HOW TO WATER YOUR PRECINCTS

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ABSTRACT

The New Zealand Government is focused on economic growth and supporting infrastructure development is one of the key priorities to achieving this goal. Provision of resilient and cost-effective water infrastructure at all levels of development is critical in achieving the growth vision. This paper presents an example of a Sydney Water Corporation (Sydney Water) project and the benefits in precinct level infrastructure planning, from a drinking water perspective.

The Western Sydney Aerotropolis Growth Area (WSAGA) consists of ten planned precincts surrounding the proposed Western Sydney International Airport (WSIA) that are forecast to undergo significant economic growth. At ultimate development (~2056), the WSAGA has the potential for 200,000 new jobs and over 100,000 new dwellings within WSAGA and the adjoining area. Construction works have commenced, and servicing is required to meet staged development. Refer to Figure 1 for locality plan.

At present, Sydney Water has limited drinking water infrastructure in the WSAGA, where the existing system capacity of the Cecil Park water supply zone (WSZ) is sufficient only for current rural land uses and is not able to service growth from the precincts. In addition to growth, a total of 10ML/day of construction water demand is required at the earliest, to support the major infrastructure projects (motorway, road upgrades, metro) underway within the WSAGA.

Strategic and adaptive planning for servicing the WSAGA area has been carried out to provide the strategic servicing for the area. Options assessment was undertaken to identify transfer capacity and staged extension of the trunk water supply infrastructure in line with the development timeframes. However, there is a need to assess the precinct level drinking water infrastructure that is ultimately required to service the demands in the precincts and staged delivery. This will be used to provide ongoing servicing advice to developers to plan their developments, and utilities for construction water requirements.

This paper describes the approach, methodology and considerations in defining an operationally efficient, precinct trunk and reticulation level servicing strategy for the WSAGA, as well as the benefits of planning drinking water infrastructure on the precinct scale.

INTRODUCTION

WINNING THE WEST - THE CATALYST

Unprecedented investment in Western Sydney continues to drive an exciting transformation with new international airport under construction within Western Sydney. Benefiting from proximity to the new Western Sydney International

Airport (operational in 2026), the Western Sydney Aerotropolis Growth Area (WSAGA) will contribute towards 200,000 new jobs in the Western Parkland City and become a high-skill jobs hub across aerospace and defense, manufacturing, healthcare, freight and logistics, agribusiness, education and research industries.

The Western Sydney Aerotropolis will become a thriving economic center in Western Sydney.

THE VISION

Sydney Water has re-imagined water in Western Sydney through its Western Sydney Regional Master Plan[1], a first for Sydney. It supports Sydney Water's vision to create a better life with world class water services and also supports the NSW Government's vision of the Western Parkland City.

The Master Plan's Vision, developed in collaboration with stakeholders is "Our customers enjoy affordable and essential water services, healthy waterways and vibrant, cool and green places."

AREA APPRECIATION

The WSAGA is located 45km west of the Sydney CBD and will provide about 11,200 hectares of new residential and employment lands. Refer to ***Figure 1***[2].

The WSAGA consists of ten precincts surrounding the Western Sydney International Airport (WSIA) and the area is forecast to undergo significant economic growth. Refer to ***Figure 2***[3] for locality plan.

The Western Sydney Airport site is approximately 1,780 hectares (almost twice the size of the Sydney, Kingsford Smith Airport site).

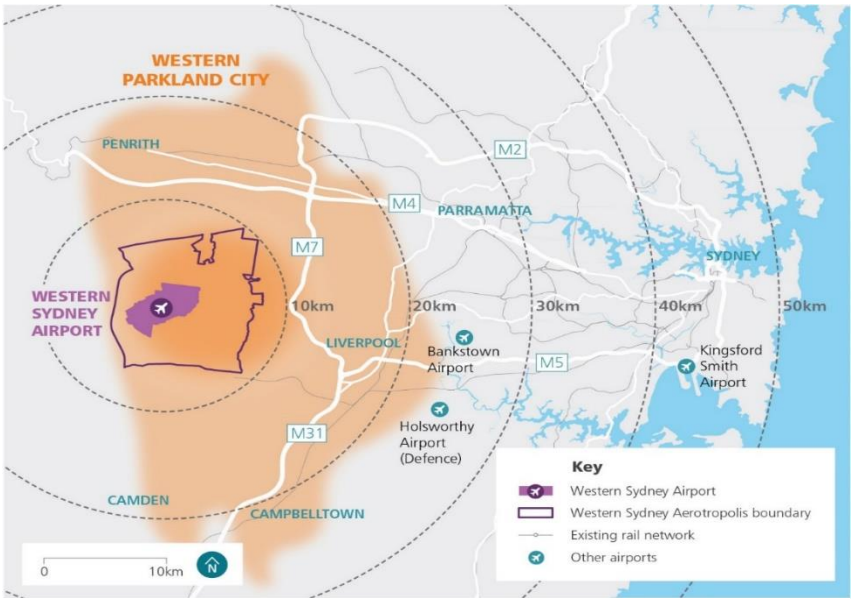


Figure 1: Source: Delivering the Western Parkland City, NSW Government Western City and Aerotropolis Authority

Some of the challenges in servicing WSAGA are:

[1] Re-imaging water in Western Sydney – Western Sydney Regional Master Plan https://www.sydneywater.com.au/content/dam/sydneywater/documents/western-sydney-regional-master-plan.pdf

[2] Delivering the Western Parkland City https://wpca.sydney/assets/Documents/Publications/Delivering+the+Western+Parkland+City_December+2019.pdf

[3] Initial Precincts Western Sydney Aerotropolis https://shared-drupal-s3fs.s3-ap-southeast-2.amazonaws.com/master-test/fapub_pdf/00-Western+Sydney+Aerotropolis/000-Final+Planning+Package/Final+Documents/Western+Sydney+Aerotropolis+Plan+2020+(Low+Res+Part+1+of+2).pdf

- Climate - Western Sydney is a hot, dry place, with a temperature increase of 6-10c during extreme heat events compared to Sydney's east coast. Even hotter and drier conditions are expected in the coming decades.
- Unprecedented infrastructure investment – The Australian Federal and NSW Governments have partnered to deliver the Western Sydney City Deal with over $6 billion in investment committed for constructure of Western Sydney Airport and other catalytic infrastructure that will unlock opportunities in education, business, and employment.
- Urban Planning – Western Sydney's population is forecast to double by 2056 reaching a total population of 1.5 million. Much of this growth will occur in currently rural or semi-rural areas.
- Staggered development will be leading the charge, expecting services available for their development
- Water security – Australia has recently experienced one of the most crippling droughts in recent history. Long dry spells are likely to increase as the effects of climate change make themselves felt with increased likelihood and duration of drought conditions. This threat affects the resilience of Western Sydney's water supply.
- Staging of assets is constrained with limited road network and proposed future roads in precincts plans by NSW Department of Planning and Environment (DPE).

PROJECT BENEFITS

The new airport is expected to be the catalyst for 200,000 new jobs in WSAGA alone. Additionally, at ultimate development (~2056), the WSAGA and adjacent South West Growth Area (SWGA) have the potential for over 100,000 new dwellings. To support the economic growth in this area a new Metro train line and road infrastructure is being delivered to service the airport and developments.

CURRENT DRINKING WATER SERVICING

At present, the area is serviced by a rural water supply network. Five precincts in the WSAGA were rezoned for development in 2021 (***Figure 2*** – orange), and servicing is required to meet staged development.

Delivery of trunk drinking water infrastructure to service this area is a priority for enabling economic growth of the area.

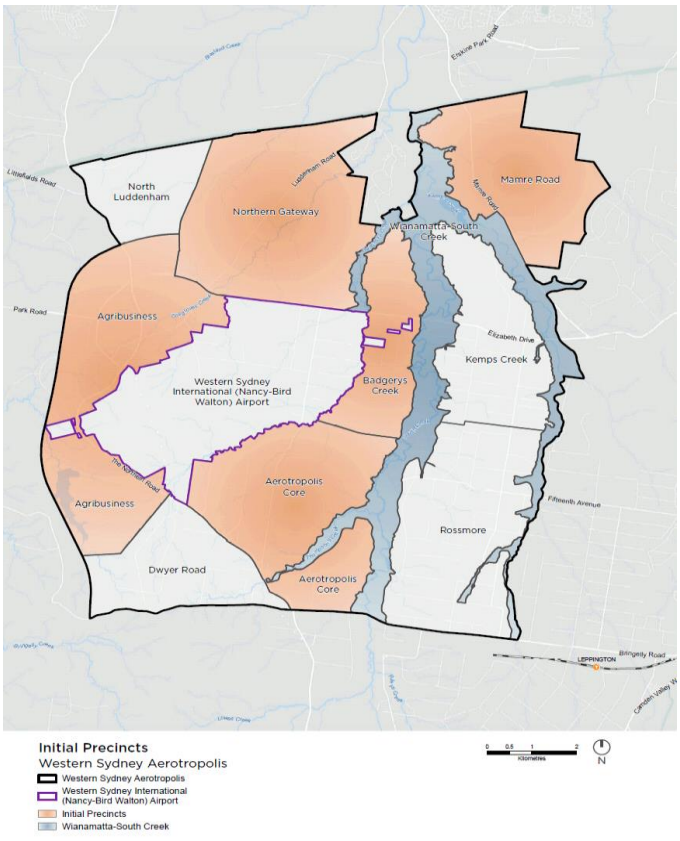


Figure 2: Source: NSW Department of Planning and Environment

PROJECT SCOPE

To identify the trunk infrastructure requirements for the WSAGA from present day to the ultimate planning horizon (2056), an integrated water strategy has been developed based on staged delivery approach to meet growth.

Recycled water servicing is still under assessment and has not been covered as part of this study.

Delivery of the first stages of trunk drinking water network is underway. Detailed planning for additional precinct level infrastructure has been accelerated and resulting 'scheme plans' produced to identify staged and ultimate servicing. This precinct level planning is the focus of this paper.

A SNAPSHOT OF THE PROJECT HIGHLIGHTS

- Development of ultimate servicing scheme plans to inform staged delivery of precinct trunk infrastructure and reticulation sizing.
- Interim servicing utilizing capacity from adjoining water supply zones prior to growth in those zones being fully developed.
- Stakeholder engagement (internal and external) for informed realistic staging/growth information and operational requirements.
- Opportunities to leverage delivery of water infrastructure with road upgrade works.
- Identification of servicing benefits and potential servicing solutions to postpone delivery cost of large infrastructure.

APPROACH AND METHODOGOGY

This section details the methodology undertaken to design the drinking water network and produce drinking water scheme plans for the initial rezoned precincts; Mamre Road, Agribusiness, Aerotropolis Core, Badgerys Creek and Northern Gateway, as well as stakeholder engagement which enabled further refinement of the servicing plans.

STAKEHOLDER ENGAGEMENT AND COLLABORATION

Key to the development of the preferred servicing option and developing a staging and investment plan, was early stakeholder engagement and collaboration with DPE, Western Sydney International Airport (WSA Co), Local Government (Councils), utilities, developers, and landowners. Through early partnership with stakeholders, we were able to plan delivery of trunk assets in line with development sequencing, leverage co delivery of water assets with transport infrastructure, resulting in time and cost efficiencies.

Working together to achieve outcomes

Early stakeholder engagement and collaboration included:

- Three tiers of government: strategic through to local planning
- Utility corridor coordination
- Major developers: city shaping, liveability and affordability
- Investment certainty – right services, right time

- Scalable – to meet growth
- Leading integrated water cycle management approach.

SERVICING PLAN

The ultimate goal - for this project is to design the optimum servicing for individual rezoned precincts while sizing the assets for growth in 2056 (for all precincts) which includes – reservoir sizes, transfer mains, pump stations, precinct trunk main, lead-in mains and reticulation mains.

The project was carried out broadly in four stages.

1) Growth Forecast and Design Demand Rates – *how many and who is using the water*
2) Carry out Hydraulic Assessment for Preferred Option and precinct level servicing
3) Refinement of preferred option – *how will we provide water within the precincts*
4) Development of Scheme Plans with reticulation and trunk lead mains – *how the water will be delivered*

The hydraulic modelling software used throughout this project is InfoWorks WS Pro.

GROWTH FORECAST AND DEMAND RATES

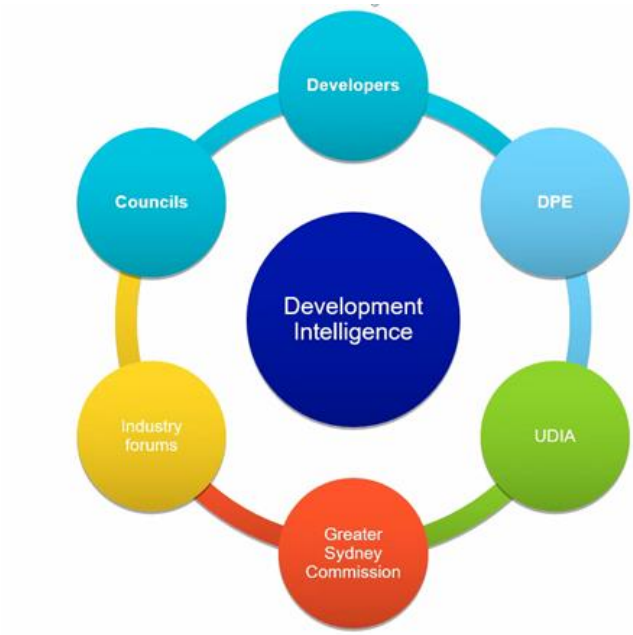
Like other fields of engineering and planning, there is a fine balance between under and over designing infrastructure. Oversized water infrastructure may lead to poor operational and sustainability outcomes. The key concern operationally is water quality, as using large assets to service an in-optimally small customer base leads to lack of turnover in the system. Whilst operational practices, such as mains flushing, are available to maintain a safe drinking water standard for customers, these generally have poorer conservation and sustainability outcomes. Construction and delivery of larger or more assets than necessary to meet level of service for customers also clearly lead to poor sustainability and financial outcomes. Staging of assets, monitoring of growth, and evidenced based demands are required to make prudent investment decisions and ensure the right level of service is delivered at the right time. The aim was also to stage assets such that said assets are not made redundant in long term.

The demand assessment for the WSAGA area over the years was fundamental in planning the system. An evidence-based water consumption approach was adopted for demand assessment which is described in the below diagram.

NSW Department of Planning and Environment growth forecast – uploaded into what is referred to as Urban Growth Intelligence (UGI), containing job and dwelling/population numbers for each year		Existing real water meter consumption for similar typology in surrounding area provided evidence-based demands, which characterize the expected consumption quantity and patterns
Validating the results using Developer data, information or insights received through development applications (Development Intelligence)		

The UGI benefits:

- Updated data
- Constant review cycle and checking with DPE/Council/Developer
- Quality Management checks



In contrast with more traditional methodology which includes application of an assumed population per land base category, assumption of consumption per population and subsequent scaling to derive a design flow. The more human centric and engagement driven methodology applied in this instance supported water planning in navigating the uncertainty of development uptake and reduce the risk of poor operational and sustainability outcomes for the project.

Precinct plans for each precinct were provided by DPE in geospatial shapefile form. The precinct plans contain proposed road alignments, development areas and land use types. For non-residential demand, the total area of each land use polygon from the shapefiles was used and evidence-based demands applied. This approach was taken in lieu of using job numbers from the UGI data as it is based on historical demand rates adopted for similar land use in the surrounding area. For residential typology, the UGI data for dwellings and census data was used to calculate population and evidence-based demands applied.

REVIEW OF PREFERRED SERVICING OPTION

Previous hydraulic assessments identified the preferred high level servicing option to service WSAGA and have driven the 'skeleton' infrastructure as below:

The trunk network is planned to be delivered in stages to meet growth and utilise spare capacity in existing assets to delay augmentation of major expenditure:

- A new pumping station and transfer main from Prospect South Water Delivery System (WDS) will supply existing and new reservoir at Cecil Park. From Cecil Park, trunk mains to supply new reservoir at Badgerys Creek and trunk mains will provide linked servicing throughout the area.

Refer to Figure 3 below for the 'skeleton' trunk infrastructure required to fully service WSAGA and parts of SWGA. For operational purposes and resilience, links between the Prospect South and Macarthur WDS have been incorporated.

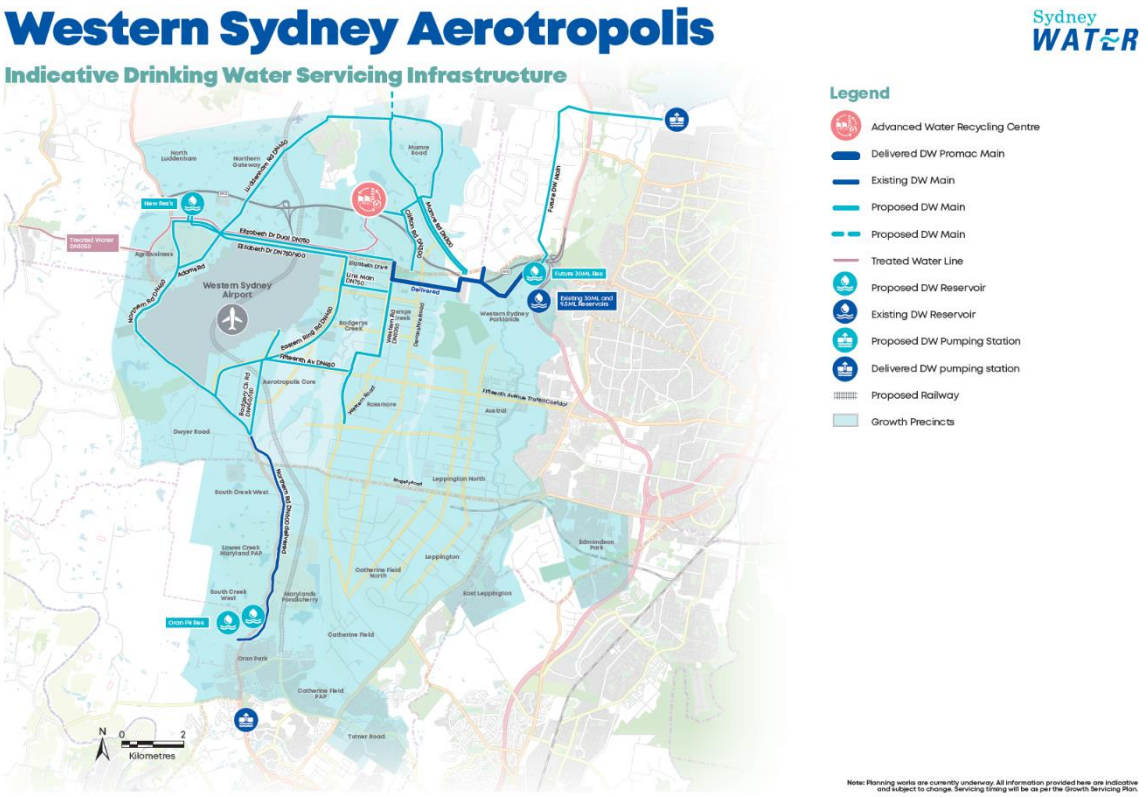


Figure 3: Preferred trunk drinking water servicing option – *indicative and subject to change based on future survey and design.*

HYRAULIC ASSESSMENT METHODOLOGY

An initial assessment was carried out to compare the static head from Badgerys Creek Reservoir with the existing topography within the precinct's boundaries. This helped to further inform an understanding of the service extents of the new

reservoir, indicatively establishing supply boundaries for each source and identifying challenging areas.

The target level of service as per the service pressure limits for new supply systems is 20m minimum pressure and 60m maximum pressure (to avoid damage to the infrastructure/reduce leakage). Based on this target pressure range and the elevation of the Badgerys Creek Reservoir (113m static head), the Reservoir could service precincts within approximately 53m and 93m elevation.

This initial review identified that areas where the ground elevation is above ~93m (shown in red text in Figure 4) exceed the Badgerys Creek Reservoir servicing range and cannot receive the target minimum pressure, even if head losses are mitigated.

Indicative boundaries were therefore created in the reticulation network to separate the high-elevation areas from the lower elevations that can be supplied by gravity from the Badgerys Creek Reservoir (Figure 4). An assessment of servicing options and further refinement was carried out for the high-elevation areas. Agribusiness Northwest and South were separated into two subzones due to their collective size. The high and low-elevation areas within Mamre Road precinct could not be clearly separated, as a ridge runs through the middle of the precinct boundary surrounded by low-elevations on either side.

Figure 4 shows the elevation range of the Precincts within WASAGA.

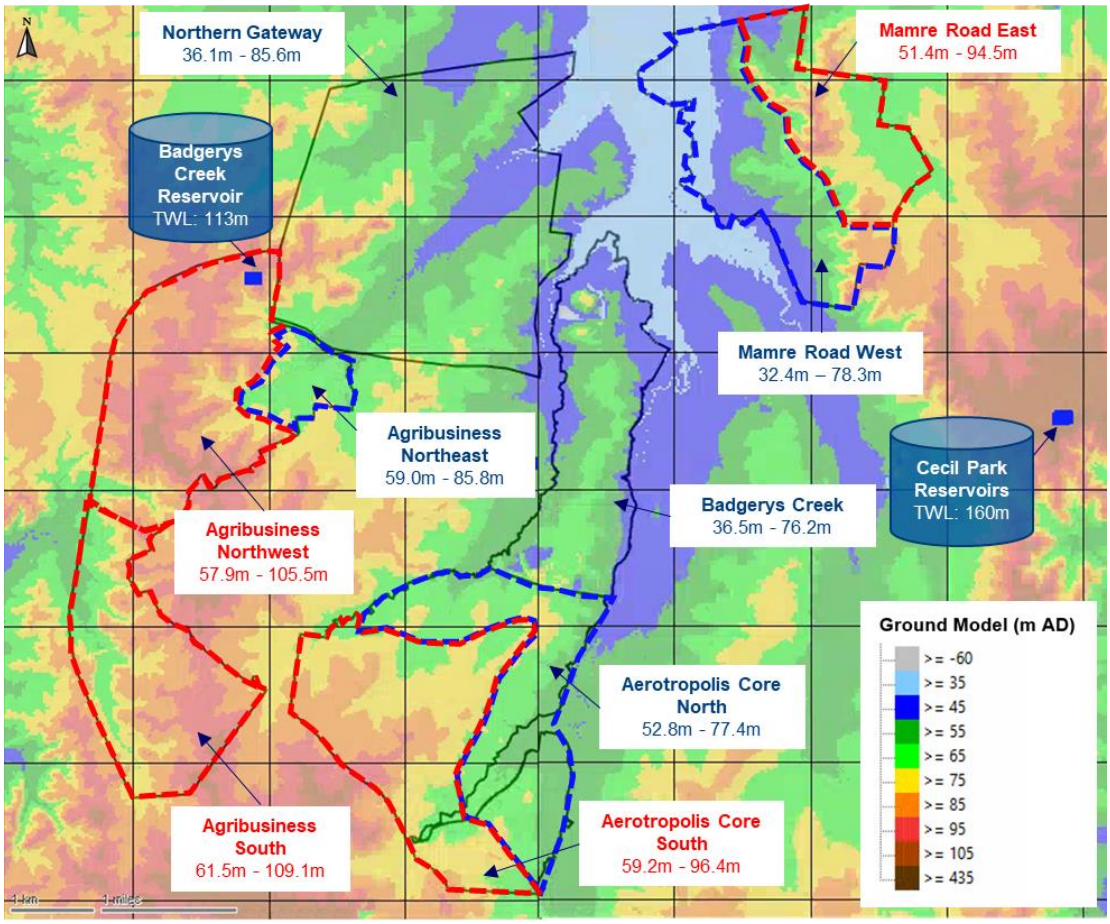


Figure 4: Elevation range of the Precincts within WASAGA

An additional consideration made was the headloss experienced when travelling from the reservoir to the relevant precinct. The model was run to assess head losses through the pipes resulting from the initial pipe sizing and the allocated demands. The pipe sizes were then further refined to maintain head losses below 5m head/km for ≤DN150 pipes and below 3m head/km for ≥DN200 pipes.

Reticulation pipes were initially assigned a minimum size, as per Table 1 below.

Table 1 Minimum pipe sizes for greenfield developments[4]

ZONING/DEVELOPMENT	MINIMUM PIPE SIZE (DN)	
	Cast iron outside diameter series	ISO series[3]
Low and medium density residential	100 [1]	125 [1]
High density residential (≥ 4 storeys)	150	180
Multiple developments of high density residential (≥ 8 storeys)	200 or 225 [2]	250 or 280 [2]
Industrial and commercial	150	180

REFINEMENT OF SERVICING OPTION

Servicing options were assessed against level of service criteria to determine optimum supply zones, including booster pumping station and Pressure Reduced Valve (PRV) zones as well as precinct trunk and reticulation sizing. Reservoir storage requirements was also updated to ensure adequate reserve storage and the reservoir operating storage cycles were maintained during peak demands.

An assessment of servicing strategy options was carried out for the high-elevation subzones. Supply sources were prioritised as follows, based on resilience, energy, and operation considerations:

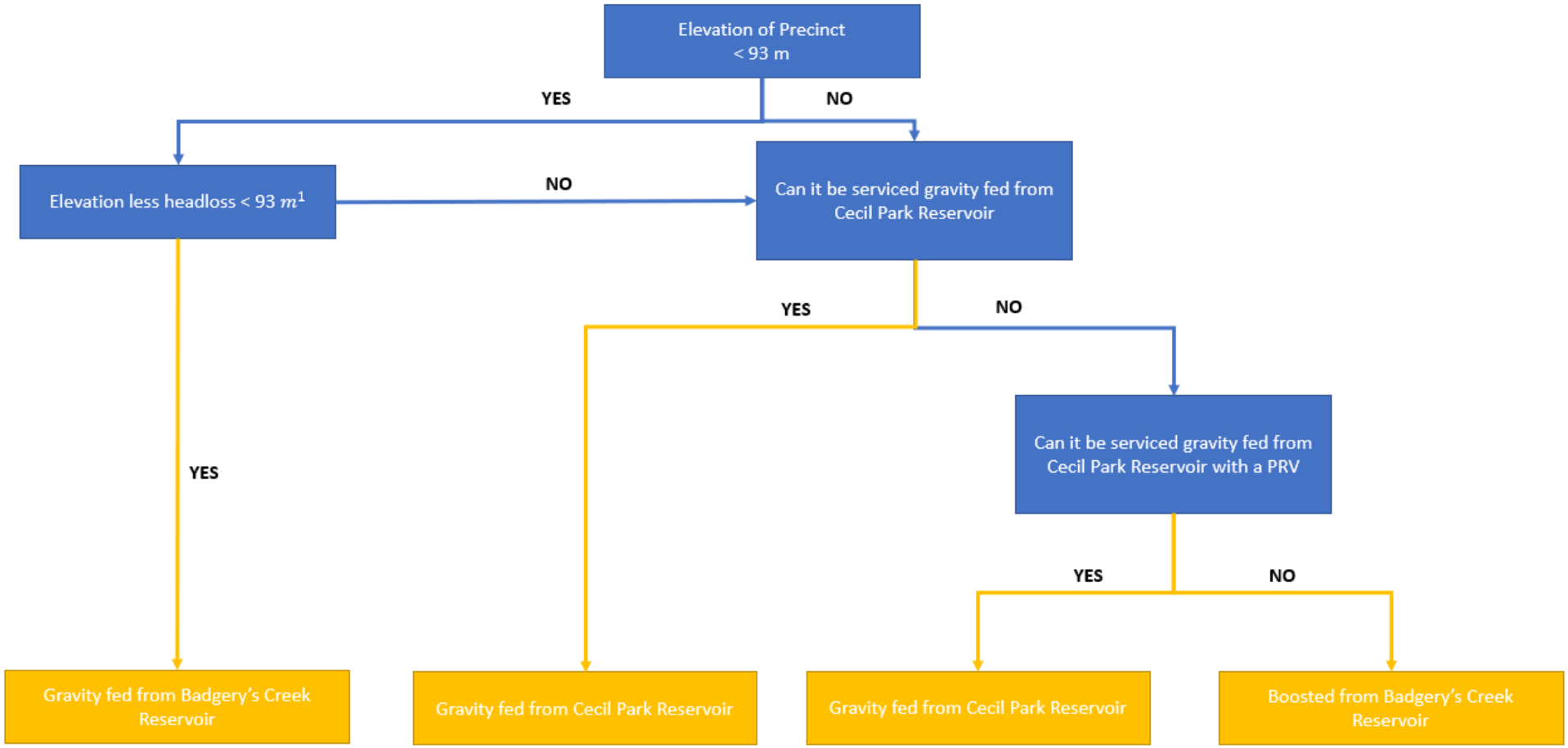
- Supply from Badgerys Creek Reservoir was tested. If the supply head was too low resulting in low pressure in the system, this option was ruled out.
- Supply from Cecil Park Reservoirs was tested. If the supply head was too low resulting in low pressure in the system, this option was ruled out.
- Supply from Cecil Park Reservoirs via a pressure-reducing valve (PRV) was tested. If low and or high pressures were still encountered in the system, this option was ruled out.
- Supply from Badgerys Creek Reservoir via a booster pump was selected if all above options failed to provide the minimum service pressure.

The terrain within WSAGA precincts is very undulating with creeks and very high ground areas. Serving whole of WSAGA as planned in previous study resulted in not meeting Sydney Water Operating License[5] for minimum pressure and target maximum pressures. Several iterations were carried out to achieve an optimal servicing plan for each precinct and balance the storage requirement at Cecil Park and Badgery's Creek reservoirs sites. Low ground areas which are currently serviced from Cecil Park reservoirs via PRV were rezoned to be serviced from

[4] WSA03 Code Sydney Water edition
[5] Sydney Water Operating Licence - https://www.sydneywater.com.au/content/dam/sydneywater/documents/operating-licence-2019-2023-sw.pdf

Badgerys Creek reservoirs via gravity to eliminate the operation and maintenance (O&M) of pressure reducing valve's (PRV's). For high ground areas, options of servicing from Cecil Park Reservoirs, having higher Hydraulic Grade Line (HGL) by 47m than Badgery's Creek Reservoir was carried out. First option was to service the high ground areas via gravity to check if all parts of the network within the precincts experience the pressure within the Operating License requirements. If the pressures within the network was found to be higher than target maximum pressures, pressure reducing valves (PRV) were introduced to achieve the desired pressure range. If high ground areas experience minimum pressure within the network while servicing from Cecil Park reservoirs, high ground areas based on the proximity were serviced via booster pumping station to maintain the minimum pressure throughout the network via Badgery's Creek reservoirs.

Refer to Figure 5 for a summary of the decision-making process involved with servicing options of the Precincts.



1. Assuming a headloss rate of 5m head/km for ≤DN150 pipes and 3m head/km for ≥DN200 pipes

Figure 5: Schematic of servicing option for Precincts

DEVELOPMENT OF SCHEME PLANS

The overall servicing schematic derived from the methodology as previously discussed is shown in **Error! Reference source not found.** schematic plan below and Figure 7 plan view. In summary, all four servicing options were utilized including: gravity fed from Cecil (with and without a PRV), gravity fed from Badgerys Creek Reservoir and pumped from Badgerys Creek Reservoir:

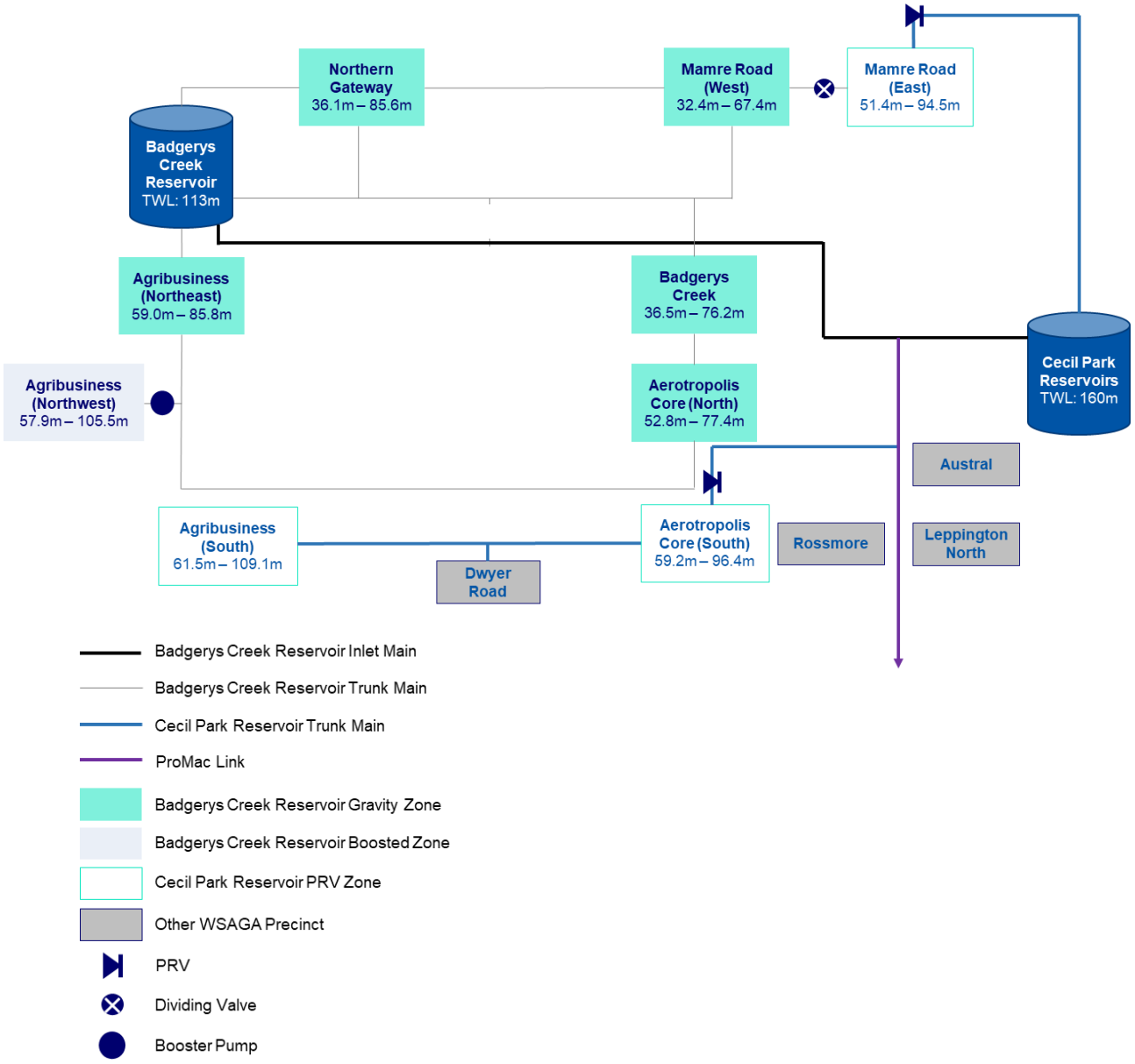


Figure 6: Preferred servicing option for the WSAGA priority precincts – *subject to future survey and design.*

The trunk and reticulation mains were also sized accordingly to provide the ultimate 2056 scheme plan for the WASAGA region as shown in Figure 7.

OUTCOMES

The outcome of the project includes updated and optimised drinking water servicing plan for WSAGA and part of SWGA (figure 7), five detailed precinct level scheme plans, and the associated precinct level hydraulic models.

The hydraulic models:

- Provide the tool for development of resilient and cost-effective sizing of infrastructure and are basis for staging and investment plan.
- The detailed models for individual precincts act as working models for ongoing efficient and fast model updates and allow for agile modification in line with changes to road layouts and developer master plans.

The scheme plans:

- Provide geographic information for location and sizing of precinct level drinking water infrastructure to service development of the area:
  - This information forms the basis for efficient and timely response to developer applications
  - Refer to Figure 8 for example of one of the five detailed scheme plans for the Aerotropolis Core Precinct – this plan shows the existing cadastral lot information with the indicative proposed road layouts and proposed drinking water assets.

The benefits of precinct level scheme plan:

- Improving livability for residents of the Western Parkland City
  - Enhancing and supporting economic prosperity by creating new jobs in the Western Parkland City.

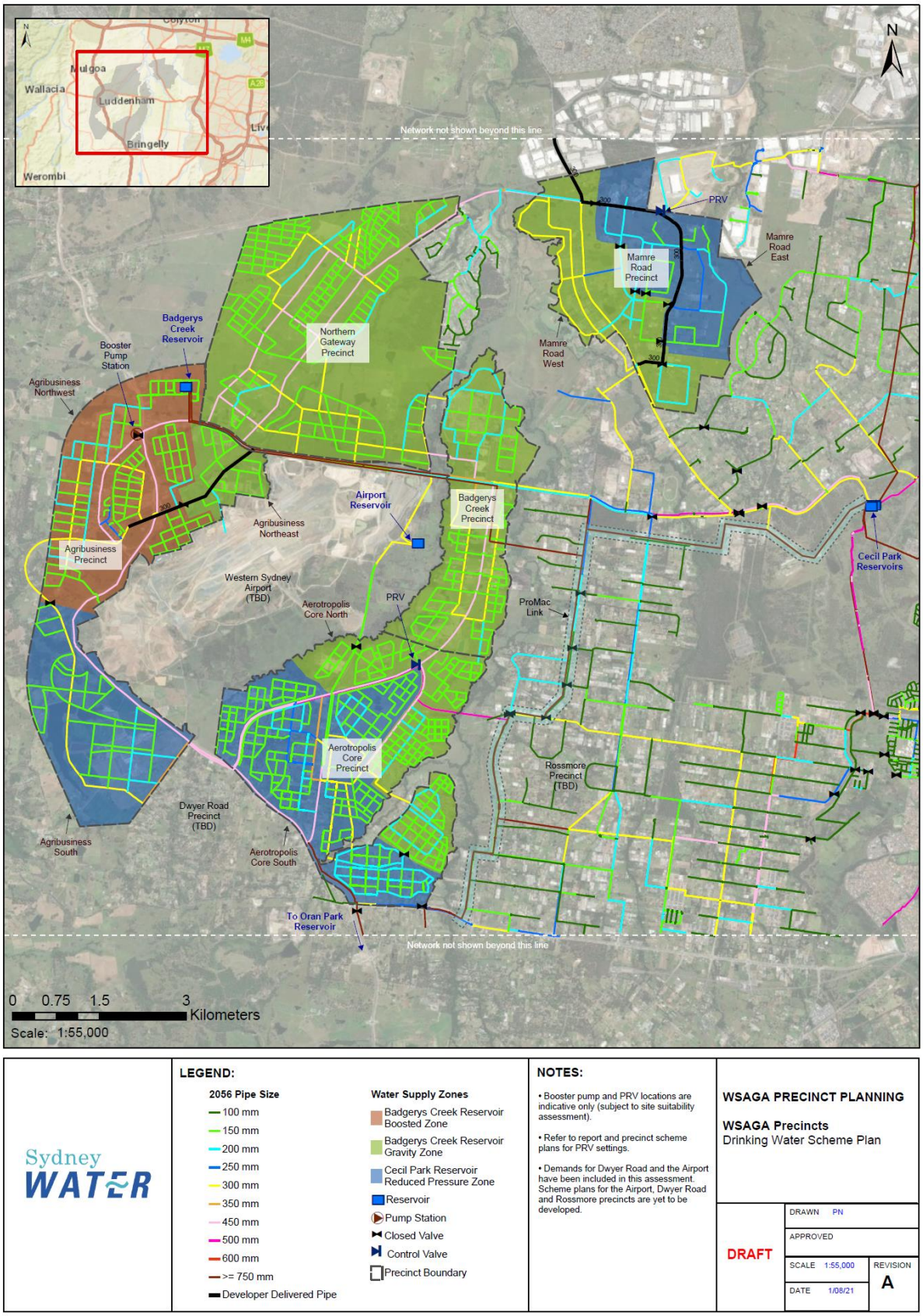


Figure 7: Ultimate (2056) Servicing of WSAGA – *subject to final road layout and future survey and design*.

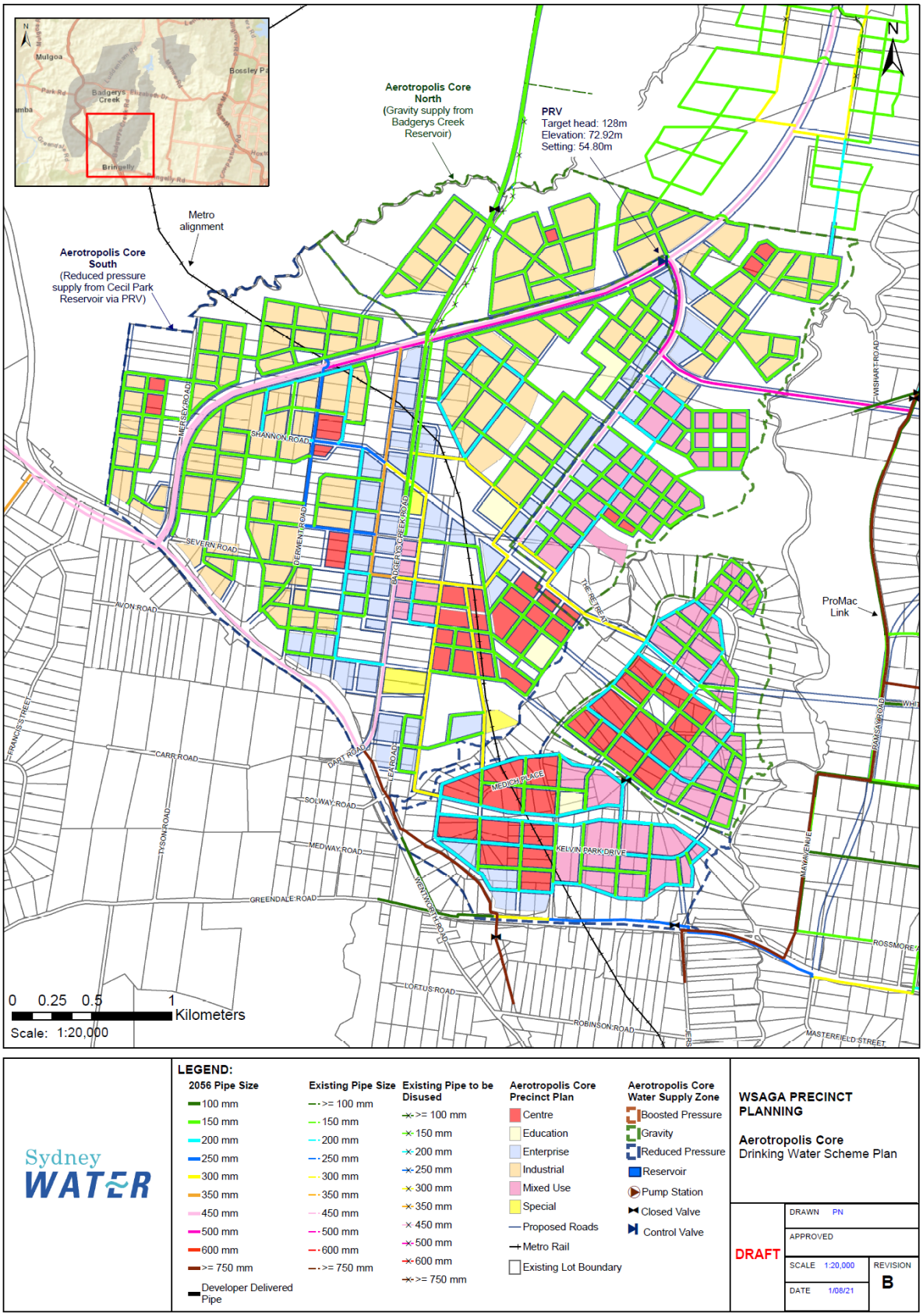


Figure 8: Ultimate (2056) Servicing of Aerotropolis Core Precinct Scheme plan– *subject to final road layout and future survey and design*.

KEY LEARNINGS

1) Continual stakeholder engagement

Effective engagement with stakeholders allowed to identify and understand the different expectations and objectives of each group. Close association with Department of Planning and Environment and developers helped in developing demand scenarios and staging requirements. It was critical to establish regular forums for receiving progress updates with utilities and WSA Co. for airport, as they set the strategic infrastructure to enable growth and influence timelines for development.

Other government agencies like Transport for New South Wales (TfNSW), Sydney Metro and other utilities were consulted regularly to identify opportunities for driving cost and time efficiencies that deliver the best outcomes to our customers.

2) Importance of Foresight

Developer's staging plans benefited Sydney Water in informing early servicing plans as well as provided confidence to the developer in committing to development areas according to early servicing areas.

While the project area was clearly delineated, ability to service short to medium growth from adjacent water supply zones was assessed thereby deferring immediate investments.

3) Leveraging outcomes of previous studies

The project benefited from previous hydraulic assessments that identified the preferred high level servicing option to service WSAGA. This provided a strategies direction while developing the precinct plans. This also helped in responding to developer enquiries while the precinct plan was under development.

4) Scalability

The approach was adopted across the five precincts with each area presenting its own uniqueness and challenges. The approach and the methodology were agile and provided flexibility to accommodate the specific constraints and opportunities of each precinct.

ACKNOWLEDGEMENTS

Sydney Water respectfully acknowledges the traditional custodians of the land and waters across WSAGA the Dharug people.

The Dharug people, share strong ties of kinship who lived as skilled hunters in family groups or clans.

Across the rest of Sydney our first nations peoples have been custodians of our waterways for over 60 million years, and Sydney Water is proud to have contributed in a small way to the ongoing care and management of our waterways over the past 130 years.

We pay respect to Elders past and present.

REFERENCES

1) Re-imaging water in Western Sydney – Western Sydney Regional Master Plan https://www.sydneywater.com.au/content/dam/sydneywater/documents/western-sydney-regional-master-plan.pdf
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4) WSA03 Code Sydney Water edition
5) Sydney Water Operating Licence - https://www.sydneywater.com.au/content/dam/sydneywater/documents/operating-licence-2019-2023-sw.pdf