation Zone

Zone C2 Environmental Conservation (C2)

The Site is known as the Appin (Part 2) Precinct. The Site directly adjoins the Appin (Part 1) Precinct – refer to **Figure 1**.

The Appin (Part 2) Precinct Plan (**the precinct plan**) shows the proposed new zones. 'The precinct plan' will be incorporated into the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* and contain the provisions (clauses and maps) that will apply to 'the Site.' 'The precinct plan' envisages the delivery of the following:

- 1,312 dwellings (as a mix of low-density, medium density and apartments)
- 30,312 sqm of gross lettable retail/commercial floor area
- 16.91ha conservation land

The planning proposal submission is aligned with strategic land use planning, State and local government policies, infrastructure delivery and PP-2022-3979. The development potential is tempered by a landscape-based approach that protects the environment and landscape values, shaping the character of new communities. A series of residential neighbourhoods are to be delivered within the landscape corridors of the Nepean and Cataract Rivers, supported by local amenities, transit corridors and community infrastructure.

2.0 INTRODUCTION

Spectrum Acoustics Pty Ltd was engaged by the Proponent in 2022 to prepare an acoustical assessment (referenced herein as SA1) to support a Structure Plan for the Appin Precinct. The present report has been commissioned to assess potential noise impacts on, and propose general mitigation methods for, residences in the proposed Appin (Part 2) Precinct.

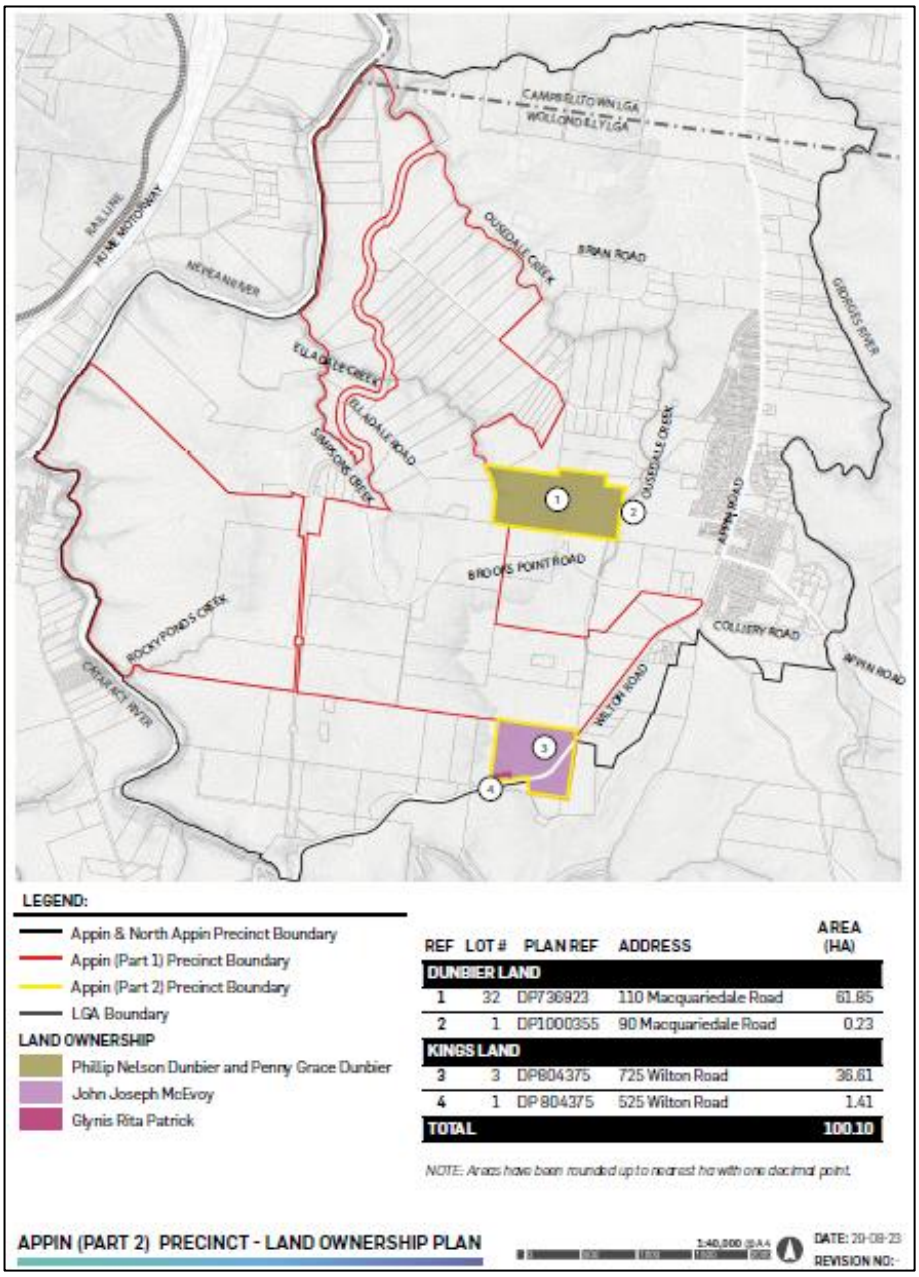


Figure 1: Appin (Part 2) Precinct Boundary

This report summarises the potential for noise emanating from various existing and proposed significant noises sources to impact on parts of the Appin (Part 2) Precinct that is proposed for rezoning for residential purposes.

The objectives of the report are to apply the findings from SA1 for the Appin Precinct to the parcels of land comprising Part 2, as applicable.

The assessment has indicated that a combination of relatively common architectural treatments and noise control such as construction of noise barriers, can be employed to achieve an adequate acoustic amenity at future residences.

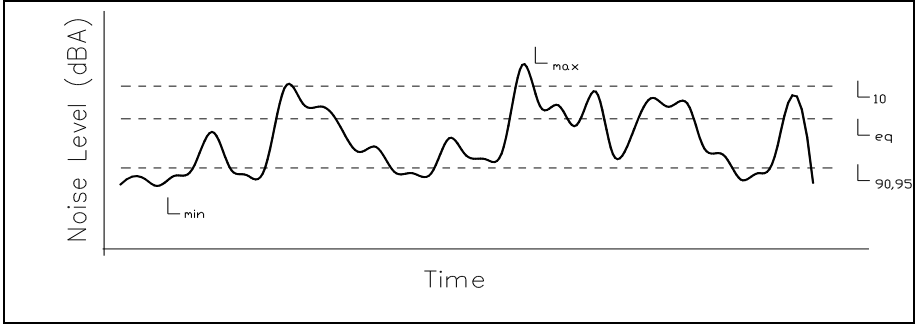
Detailed and specific acoustic assessment will be required for the key existing and proposed noise generating sources identified in this report.

From an acoustic point of view, the proposed development may be supported provided the appropriate noise attenuation measures are incorporated in proposed infrastructure deliverables for the project.

3.0 DESCRIPTION OF TERMS

Table 1 contains the definitions of commonly used acoustical terms and is presented as an aid to understanding this report.

Table 1: Definition of acoustical terms

Term	Definition
dB(A)	The quantitative measure of sound heard by the human ear, measured by the A-Scale Weighting Network of a sound level meter expressed in decibels (dB).
SPL	Sound Pressure Level. The incremental variation of sound pressure above and below atmospheric pressure and expressed in decibels. The human ear responds to pressure fluctuations, resulting in sound being heard.
STL	Sound Transmission Loss. The ability of a partition to attenuate sound, in dB.
Lw	Sound Power Level radiated by a noise source per unit time re 1pW.
Leq	Equivalent Continuous Noise Level - taking into account the fluctuations of noise over time. The time-varying level is computed to give an equivalent dB(A) level that is equal to the energy content and time period.
L1	Average Peak Noise Level - the level exceeded for 1% of the monitoring period.
L10	Average Maximum Noise Level - the level exceeded for 10% of the monitoring period.
L90	Average Minimum Noise Level - the level exceeded for 90% of the monitoring period and recognised as the Background Noise Level. In this instance, the L90 percentile level is representative of the noise level generated by the surrounds of the residential area.
	

4.0 NOISE SOURCES

The area proposed for rezoning adjoins the western and southwestern extremities of the West Appin Precinct. There are several known

existing and proposed significant noises sources in the area which are shown in **Figure 2**, and detailed below;

- Appin Motocross Track,
- Appin Power Station,
- South 32 Ventilation Shaft,
- Proposed Outer Sydney Orbital Phase 2,
- Existing Hume Highway,
- Existing Wilton Road, and
- Existing Appin Road.

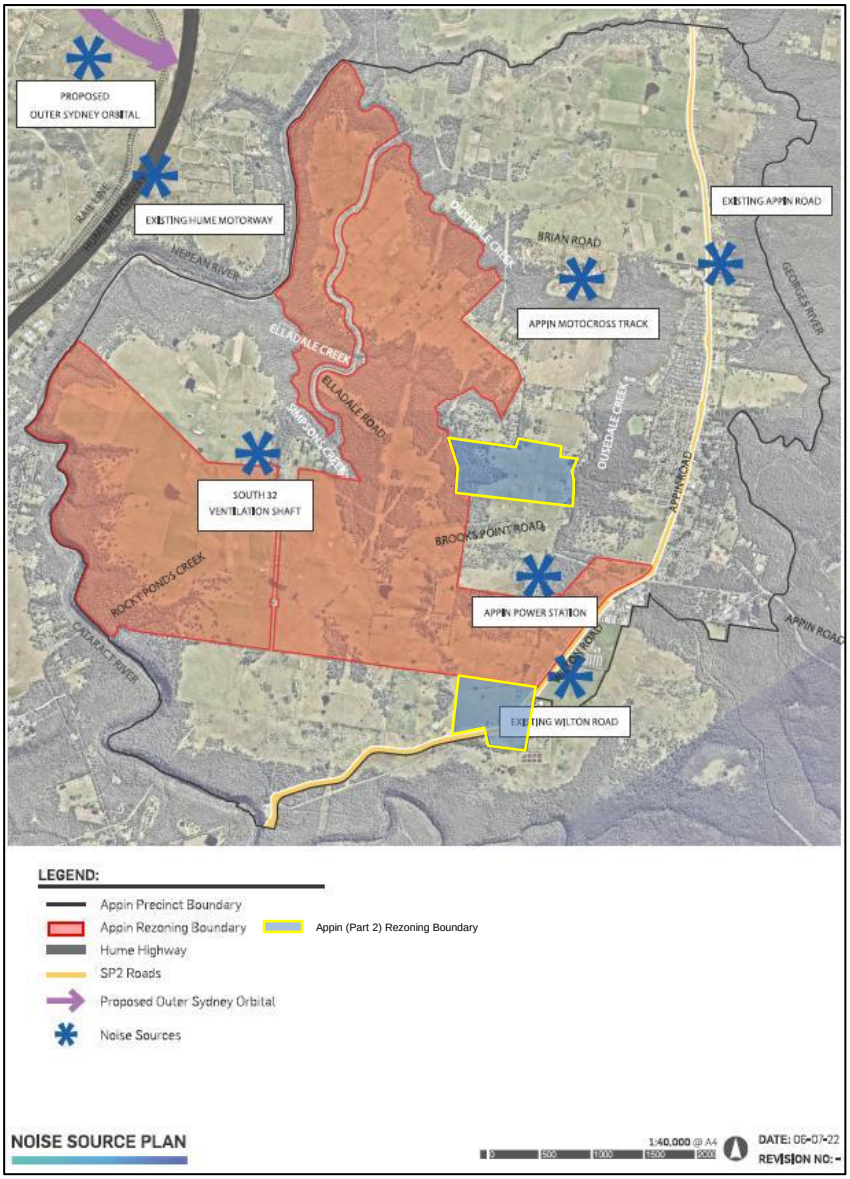


Figure 2: Noise Sources

Each of these noise sources was considered separately in SA1 for compliance with the relevant impact criteria. The sources relevant to the current assessment of Part 2 are the Appin power station and Wilton Road. Assessment of each of these sources is reproduced below from SA1.

4.1 Appin Power Station

Appin Power Station utilises waste coal mine gas to supply generators that produce electricity for supply to the power grid (shown as a star in **Figure 3**).

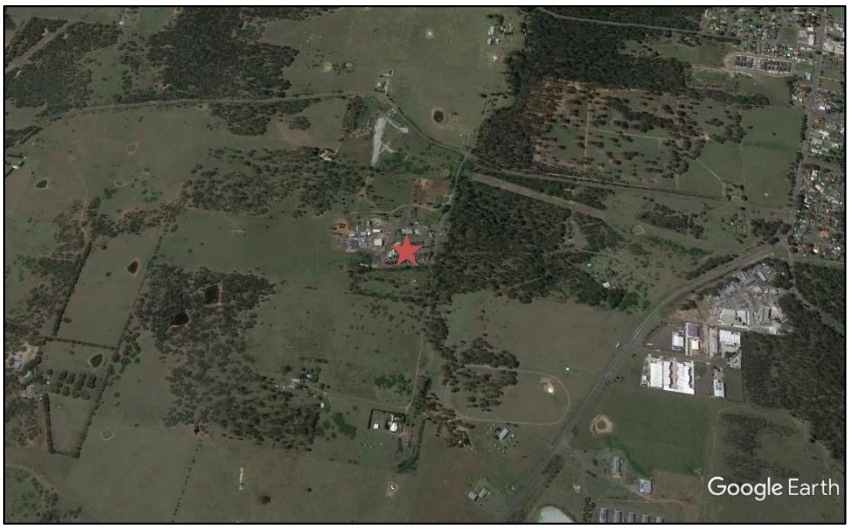


Figure 3: Appin Power Station Location

Assuming that the power station and mine facilities are currently operating in compliance with the adopted noise criteria, implies that the noise at the receiver approximately 450m from the site is less than 41 dB(A) L_{Aeq} (15 min). It can also be assumed that noise generation from the power station doesn't contain any directional components and, therefore, the noise propagation would be similar in all directions from the site.

Under such circumstances, the noise at receivers that are about 200m from the power station could be up to 47 dB(A) L_{Aeq} (15 min). This would be 6 dB(A) over the adopted day, evening and night time noise criteria for the site.

In the current situation a noise barrier would have to be constructed close to the power station. From an acoustic point of view, a single noise barrier, built around a noises source is, usually, preferable to applying multiple noise control options and many receivers.

Any acoustic assessment would also require quantification of the Lw of the power station, and other mine facilities at the site, throughout all times of the day, evening and night and under all operating conditions. Calculation of received noise at all potentially affected receivers would subsequently need to be performed. (SA1, pp 18-19)

The power station is approximately 720m south of the southern boundary of the northern portion of the Part 2 lands. Based on the calculation in SA1, the noise level from the power station would be less than 36 dB(A), which is 5 dB below the established night time noise criterion and no mitigation will be required.

4.2 Wilton Road

Assessment of road traffic noise in SA1 resulted in general noise control recommendations that are applicable to the southern portion of Part 2 lands. These recommendations are reproduced below with section headings changed for consistency with this report.

In general the Guideline indicates that where a new residential development is planned to occur near a busy road appropriate building design, layout and construction techniques should be applied to minimise noise intrusion and provide suitable internal noise levels for sleeping and other uses.

The following sections provide some general information in relation to incorporating sound acoustic practises in house design.

4.2.1 Walls

Masonry walls typically have better noise insulation properties than other elements in the building envelope. Generally, walls are not a significant noise transmission path. Therefore attention should be given to the windows, doors, roof and ventilation openings as these elements will not insulate as well as the walls.

Walls of lightweight construction (e.g. weatherboard, compressed fibrous cement sheeting, timber slats, timber sheeting etc.) provide less noise insulation than masonry walls to low frequency noise. On noisy sites lightweight cladding should be avoided unless specifically designed to provide adequate insulation.

Whether the walls are masonry or of light-weight construction, the wall's insulation capacity will be weakened if it contains ventilators, doors or windows of a lesser insulation capacity. To improve insulation response, ventilators can be treated with sound-absorbing material or located on walls which are not directly exposed to the external noise.

4.2.2 Windows

In acoustic terms windows are one of the weakest parts of a facade. An open or acoustically weak window will severely negate the effect of an acoustically strong facade. Whenever windows are incorporated in a building design their effect on acoustic performance of the building facade should be considered. Reducing the numbers of windows and/or appropriately positioning them away from the road can be beneficial.

Proper sealing is crucial to the success of noise reduction of windows. To prevent sound leaks, windows should be caulked (with a flexible sealant such as mastic or silicone) thoroughly from the inside, and outside between the wall opening and the window frame. Usually the best option is use one of the many commercially available double glazed or laminated windows with acoustic seals.

Laminated glass is usually cheaper and easier to install than double glazing and is relatively effective in reducing moderate to high levels of traffic noise as indicated previously in this report. Double-glazing: is cost-effective when a very high level of noise attenuation is required. When using double-glazing, the wider the air space between the panes the higher the insulation.

Other factors influencing the acoustic performance of windows include:

- *Window seals: ensure windows are fitted with high quality acoustic seals and close windows to reduce internal noises levels.*

- *Reduction in window size, recognising that reducing the proportion of window to wall size from 50% to 25% reduces noise by only 3 decibels.*

- *Increase the glass thickness: the thicker the glass the more noise resistance it provides. However, glass thickness is only practical up to a point before the costs exceed the acoustic benefits of increasing glass thickness.*

- *The presence of absorbent materials on the window reveals will improve noise insulation.*

- *Window frames and their installation in wall openings must be air tight and operable. Windows must incorporate acoustic seals for optimal noise insulation.*

The Guideline also indicates that external areas at residences should be shielded from high levels of noise.

Whilst it may not be possible to acoustically shield the entire yard of a house it is usually relatively simple to shield smaller active recreation

areas such as courtyards. Such courtyard areas can be located to be acoustically shielded by the building elements of the house or garage or can be otherwise shielded by the construction of solid fencing or walls. To act as an acoustic barrier any fencing or walls must be solid to the intended height (to be determined by individual assessment) with no gaps for the passage of sound. (SA1, pp 27-29)

5.0 CONCLUSION

An acoustic assessment has been undertaken into the potential for noise emanating from various existing and proposed significant noises sources to impact on the Appin (Part 2) Precinct that is proposed for rezoning for residential purposes.

The assessment has identified several existing noise sources and the typical noise levels from them. Based on this general noise control options have been detailed.

The assessment has indicated that a combination of relatively common architectural treatments and noise control such as construction of noise barriers, can be employed to achieve an adequate acoustic amenity at future residences.

In conclusion, from an acoustic point of view, the proposed development may be supported provided the appropriate noise attenuation measures are incorporated at key existing noise generating sites and proposed infrastructure deliverables for the project.